

# Missouri University of Science and Technology

## Undergraduate Catalog

### 2017-2018

Missouri S&T publishes an electronic catalog available at <http://catalog.mst.edu>.

All statements in the publication are announcements of present policies only and are subject to change at any time without prior notice. They are not to be regarded as offers to contract.

Missouri S&T is an equal opportunity/affirmative action institution.

# TABLE OF CONTENTS

Missouri S&T .....	3	Aerospace Engineering .....	47
Educational Goals of Missouri S&T .....	3	Aerospace Studies .....	53
Administrators .....	4	Architectural Engineering .....	55
Introduction to Missouri University of Science and Technology .....	5	Art .....	60
Academic Calendar .....	6	Arts, Languages & Philosophy .....	62
General Information .....	7	Bioinformatics Minor Curriculum .....	62
Academic Resources On Campus .....	7	Biological Sciences .....	62
Admission Requirements .....	7	Business and Management Systems .....	68
Aerospace Studies (Air Force ROTC) .....	10	Ceramic Engineering .....	74
Career Opportunities and Employer Relations (COER) .....	11	Chemical & Biochemical Engineering .....	78
Cooperative Education Program (Co-op) .....	12	Chemistry .....	84
Counseling, Disability Support, and Student Wellness .....	13	Civil Engineering .....	92
Curtis Laws Wilson Library .....	15	Computer Engineering .....	101
Fees .....	16	Computer Science .....	107
Financial Assistance .....	18	Economics .....	113
Global Learning .....	21	Education .....	118
Information Technology (IT) .....	21	Electrical Engineering .....	121
International Affairs .....	23	Engineering Management .....	130
Military Science (Army ROTC) .....	24	English .....	137
Nuclear Reactor .....	26	Enterprise Resource Planning .....	141
Oak Ridge Associated Universities (ORAU) .....	26	Environmental Engineering .....	142
Office of the Registrar .....	26	Etymology .....	146
Other Programs .....	29	Explosives Engineering .....	146
Professional Leadership and Campus Engagement .....	30	Finance .....	148
Required Assessment Testing .....	30	Foreign Languages .....	149
Residential Life .....	31	French .....	149
S&T Police Department .....	32	Freshman Engineering Program .....	150
Student Design and Experiential Learning Center (SDELC) .....	35	Geological Engineering .....	150
Student Diversity Initiatives .....	35	Geology and Geophysics .....	157
Student Health Services .....	36	German .....	165
Student Organizations .....	36	Global Studies .....	165
Student Success Programs .....	37	History .....	166
Teacher Education Program .....	38	Information Science and Technology .....	171
The Honors Academy .....	39	Latin American Studies for Technical Applications Minor .....	176
Veteran Affairs .....	39	Marketing .....	177
Writing Center .....	40	Materials Science and Engineering .....	178
Minors .....	41	Mathematics .....	179
Certificates .....	42	Mechanical Engineering .....	186
Teacher Certifications .....	43	Metallurgical Engineering .....	195
Degree Programs .....	44	Military Science .....	200

Mining Engineering .....	202	Explosives Engineering (EXP ENG) .....	301
Multiculturalism & Diversity .....	210	Finance (FINANCE) .....	302
Multidisciplinary Studies .....	210	French (FRENCH) .....	302
Music .....	211	Freshman Engineering (FR ENG) .....	303
Nuclear Engineering .....	211	Geological Engineering (GEO ENG) .....	303
Petroleum Engineering .....	217	Geology (GEOLOGY) .....	306
Philosophy .....	221	Geophysics (GEOPHYS) .....	310
Physical Education and Recreation .....	224	German (GERMAN) .....	311
Physics .....	225	History (HISTORY) .....	311
Political Science .....	229	Info Science & Technology (IS&T) .....	314
Prehealth Professions .....	231	Marketing (MKT) .....	316
Prelaw .....	232	Materials Science & Eng (MS&E) .....	317
Psychology .....	232	Mathematics (MATH) .....	318
Russian .....	240	Mechanical Engineering (MECH ENG) .....	321
Spanish .....	241	Metallurgical Engineering (MET ENG) .....	325
Speech and Media Studies .....	242	Military Science - Air Force (MIL AIR) .....	329
Statistics .....	243	Military Science - Army (MIL ARMY) .....	329
Sustainability .....	245	Mining Engineering (MIN ENG) .....	330
Systems Engineering .....	245	Music (MUSIC) .....	334
Technical Communication .....	246	Nuclear Engineering (NUC ENG) .....	334
Theatre .....	249	Petroleum Engineering (PET ENG) .....	337
Course Information .....	251	Philosophy (PHILOS) .....	339
Course List .....	252	Physical Education (PHYS ED) .....	340
Aerospace Engineering (AERO ENG) .....	252	Physics (PHYSICS) .....	341
Architectural Engineering (ARCH ENG) .....	255	Political Science (POL SCI) .....	344
Art (ART) .....	257	Pre-Medicine (PREMED) .....	345
Biological Sciences (BIO SCI) .....	258	Psychology (PSYCH) .....	345
Business (BUS) .....	262	Russian (RUSSIAN) .....	348
Ceramic Engineering (CER ENG) .....	264	Spanish (SPANISH) .....	348
Chemical Engineering (CHEM ENG) .....	266	Speech & Media Studies (SP&M S) .....	349
Chemistry (CHEM) .....	270	Statistics (STAT) .....	350
Civil Engineering (CIV ENG) .....	273	Systems Engineering (SYS ENG) .....	351
Computer Engineering (COMP ENG) .....	278	Technical Communication (TCH COM) .....	352
Computer Science (COMP SCI) .....	280	Theatre (THEATRE) .....	353
Economics (ECON) .....	284	Index .....	354
Education (EDUC) .....	286		
Electrical Engineering (ELEC ENG) .....	288		
Engineering Management (ENG MGT) .....	293		
English (ENGLISH) .....	296		
Enterprise Resource Planning (ERP) .....	299		
Environmental Engineering (ENV ENG) .....	300		
Etymology (ETYM) .....	301		

# MISSOURI S&T

## Statement of Affirmative Action

It is the policy of the Missouri University of Science and Technology to provide full and equal employment opportunities to all persons without regard to race, color, national origin, ancestry, religion, sex, sexual orientation, gender identity, gender expression, age, genetic information, disability or protected veteran status; to prohibit discrimination in recruitment, employment or conditions of employment, including salary and benefits related thereto; to promote employment opportunity and to take affirmative action in this regard.

### Title VI of the Civil Rights Act of 1964

"No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance."

### Title IX of the Education Amendments of 1972

"No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance."

### Section 504 of the Rehabilitation Act of 1973

"No otherwise qualified handicapped individual in the United States...shall, solely by reason of the handicap, be excluded from the participation in, be denied the benefits of, or be subject to discrimination under any program or activity receiving Federal financial assistance."

### Section 303 of the Age Discrimination Act of 1975

"No person in the United States shall, on the basis of age, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance."

## The Americans with Disabilities Act of 1990 Section 102 Discrimination

General Rule – No covered entity shall discriminate against a qualified individual with a disability because of the disability of such individual in regard to job application procedures, the hiring, advancement, or discharge of employees, employee compensation, job training, and other terms, conditions, and privileges of employment.

Missouri S&T conducts its programs and activities involving admission and treatment of students, employment, teaching, research, and public service in a non-discriminatory manner as prescribed by Federal law and regulation.

Inquiries concerning the above may be addressed to:

Shenethia Manuel, J.D., Campus Title IX Coordinator, ADA Coordinator and Chief Equity Officer  
113 Centennial Hall, Missouri University of Science and Technology  
<http://titleix.mst.edu/>

Neil Outar, Deputy Title IX Coordinator  
Temporary Facility A, Missouri University of Science and Technology

Chancellor, Missouri University of Science and Technology

Rolla, Missouri 65409-9957

Director, Office for Civil Rights Department of Education  
Washington, D.C. 20201

## Accreditation

Missouri University of Science and Technology is accredited by the Higher Learning Commission of the North Central Association of Colleges and Schools:

30 North LaSalle Street  
Suite 2400  
Chicago, Illinois 60602-2504  
314-263-0456  
<http://www.ncahigherlearningcommission.org>

Further information on specialized accreditation by department is available at the Office of Institutional Research and Assessment website at <http://ira.mst.edu/accreditation/>.

## Registrar's Office Contact Information

103 Parker Hall  
300 W. 13th Street  
Rolla, MO 65409  
573-341-4181  
Email [registrar@mst.edu](mailto:registrar@mst.edu) or visit <http://registrar.mst.edu>

## Educational Goals of Missouri S&T

Missouri University of Science and Technology's mission is to integrate education, research and application to create and convey knowledge that serves our state and helps solve the world's great challenges. In a world growing increasingly dependent on science and technology, tomorrow's graduates must be prepared to be leaders in more than just their chosen professions. They must also be leaders in business, in government, in education and in all aspects of society. Missouri S&T is dedicated to providing leadership opportunities for its students. Getting an excellent technological education is only part of the educational experience that Missouri S&T offers. Missouri S&T provides a full range of engineering and science degrees, coupled with business and liberal arts degrees and programs that are vital to the kind of comprehensive education that turns bright young men and women into leaders.

Missouri S&T is nationally recognized for its excellent undergraduate engineering programs, and is distinguished for producing cutting-edge research and key technologies vital to the economic success of Missouri and the nation. Missouri S&T has a distinguished faculty dedicated wholeheartedly to the teaching, research and creative activities necessary for scholarly learning experiences and advancements to the frontiers of knowledge. Missouri S&T has excellent physical facilities, which support the best possible education in the liberal arts, humanities, engineering, science, applied science and selected interrelated fields.

Missouri S&T's programs in science, engineering and business, its technology transfer programs, its leadership opportunities, and its learning environment are all integral parts of the total educational package available.

## Mission Statement

Missouri S&T integrates education, research and application to create and convey knowledge that serves our state and helps solve the world's great challenges.

## Vision

Missouri S&T will be the leading public technological research university for discovery, creativity and innovation.

## Administrators

### University of Missouri Board of Curators

**Maurice B. Graham**, 1-1-2021 (chair)

**John R. Phillips**, 1-1-2019 (vice chair)

**Darryl Chatman**, 1-1-2023

**Jamie Farmer**, 1-1-2023

**Jeffrey Layman**, 1-1-2021

**Philip H. Snowden**, 1-1-2021

**David L. Steelman**, 1-1-2019

### Missouri University of Science and Technology Administrators

**Christopher G. Maples**, Interim Chancellor

**Venkat Allada**, Vice Provost, Graduate Studies

**Cuba Plain**, Interim Vice Chancellor, Finance and Operations

**Jeffrey D. Cawfield**, Vice Provost, Academic Support

**Mariesa Crow**, Vice Provost, Research

**Robert J. Marley**, Provost and Executive Vice Chancellor, Academic Affairs

**Joan M. Nesbitt**, Vice Chancellor, University Advancement

**Anthony Petroy**, Vice Provost, Global Learning

**Stephen P. Roberts**, Vice Provost and Dean, College of Arts, Sciences and Business

**Debra Robinson**, Vice Chancellor, Student Affairs

**Daniel Uetrecht**, Chief Information Officer

**Neil Outar**, Interim Chief Diversity Officer

**Timothy Albers**, Vice Provost and Dean, Enrollment Management

**Richard W. Wlezien**, Vice Provost and Dean, College of Engineering and Computing

### Missouri S&T Board of Trustees

**Wayne Alexander**, (retired) SBC Southwestern Bell, San Antonio, TX

**Tim Bradley**, (retired) Kinder Morgan CO2 Company, Austin, TX

**Robert G. Brinkmann**, Brinkmann Constructors, St. Louis, MO

**Michael Bytnar**, (retired) Nooter Corporation, St. Louis, MO

**Bipin Doshi**, Schafer Industries, Inc., Southbend, IN

**James A. Faletti**, (retired) Strategic Insights, Ltd., Homewood, IL

**Gary Havener**, Havener Companies, Fort Worth, TX

**Mike Hurst**, (retired) McCarthy, St. Louis, MO

**Jeremiah D. King**, Brinkmann Constructors, St. Louis, MO

**John Lovitt**, (retired) Pattern Insight, San Diego, CA

**Christopher G. Maples**, Missouri S&T, Rolla, MO

**Richard S. Martin**, Boeing, St. Louis, MO

**Peggy Montana**, (retired) Shell's Midstream Partners, LP, Houston, TX

**Joan Nesbitt**, Missouri S&T, Rolla, MO

**Helene Hardy Pierce**, GAF, Wayne, NJ

**Stephen W. Rector**, RIM Operating, Inc., Englewood, CO

**Joseph Rupp**, Olin Corporation, Clayton, MO

**Jeffrey W. Sheets**, (retired) ConocoPhillips, Houston, TX

**Susan Simmons**, (retired) Anheuser-Busch Companies, Inc., St. Louis, MO

**Geoffrey Steinhart**, (retired) Anheuser-Busch Companies, Inc., St. Louis, MO

**Cynthia Tang**, (retired) Insight Industries, Inc., Platteville, WI

**Thomas Voss**, (retired) Ameren, St. Louis, MO

**Kathryn Walker**, OPENAIR Ventures, Olathe, KS

**Theodore Weise**, (retired) Federal Express Corporation, Memphis, TN

**Joan Woodard**, (retired) Sandia National Laboratories, Albuquerque, NM

**Steve Wunning**, (retired) Caterpillar, Inc., Peoria, IL

### Missouri S&T Named Professorships

**Baojun Bai**, *Lester Birbeck Endowed Chair*

**Mariesa Crow**, *Fred W. Finley Distinguished Professorship of Electrical and Computer Engineering*

**Sajal Das**, *Daniel St. Clair Endowed Chair in Computer Science*

**Nuran Ercal**, *Richard K. Vitek/FCR Endowed Chair in Biochemistry*

**David M. Borrok**, *Gulf Oil Foundation Professorship*

**Samuel Frimpong**, *Robert H. Quenon Missouri Endowed Chair in Mining Engineering*

**Kamal Khayat**, *Vernon and Maralee Jones Endowed Professorship*

**Ming Leu**, *Keith and Pat Bailey Missouri Professorship in Mechanical Engineering and Aerospace Engineering*

**Frank Liou**, *Michael and Joyce Bytner Product Innovation and Creativity Professorship*

**Ronald J. O'Malley**, *F. Kenneth Iverson Chair of Steelmaking Technologies*

**David J. Rogers**, *Karl F. Hasselman Missouri Chair in Geological and Petroleum Engineering*

**Jagannathan Sarangapani**, *Rutledge-Emerson Professor in Electrical Engineering*

**Joseph D. Smith**, *Laufer Endowed Chair in Energy*

**Jay Switzer**, *Castleman/FCR Missouri Professorship of Discovery in Chemistry*

**TBD**, *Maxwell C. Weiner Professorship in English and Technical Communications*

**TBD**, *Union Pacific Foundation/Rocky Mountain Energy Co. Professorship*

**Donald Wunsch**, *Mary K. Finley Missouri Professorship in Computer Engineering*

**Reza Zoughi**, *Schlumberger Distinguished Professor in Electrical and Computer Engineering*

### Curators' Professors

**Muthanna H. Al-Dahhan** of chemical and biochemical engineering

**Harlan Anderson** of ceramic engineering (emertius)

**S.N. Balakrishnan** of mechanical and aerospace engineering

**Martin Bohner** of mathematics and statistics

**Richard K. Brow** of ceramic engineering

**Joel Burken** of civil, architectural and environmental engineering

**K. Chandrashekhara** of mechanical and aerospace engineering

**Ta-Shen Chen** of mechanical engineering (emertius)

**Franklin Cheng** of civil engineering (emertius)

**Alfred L. Crosbie** of mechanical engineering

**Delbert Day** of ceramic engineering (emertius)

**Lokesh Dharani** of mechanical engineering

**James Drewniak** of electrical engineering

**Walter Eversman** of mechanical and aerospace engineering (emertius)

**William G. Fahrenholtz** of ceramic engineering

**Richard Hagni** of geology (emertius)

**Greg Hilmas** of ceramic engineering

**Nicholas Leventis** of chemistry

**Don Madison** of physics

**John McManus** of history  
**Ronald Olson** of physics (emertius)  
**Michael Schulz** of physics  
**James Stoffer** of chemistry (emertius)  
**David Summers** of mining engineering (emertius)  
**Jay Switzer** of chemistry  
**Thomas Vojta** of physics  
**Wei-Wen Yu** of civil engineering (emertius)

## Curators' Teaching Professors

**Diana Ahmad** of history and political science  
**James Bogan, Jr.** of arts, language and philosophy (emertius)  
**James S. Drallmeier** of mechanical engineering  
**Xiaoping Du** of mechanical engineering  
**Nord Gale** of biological sciences (emertius)  
**Larry Gragg** of history and political science (emeritus)  
**Leonard Koederitz** of petroleum engineering (emertius)  
**Roger LaBoube** of civil engineering (emertius)  
**Yinfa Ma** of chemistry  
**Frances Dee Haemmerlie Montgomery** of psychology (emeritus)  
**O. Allan Pringle** of physics  
**Jack Ridley** of history (emertius)  
**David Riggins** of mechanical and aerospace engineering  
**V. A. Samaranayake** of mathematics and statistics  
**David C. Van Aken** of materials science and engineering

## Introduction to Missouri University of Science and Technology

A college education offers you a number of options. It can be the foundation you'll need to pursue a rewarding career or the background to further your studies in a graduate or professional school.

Selecting the college or university that will help you prepare for these options is a decision that requires careful consideration. What do you want from an education? What are your goals? You should consider quality of academic programs, location, return on your investment, and the availability of scholarships and financial assistance.

Before you make your decision, we would like you to learn more about what Missouri University of Science and Technology has to offer you, including:

- degrees in business, computing, engineering, science, and the humanities and social sciences as well as an education program certification
- national recognition as a top investment and top public university
- a national leader in the number of bachelor's degrees granted in engineering
- medium-sized campus of about 8,900 students located in a beautiful area of Missouri
- financial assistance and scholarships for qualified individuals
- one of the top career opportunities offices in the country

Missouri S&T's wide range of classes encourages you to participate in and explore subjects that interest you. Technologically advanced laboratories help you understand the concepts learned in the classroom. Tenured or tenure-track professors and advisors will help you plan your academic program so that you may attain your academic and career goals.

Co-curricular activities provide outlets for your interests and talents. With over 200 student organizations, including intercollegiate athletics and intramural sports, musical groups and dramatic productions, service groups, special interest organizations, and student media and publications, you are sure to find a group that fits your interest. You can explore the rivers, parks and lakes of the nearby Missouri Ozarks, or take a road trip to St. Louis and Springfield, each within about 100 miles of Rolla.

Missouri S&T offers opportunities to help you with your educational finances. There are loans, grants and scholarships available for eligible students, or you can apply for a part-time job through the work-study program.

The cooperative training program at Missouri S&T allows qualified students to alternate semesters of school with semesters of work in business or industry. When you are ready to graduate, the university offers outstanding career assistance.

We invite you and your parents to take a closer look at Missouri S&T. This catalog will introduce you to the opportunities that await you. We also encourage you to visit the campus. If you would like more information, or to arrange a tour of the campus, please contact:

Office of Admissions  
 106 Parker Hall  
 Missouri University of Science and Technology  
 Rolla, MO 65409-1060  
 1-800-522-0938

## About the Campus

Founded in 1870 during the height of the Industrial Revolution, today Missouri S&T is building upon its heritage of discovery, creativity and innovation to inspire and prepare students of all majors to solve the world's great challenges. Originally known as the University of Missouri School of Mines and Metallurgy, the campus was later named the University of Missouri-Rolla in 1964 and Missouri University of Science and Technology in 2008. Missouri S&T is one of the four campuses of the University of Missouri System.

The 284-acre campus is located in Rolla, Missouri, a town of nearly 20,000 in the heart of the Ozarks. The university offers bachelor of arts and bachelor of science degrees in 30 fields of study, including engineering, science, humanities, business and the social sciences. Master of science degrees are offered in 27 disciplines, the doctor of philosophy in 20 and the doctor of engineering in eight.

The Missouri S&T campus is home to 50 research and academic support centers. Externally sponsored program expenditures have increased by over 150 percent since fiscal year 2001, from \$17.23 million to \$43.8 million in fiscal year 2014. In fiscal year 2014, Missouri S&T received \$30.7 million in new grant and contract awards. Missouri S&T will enhance its research activity in order to distinguish itself through interdisciplinary collaborations of national significance.

Missouri S&T enrolls more than 8,900 students from 50 states and 55 countries. More than 70 percent of students study in engineering, science or computer fields, but Missouri S&T also offers liberal arts, humanities, social science and business degrees, as well as certification in select education fields. More than 1000 different employers, including many of the nation's top companies, recruited S&T graduates in fiscal year 2016. S&T graduates get great jobs at great salaries. In fiscal year 2016, graduates with bachelor's degrees started at over \$61,800 on average



and graduates earning post-baccalaureate degrees started at greater than \$76,600 on average.

## Campus Life

Missouri S&T offers a number of campus living options, including fraternity and sorority houses, traditional residence halls, the residential college, and university commons. The university has more than 200 student organizations, including over a dozen student design teams, a competitive NCAA Division II athletic program, student professional societies, a student radio station, and theater and music programs. Each year, Missouri S&T students help to organize one of the largest St. Pat's celebrations in the nation.

## University of Missouri System Structure and History

The four University of Missouri System campuses are located in Rolla, Columbia, Kansas City and St. Louis. Governing these campuses is the Board of Curators, whose members are appointed by the governor of Missouri and confirmed by the Missouri Senate. The president of the University of Missouri System directs and coordinates programs of all four campuses with assistance from staff in finance, business management, academic affairs, research, extension, human resources, university relations, and other university services. The activities of each campus are under the supervision of a chancellor, who directs campus affairs within policies established by the UM System Board of Curators and the president.

The UM System has a long and proud history. The first campus was established at Columbia in 1839, only 18 years after Missouri became a state. A land-grant university, the UM System is recognized as the first state university west of the Mississippi River. The university remained a single-campus institution until 1870 when the University of Missouri School of Mines and Metallurgy (Missouri S&T's former designation) was established at Rolla. Campuses at St. Louis and Kansas City were added in 1963.

On July 1, 1964, the UM System Board of Curators took action to rename the University of Missouri School of Mines and Metallurgy to the University of Missouri-Rolla.

## Missouri University of Science and Technology

On January 1, 2008, the University of Missouri-Rolla became Missouri University of Science and Technology, or Missouri S&T. Our new name has helped us gain broader national recognition and gives us an identity that fits our mission as a leading technological research university.

## Student Consumer Information

Various state and federal laws, specifically the Higher Education Opportunity Act, require Missouri University of Science and Technology to provide information and notice to students on a variety of topics. In addition, Missouri S&T occasionally develops statements or policies on important matters and distributes them to all students. For a listing of official notifications that are currently provided to students visit the web at: <http://registrar.mst.edu/studentconsumerinfo/>.

It is a student's responsibility to know and follow current requirements and procedures at the departmental and university levels, including those described in the university's Student Academic Regulations, Student Handbook, Undergraduate and Graduate Catalogs, Residential Housing

Terms and Conditions, and the Collected Rules and Regulations of the University of Missouri System.

## For More Information

If you have additional questions, contact the Director of Admissions, Missouri University of Science and Technology, Rolla, MO 65409-1060, [admissions@mst.edu](mailto:admissions@mst.edu) ( [admissions@mst.edu](mailto:admissions@mst.edu)), call 800-522-0938 or visit <http://admissions.mst.edu>. You also may wish to contact one of the following offices for specific information:

- Air Force ROTC 573-341-4925
- Alumni Affairs and Constituent Relations 573-341-4145
- Army ROTC 573-341-4744
- Career Opportunities and Employer Relations 573-341-4343
- Counseling, Disability Support and Student Wellness 573-341-4211
- Global Learning 573-341-6222
- Freshman Engineering 573-341-4977
- Honors Academy Program 573-341-4131
- Intercollegiate Athletics 573-341-4175
- International Affairs 573-341-4208
- Minority in Engineering and Science Program 573-341-4212
- New Student Programs 573-341-4025
- Registrar 573-341-4181
- Residential Life and Student Support 573-341-4218
- Student Diversity Programs 573-341-4212
- Student Financial Aid 573-341-4282
- University Advancement 573-341-6900
- University Police 573-341-4300
- Vice Chancellor of Student Affairs 573-341-4292
- Women in Engineering and Science Program 573-341-4212

## Academic Calendar

The academic calendar can be found at <http://registrar.mst.edu/calendars>.

# GENERAL INFORMATION

This section includes information about various academic, campus and extracurricular resources available to Missouri S&T students. These links include resources for admissions, fees, academic and extracurricular programs, student opportunities, policies, and services and support available to undergraduate students.

Please navigate this section by using the menu at the left and selecting the category that best represents the information you wish to view. For more comprehensive information please visit the individual department websites.

## Academic Resources On Campus

### “Learning Enhancement Across Disciplines” (LEAD) Program

The LEAD program offers learning forums for students who wish to increase their understanding, improve their skills, and validate their mastery of concepts and techniques in a wide range of courses. LEAD sponsors learning centers and tutoring for courses currently listed at <http://lead.mst.edu/assist>. Our goal is to assist students in achieving their full potential.

### LEAD Learning Centers

The LEAD program sponsors open-environment Learning Centers for many courses in more than ten departments. Discipline-based faculty and undergraduate peer instructors staff the centers during fixed hours each week. Students are encouraged to work in collaborative groups to solve problems and to develop solution strategies – guided and validated by the instructional experts on duty. The centers are designed not only to assist students with course content, but to also help them gain professional skills in communication, problem solving and teamwork.

### LEAD Peer Tutoring

Scheduled walk-in peer tutoring is available for over twenty foundational courses at S&T. It focuses on individual and small-group interactive assistance. Our undergraduate LEAD tutors are accomplished in the course material, trained by professional staff, and communicate with LEAD faculty mentors in the associated disciplines.

Check out the current schedule of LEAD academic assistance at <http://lead.mst.edu/assist> or call the LEAD office at 573-341-4608 for more information.

## Sources of Academic Assistance at Missouri S&T

There are several sources of academic assistance at Missouri S&T that students can access to improve their understanding of and proficiency with course material and learning process.

- **Burns and McDonnell Student Success Center:** Students’ one stop shop for guidance to campus resources and support, one-on-one training available, 198 Toomey Hall, 573-341-7596, [success@mst.edu](mailto:success@mst.edu)
- **Counseling Center:** Study skill reference material at the Van Matre Resource Center, 204 Norwood Hall, 573-341-4211, <http://counsel.mst.edu>

- **Library:** Great study or meeting facility with broad learning resources, 573-341-4227, <http://library.mst.edu/>
- **Math Help Program:** Mathematics and Statistics department, 202 Rolla Building, 573-341-4641, <http://math.mst.edu>
- **Professors:** Clarify concepts or refer students to peers or resources that can provide academic assistance
- **Student Veterans Resource Center:** To empower and educate all student veterans/military on utilizing the campus tools and resources to be successful students, 610 W. 10<sup>th</sup> St. (ground floor), 573-341-6117, <http://svrc.mst.edu/>
- **Writing Center:** New facility with state-of-the-art computers, all the latest software, and a staff of highly trained, motivated, and friendly peer writing tutors, 113 Campus Support Facility, 573-341-4436, <http://writingcenter.mst.edu>

## Admission Requirements

Students applying to Missouri S&T should submit an undergraduate application for admission and all required materials as described below. Applications for the fall semester should be submitted by July 1, for the spring semester by December 1, and for the summer session by May 1. All first-time applicants must submit an application fee, paid in U.S. currency only. Acceptance is on a rolling basis.

The completed admission application (with supporting documents) serves as the scholarship application for most merit-based aid programs. Explore additional scholarships at <https://scholarships.mst.edu>. The priority scholarship deadline is December 1 and the final scholarship deadline is February 1 with scholarships awarded on a rolling basis.

## Regular Admission from High School

Students should submit the undergraduate application for admission ([apply@mst.edu](mailto:apply@mst.edu)), application fee, high school transcript, and standardized test score (ACT or SAT).

The following minimum requirements are established for general admission of first-time college students to the Missouri University of Science and Technology. Meeting the minimum requirements, however, does not guarantee admission to all degree programs. The office of admissions will notify applicants in a timely manner whether they have been accepted, denied, or placed on a waiting list.

Effective as of the fall semester 1997, regular admission of first-time college students (entering freshman) requires completion of at least 17 units of credit (1 unit = 1 year in class) as follows:

1. Four (4) units of English, one of which may be speech or debate. Two units emphasizing composition or writing skills are required.
2. Four (4) units of mathematics (Algebra I or higher). This requirement may be satisfied by the completion of courses in middle school, junior high, or senior high.
3. Three (3) units of science (not including General Science). The three units of science must include at least one laboratory course and must include units from at least two of the following areas: physical science, biology, physics, chemistry, and earth sciences. This requirement may be satisfied by the completion of courses in middle school, junior high, or senior high.
4. Three (3) units of social studies.



5. One (1) unit of fine arts, to be taken in visual arts, music, dance or theater.
6. Two (2) units of a single foreign language. This requirement may be satisfied by the completion of courses in middle school, junior high, or senior high.

Students will also be evaluated on a combination of aptitude examination percentile (ACT or SAT test), class rank and grade point average (GPA). If the sum of the high school class rank percentile and aptitude examination percentile is:

- 120 or greater: The student is generally directly admissible. The university placement process may indicate enhanced advising, recommendations for remediation, and reduced academic schedules for some students.
- 100-120: Students in this range are at higher risk of experiencing difficulty with university-level work and typically will not be admitted unless additional factors (see below) are presented for consideration.
- Less than 100: Students in this range are normally admissible only after additional academic development which is not available at Missouri S&T. Students in this category are encouraged to enroll at one of Missouri S&T's transfer partner schools and later apply to Missouri S&T through the Transfer Assistance Program (TAP).

The university seeks a heterogeneous student body reflecting diversity of race, gender, ethnicity, age, geography (including international students), and physical disability. Factors given prime consideration for admission to undergraduate study are an applicant's previous academic success and the quality of the records presented. Applicants who do not meet the criteria set forth for regular admission from high school may be considered by appealing to the Admissions Appeal Committee. Additional factors which may be considered for admission include:

- extensive extracurricular activity
- personal statement of 200 words or less (optional)
- outstanding talents and/or abilities
- number and scope of college preparatory courses taken
- evidence of marked improvement, over time, in high school academic record
- significant work experience and/or family responsibilities

## Special Admission Cases

Students should submit the undergraduate application for admission, \$50 application fee, high school transcript, and one appropriate test score (ACT or SAT). Admission decisions will be based on the following criteria.

1. Early Admission from High School. Superior high school students may be admitted before they have graduated from high school. There are two types of early admission:
  - A. If the student has completed all of the requirements for graduation from high school, eligibility for admission will be determined by the procedures established for regular admission from high school. Certification by the high school principal or counselor that graduation requirements have been met and a high school diploma will be issued is required.
  - B. If the student has not completed all requirements for graduation from high school, a test score and a high school class rank must be presented. The combination of test score and class rank will be evaluated on the basis of a standard that is higher than the standard for regular admission from high school. A HiSET or GED score will be required in lieu of a diploma.

In either case, an interview will be required and the following information is required from each applicant:

- application for admission
- high school transcript (sent by school)
- letter of recommendation from high school principal or counselor

2. Dual High School-University Enrollment. Superior high school students may be admitted in a special student category for the purpose of taking university courses while in high school. Students from high schools in the local areas are served by this option. Students must submit application for admission and required documents and test scores, along with application fee. Course availability may be limited and governed by space available in and prerequisites for the desired course or courses. Dual enrollment students may enroll in courses during the Open Enrollment period. Contact the Registrars office to determine open enrollment dates for each semester.
3. Trial Admission. Graduates of Missouri high schools who do not meet the standards for regular admission from high school may be admitted on a conditional basis, in the summer session, to any campus of the University of Missouri System. Typically, the enrollment is for six hours in the highest level math and English course for which the student is eligible, and if "C" grades or better are earned in those six hours, the student is permitted to enroll the following semester.
4. Accredited High School Equivalency. An individual may apply for admission on the basis of scores on an accredited high school equivalency exam, such as the High School Equivalency Test (HiSET) or the General Educational Development (GED) test after the individual's high school class has graduated. Applicants in this category are admitted on an individual basis.
5. Graduates of Accredited High Schools. Graduates who have been out of high school for a number of years should submit required admission application and documents, and will be evaluated on an individual basis.
6. Admission from Non-Accredited High Schools and Home Schooled Students. Graduates of high schools that are not accredited by recognized regional accrediting associations or approved by recognized state agencies; e.g., the University of Missouri Committee on the Accreditation of Non-Public Schools, are required to have a minimum ACT composite of 24 or equivalent SAT.
7. Admission from Non-Ranking High Schools. Graduates of high schools that do not rank their students are evaluated on high school GPA in lieu of class rank.
8. HiSET and (GED) requirements for students without a high school diploma.

Missouri S&T will consider application from students whose high school diploma was awarded through receipt of a high school equivalency testing program such as the HiSET or the GED (General Education Development) program. Missouri residents earning an equivalency diploma in January 2014 or later should have taken the HiSET Exam. Please check with your home state for the appropriate program.

HiSET Exam requirement for admission:  
 Language Arts-Reading: 15 or higher  
 Language Arts-Writing: 15 or higher

Mathematics: 15 or higher  
 Science: 15 or higher  
 Social Studies: 15 or higher

The GED requirement for admission is a minimum of 500 on each of the five sections of the exam.

A campus admissions committee will establish necessary policies for and oversee the administration of these regulations. The committee or the director of admissions acting under its direction will determine which applicants will be admitted. The committee has the authority to establish standard application forms, to request interviews from an applicant, and to establish procedures for admission during the senior year while required courses are being completed. The committee has the authority to establish procedures for early admission from high school, dual high school-university enrollment, trial admission, and GED high school equivalency enrollment.

## Admission of Transfer Students

Students should submit the undergraduate application for admission, application fee, and official transcripts from any college or university attended. To be eligible for federal financial aid, all transfer students should submit an official high school transcript. Transfer students who have completed fewer than 24 college-level credits must also submit high school transcripts and one appropriate test score (ACT or SAT).

The following minimal requirements are established for general admission of transfer students. They do not include more stringent requirements that may be established by the faculties of the individual campuses or the requirements of specific degree programs (most engineering degree programs require a higher GPA for admission). It is the responsibility of the transfer student to check with Missouri S&T transfer personnel regarding admission requirements.

1. A transfer student who has completed fewer than 24 semester hours of college-level credits must submit high school transcripts and one appropriate test score (ACT or SAT) in addition to the regular application documents for transfer students. These students will be evaluated for admission based on a combination of their high school records, test scores, and college-level GPA.
2. An applicant who has completed 24 or more semester hours of college-level work is eligible for admission if he or she is in good standing and has attained an overall grade point average of at least 2.0 (4.0 system) in all college-level courses attempted at previous institutions. (Each campus faculty governing group shall review the performance of transfer students and may recommend at that time a measure of performance which would indicate a reasonable chance of making a 2.0 grade point average at the university.) A 2.0 GPA does not guarantee admission to specific degree programs.
3. An applicant who does not meet these standards may apply by submitting to the admissions committee such data as the committee considers appropriate. The committee or the director of admissions acting under its direction may determine who shall be admitted.

## Admission of International Students

Students for whom English is a second language must follow Missouri S&T admission processes for international students as outlined below:

1. Demonstrate sufficient command of English to successfully pursue work at the Missouri University of Science and Technology. Departments normally require a TOEFL score of 79 (internet-based scoring) or an IELTS score of 6.0. Students, who are admitted to the

university, but do not meet the language requirement, may attend and successfully complete the intensive English program within Missouri S&T's intensive English program.

2. Submit an undergraduate application for admission, accompanied by an admission application fee, paid in U.S. dollars.
3. Submit official transcripts (mark sheets) for each year from all secondary schools, colleges, and universities attended, showing courses taken, grades earned, rank in class, grade point average, and class or division earned if applicable. Additionally, students should submit an English translation of the official transcript along with course descriptions in English for all courses reported on the transcript. Students may be required to submit transcripts and other credentials for evaluation through an approved credential evaluation agency.

### Please note the following conditions:

Students transferring from another US college or university are required to complete at least one semester before transferring. With the application for admission, students must submit a complete official transcript. Official transcripts must be sent directly to the admission's office from all previously and currently attended colleges or universities. A list of courses in progress must also be sent. Missouri S&T's International Student School Transfer Eligibility form must be completed by the international student advisor from the US educational institution the student is currently attending so that the student's SEVIS record can be transferred from the current school to S&T. The form should be emailed to S&T's office of international and cultural affairs at [ia@mst.edu](mailto:ia@mst.edu) or faxed to 573-341-4024.

4. Submit a statement verifying ability to provide financial support:
  - A. Applicants: A bank statement made by the sponsor or bank indicating source and amount of funds available per year.

Note: Your application for admission will not be given consideration until items one through three (English verification, application fee, complete transcripts) have been received. The I-20 cannot be processed without a financial statement. If your completed application materials are not received by the deadlines indicated below, admission may be delayed one semester.

- Fall semester – June 15
- Spring semester – November 15
- Summer session – April 1

## Dual Enrollment of Missouri S&T Undergraduate Students in Graduate School

Undergraduate students may apply for dual enrollment as both an undergraduate and a graduate student. A student who seeks dual enrollment must submit a graduate admission application to the Office of Admissions. Admission for dually enrolled students is granted by the academic department and the Vice Provost of Graduate Studies. Students are eligible to enroll when they have obtained senior status, with a minimum GPA of 3.5 if two semesters remain, 3.0 if in their final semester. Students must declare which courses are to be taken for graduate credit within the first two weeks of the semester. A dually enrolled student must take at least three hours of undergraduate credit from Missouri S&T each semester.

Dually enrolled students are limited to sixteen total credit hours per semester, but petitions for additional credit hours will be considered

by the provost. Petition forms are available at <http://registrar.mst.edu/media/administrative/registrar/documents/dualenrolled.pdf>. If a dually enrolled student fails to meet minimum undergraduate scholastic standards, his or her resulting academic probationary status will be that of an undergraduate and will be evaluated without reference to the student's grades in his or her graduate course(s).

## Transfer Credit Policy

Missouri S&T accepts college-level course credits. All grades, quality points and credit hours are transferred and computed in the cumulative GPA. Grades not included in the transfer institution's GPA due to a repeat or forgiveness policy may be removed from the Missouri S&T cumulative GPA upon verification to the registrar's office. No more than 15 semester transfer hours will be dropped from the calculation of the student's cumulative GPA.

College-level course credit earned while enrolled in high school (dual-credit) shall follow the same policy as transfer credit.

The last 60 hours of an undergraduate program must normally be taken in residence at Missouri S&T. A student may, with departmental approval, take up to 15 hours of this 60 hours off campus. If the student wishes to exceed 15 hours (of the last 60 hours) taken off campus, the student must obtain approval from the provost upon recommendation of the student's academic department chair.

## Transferring within the University of Missouri System

University of Missouri policy states that "Any course that leads to an undergraduate degree on any campus of the University of Missouri shall be accepted in transfer toward the same degree on each campus of the university offering said degree." Students transferring within the UM System are still required to satisfy the course and residency requirements of the campus from which they wish to graduate. Grades, including D and F grades, and grade points earned will also transfer and be included in the cumulative UM grade-point average.

For more information contact the following offices:

University of Missouri-Columbia, Office of Admissions  
800-225-6075  
[mu4u@missouri.edu](mailto:mu4u@missouri.edu)

University of Missouri-Kansas City, Registration & Records Office  
816-235-1125  
[registrar@umkc.edu](mailto:registrar@umkc.edu)

Missouri University of Science and Technology, Registrar's Office  
573-341-4181  
[registrar@mst.edu](mailto:registrar@mst.edu)

University of Missouri-St. Louis, Registrar's Office  
314-516-5545  
[registration@umsl.edu](mailto:registration@umsl.edu)

## Mathematics Placement Test

New freshmen, whose degree requires a college-level calculus mathematics course, will take placement tests. These tests will be given during the orientation sessions or during the fall registration (for those who do not preregister). A high level of performance is required on both these tests in order to place into Calculus with Analytic Geometry I the first semester. Therefore, it is strongly recommended that students have

four years of high school mathematics courses and that algebra and trigonometry be thoroughly reviewed before taking the placement test.

## Credit by Examination

There are six different programs included in Missouri S&T's credit by examination policy. These programs include Advanced Placement (AP), International Baccalaureate (IB), subject exams in the College Level Examination Program (CLEP), Missouri S&T Placement Testing, military coursework/experiences (Commission on Accreditation of Services), and in some instances, departmental examinations. Contact admissions at 1-800-522-0938 or <http://www.mst.edu> for Credit by Exam information. To inquire about Math Placement or CLEP testing, contact the Missouri S&T Testing Center at 573-341-4222 or at <http://testcenter.mst.edu>.

## Transfer Assistance Program (TAP)

Missouri institutions of higher education welcome transfer students; however, you should be aware that actual requirements for degrees vary from institution to institution. This factor makes it particularly important for you to contact the campus where you eventually wish to graduate very early in your academic program. By arranging an advance understanding of the transfer of applicable courses, it is likely that problems can be minimized. Unresolved problems of credit transfer may be appealed to the Student Scholastic Appeals Committee.

The Transfer Assistance Program (TAP) is designed to assist prospective students during their first two years of college at another participating institution and then assist them in completing their education at Missouri S&T.

When students enroll in TAP, they will be provided with access to a transfer course guide that is developed in conjunction with the participating local college.

Missouri S&T's transfer admissions staff will assist transfer students with questions and make regularly scheduled visits to participating colleges. Specially trained Missouri S&T academic advisors assist with pre-advising programs that offer the same opportunity for course selection as currently enrolled students.

Orientation programs, designed specifically for the transfer student, allow new transfer students to speak with students who have already made the transition from their two- or four-year local college to Missouri S&T and to discuss career and personal counseling, computer services, placement services, health services, student activities, and library instruction.

If you decide to become part of TAP, check the web site, <http://admissions.mst.edu/transfer>, or contact the following:

Transfer Programs, Office of Admissions  
Missouri S&T  
Rolla, MO 65409-1060  
1-800-522-0938  
[transfer@mst.edu](mailto:transfer@mst.edu)

## Aerospace Studies (Air Force ROTC)

The Air Force Reserve Officer Training Corps (AFROTC) is an educational program designed to give young men and women the opportunity to become Air Force officers while completing a bachelor's degree. The mission of Air Force ROTC is to develop quality leaders for the Air Force. As the largest commissioning source for Air Force officers, AFROTC prepares officer candidates to assume positions of increasing

responsibility and importance in today's Air Force. Leadership, communication, and basic military skills are the focus of the AFROTC program. In addition to helping students succeed during college, AFROTC also fosters self-confidence and self-discipline.

## The Program

The AFROTC program at Missouri S&T is a four year program. However, some students may choose a three and a half or three year course of study, determined by personal circumstances. The first two years of the program, called the General Military Course (GMC), cover basic introductory military topics as well as communication and leadership. Each GMC class is a one-hour course. Students can enroll in the GMC by registering for Aerospace Studies just as they register for any other university course. There is absolutely no obligation incurred for service in the Air Force for taking GMC courses, unless the student has an active AFROTC scholarship.

The final two years of the program, called the Professional Officer Course (POC), cover topics such as leadership, management, doctrine, international events, quality, communication, and officership. Each POC class is a three-hour course. In addition to the academic GMC/POC ROTC class, all cadets attend a two hour leadership laboratory and two hours of physical training each week. Leadership laboratory provides cadets with the knowledge and practical command and staff leadership experience in preparation for active duty as Air Force officers. It is largely cadet planned, directed, and centered.

## Scholarships

Students do not have to be on a scholarship to complete our program and be an Air Force officer. However, an Air Force ROTC Scholarship may include all tuition costs, incidental and lab fees, and a flat rate for text books. A monthly stipend is given during the academic year to each cadet on scholarship and contracted members of the POC. Students who receive an AFROTC scholarship also receive an annual supplemental scholarship from Missouri S&T.

## Leadership Evaluation, Assessment, and Development

Air Force ROTC cadets' first extended exposure to a military environment comes during the Leadership Evaluation, Assessment, and Development (LEAD) course. Cadets usually attend LEAD the summer between their sophomore and junior year, before elevation into the POC. Selection is based on the "whole person" concept, which considers the results of an Air Force Office Qualifying Test, a military physical examination, cumulative grade point average (college), and physical fitness performance.

LEAD is a four week encampment. The cadets get a close look at Air Force life and activities and the Air Force simultaneously takes a close look at the cadets. LEAD includes cadet orientation, junior officer training, physical training, organization and functions of an Air Force base, career orientation, drill and ceremony, small arms familiarization, and supplemental training.

## Graduate Study

The Air Force realizes there is an increasing demand for graduate education among its personnel and has established several programs to provide this training. The Air Force Institute of Technology is available to AFROTC graduates and offers advanced degree training in college curricula that are related to Air Force career fields, including engineering,

meteorology, the physical sciences, mathematics, languages, logistics, and business administration.

## Qualifications

All students who desire to enter Air Force ROTC must be citizens of the United States, be of sound physical condition, and be of the highest moral character. Pilot and combat system operator candidates must be no older than 29 at commissioning; other age restrictions may apply for non-rated commissionees.

## Physical Requirements

Detailed information on physical requirements is available at the detachment on campus located on the second floor of Harris Hall, or at [www.afrotc.com](http://www.afrotc.com) (<http://www.afrotc.com>).

## Military Obligation

Upon graduation and commissioning as an officer in the U.S. Air Force, students fulfill their military obligation by agreeing to retain their commission for a period of eight years, serving at least four years on active duty, depending on their assigned Air Force career field. Pilots incur a ten-year active duty service commitment after completing undergraduate pilot training. Combat system operators incur an eight-year active duty service commitment after completing undergraduate navigator training. Aircraft Battle Management Officers and Remote Pilot Aircraft operators incur a six-year active duty service commitment after completing training.

## Opportunities

Opportunities in the Air Force are excellent, with over 100 possible career fields available. Career field availability depends on academic discipline, medical condition, desires of the individual, and needs of the Air Force. As newly commissioned Second Lieutenants on active duty, Air Force ROTC graduates can serve rewarding duties in highly technical, scientific, and operational areas such as developmental engineer, pilot, combat system operator, remote pilot, scientist, cyber operations, intelligence operations, space operations, civil engineer, combat control officer, acquisitions, and maintenance.

## The Corps of Cadets

The Air Force ROTC unit at Missouri S&T is organized as an objective wing, with associated groups, squadrons, and flights. Freshmen and sophomore cadets are assigned to flights. They receive instructions from POC cadets in basic military customs and courtesies, drill movements, and many other facets of Air Force operations. Additionally, they are offered the opportunity to visit Air Force bases and discuss career opportunities with Air Force members. Junior and senior cadets are assigned and rotated through various leadership positions, gaining experience in management procedures.

If you are interested in the Air Force ROTC program here at Missouri S&T or have any questions, please call or visit the detachment. We are on the second floor of Harris Hall. Our phone number is 573-341-4925, or you can also find us at <http://afrotc.mst.edu/>.

## Career Opportunities and Employer Relations (COER)

Career opportunities and employer relations (COER), located on the third floor of Norwood Hall, provides many services to assist Missouri



University of Science and Technology students and graduates in their job search for professional full-time, intern (summer) and co-op employment.

COER is an effective link between Missouri S&T students and employers, and its goals are two-fold: first, to PREPARE students for conducting a successful job search, and second, to PROVIDE opportunities for employment.

## Job Search Preparation

The COER webpage, <http://career.mst.edu>, contains information on services, career fairs, events, on-campus interviews, and job listings, as well as on-line copies of the COER Career Guide.

### Individual Advising

Appointments are available with career advisors who work one-on-one with students to review their resume and cover letter and to discuss job search concerns.

### Workshops & Events

Workshops on resume and cover letter writing, conquering the career fair, professionalism and interviewing skills, networking, negotiating a job offer and more are presented each semester at convenient times for students.

An etiquette dinner is provided each semester to review dining and business etiquette. Reservations are required and there is a \$15 charge.

Adulting 101 is presented each spring and fall for graduating students. This is a series of seminars to help students make a smoother transition to the real world and includes tips from business and industry experts.

### Practice Interviews

Practice interviews are available for students who would like to assess their interviewing skills. Students are evaluated by a career advisor and given feedback on their strengths and areas that need improvement. Students can also use an online/webcam interviewing software called InterviewStream from their residence.

## Job Search Opportunities

### Career Fairs

Two career fairs are sponsored each year to provide students direct access to hundreds of employer representatives. Students have the opportunity to meet face-to-face with recruiters, hand out resumes, and collect employer information. These contacts often lead to full-time, intern, and co-op interviews and employment.

### On-Campus Interviews

Full-time, intern and co-op interviews are conducted by employers in COER's professional interview suites, located on the 3rd floor of Norwood Hall. Students must be registered with COER to upload their resume into MinerJobs and participate in on-campus interviews. Students should check the system daily for information about employers coming to interview, job requirements, and important dates. Each student is responsible for submitting his or her resume electronically and for signing up for interviews by the stated deadlines.

### Resume Referrals

When a student registers with COER, his or her resume can be referred to employers who are interested in hiring Missouri S&T students even though the employer may not necessarily be coming to campus to interview. The employer will then contact the student directly if he or she is interested.

### Resume Drops

Some employers will list their job opportunities and request a "resume drop" from students. Interested students are responsible for submitting their resume to the employer through MinerJobs by a designated date. Resumes submitted are reviewed and students the employer is interested in will be contacted.

### Alumni

Missouri S&T alumni may also register with COER. Once registered, they will receive access to MinerJobs to search job listings. In addition, alumni resumes that are uploaded in the system will be sent to employers requesting resume referrals if they match their hiring qualifications.

## Cooperative Education Program (Co-op)

The Missouri University of Science and Technology's cooperative education program, administered by Career Opportunities and Employer Relations (COER), is designed to provide students with an employment opportunity to gain practical degree-related, work experience prior to graduation. The program is set up so that students can take a break from studies and work full-time for one or for a combination of semesters such as spring/summer or summer/fall, allowing five to nine months of work experience versus the three summer months allowed for internship positions. Students may also obtain parallel co-op jobs in which they work and take classes on a part-time basis simultaneously. Over 170 employers hire Missouri S&T co-op students annually, and students can apply for many of those positions through the online resume/interview job search process that is facilitated by COER. A focus area of COER is to create new student co-op opportunities with employers who have not previously hired co-ops at Missouri S&T.

## Co-op Benefits

- Gain future employment advantage
- Earn a higher starting full-time salary
- Validate career plans
- Option to earn academic credit in certain academic departments
- Network with professionals and other college students
- Apply knowledge
- Learn corporate recruiting strategies
- Help finance college - the average monthly co-op salary is approximately \$3,300.00
- Increase odds of having a full-time job lined up before graduation by 1.5 times

## Co-op Eligibility

To be eligible to participate in the co-op program, a student must be enrolled full-time. Full-time is defined as satisfactorily carrying and passing a minimum of 12 credit hours (nine credit hours for a graduate student) in a fall or spring semester.

A student must have a cumulative GPA of at least 2.0 out of 4.0 to apply to and participate in the program. The student must not be on any type of probation. Students in all majors at Missouri S&T may participate in the co-op program.

The actual amount of academic work that must be completed before being selected for the program or before beginning a work period is up to the employer, but a freshman must have completed at least two

semesters. Other eligibility requirements may be established by the sponsoring company with the concurrence of Missouri S&T. Financial need is not a determining factor for co-op eligibility.

A transfer student may register for co-op as soon as he or she begins classes at Missouri S&T. A transfer student who is participating in a co-op program through another institution may transfer and continue the co-op affiliation subject to Missouri S&T's guidelines.

## Missouri S&T Registration during Co-op

Students participating in the co-op program register each work term (summer, fall, and/or spring) with COER. To register with the university, students pay the educational fee of one in-state credit hour plus a \$100 processing fee, regardless of residency. These fees are administered in the spring and fall semesters only, not the summer semester.

Registration includes:

- Retaining scholarship(s) which require that the student be registered with the university
- Maintaining continuously enrolled status for insurance and loan purposes
- Not having to apply for readmission to Missouri S&T to attend classes following the co-op work term
- Receiving pre-registration information
- Documentation of co-op participation on the student transcript

Credit for co-op is awarded at the discretion of the student's academic department. Students must be registered with the university for work terms when academic credit is to be earned. Regular tuition rates apply based upon in-state/out-of-state tuition and the number of hours received. In addition the student will be billed for; IT, health, and departmental fees.

## International Students

International students are required to register for co-op with COER in order to be legally eligible to obtain work authorization. International students must complete CPT paperwork with the office of international and cultural affairs first and then with COER. After completion and approval of paperwork, international students will receive work authorization and the necessary documentation to provide to their employer. International students are eligible for co-op after 9 months of studies, with academic department approval.

## More Information

For additional information concerning COER please contact:

Career Opportunities and Employer Relations  
320 W. 12th Street  
Third Floor Norwood Hall  
Missouri University of Science and Technology  
Rolla, Missouri 65409-0240  
573-341-4343  
<http://career.mst.edu>  
[career@mst.edu](mailto:career@mst.edu)

## Counseling, Disability Support, and Student Wellness

Counseling, disability support, and student wellness (CDSW) promotes self-awareness and skill development to support individual success

and well-being. CDSW offers a variety of services to the Missouri S&T campus community including individual, group, and crisis counseling; consultation; programming on many topics; the StressLess room; the Van Matre resource center of self-help materials; the Employee Assistance Program (EAP); assistance for students with disabilities; wellness education and activities; and case management.

Missouri S&T's disability support services (DSS) ensures that students with disabilities have equal access to academic classrooms and curricula by coordinating services and academic support. Accommodations can make a difference in academic success.

## Counseling/Employee Assistance Program (EAP)

Personal and career counseling is provided on a time-limited basis to Missouri S&T students and benefit-eligible employees. Services, which are provided by licensed counselors and psychologists, are free and confidential within ethical and legal limitations. Concerns commonly addressed in personal counseling include self-exploration, college adjustment, family issues, feelings of depression and anxiety, interpersonal issues, communication skills, and self-esteem. Relaxation strategies and methods to cope with the many stressors of daily living may also be addressed. Overcoming test anxiety or procrastination, improving self and time management, and developing other skills related to success at Missouri S&T may be a focus in counseling.

Individuals wondering about their majors and career options may benefit from career counseling, which typically explores personal and professional goals and how to achieve them.

Group counseling is an interactive, supportive, and interpersonal form of therapy. Counseling offers several groups based on campus need and interest. Some current and past groups are Asperger's support, building social confidence, ADD/ADHD support group, miners for recovery, and test anxiety.

CDSW actively promotes student learning and professional development through its outreach programming services. Staff members offer programs to campus groups on topics such as teamwork, stress management, conflict resolution, and time management.

The Van Matre resource center, a self-help library, contains a wide range of reading materials. Topics range from communication skills to parenting, career exploration to dealing with depression, anxiety, and abuse. Materials are available for checkout.

EAP provides a variety of services for faculty and staff such as counseling, consultation, organizational development, and programming.

### Contact Information

Counseling, Disability Support, and Student Wellness  
204 Norwood Hall  
Phone: 573-341-4211  
Fax: 573-341-4172  
E-mail: [counsel@mst.edu](mailto:counsel@mst.edu)  
Web: <http://counsel.mst.edu>

## Case Management

Case management is designed to support students throughout their Missouri S&T student experience in order to best achieve their academic, personal, and professional goals. Case management helps students face challenges by identifying immediate needs, providing appropriate



resources, and partnering with the student to develop an action plan. Case management supports and empowers students to take action and advocate on their own behalf. This is a collaborative process that helps a student evaluate his/her options.

Case management services include:

- Assistance navigating campus and community resources
- Coordination and follow up during and after hospitalization and/or medical leaves of absence
- Crisis management
- Exploration of and referral for mental health or physical health concerns
- Help managing complex medical needs
- Problem solving
- Referrals to campus and other resources

The case manager coordinates with other campus departments and offices to facilitate communication. Every effort is made to ensure privacy and information is shared on a need to know basis. The case manager can refer you to a confidential provider. Signed releases of information are often used.

### Contact Information

Case Management  
Counseling, Disability Support, and Student Wellness  
202 Norwood Hall  
Phone: 573-341-4211  
Fax: 573-341-4172  
E-mail: [cm@mst.edu](mailto:cm@mst.edu)  
Web: <http://casemanagement.mst.edu/>

## Student Wellness

Student wellness promotes healthy behaviors to create a campus environment conducive to academic, professional, and personal success. Wellness is an active, continuing process of becoming more conscious of and making choices towards a fulfilling and thriving life. S&T's Student Wellness program takes an environmental approach to address the well-being of the campus community because individuals are influenced both positively and negatively by the behaviors of others and the environment in which they live.

Student wellness topic areas include: alcohol and other drug prevention; stress management and mental health promotion; healthy eating and physical activity promotion; sexual health; and sexual violence prevention. Student wellness, along with assistance from the Joe's PEERS (the campus health and wellness peer educators) and student wellness educators, provides workshops covering various health and wellness topics; social norms and awareness campaigns; Miner Well events and information tables; Brief Alcohol Screening and Intervention for Collegeon-line education; and one-on-one wellness consultations.

The STEP UP! bystander intervention program is one example of a student wellness initiative. It is a behavioral and educational program for college students that aims to:

- Raise awareness of helping behaviors
- Increase motivation to help
- Develop skills and confidence when responding to problems or concerns

- Ensure the safety and well-being of self and others

### Contact Information

Health Educator  
Counseling, Disability Support, and Student Wellness  
201 Norwood Hall  
Phone: 573-341-4225  
Fax: 573-341-4172  
E-mail: [healthed@mst.edu](mailto:healthed@mst.edu)  
Web: <http://studentwellness.mst.edu>

## Disability Support Services

This policy statement relating to otherwise qualified persons with disabilities outlines the roles and responsibilities of students, faculty, staff and the coordinator of disability support services (coordinator/advisor) in making Missouri University of Science and Technology programs and services available to all persons. The university places specific emphasis on accommodating the needs of matriculated students with a disability, providing related services, and ensuring the academic integrity of Missouri S&T. This policy statement is in accordance with Section 240.040 E, Policy Related to Students with Disabilities, Collected Rules and Regulations of the University of Missouri, the Missouri Human Rights Act, Section 504 of the Rehabilitation Act of 1973, and the Americans with Disabilities Act of 1990.

### I. Confidentiality

- A. In accordance with the requirements of the Family Educational Rights and Privacy Act, medical information concerning a disability will be treated with utmost confidentiality. It will be:
  1. treated like other medical information
  2. maintained in secure files under the jurisdiction of the coordinator/advisor
  3. released only on a need-to-know basis within the university community

### II. Responsibilities of the Student

- A. All disabled students seeking reasonable accommodations and provision of disability-related services must:
  1. identify himself or herself to the coordinator/advisor as desiring accommodations
  2. provide current and adequate documentation of his/her disability and of appropriate accommodations to the coordinator/advisor
  3. request needed classroom accommodations and related services of the coordinator/advisor
- B. All of the above requirements must be met by the student in a timely manner to ensure full resolution of accommodations and related services prior to the student's entrance into the program or course of study. The student should provide the necessary documentation at least six weeks prior to the first semester for which accommodations are being requested and should provide the coordinator/advisor with a copy of his/her class schedule as soon as it is available for each semester during which s/he is seeking accommodations. Waiver of these deadlines may be made by the coordinator/advisor on a case by case basis. Failure to meet the specified deadlines and requirements may result in a denial of accommodations.

### III. Documentation Procedure

- A. Documentation of a specific disability provided to the coordinator/advisor must be adequate and up to date. Diagnosis and evaluation costs shall not be the responsibility of the university.
  1. current medical or other diagnostic documentation of a disability must be provided by a qualified physician or other qualified diagnostician
  2. current documentation of the need for reasonable accommodations and related services must also be provided to the coordinator/advisor
  3. if existing documentation is incomplete or outdated, the coordinator/advisor may require the student to provide additional documentation at the student's expense

### IV. Collaborative Responsibilities of the Coordinator, Faculty, and Staff

- A. The coordinator/advisor shall review the documentation provided by the student and discuss the accommodation and related services requested
- B. The coordinator/advisor shall make an initial determination as to whether requested accommodations and related services are required
- C. The coordinator/advisor shall provide the student with a letter describing recommended accommodations and related services
- D. The faculty or staff member responsible for a specific class, program, or service shall then determine accommodations of the disability and provision of related services in consultation with the coordinator/advisor if necessary
- E. Any disagreement relating to accommodations shall be described in writing and submitted to the chancellor or his/her designee for resolution in a prompt manner. This appeal must specify why the accommodation request is considered unreasonable or unworkable
- F. In any disagreement related to IV.5, the chancellor or his/her designee shall take into consideration all relevant factors including but not limited to:
  1. current documentation of the specific disability
  2. the need for the requested services or accommodations
  3. the essential elements of the academic program or course of study being pursued
  4. the fact that no applicable law requires Missouri S&T to substantially alter essential elements of its academic program or course of study or to otherwise compromise its academic standards
- G. The written judgment of the chancellor or his/her designee shall be presented to the faculty member or department administrator within ten working days following receipt of the written notice of disagreement.

### V. Specific Responsibilities of the Faculty

- A. It is the responsibility of the faculty to:
  1. establish curriculum requirements and uphold the academic standards of Missouri S&T
  2. determine that the essential elements of these curricula, as well as those of an individual course, are being fulfilled
  3. work with the coordinator/advisor to determine the provision of reasonable accommodations and related services for disabled students when requested by the coordinator/advisor

4. follow applicable rules with respect to individual privacy and confidentiality

- B. If the faculty member concerned opposes the determination made by the coordinator/advisor, he or she should proceed as follows:

1. He or she initiates a review of this determination with the coordinator/advisor
2. If after this review the faculty member or department administrator still does not agree with the coordinator/advisor's determination, he or she may have recourse to the procedures outlined by section IV, subsections 5 and 6

### VI. Disability Complaint Process

- A. A student who believes that the determination of the coordinator/advisor for the provision of reasonable accommodations and related services is not being fulfilled by a faculty or staff member must contact the coordinator/advisor in a timely manner to discuss the concern. A student who is not satisfied with the accommodation plan or the initial determination of the coordinator/advisor may contact the office of the dean of students in 107 Norwood Hall or 573-341-4209, to discuss their concern.
- B. A student who believes he or she has been discriminated against, on the basis of a protected class, with regard to his/her disability accommodation plan or the determination of the coordinator/advisor may process their complaint of disability discrimination through the appropriate Equity Resolution Process (CR&R 600.030, 600.040, 600.050, 600.060 ([https://www.umsystem.edu/ums/rules/collected\\_rules/programs/ch600](https://www.umsystem.edu/ums/rules/collected_rules/programs/ch600))). Access to policy information is available from the following sources:
  1. UM System website [https://www.umsystem.edu/ums/rules/collected\\_rules/equal\\_employment\\_educational\\_opportunity/ch600](https://www.umsystem.edu/ums/rules/collected_rules/equal_employment_educational_opportunity/ch600)
  2. Human Resources, Equity and Inclusion located in 113 Centennial Hall 573-341-4241
  3. Office of the Dean of Students located in 107 Norwood Hall 573-341-4209

#### Contact Information

Coordinator/Advisor of Disability Support Services  
Counseling, Disability Support, and Student Wellness  
203 Norwood Hall  
Phone: 573-341-6655  
Fax: 573-341-4172  
E-mail: [dss@mst.edu](mailto:dss@mst.edu)  
Web: <http://dss.mst.edu>

### Curtis Laws Wilson Library

The Curtis Laws Wilson Library provides services and materials to support the university's academic programs. In addition to providing students with research resources and skills, the library is a place for collaborative learning. Spaces are technologically enabled, with resources such as the Nonavitra visualization wall, high performance computers, computer learning centers (CLC), and 3D scanner and printers.

In addition to a legacy print collection, the library provides strong online and full-text resources. Missouri S&T is a selective depository for United States government documents. The library receives a wide selection of materials from the Government Printing Office and other agencies.

Through interlibrary loan, the Missouri S&T collection is supplemented by materials owned by other libraries throughout the United States.

The Curtis Laws Wilson Library is home to the Scholars' Mine, the university's online repository of scholarly contributions created by S&T faculty and students. The library provides support on campus for scholarly communications and related questions such as copyright and data management plans.

Librarians provide direct support and consultation with students and faculty. One-on-one research consultations are welcome, and librarians meet regularly with classes and student groups.

The Curtis Laws Wilson Library is Missouri S&T's gateway to the ever-expanding world of information. Students are encouraged to explore the library's homepage at <http://library.mst.edu>.

## Fees

*"The university reserves the right to modify by increase or decrease the fees charged for attendance and other services at the University, including but not limited to tuition, at any time when in the discretion of the governing board the same is in the best interest of the University, provided that no increases can or will be effective unless approved by the governing board not less than thirty (30) days prior to the beginning of the academic term (semester, etc.) to which the fees are applicable, with all modification of fees to be effective irrespective as to whether fees have or have not been paid by or on behalf of a student prior to the effective date of the modification."*

To review the statement of financial responsibility and its terms visit <http://cashier.mst.edu/studentfees/statementoffinancialresponsibility/>. This statement allows students to confirm their understanding of financial implications when registering each semester.

## Electronic Billing Statements

Electronic billing is the official billing method for currently enrolled students at Missouri University of Science and Technology. Students will be notified by e-mail at their Missouri S&T e-mail account when monthly billing statements are available. Currently enrolled students will be able to view, print, and pay their student fee bill online at Joe'SS.

Currently enrolled students can also authorize others (parents, grandparents, guardians) to view and pay their student fee bill. Access to student account information can be granted by visiting <http://registrar.mst.edu/psinfo/additionalauthorizedaccess/>. As an additional authorized access (AAA) member, they have access to electronically view and print the monthly billing statement and make payment online. They are also notified when the statement is available at the e-mail address entered by the student during set-up. For further information, visit the Missouri S&T registrar's office web site at <http://registrar.mst.edu>.

## Tuition per Credit Hour

All students enrolled at Missouri S&T are required to pay tuition. Visit the Missouri S&T cashier's office web site for fee information at <http://cashier.mst.edu>.

Courses audited and courses taken for reduced credit will be counted at their normal credit value in computing the amount of tuition to be paid. Students enrolling in zero credit hours are required to pay tuition and fees according to the equivalent credit for the course.

## Information Technology Fee

All students enrolled at Missouri University of Science and Technology are required to pay an information technology fee per credit hour.

## Course Fees

An additional course fee will apply to the following and will be charged per credit hour:

Engineering and sciences course fee will be charged per credit hour to all students enrolled in engineering, biological sciences, chemistry, computer science, geology, geophysics and physics courses. Co-listed courses are subject to the engineering and sciences course fee.

Business and information technology course fee will be charged per credit hour to all students enrolled in business, IS&T and M&IS courses. Co-listed courses are subject to the business and information technology course fee.

## Student Activity/Facility Fee

A student activity/facility fee is charged to students each semester to pay for a variety of activities, services, and bonded debt on student fee funded buildings. The activity/facility fee is determined and approved by the Student Council. The activity/facility fee includes fees for the Havener Center, intramural and recreational facilities and programs, campus events, the student newspaper, radio station and yearbook, and funding for a variety of student organizations. The Rollamo Yearbook fee will be charged during the fall semester to all undergraduate students enrolled for seven or more hours and will remain optional for all undergraduate students enrolled for fewer than seven hours and all graduate students. Graduate students pay a fee to fund the Council of Graduate Students. The activity/facility fee is prorated for students enrolled in fewer than ten hours.

The activity/facility fee is charged to all students, undergraduate and graduate. Students attending the Engineering Education Center in St. Louis do not pay the student activity fee.

Additional information concerning the Missouri S&T Student activity/facility fee is available at: <http://studentlife.mst.edu>.

## Health Service Fee

The mandatory health service fee is charged to all students, graduate and undergraduate (full or part time enrolled) each semester. This allows students access to the Student Health Complex.

## Academic Testing Fee

An academic testing fee will be charged to all undergraduate students that have reached the level or sophomore, junior and senior. The fee will be assessed each semester at the following rates:

- Senior Fee: \$19.50 per semester
- Junior Fee: \$12.00 per semester
- Sophomore Fee: \$5.00 per semester

## Graduation Fee

A \$75 graduation fee is assessed to all students who have applied as a candidate for graduation. This fee will be charged to the student account after submitting an application for graduation.

## Time of Payment of Fees

All fees must be paid in full or payment arrangements made at the time of registration at the opening of each semester or term as a condition of admission to classes. Consult the academic calendar for dates of registration and payment of fees.

## Minimum Fee Payment Plan

The student's account (to include tuition and fees, housing, traffic violations, etc.) will be billed for the full amount each month with a minimum payment allowed. The minimum payment is derived by dividing the full account balance by the number of scheduled payments remaining in the semester. If a student chooses to pay the minimum amount, a 1 percent per month interest charge will be assessed on the remaining unpaid account balance.

## Late Payment Fee

Student fee accounts will be subject to a late fee for unpaid amounts billed when payment is not received by the scheduled due date as communicated on the student's monthly billing statement. If the minimum payment or billed balance due is paid on or before the scheduled due date, as it appears on the student's monthly billing statement, no late fees will apply.

Past due amounts owed to the university must be satisfied by payment in full. Failure to pay may result in transcripts or diplomas being withheld. The university will pursue appropriate collections practices which may include referrals to a collection agency for accounts that remain past due. The account may be assessed an additional collection charge of up to 50 percent of the balance if referral to a collection agency becomes necessary.

## Fall Semester Payment Due Dates

Preregistered students: five installments due July, August, September, October, and November 15th.

Open registration students: the number of installments available will be dependent upon the timing of your registration.

## Spring Semester Payment Due Dates

Preregistered students: five installments due December, January, February, March, and April 15th.

Open registration students: the number of installments available will be dependent upon the timing of your registration.

## Summer Semester Payment Due Dates

Preregistered students: 50 percent of fees due May 15th and 50% due June 15th.

Open registration students: total fees will be billed and due June 15th.

## Financial Aid

Approved financial aid is applied directly to a student's account. The entry will appear as a credit on the billing statement and will reduce the current term balance due. The balance remaining after application of financial aid will be billed to the student and will be subject to the minimum payment process and interest charge calculation.

## Personal Checks

Personal checks will be accepted only for the amount due from the student. Personal checks can be presented to the cashier's office in person or by mail to G4 Parker Hall, Rolla MO 65409. A late registration fee will be assessed if a check presented in payment of student fees is returned unpaid and remains unpaid after the close of the registration period.

## Online Payment Options

Missouri S&T has convenient online payment options for our students and their authorized payers. Students can make online check and credit card payments by accessing the student self-service module Joe'SS>Self-Service>Campus Finances>Make a Payment. Authorized payers with access to student account information will log in to <https://joess.mst.edu/> to make online payment..

The University of Missouri contracts with a third party vendor to process credit card payments applied to the student fee account. Credit card payment can be made by Visa, MasterCard, Discover and American Express online only. A convenience fee of 2.75 percent will be charged by the third party vendor on all credit card payments.

To avoid the convenience fee, students and their authorized payers, have the option to make an online electronic check payment by simply entering the bank/financial institution routing and account numbers at the time of the online payment. Online payment information can be found on the cashiers website at <http://cashier.mst.edu/>.

## Debit Card Payment

PIN based debit card payments are processed at the cashier's office at no cost to the student. The student must present the card at the time of the transaction and will enter their personal identification number (PIN) to complete. Credit card payments, for payment of a student account, are not accepted at the cashier's office.

## Late Registration Fee

A student who registers after the start of the semester will be charged a late fee equivalent to one hour undergrad tuition. Also, by registering late, a student may find certain sections or entire courses closed to registration. Each department reserves the right to close sections of courses or even to close enrollment in a department when the capacity of the class is reached.

## International Student Sponsored Program

A full range of services for sponsored international students is provided through the office of international affairs. International students sponsored by international agencies receive special services and are charged an administrative fee per semester. Individual students desiring to take advantage of these special services may apply for them. Details on the current Sponsored Student program and costs are available upon request from:

Office of International Affairs  
103 Norwood Hall  
Rolla, MO 65409-0160



## Sponsor Billing

If part or all of your educational expenses are being paid by an embassy, agency or company, you can elect to have them billed directly through our sponsor billing process.

Upon receipt of written authorization, a credit will be posted to your student account for the amount authorized. We will discontinue billing you for that amount and bill your sponsor directly. If the sponsor does not pay in a timely manner, the credit will be removed from your account and you will be responsible for this amount again, including the accrual of finance charges.

Additional information is available on the cashier's website under sponsor billing.

## International Student Services Fee

The office of international affairs (IA) student services provides a full range of services to international students including, but not limited to, communication with prospective international students and applicants, issuance of immigration documents, new international student orientation as well as ongoing orientation/acclimation programs. IA manages the federally-mandated Department of Homeland Security Student and Exchange Visitor Information System (SEVIS) database and is responsible for meeting current requirements, the upcoming SEVIS II, and all follow-on phases. Due to the complexity and scope of these associated mandatory requirements, a fee has been implemented in order to meet the system demands. Therefore, all F-1 and J-1 international students who are enrolled in one or more academic hours will be charged an International Student Fee of \$80.00 per semester for fall and spring semesters, and \$40.00 for summer semester.

## Mandatory Health Insurance for International Students

All international students, as a condition of their enrollment, are required to purchase mandatory health insurance. This includes all F-1 and J-1 visa students. In addition, J-1 visa students whose spouse and/or children are living in the U.S. are required to carry health insurance. An independent carrier working through the International Affairs (IA) office, provides an insurance policy at a reasonable cost. Premiums will be charged during the fall and spring semester. Summer premiums are included in the spring semester.

For more information on the mandatory health insurance requirements for international students, contact:

International Affairs Office  
103 Norwood Hall  
573-341-4208

## Refund of Fees

Fees subject to refund include: tuition, information technology fees, engineering, science, and business supplemental fees, student activity/faculty fees, health service fees and any instruction-related miscellaneous fees that may be assessed.\* Students who have registered for credit courses, and made payment of fees, and whose registration is subsequently canceled, or who withdraw from the university or reduce their course load, will, subject to certain exceptions and upon written request to the cashier's office, receive a refund of the fees in accordance with the following schedule: class day of cancellation, withdrawal, or change of course load. The official Missouri S&T refund

policy can be found from the Chancellor's Policy Memorandum site at: <http://chancellor.mst.edu/media/administrative/chancellor/documents/policy/III-16.pdf>. (<http://chancellor.mst.edu/documents/policy/III-16.pdf>)

### Fall/Spring Semester – 16 weeks

Elapsed Days	Percent of Refund
Before the first day of classes	100%
Class days 1-5	90%
Class days 6-10	70%
Class days 11-25	50%
After class day 25	NO REFUND

### Summer Session – 8 weeks

Elapsed Days	Percent of Refund
Before the first day of classes	100%
Class days 1-3	90%
Class days 4-5	70%
Class days 6-13	50%
After class day 13	NO REFUND

Class days are counted by excluding Saturdays, Sundays and holidays.

\*Deductions may be made from any refund of fees for any financial obligation due the university.

## Financial Assistance

### Our Mission

The Student Financial Assistance Office (SFA) assists families with understanding college costs at Missouri University of Science and Technology. Our team facilitates access to federal, state, institutional and private financial resources and coordinates access to university scholarship and loan awards for our students, while adhering to NASFAA's statement of ethical principles.

The SFA Office continually strives to provide high quality service to all students, families, faculty, staff, alumni and other interested parties. Our team works to meet campus strategic goals through financial aid administration, community outreach, financial literacy and debt counseling programs.

Missouri S&T has many ways for you to get financial assistance. New freshman and transfer applicants must complete the Missouri S&T undergraduate application for admission and scholarships and be accepted to the university by appropriate deadlines for scholarship consideration.

For other financial aid (grants, loans, work-study), you must complete a Free Application for Federal Student Aid (FAFSA). Preference will be given to those students whose FAFSA has been received by February 1. If you apply at any other time of the year, Missouri S&T will attempt to fill your financial needs to the extent that funds or opportunities are available. Missouri's need-based Access Missouri scholarship absolutely requires FAFSA submission by February 1. Federal aid is contingent upon students meeting satisfactory academic progress.

Student financial assistance begins generating financial aid packages by early March. A detailed list of financial aid can be found on our website <http://sfa.mst.edu>. Please contact the student financial assistance office for more detailed information.

Completing the FAFSA provides access to federal and state financial aid including grants, loans, and work study. Non-need based campus jobs are listed on MinerJobs at <http://career.mst.edu/hireminers/>. In the cooperative training program, you can alternate semesters of school at Missouri S&T with semesters of work in industry. You may want to look into Missouri S&T's Minority Engineering and Science Program and Women in Engineering and Science Programs. Army and Air Force ROTC each offer scholarships. The athletic department offers many grants in various sports.

## Satisfactory Academic Progress Policy

To receive federal financial aid, students must be eligible to enroll in an academic program that leads to a degree or certificate program associated with a degree program and must meet satisfactory academic progress per federal financial aid guidelines and per Missouri University of Science and Technology policy.

The Missouri University of Science and Technology (S&T) satisfactory academic progress (SAP) policy has established the following definition of satisfactory academic progress (SAP):

Missouri S&T satisfactory academic progress is defined by the following three criteria:

- Meeting a minimum cumulative grade point average requirement (GPA).
- Earning a minimum number of credit hours each semester (semester progress).
- Completing the degree objective within a maximum number of attempted credits (maximum time allowance).

### Cumulative Grade Point Average (GPA) Requirement:

- Undergraduate students with 59 or fewer credit hours must have a 1.67 cumulative GPA.
- Undergraduate students with 60 credit hours or more must have a 2.00 cumulative GPA.

### Semester Progress Requirements:

- Students must complete a minimum of 75% of attempted coursework.
- Undergraduate students who attempt at least 6 credit hours, and graduate students who attempt at least 4 credit hours during the semester, are expected to complete at least 1 credit hour during the semester. Students who have attempted these minimum hours and who do not complete at least 1 credit hour will be suspended from future aid.
- Completing a course with an "F", "WD", "DL", "I" (incomplete) or switching to Hearer (Audit) Status or another failure to receive a letter grade will be considered as not having satisfactorily completed a course.

**Maximum Time Allowance:** Students must complete their degree program within 150 percent of the semester hours required for that degree.

Calculations are performed on attempted hours, not completed hours.

**Examples:**

- The Bachelor of Art in History requires 120 credit hours. Students must complete this degree before they have attempted 180 credit hours (120 hours \* 150%), or their aid will be suspended.

- The Bachelor of Science in Chemical Engineering requires 129 credit hours. Students must complete this degree before they have attempted 193.5 hours (129 \* 150%), or their aid will be suspended.

Each program requirement may differ and students should review the course catalog <http://catalog.mst.edu/#text> to determine the number of credit hours required for their degree.

## Missouri S&T Curators' Scholarship Program

You must be from a Missouri high school. You must be a Missouri resident and an incoming freshman student to qualify. The Curators' Scholarship will be included as part of the Excellence or Trustees Scholarship package.

1. Freshman Scholar. You should rank in the top five percent of your graduating class and have an ACT composite test score of 28 or better. The value of the Missouri S&T Curators' Freshman Scholarship is \$3,500. Renewal is considered automatically and is based on a cumulative GPA of 3.25 or better. If renewed, you are a Freshman Scholar-Renewal.
2. Freshman Scholar-Renewals. You must have a cumulative grade point average of 3.25 or better and have completed at least 24 credit hours during the previous academic year.

## Institutional Scholarships

To be considered for the majority of institutional scholarships (i.e. Excellence, Trustees, and Miner) offered by the student financial assistance office to incoming, first-time freshmen, you must apply for admission to Missouri S&T by December 1 (for early awards) and February 1 (final deadline). First-time incoming transfer students for the fall semester must apply for admission by May 1 and for the spring semester by December 1, to be considered for transfer scholarships. Transfer students must have completed 24 college-level, graded, transferable credits from a US institution and be pursuing their first bachelor's degree.

We will consider you for institutional scholarships based on ACT/SAT test scores and high school GPA. Transfer students will be evaluated for scholarships based on their cumulative GPA from all previously attempted college-level credit.

University scholarships include funds provided by the Alumni Association, business firms, foundations, trusts, and friends of Missouri S&T.

Scholarships for new freshmen and transfers are awarded on a rolling basis 2-3 weeks after admission. Scholarship amounts are listed on the website or scholarship brochure. Most scholarships are renewable and that renewal is based on the recipient's academic performance. Renewal is automatically reviewed.

## The Missouri Higher Education Academic "Bright Flight" Scholarship Program

The "Bright Flight" scholarship program will provide awards in the amount of up to \$3,000 (may change based on state funding) to eligible entering freshman students. To be eligible for this scholarship, a student must:

- Be a Missouri resident



- Have a test score in the top 3 percent of Missouri residents (currently an ACT enhanced composite score of 31 or higher or an SAT score of reading 800 and math 800 or higher)

## National Merit Scholarships

Missouri S&T offers a number of National Merit Scholarships, ranging from \$1,000 to \$2,000 each year to students who are classified as “finalists” in the National Merit Scholarship Competition and select Missouri S&T as their first school of choice.

## Alumni Sons/Daughters/Grandchildren Scholarship Program (For Non-Missouri Residents)

The Alumni Sons/Daughters/Grandchildren Scholarship Program is for non-Missouri resident students whose parent(s) or grandparent(s) graduated from Missouri S&T. To qualify, students must be incoming freshmen with a 3.0 high school cumulative GPA and have an ACT composite score of 24 or better. Non-Missouri resident transfer students are eligible, as are non-Missouri resident Missouri S&T upper-class students who have completed 30 hours of university-level course work and have a cumulative grade point average of 3.25 or higher. A student must complete an application to be considered for this scholarship. Scholarship applications may be completed at <https://scholarships.mst.edu>.

## Excellence, Trustees & Miner Out-of-State Scholarship Programs (For Non-Missouri Residents)

The Excellence, Trustees and Miner Out-of-State Scholarship programs will provide a scholarship toward out of state tuition to incoming, first-time freshmen. Qualifications for consideration: Complete the Missouri S&T undergraduate application for admission.

The application priority deadline is December 1 and the final scholarship deadline is February 1 preceding the academic year of enrollment. This scholarship is renewed each academic year for a total of eight semesters as long as the student maintains a cumulative GPA of 3.25 or higher, enrolls in a minimum of twelve credit hours, and has not established Missouri resident status.

## Federal Pell Grant

The source of funding is the federal government.

- **Eligibility:** You must have a financial need, be at least a half-time student, be a U.S. citizen or permanent resident, and have never received a bachelor's degree.
- **Amount:** Up to \$5,920 (during the 2017-2018 academic year)
- **Repayment:** None
- **Renewal:** Must re-apply and meet eligibility each year. Students may only receive 600% of Pell Grant over undergraduate career.
- **Applications:** Complete a Free Application for Federal Student Aid (FAFSA).

## University Loans

The source of funding is gifts to Missouri S&T from the Alumni Association, business firms, foundations, trusts, and friends of Missouri S&T.

- **Eligibility:** You must have an established need, be at least a half-time student, and a U.S. citizen or permanent resident.
- **Amount:** Varies depending on the stipulations of the loan guidelines.
- **Repayment:** Repayment begins after you leave Missouri S&T.
- **Applications:** Complete a Free Application for Federal Student Aid (FAFSA).

## Federal Supplemental Educational Opportunity Grant (SEOG)

The funds for this program are awarded to students with an extreme need.

- **Amount:** Varies from \$200 to \$800 per year.
- **Eligibility:** You must be at least a half-time student, a U.S. citizen or permanent resident, and never have received a bachelor's degree.
- **Applications:** Complete a Free Application for Federal Student Aid (FAFSA) by priority deadlines.

## Federal Work-Study (FWS)

The source of funding is from the federal government to the university. All students who have completed a FAFSA and have an established need will be considered automatically for the FWS program, with special consideration given to students from low-income families who file the FAFSA by the priority deadline. The FWS program is financial aid that the student must earn through work. The student is paid minimum wage and usually works up to 20 hours per week. The student must be a U.S. citizen or permanent resident.

## Access Missouri Program

Full-time Missouri resident undergraduates with expected family contribution between \$0-\$12,000. The amount varies and is based on available share funding. To apply, complete FAFSA annually by the February 1 deadline.

## Ford Direct Student Loans

The source of funding for the Ford Direct Loan program is provided by the federal government. The amount can vary depending on the individual student's need, up to a maximum of \$5,500 as a dependent freshman, \$6,500 as a dependent sophomore, and \$7,500 as a dependent junior, senior, or fifth-year student. Graduate students may receive up to \$20,500 per year. A student must be enrolled at least half-time.

A FAFSA must be completed in order for a student to receive a Ford Direct Loan. Interest on subsidized Ford Direct Loans begins as soon as a student graduates or ceases to be at least a half-time student. Interest on unsubsidized Ford Direct Loans begins as soon as the loan is disbursed to the student's account.

Undergraduate borrowers' subsidized and unsubsidized Ford Direct Loans carry a fixed interest rate. Graduate borrowers' unsubsidized loans also have a fixed interest rate. Rates are subject to change based on U.S. Congress decision. Please refer to <http://sfa.mst.edu/loans> for current interest rates.

## Global Learning

### Global Learning

Global learning's mission is to bring Missouri S&T's teaching, research, and service capabilities to a global market. Through its programs, you can earn an advanced degree or a graduate certificate via distance education; earn professional development hours by attending technical conferences; or take online training to enhance your skills.

Global learning blends technology and education to enhance learning. Programming is available both face-to-face and online through live streaming video. With collaborative learning tools and archived classes, global learning provides an education that fits your needs. Go online to <http://distance.mst.edu> for a current list of graduate degrees and certificate programs offered through distance education. Graduate certificates are a great way to earn college credit toward a master's degree.

Global learning includes:

- **Distance and Continuing Education:** administers and coordinates a wide variety of credit and non-credit programs. Visit <http://distance.mst.edu> for more information. For credit programs contact 573-341-6591, [global@mst.edu](mailto:global@mst.edu). For non-credit programs contact 573-341-6222, [dce@mst.edu](mailto:dce@mst.edu).
- **Educational Technology:** provides support to faculty in effective teaching strategies and related technologies. Contact 573-341-4131, [edtech@mst.edu](mailto:edtech@mst.edu), <http://edtech.mst.edu/>
- **Missouri S&T Global - St. Louis:** provides educational services to the greater St. Louis, Rolla, and distance locations. Contact 573-835-9822, [global-stl@mst.edu](mailto:global-stl@mst.edu), <http://global-stl.mst.edu/>.
- **Video Communications Center:** manages communication technologies that bring together Missouri S&T instructors and students. Contact 573-341-4526, [vcchelp@mst.edu](mailto:vcchelp@mst.edu), <http://vcc.mst.edu>.

For further information, contact:

Global Learning  
216 Centennial Hall  
300 West 12th Street  
Phone: 573-341-4132  
Fax: 573-341-4992  
Web: <http://global.mst.edu>

## Video Communications Center

The Video Communications Center (VCC), located in G-8 Library, offers a variety of media production services to the campus community. This is achieved through specialized studio classrooms, teleconference rooms, field production equipment and several Internet-based broadcasting technologies.

For the student – especially those pursuing advanced degrees – the VCC offers an array of communication tools for extending the traditional classroom and laboratory out into “the real world.”

Services include:

- The opportunity to take courses “at a distance” while away from, or after leaving, Missouri S&T
- Participation in advanced coursework streamed over and stored on the Web for later access

- Studio classroom use for thesis defense and project presentation
- DVD or web-streaming video recording of the above
- Video teleconferencing for project presentation to sponsoring companies and for student organizations meeting between campuses, or for job interviews
- Assistance in setting up, capturing, and converting research lab project videos for documentation and presentation

For more information on these and other VCC services, contact the Video Communications Center at 573-341-4526, e-mail: [vcchelp@mst.edu](mailto:vcchelp@mst.edu), or visit our website at: <http://vcc.mst.edu>.

## Information Technology (IT)

### Getting Started

Missouri S&T's information technology (IT) department provides a variety of computing tools and resources to assist with academic, research and administrative work done at the university. Students, faculty, and staff use computers daily to register for classes, communicate with friends, send email, collaborate on group projects and research, publish web pages, write reports, and find course schedules.

### Computer Accounts

Computer accounts are assigned to students and are used to access various resources at Missouri S&T, such as the computing network and the computers and software in computer learning centers (CLCs). Most Missouri S&T IT services require an authorized computer account (username and password) to gain access. The following services are available through IT computer accounts:

- Access to the campus network, including wireless networks on campus
- Google Apps, including Gmail, Drive, Sites, Google+
- High Performance Computing clusters
- Joe'SS (student web portal)
- Learning Management System (Canvas)
- Network file storage

## University Communications to Students

Each student, once initially registered for classes, will be issued a Missouri S&T email account with an address on the mst.edu domain. This is the account used for official university business and official university communications to students. Students are expected to check their Missouri S&T email account regularly for university communications and are responsible for communications sent to this and from this account. Therefore, communications sent to this account will be considered to have fulfilled any university obligation for notification.

Students must activate their email account online at: <http://it.mst.edu/services/email/student/activate/>.

## Leaving Missouri S&T

Assigned computer accounts remain active and available for use as long as a student is enrolled in classes at Missouri S&T. Additional information regarding account maintenance may be found at <http://it.mst.edu/policies/> and then clicking the “username maintenance” link.

Following graduation, Missouri S&T students retain access to their student email accounts. Local account access is removed one semester

after students graduate or stop attending. If the student was also employed by the university, account removal may occur sooner.

Students are responsible for creating a backup of any data on their network storage prior to leaving the university.

## Systems and Software

Missouri S&T's IT department provides a wide variety of computing and networking facilities and support. These facilities include, but are not limited to the following:

- 3D printing
- Computer learning centers (CLCs)
- General purpose cluster computing
- HPC
- Linux systems
- Macintosh systems
- Nonavitra high definition wall
- Software for use on personal computers
- Windows-based PCs

## Computer Learning Centers (CLCs)

Computer labs, called computer learning centers (CLCs), provide computers and specialty software for students to use for in-class, homework, and project related work.

CLCs are located in various buildings around campus. Use of computers and technology in these locations is restricted to Missouri S&T faculty, staff and students. The list of CLC locations, hours of operation, and equipment is available online at <http://clc.mst.edu>.

Missouri S&T is now using a print management system, PaperCut NG, in campus computer labs (CLCs). Students and instructors will be given a semester printing quota sufficient for completing academic work. This initiative will help conserve paper, toner and electricity and help ensure fair use of campus printing resources. As of Fall 2014, all print quota is reflected in shamrocks. It is important to note that shamrocks in no way correlate to real money. More information can be found online at <http://edtech.mst.edu/clcprint/>.

The Web Print service allows users to initiate a print job from their local machine or device and then direct that print job remotely to a select few printers on campus. Once you are at the printer, you can simply retrieve your print job and have it print while you are there at the printer. You can find more information online at <http://edtech.mst.edu/clcprint/webprint/>.

## Instructional Technology

To support teaching and learning, IT supports a broad set of instructional technologies. In addition to CLCs, classroom presentation technology, such as podium computers, laptop connections, projectors, and speakers, are provided to enhance the ability of instructors and teaching assistants to present course materials and use student response systems (clickers) in the classroom.

Teaching and learning are also enhanced by a number of online technologies at Missouri S&T. See <http://edtech.mst.edu/instructionalservices> for more information. Personalized assistance in best practices and usage of these technologies is available to instructors and teaching assistants upon request by calling the IT help desk at 573-341-HELP (4357).

The learning management system, Canvas, is used to enhance the distribution of course materials, assess student learning (e.g., quizzes and exams), enable student discussion, and facilitate learning collaboration.

More information about available instructional technologies can be found online at <http://edtech.mst.edu>. (<http://edtech.mst.edu>)

## Privileges and Responsibilities

Missouri S&T IT provides access to computing, networking and information resources in support of teaching, research and other official duties of the university. Access to the computing resources and facilities is a privilege, not a right. The Missouri S&T Computing and Network Facilities Acceptable Use Policy describes the ethical and legal responsibilities regarding computing resources.

Other computing policies and procedures, including the University of Missouri policies, can be found at <http://it.mst.edu/policies/>.

## Individually Owned Devices

Missouri S&T's IT department, in partnership with The S&T Store, provides recommendations for hardware and software to those wishing to purchase for personal use.

Academic discounts are available for personally-owned computers and software purchased through The S&T Store. Most software on university-owned machines is provided through licensing agreements with various vendors.

All students have access to a free copy of Office Professional for Students through Missouri S&T (Microsoft Office Suite). Contact the IT Help Desk at 573-341-4357 or visiting the IT Help Desk on the first floor of the Curtis Laws Wilson Library.

Missouri S&T faculty and staff can purchase a discounted version of Microsoft Office for their use at home through Microsoft's Home Use Program (HUP) as part the University's software licensing agreement with Microsoft. Visit the UM DoIT "My Services (<https://myservices.missouri.edu/Services/ServiceDetails.aspx?sdi=nqBZH0XoALuh1nBlSd6vJlf0ovAu86pxmhBlv5sv9us1>)" application for additional information and instructions on how to sign up.

IT recommends specific free antivirus software. In particular, Microsoft Security Essentials (<http://windows.microsoft.com/en-US/windows/products/security-essentials>) for Windows Computers.

Please visit <http://it.mst.edu/services> for more information on supported technology and recommended systems.

## Connecting to the Network

Computers in campus residence halls and fraternities or sororities connect to the network through an Ethernet connection or via wireless connection. Wireless coverage currently extends to nearly 100 percent of the campus - providing great flexibility and convenience for members of the campus community.

Detailed instructions on connecting to the network, using either wired or wireless Ethernet, are available by supported operating system at: <http://it.mst.edu/services>.

Virtual private network (VPN) connections are available, which allow members of the campus community to connect to the network while away from campus or traveling.

Special usage policies apply to network connections. For more information, see the policies and procedures web page at <http://it.mst.edu/policies/>. (<http://it.mst.edu/policies/>) In addition, Ethernet cards (both wired and wireless) and cables may be purchased through The S&T Store, located in the Havener Center.

## Emergency Alert System

Missouri S&T has a system in place to alert the campus community in the event of a campus-wide emergency. An email is automatically sent to every university email account, but students, faculty and staff can enter additional contact information and register to receive emergency alerts via cell phone voicemail or text message.

For more information, or to register for the Emergency Alert System, visit: <http://alert.mst.edu/>.

## Getting Help

The Missouri S&T IT help desk is available to assist the students, faculty and staff of Missouri S&T in using the different computing systems on campus.

Help is available on a wide range of items, including Windows-based PCs, Macintosh systems, and Linux workstations, as well as supported software on these systems.

Members of the campus community may call 573-341-HELP (4357), stop by the IT help desk on the first floor of the Missouri S&T Library, or access the online help request system at <http://help.mst.edu>. Hours of operation are available by visiting <http://it.mst.edu/help-desk>.

## Internet Resources

- Campus Library – <http://library.mst.edu>
- Education Technology – <http://edtech.mst.edu>
- IT Department Homepage – <http://it.mst.edu>
- IT Help Desk – <http://it.mst.edu/help-desk>
- IT Services – <http://it.mst.edu/services/>
- Joe'SS (student web portal) – <http://joess.mst.edu>
- Missouri S&T campus gateway – <http://www.mst.edu>
- Online Help Request – <http://help.mst.edu>

## International and Cultural Affairs

The office of international and cultural affairs (OICA) coordinates international activities, administers all matters involving immigration for international students and scholars, and provides advisement services to the university's international population.

OICA is responsible for the recruitment of international students, and serves as a direct contact with U.S. government agencies, embassies, consulates, and the private sector concerning international activities. The office serves as the campus home for international student exchange programs and study abroad programs. In addition, the office assists faculty and staff wishing to travel or work overseas, and offers special educational and training programs, both domestically and abroad.

The office of international and cultural affairs administers Missouri S&T's Applied Language Institute, which houses the Intensive English Program.

OICA is responsible for the organization of international protocol activities, promotes and monitors international linkage agreements, and administers a variety of international contracts.

Office of the Assistant Vice Chancellor  
International and Cultural Affairs  
209 Norwood Hall  
Rolla, MO 65409-0160 USA  
573-341-6425

## International Sponsored Student Program

A full range of services for sponsored international students is provided through the office of international and cultural affairs. International students sponsored by international agencies receive special services and are assessed a sponsored student fee for each semester.

Details on the current sponsored student program and costs are available upon request from:

Office of International and Cultural Affairs  
Sponsored Student Programs  
104 Norwood Hall  
Rolla, Missouri 65409-0160 USA  
573-341-6015  
[iasss@mst.edu](mailto:iasss@mst.edu)

## Mandatory Health Insurance for International Students

All international students are required to purchase Missouri S&T international student health insurance as a condition of their enrollment. This includes all F-1 and J-1 visa holders. F-2 visa holders who are enrolled in classes at the applied language institute and/or Missouri S&T are also required to purchase Missouri S&T international student health insurance. Student insurance premiums are charged to the student's Missouri S&T cashier's account.

In addition, the J-2 dependents of the J-1 visa holders are required by U.S. department of state immigration regulations to purchase health insurance meeting J visa requirements.

For more information on the mandatory health insurance requirement, contact:

Office of International and Cultural Affairs  
Health Insurance  
104 Norwood Hall  
Rolla, MO 65409-0160 USA  
573-341-6015  
[iainsure@mst.edu](mailto:iainsure@mst.edu)

## Study Abroad Programs

The office of international and cultural affairs coordinates study abroad opportunities for Missouri S&T students. Students may choose from a variety of exchange opportunities including semester or year abroad, faculty-led short term exchange, summer abroad, and experiential learning opportunities such as Engineers Without Borders. Semester, year, or summer abroad programs offer opportunities to earn credit towards the student's Missouri S&T degree program.

Semester, year, and summer study abroad programs are available in approximately 50 countries. Missouri S&T offers exchange options ranging from studying courses in English at a foreign university, studying

in a foreign language, or participating in a faculty-led program. Additional information, including a list of countries and universities where students may study abroad, is available at <http://studyabroad.mst.edu>.

Students eligible for financial assistance at Missouri S&T may be able to apply financial aid to study abroad. Students are encouraged to contact the student financial assistance office for details.

For additional information, contact

Office of International and Cultural Affairs  
Study Abroad  
104 Norwood Hall  
Rolla, MO 65409-0160 USA  
573-341-6015  
[studyabroad@mst.edu](mailto:studyabroad@mst.edu)  
<http://studyabroad.mst.edu>

## Travel Registry

All students traveling on a university-related trip should register in a university approved travel registry. Missouri S&T travelers can access the travel registry at <http://globalminers.mst.edu>. Faculty and/or staff members or non-S&T affiliated travelers who are accompanying students are also required to register their travel. Faculty and/or staff members who are not traveling with students may voluntarily register their travel.

The purpose of the travel registry is to provide information to travelers of resources available to them while traveling and to assist the university to quickly and easily locate university travels during an emergency.

For additional information, contact:

Office of International and Cultural Affairs  
Insurance Services  
104 Norwood Hall  
Rolla, MO 65409-0160 USA  
573-341-6015  
[iainsure@mst.edu](mailto:iainsure@mst.edu)  
<http://international.mst.edu/travelingonbehalfofst/>

## Intensive English Program (IEP)

The Intensive English Program (IEP) at Missouri University of Science and Technology provides intensive instruction in the English language for international students whose proficiency in the language is insufficient for full-time academic admission to Missouri S&T.

The mission of the IEP at Missouri S&T is to assist international students in attaining the proficiency level needed to meet language standards and promote a successful transition to academic programs. The program provides courses in English grammar, writing, reading comprehension, listening comprehension, pronunciation, and presentation at four proficiency levels.

All international students who have not satisfied S&T's language proficiency requirements are required to complete IEP's assessment testing, which is comprised of four parts:

**Michigan Test of English Language Proficiency (MTELP)** A standardized test that evaluates abilities in grammar, reading comprehension, and vocabulary.

**Michigan English Language Institute College English Test - Listening (MELICET-L)** A standardized test that evaluates abilities to understand spoken English.

**Test of Writing Proficiency (TWP)** A locally developed test that evaluates abilities to write clear, well-organized English based on nationally developed guidelines.

**Oral Proficiency Evaluation (OPE)** A locally developed test that evaluates abilities to speak English clearly based on nationally developed guidelines.

Students who perform well on all tests may be approved immediately for academic course work at the university. Other students are enrolled in IEP course work, and may then complete the series of tests again at the end of the semester. Recommendations for promotion into a higher level of the IEP or for advancement into university course work are made by the IEP's academic coordinator based on student testing and faculty input.

Students who enroll in the IEP must complete that program to the satisfaction of its director and academic coordinator (i.e. satisfy all completion requirements) before being allowed to enroll full-time in university course work.

Ordinarily, the IEP is open only to students who intend to pursue study at Missouri S&T, and who have been conditionally admitted to the university. If space exists, international students already admitted to Missouri S&T and already taking course work may enroll in IEP courses to improve their English. In addition, international persons with no academic affiliation with the University may be considered for admittance into the Intensive English Program.

For more information on IEP, testing fees and program costs please contact:

Intensive English Program (IEP)  
1207 N. Elm St.  
114 SWBCC  
Missouri University of Science and Technology  
Rolla, MO 65409-1140 USA  
Phone: 573-341-6640  
Fax: 573-341-4514  
[mstali@mst.edu](mailto:mstali@mst.edu)  
<http://ali.mst.edu>

## Military Science (Army ROTC)

### Reserves Officers' Training Corps (ROTC)

Army Reserve Officer Training Corps (ROTC) is the primary source of officers for the U.S. Army, the Army Reserve, and the Army National Guard. Army ROTC has been a part of the Missouri S&T campus since 1919. Over 2,700 officers have earned their commissions as lieutenants in the U.S. Army through ROTC at Missouri S&T. Eleven of these have become generals. Thousands of other students have received leadership training provided by the department of military science, and applied it to their civilian careers.

Army ROTC is a four-year program divided into two parts – the basic course and the advanced course. The basic course is normally taken during the freshman and sophomore years, although these classes are open to any student on campus. No military commitment is incurred in the basic course unless students are contracted or on scholarship.



Subjects taught include leadership and management development, communications, land navigation, military history, small unit tactics, survival techniques, marksmanship, drill and ceremonies, military courtesy, discipline, and customs. The summer after their freshmen year, contracted freshmen will attend a four-week Cadet Initial Entry Training (CIET) at Fort Knox, Kentucky.

All students enrolled at Missouri S&T can take any of the basic military science classes without further enrollment or obligation to ROTC or the Army.

After completing the basic course, selected students may enroll in the advanced course. Instruction in this program includes further leadership development, ethics and professionalism, principles of war and military justice. During the advanced course, cadets are provided hands-on leadership experience in various kinds of leadership positions within the cadet chain of command. Campus and laboratory instructions are reinforced with weekend field training exercises (usually two per semester). Contracted cadets in both the basic and advanced courses receive uniforms and a subsistence allowance of up to \$5,000 each year.

Cadets in the advanced courses must attend a four-week Cadet Leadership Course (CLC) normally held during the summer between their junior and senior years. This course permits cadets to further refine and put into practice the principles, theories, and skills they have acquired. CLC includes leadership, tactics, marksmanship, land navigation, physical training, and many other leadership and military skills. Cadets receive a salary during CLC, as well as free room, meals, and transportation to and from the course. Successful completion of CLC is required prior to commissioning.

## Army Schools

There are summer opportunities for selected students to attend the following Army schools:

- **Airborne School** – A three-week school that teaches the fundamentals of Army parachute jumping. After initial training, students make at least five actual jumps.
- **Air Assault School** – A physically and mentally demanding two-week school that teaches the fundamentals of employing Army helicopters in support of front line units. In addition to helicopter rappelling, students learn various techniques to balance loads in a helicopter and to configure various sling loads for large equipment. Training and testing are done in a stressful environment.
- **Cultural Understanding and Language Proficiency (CULP)** – Opportunities available for fully-funded studying abroad internships, foreign language scholarships, and culture and language incentive pay. The Army wants officers who can fully grasp the complexity of the security environment in which they operate and have sufficient knowledge of geo-politics, culture, language, economics, and the information environment. Selected Cadets are chosen for CULP opportunities to learn more about foreign cultures. Our Cadets have been selected for internships in Central America (Panama), Africa (Benin and Ghana) and Europe (Slovakia), and Asia (Mongolia, Laos, and Thailand). Other world-wide opportunities exist.
- **Army Corps of Engineer Internships** – Cadets will typically work in USACE district, battalion or brigade command equivalent (usually in a resident construction office) working on civil, mechanical, electrical, or environmental engineering projects. Districts are located all across the U.S. (36 Districts), and OCONUS (5 Districts). Projects support U.S. Army or Air Force installations (military construction) or state and local communities (civil works-dams, levees, navigation, etc.).

Cadets may perform engineering functions such as design, project management, project engineer, construction representative (quality assurance), GIS, and more.

## Two-Year Program

There is a special two-year program for community and junior college graduates and students at Missouri S&T who have not taken part in Army ROTC during their first two college years. Students can enter this program and qualify for the advanced course by successfully completing a four-week Leader's Training Course (LTC), for which they receive pay. LTC replaces and is the equivalent to the basic course (the first two years of the regular four-year ROTC program).

## Scholarships

Army ROTC offers scholarships for four, three and two years. Most four-year scholarships are awarded on a nationwide competitive basis to U.S. citizens who will be entering college as freshmen. Four-year scholarship applications are available from June 1 to January 10 of the High School senior year. Four-year scholarship applications can be obtained by applying online at <http://goarmy.com/rotc>.

Some four, three, and two-year scholarships are awarded competitively to students who are already enrolled in college. Students who attend CIET before entering the two-year program may also compete for two-year scholarships while at camp. Four, three, and two-year scholarships are also available for active duty Army enlisted personnel through the Green to Gold program.

All ROTC scholarships pay full college tuition and mandatory educational fees, plus \$1,200 per year for miscellaneous fees, textbooks, supplies, and equipment. Each scholarship also provides a subsistence allowance of up to \$5,000 each year the scholarship is in effect. Selected students who receive a scholarship through the Army ROTC program at Missouri University of Science and Technology will receive an additional \$2,000 scholarship from Missouri S&T each year they retain their ROTC scholarship.

Four-year scholarship recipients incur a military obligation at the beginning of their sophomore year. Three and two-year scholarship recipients incur an obligation concurrently with the commencement of their scholarship benefits. After commissioning and graduation, Army ROTC scholarship recipients serve in the military. The eight year service obligation can be done in the Active Army, Army National Guard, or Army Reserve.

## Reserve Forces Duty

Under the ROTC-Guaranteed Reserve Forces Duty and Dedicated National Guard Scholarship program, a limited number of two and three-year scholarships are also available to students who desire to serve with the Army Reserve or the Army National Guard in lieu of extended active duty.

The Simultaneous Membership Program (SMP) permits a cadet to combine service in the Army Reserve or National Guard as an officer trainee with participation in ROTC, and be paid for both. Federal Tuition Assistance (FTA) and State Tuition Assistance (State TA), as well as other financial benefits, are available to qualified Guard and Reserve members.

Details about the Army ROTC program may be obtained at:

US Army ROTC Stonehenge Battalion  
301 Harris Hall



573-341-4744

## Missouri Consortium for International Studies (MOCON)

The Missouri University of Science and Technology is a member of the Missouri Consortium for International Programs and Studies (MOCON). As a member of MOCON, Missouri S&T is able to offer its students several unique study abroad opportunities.

## Nuclear Reactor

The Missouri S&T Nuclear Reactor is a Nuclear Regulatory Commission (NRC) licensed 200 kilowatt pool-type reactor that is used to support the engineering and science activities on campus. Using the facility, the reactor staff provides hands-on laboratory, research & development, and project opportunities. The reactor itself uses uranium fuel and is cooled by either natural convection or a 400 kilowatt forced cooling system in a pool containing approximately 30,000 gallons of water. The reactor generates a brilliant blue glow (Cerenkov radiation) when operated at higher power.

The open pool design allows access to the reactor core where experiments and samples to be irradiated can be positioned. The facility is equipped with a pneumatic sample irradiation system, a collimated neutron beam, a thermal column that provides a diffuse thermal neutron source, a gamma spectroscopy system, computer data acquisition and control systems, and an internet accessible hot cell.

The reactor is open to the greater campus community and offers an active (operations) licensure program for interested students and others. The facility hosts numerous projects that actively engage students of various backgrounds; some recent projects include activities in:

- applied robotics
- applied biometrics
- photolytically-induced material development
- radiation tolerance of electronic chips
- instrumentation and sensors
- convective heat transfer and multiphase flows

We encourage you to contact the facility for additional information.

## Oak Ridge Associated Universities (ORAU)

Since 1981, students and faculty of the Missouri University of Science and Technology have benefited from its membership in Oak Ridge Associated Universities (ORAU). ORAU is a consortium of 91 colleges and universities and a contractor for the U.S. Department of Energy (DOE) located in Oak Ridge, Tennessee. ORAU works with its member institutions to help their students and faculty gain access to federal research facilities throughout the country; to keep its members informed about opportunity for fellowship, scholarship, and research appointments; and to organize research alliances among its members.

Through the Oak Ridge Institute for Science and Education (ORISE), the DOE facility that ORAU operates, undergraduates, graduates, postgraduates, as well as faculty enjoy access to a multitude of opportunities for study and research. Students can participate in programs covering a wide variety of disciplines including business, earth sciences, epidemiology, engineering, physics, geological sciences,

pharmacology, ocean sciences, biomedical sciences, nuclear chemistry, and mathematics. Appointment and program lengths range from one month to four years. Many of these programs are especially designed to increase the number of under-represented minority students pursuing degrees in science- and engineering- related disciplines. A comprehensive listing of these programs and other opportunities, their disciplines, and details on locations and benefits can be found at <http://www.orau.gov/orise/educ.htm> or by calling either of the contacts below.

ORAU's office of partnership development seeks opportunities for partnerships and alliances among ORAU's members, private industry, and major federal facilities. Activities include faculty development programs, such as the Ralph E. Powe Junior Faculty Enhancement Awards, the Visiting Industrial Scholars Program, consortium research funding initiatives, faculty research, and support programs as well as services to chief research officers.

For more information about ORAU and its programs, contact:

Mariesa L. Crow, vice provost for research, sponsored programs, ORAU counselor for Missouri S&T 573-341-4154

Monnie E. Champion, ORAU corporate secretary  
865-576-3306 or visit <http://www.orau.org>

## Office of the Registrar Mission Statement

The primary mission of the office of the registrar is to ensure the accuracy, integrity, and security of the academic records of the Missouri University of Science and Technology. In addition, the office will strive to provide quality service to students, alumni, faculty, staff, and other constituents of the university. To this end, the office will attempt to utilize available technology to deliver services and information in an efficient manner. Further, the office will seek to interpret and apply the academic policies and regulations of the university for the benefit of the institution and its constituents.

## Confidentiality Policy: The Family Educational Rights and Privacy Act of 1974 (FERPA)

These statements are set forth as guidelines and procedures to implement the University of Missouri policy on student records developed from the Family Educational Rights of Privacy Act 1974 (FERPA).

The Missouri University of Science and Technology as charged in the act will annually inform its eligible students by including in the academic regulations and the general catalog the following information:

1. "Educational records" are those records, files, documents, and other materials which contain information directly related to a student and are maintained by the university. Those records made available under FERPA are student financial aid, the student's cumulative advisement file, student health records, disciplinary record, the admissions file, and the academic record. The Missouri University of Science and Technology "educational records" do not include:
  - A. Records of instructional, supervisory, and administrative personnel and educational personnel ancillary thereof which are in the sole possession of the maker thereof and which are not accessible or revealed to any other person except a substitute.

- B. The records and documents of the University of Missouri police department that are maintained solely for law enforcement purposes and are not available to persons other than law enforcement officials of the same jurisdiction.
  - C. In the case of persons who are employed by the university but are not in attendance at the university, records made and maintained in the normal course of business which relate exclusively to such person and person's capacity as an employee where the records are not available for any other purpose.
  - D. All records on any university students which are created and maintained by a physician, psychiatrist, psychologist, or other recognized professional or paraprofessional acting in his or her professional or paraprofessional capacity, or assisting in that capacity, and which are created, maintained, or used only in connection with the provision of treatment to the student, and are not available to anyone other than persons providing such treatment, provided, however, that such records can be personally reviewed by a physician or other appropriate professional of the student's choice.
2. The Missouri University of Science and Technology recognizes "directory information" to be the student's name, e-mail address, address, telephone listing (including local and permanent address), major field of study, participation in officially recognized activities and sports, dates of attendance, degrees and awards received, the most recent previous educational agency or institution attended by a student, student level, and full- or part-time status. All students must inform the Registrar's Office before the end of the two-week period following the first day of classes that this information should not be released without the student's prior consent. The information listed above will become directory information as of the first day of classes following the end of the one-week period during the summer session.
  3. Missouri University of Science and Technology students have access to the educational records identified in paragraph one above. In accordance with Pub. L. 93-380, as amended, the Missouri University of Science and Technology will not make available to students the following material:
    - A. Financial records of the parents of students or any information contained therein.
    - B. Confidential letters and statements of recommendation which were placed in the education records prior to January 1, 1975, if such letters or statements are not used for the purpose other than those for which they were specifically intended.
    - C. Confidential recommendations respecting admission to the university, application for employment, and receipt of an honor or honorary recognition, where the student has signed a waiver of the student's rights of access as provided in 6.0404 the university policy on student records.
  4. The director of financial aid, the appropriate academic department chair, the director of the student health service, the vice chancellor for student affairs, the director of admissions, and the registrar are the officials responsible for the maintenance of each type of record listed in paragraph one.
  5. Any student may, upon request, review his or her records and if inaccurate information is included, may request the expunging of such information from his or her file. Such inaccurate information will then be expunged upon authorization of the official responsible for the file.
  6. Students desiring to challenge the content of their record may request an opportunity for a hearing to challenge the content of his or her educational record in order to ensure that the record is not inaccurate, misleading or otherwise in violation of the privacy or other rights of the student, and to provide an opportunity for the correction of deletion of any such inaccurate, misleading, or otherwise inappropriate data contained therein and to insert into such records a written explanation respecting the content of such records.
  7. The university official charged with custody of the records will attempt to settle informally any disputes with any student regarding the content of the university's educational records through informal meeting and discussions with the student.
  8. Upon request of the student or the university official charged with custody of the records of the student, a formal hearing shall be conducted, as follows:
    - A. The request for a hearing shall be submitted in writing to the campus chancellor who will appoint a hearing officer of a hearing committee to conduct the hearing.
    - B. The hearing shall be conducted and decided within a reasonable period of time following the request for the hearing. The parties shall be entitled to ten days prior written notice of the item and place of the hearing.
    - C. The hearing shall be conducted and the decision rendered by an appointed hearing official or officials who shall not have a direct interest in the outcome of the hearing.
    - D. The decision shall be rendered in writing within a reasonable period of time after the conclusion of the hearing.
    - E. Either part may appeal the decision of the hearing official or officials to the campus chancellor. Appeal from the chancellor's decision is to the president of the Board of Curators.
  9. The Missouri University of Science and Technology may permit access to or release the educational records without the written consent to a school official with legitimate educational interest. A school official is determined to have legitimate educational interest if the information requested is necessary for that official to (a) perform appropriate tasks that are specified in his or her position or by a contract agreement; (b) perform a task related to a student's education; (c) perform a task related to the discipline of a student; (d) provide a service or benefit relating to the student or student's family, such as health care, counseling, job placement or financial aid.
  10. If any material or document in the educational record of a student includes information on more than one student, they may inspect and review only such part of such material or document as relates to him or her or to be informed of the specific information contained in such part of such material.
  11. Students desiring reproduction of copies of educational records will be charged \$.10 per page. Official copies of transcripts are \$10.00 per copy for currently enrolled students and alumni.

## University Communications to Students

Each student, once initially admitted, will be issued a Missouri S&T e-mail account with an address on the mst.edu domain. This is the account used for official university business and official university communications to students. Students are expected to regularly check their Missouri S&T e-mail account for university communications and are responsible for communications sent to this account. Therefore, communications sent to this account will be considered to have fulfilled any university obligation for notification.

## Application for Graduation

Students planning on graduating must do the following:

- Check application deadlines for semester in which you are applying for graduation
- Fill out the online application for graduation form found in Joe'SS and submit through the online process

A \$75 graduation fee is assessed to all students who have applied as a candidate for graduation. This fee will be charged to the student account after submitting an application for graduation.

## Schedule of Classes

The most current information regarding the schedule of classes is located at <http://registrar.mst.edu/classofferings/index.html>.

## Course Information

The number in parentheses following the name of the course indicates the number of credit hours given for successfully completing the course. It also reflects the section type; for example, (LEC 3.0) designates a lecture course of three hours credit; (LAB 1.0) designates a laboratory course of one-hour credit, (RSD 2.0) designates a recitation, seminar, discussion of two hours credit, and (IND 0.0-15.0) designates independent study or research with variable hours. A lecture credit hour is usually the credit granted for satisfactorily passing a course of approximately 15 classroom hours. A laboratory course of one-hour credit would normally meet three classroom hours per week for 15 weeks.

Three credit hour courses normally meet 50 minutes three times per week, or 75 minutes twice a week, for 15 weeks. The time in class is the same in each case. If you have two classes in succession, there should be at least ten minutes between classes. Classes meeting Monday-Wednesday-Friday will normally begin on the hour. Classes meeting Tuesday-Thursday will normally alternate between the hour and half hour, beginning at 8:00 a.m.

Students must have completed the stated prerequisite(s) for the course for admission to the course or obtain the 'consent of the instructor' of the course.

## Course Numbers

This section has been prepared to give you a listing and description of the approved undergraduate courses at the Missouri University of Science and Technology. Courses listed are those approved at the time this publication went to press. Changes are made at regular intervals. Electronic catalog descriptions, which are updated during the academic year, are available through Joe'SS at <http://registrar.mst.edu>. This will enable you to keep abreast of new course additions. For current information on when courses are available, consult class offerings available through the Office of the Registrar website at: <http://registrar.mst.edu/classofferings>.

Number	Description
1000-1999	Freshmen-level courses
2000-2999	Sophomore-level courses
3000-3999	Junior-level courses
4000-4999	Senior-level courses
5000-5999	Entry and mid-level graduate courses (undergraduate enrollment allowed)

6000-6999

Advanced graduate courses

## Absence from Class

Work missed due to absence from class must be made up to the satisfaction of the instructor concerned. Excessive absences from class may result in the student being dropped from the course at the request of his or her instructor.

## Missouri S&T Grade Reports on the Web

Students may obtain their grades on the web through Joe'SS. Students who desire a paper copy of their grade report should contact the registrar's office.

## Certification of Enrollment Status

Certifications of enrollment status should be requested through the registrar's office either by visiting 103 Parker Hall or using the form located at <http://registrar.mst.edu/media/administrative/registrar/documents/certlet.pdf>. Certification of full-time or half-time status is based on the number of credit hours for which the student is enrolled and includes courses in which the student is enrolled as a hearer, with one exception. Hearer courses are not included for international student status, as defined by SEVIS.

For undergraduate students, full-time is based on at least 12 credit hours; half-time is at least six credit hours during the regular fall and spring term. For the summer term full-time is six credit hours and half-time is at least three credit hours.

## Grading System

The following system of grades is used:

Grade	Grade Points Per Credit Hour
A-Excellent	4
B-Superior	3
C-Medium	2
D-Inferior	1
F-Failure	0
I-Incomplete	
S-Satisfactory	Indicates credit has been earned for the course scheduled
U-Unsatisfactory	Indicates credit has not been earned for the course scheduled
DL-Delayed	Permissible for undergraduate research 4099 and must be removed at the end of the next semester or a grade of U will be assigned by the registrar
Y	No grade available

Grades of "S" and "U" are permitted only for orientation courses, seminars, special problems, special readings, independent study courses (numbered 2000, 3000, 4000 and 409), education laboratories, research, and pass/fail courses. Standard grades also may be used for all of the above courses except the pass/fail courses.

The purpose of the "I" grade is to allow a student to complete a course when, due to illness or unavoidable absence within the last four weeks (three weeks of classes plus finals weeks) of a fall or spring semester or within the last week and a half plus the final exam period of an eight-week

summer session, he/she would otherwise be unable to do so. The intent is to provide a means for completing a course without having to retake the entire subject for lack of fulfillment of one or two requirements of the course.

For a complete explanation of grades and grading options refer to the Student Academic Regulations handbook at: <http://registrar.mst.edu/academicregs/index.html>.

## Student Levels

Hours	Level
0-29	Freshman
30-59	Sophomore
60-89	Junior
90	Senior

## Degree Requirements/Catalog Year

The semester (term) that you enter college, after graduation from high school, is stored in the Missouri S&T student information system database. This permanent record is referred to as your catalog year and provides the definition of the catalog of graduation that describes the degree requirements that you should follow to reach your degree goal. Your catalog year can change if you do not remain continuously enrolled. The Academic Council, on April 26, 1990, addressed the issue of students who discontinue enrollment with the following regulation:

Students are responsible for knowing and meeting degree requirements stated in the undergraduate catalog, current at the time of their initial enrollment as freshmen. Transfers from community colleges and other universities are permitted to complete degree requirements in effect at the time of their enrollment as freshmen at the community college or university. Students may elect to graduate under the most recent degree requirements.

Students who interrupt their enrollment for two consecutive semesters, excluding summer sessions, must meet the degree requirements in effect at the time of readmission. Students who interrupt their enrollment for extenuating circumstances may appeal this regulation to the chair person of the degree-granting department. The chair person will notify the registrar's office if the student's original catalog of graduation is reinstated.

Non-enrolled students who intend to complete the degree requirements by transferring work from another institution or through correspondence courses must do so within a year of leaving Missouri S&T. Otherwise, students who exceed this time limitation must meet the degree requirements in effect at the time of graduation. The person may appeal to the chair person of the degree granting department to reinstate the catalog in effect during the last term enrolled.

In order to meet accrediting standards and to upgrade course offerings, the degree requirements specified by your catalog can be changed by the faculty under certain conditions. On October 29, 1992 the Academic Council approved the following regulations specifying these conditions:

Students are responsible for knowing and meeting degree requirements stated in the current undergraduate catalog at the time of their initial enrollment as freshmen. A student whose initial enrollment is in the summer will use the catalog current the following fall. A student whose initial enrollment is in the spring will use the catalog current the previous fall. Because of the rapid changes in the world today, the faculty may feel

it is in the best interests of the university's students to make changes in their degree requirements. In the event of such changes after a student enters Missouri S&T, that student will be required to satisfy the new degree requirements, provided the following conditions are met:

1. The total hours required to graduate cannot be increased for a continuously enrolled student, without that student's permission.
2. The total number of semesters needed to graduate cannot be increased for a continuously enrolled student, without that student's permission.
3. A new course cannot be substituted for an old course which a continuously enrolled student has already satisfactorily completed, without that student's permission.

Transfer students from community colleges or other universities will complete the Missouri S&T degree requirements in effect at the time of their initial enrollments at their community colleges or universities. If there are changes in Missouri S&T degree requirements after such students' initial enrollments at their community colleges or universities, the rules stated above apply.

## Other Programs

### Alumni Educational Assistance Program

The source of funding is the Alumni Association.

- **Eligibility:** Normally advanced standing and approval of a special committee.
- **Amount, repayment, renewal and limitations:** Same as work-study employment.

## Student Diversity Program

This scholarship is designed to encourage and support under represented minority students (African American, Hispanic American, and Native American) who desire to pursue an engineering or science degree. Scholarships are for freshmen and transfers and vary from \$500-\$2,000. The Diversity Scholarship also includes services to students to help foster academic, professional, and personal growth. For more information contact us at 573-341-7286, via email at [sdi@mst.edu](mailto:sdi@mst.edu) or visit <https://sdi.mst.edu/>.

## Women's Program

The mission of the women's program is to meet the needs of female students within the university community, with the aim of increasing the number of female graduates entering the engineering and science workforce. The women's program office provides a variety of services including: scholarships for incoming freshmen and transfer students, student socials, professional/ technical workshops, and mentoring/ networking programs. The women's program office also houses the Society of Women Engineers student office, resource library, computer center, and conference room for student meetings. To apply for scholarships and obtain more details, contact the women's program office at 573-341-7286, [sdi@mst.edu](mailto:sdi@mst.edu), <https://sdi.mst.edu/>.

## Athletic Grants

For information on athletic programs at Missouri S&T, contact:

Missouri S&T Athletic Department  
Gale Bullman Multi-Purpose Building  
Missouri S&T  
Rolla, MO 65409-0740



573-341-4175

## Music/Theater Awards

For more information on music and theater awards available at Missouri S&T, write:

Music/Theater  
127 Castleman Hall  
Missouri S&T  
Rolla, MO 65409-0670

## Cooperative Training Programs

For information on the co-op/internship program at Missouri S&T, contact:

Career Opportunities and Employer Relations  
303 Norwood Hall  
Missouri S&T  
Rolla, MO 65409-0240  
573-341-4309

## Transfer Scholarship Program

Missouri S&T offers a significant number of scholarships to new transfer students who will be enrolling at Missouri S&T. For more information on this scholarship program, contact:

Office of Admission, Transfer Admissions  
106 Parker Hall  
Missouri S&T  
Rolla, MO 65409-0250  
573-341-4165

## Departmental Scholarships

Various departments within the university offer a number of scholarships to students majoring in that area. Interested students who have been admitted should visit <http://sfa.mst.edu/academicworks/>.

## ROTC (Army or Air Force)

For more information on the ROTC programs at Missouri S&T, contact:

Army ROTC  
301 Harris Hall  
Missouri S&T  
Rolla, MO 65409-0310  
573-341-4744

or

Air Force ROTC  
206 Harris Hall  
Missouri S&T  
Rolla, MO 65409-1450  
573-341-4925

## Graduate Student Aid

Federal Work Study, Federal Perkins Loans, University Loans and Ford Direct Loans are available for graduate students through the Missouri S&T student financial assistance office. Graduate students should contact the department in which they are majoring for information or scholarships, grants, fellowships or assistantships.

## Scholarship Reinstatement Policy

Students who lose a renewable scholarship due to not earning the required renewal cumulative grade point average, and are able to raise their cumulative grade point average after the completion of the next academic year (i.e. spring semester) to the renewal cumulative grade point average, could have their scholarship reinstated for the following academic year.

It is the scholarship recipient's responsibility to inform the student financial assistance office that he or she meets the renewal cumulative grade point average to receive their scholarship for the next academic year. This notification must be received in writing by the student financial assistance office prior to the end of the fourth week of classes in the fall semester.

Once the fourth week of classes in the fall semester has passed, a student cannot receive scholarship funds retroactive for the current or previous semesters based upon meeting the renewal cumulative grade point requirement.

This policy only applies to general operating scholarships. Departmental, Alumni, donor (non-general operating), and state scholarships will not be reinstated under this policy.

## Professional Leadership and Campus Engagement

Leadership and cultural program's mission is to assist students in developing skills they need to serve as successful leaders in a global community. We realize that in order to be successful citizens and competitive in the job market, students need to be culturally competent and possess strong communication, leadership, and personal management skills. We contribute to student retention and satisfaction by enhancing students' educational experience through providing quality programs and resources. Our programs include cultural celebrations, skill development workshops, dialogue series, and experiential learning activities on and off campus. For more information visit our website at: <http://minerleaders.mst.edu/>.

## Required Assessment Testing

### Missouri S&T Assessment Policy

All students at Missouri S&T are required to participate in assessment of learning outcomes before graduation. The requirement for assessment originated from directives of the governor and Missouri General Assembly for institutions to show direct evidence of student learning. The coordination of assessment processes is housed within the provost's office under the guidance and support of the assistant vice provost for the office of institutional research and assessment and the University Assessment Committee.

## General Education Assessment

All students who have attained the junior class level, in each semester, are automatically scheduled to take the ETS' proficiency profile test, which measures general education skills in reading, writing, mathematics, and critical thinking. Students will be notified the semester they qualify to take the test. Students who have earned 61 or more credit hours and who did not test will have a HOLD placed on their academic account. This HOLD will prevent the students from future registration of courses.

Information on how to take the general education test can be found at <http://ira.mst.edu/ets/>.

## General Education Program Learning Goals

The seven general education learning goals below are designed to help students acquire sufficient general knowledge and intellectual versatility. Students are expected to obtain the following competencies:

1. an ability to communicate effectively both orally and in writing
2. an ability to think critically and analyze effectively
3. an ability to apply disciplinary knowledge and skills in solving critical problems
4. an ability to function in diverse learning and working environments
5. an understanding of professional and ethical responsibilities
6. an awareness of national and global contemporary issues
7. a recognition of the need for, and an ability to engage in life-long learning

## General Education Course Distribution

The general education learning goals can be achieved by taking up to 60 credits in the following six content areas:

- English/Composition, 6 credits
- Western Civilization, 6 credits
- Foreign Languages, 12-16 credits
- Sciences, 12 credits
- Humanities, 12 credits
- Social Sciences, 12 credits

Students pursuing a bachelor of science degree in engineering must fulfill all courses in the common freshmen year program as listed under the Freshman Engineering Program. The degree program shall include a minimum of 21 credit hours in the following subjects: English, history and economics with the remaining courses chosen from the list of approved humanities/social sciences courses. Each department may further specify the requirements for electives.

## Assessment in Student Majors

Seniors are scheduled to take the major field test before clearance for graduation. Engineering student majors are required to take the Fundamentals of Engineering (FE) test, and non-engineering student majors are required to take the ETS' major field test (MFT) in their respective field of study. Note that some departments administer in-house tests in lieu of the FE or MFT.

Information about the FE test and requirements are available in each Engineering department. Students receive the MFT notification from their department. The office of institutional research and assessment collaborates with the testing center to administer the MFT. Information about MFT test dates and sample questions are available at [http://ira.mst.edu/assess/assess\\_tests/](http://ira.mst.edu/assess/assess_tests/).

## Student Engagement

In addition to the direct measures of assessment outlined above, student learning outcomes are also assessed indirectly through various institutional effectiveness surveys. For example, freshmen and seniors are scheduled every three years to complete the National Survey of

Student Engagement (NSSE), which obtains information about student engagement and participation in degree programs and activities that institutions provide for their learning and personal development.

## Use of Assessment Results

In these integrated assessment processes, the evidence gathered through assessment activities are used in several ways:

- Students use evidence to improve their own learning processes and outcomes.
- Faculty use evidence to update and improve curricula, either in content or methodology.
- Degree programs use evidence in periodic program reviews and ongoing curriculum development to ensure that the program outcomes for student learning are being met.
- Colleges use evidence to set priorities for resource allocations and to monitor the contribution of degree programs to the college mission and goals.
- Professional staff members use evidence to modify existing services and to create new approaches for delivering services to students.
- University administrators use evidence to assess the quality of the degree programs and support services provided to students and the effectiveness of the university in carrying out its mission

## Residential Life

The residence halls at Missouri S&T are divided into 5 complexes. These include Thomas Jefferson Hall, University Commons, Residential Commons, Miner Village, and the Downtown Complex which contains buildings both owned by the university and leased from local landlords. Leased units are within close proximity to campus and are staffed and managed similar to on-campus facilities. The goal of the department of residential life is to provide students with a living environment that is best designed to meet the academic and personal needs of the individual student. Each residence hall complex is administered by a professional live-in resident director (RD) and is staffed by paraprofessional students called resident assistants (RAs). All residence hall staff members work to develop academic living environments and are trained to help students cope with the challenges associated with college. Their efforts are supervised by the residential life staff and they work closely with the counseling center staff and other members of the student affairs division.

The department of residential life works to provide students with facilities and services that will best serve the lifestyle needs of Missouri S&T students. Various living arrangements are available to students, including quiet floors, specialized learning communities and interest area communities, upperclassmen housing, double rooms, suite-style housing, cooperative living units, and apartments. All rooms are furnished with beds, closets or wardrobes, desks and chairs. Students have the option of bringing personal items to give their room their own individual touch. Most communities have study rooms and lounges available for resident use. Other facilities in the residence hall include laundry facilities, computer learning centers, meeting areas, game rooms, and vending machines, depending on the complex.

The residence hall communities are administered with input from students. Each complex has its own governing body and the residence hall association (RHA) is a representative group of all residence hall students. These groups play a major role in defining the policies that govern the residence halls and sponsor a significant number of social,



diversity, community service and educational programs. Representatives for these groups are selected in community or complex elections.

Being a residential university, Missouri S&T requires freshman and sophomores to reside in university approved housing: the residence hall complexes, the downtown leased properties, an approved fraternity house, an approved sorority house, or Christian Campus Fellowship house. Exceptions may be granted for married students, students whose parents reside in the Rolla area, military veterans, students over 21 years of age, or other justified situations.

Meals are served in dining halls located in or near each complex. Dining halls offer full-meal service on the weekdays and partial-meal service on the weekends when school is in session. Throughout the year, special meals are served to provide more variety in the cafeteria service. Several meal plans are available that can be used at all on-campus retail and dining locations. These plans are designed to allow students the opportunity to select the meal plan that is best tailored to meet their needs. Students who live in the residence halls are required to contract for one of these seven plans. Students who live in the university's apartments or who live off campus have the option of purchasing a dining plan if they so choose.

For the most recent information on the residence halls, please refer to our web page at <http://reslife.mst.edu/>

## How to Apply

Applications and information regarding university housing are sent beginning in October to students who are accepted for admission. If you are interested in more information about university housing, contact:

Residential Life Office  
205 W. 12th Street  
Missouri University of Science and Technology  
Rolla, MO 65409-0510  
[reslife@mst.edu](mailto:reslife@mst.edu)  
<http://reslife.mst.edu>  
573-341-4218

## Housing Expenses for 2017-2018 Academic Year

### Residence Halls

Downtown Complex	\$5370-8185
Miner Village	\$7670-8250
Residential Commons	\$5735-9070
Thomas Jefferson Hall	\$5405-6780
University Commons	\$7635-8960

Several factors influence the cost of affiliating with fraternities and sororities. Consequently, the cost varies from chapter to chapter, but compares favorably with other types of student housing. To obtain the most accurate information, contact an individual fraternity or sorority or the student life office. Meals are available by each fraternity or sorority and additional meal plans are available through residential life.

Additional information about the housing and food services offered by the university is available through:

Residential Life Office  
205 W. 12th Street  
Missouri University of Science and Technology

Rolla, MO 65409-0510  
[reslife@mst.edu](mailto:reslife@mst.edu)  
<http://reslife.mst.edu>  
573-341-4218

## Student Conduct

A student enrolling in Missouri S&T assumes an obligation to behave in a manner compatible with the university's function as an educational institution. The university's standard of conduct and rules of procedures in student conduct matters are printed in the Student Handbook and the Student Academic Regulations and can be found on the web. Other departments and organizations, such as residential life and computer services, have specific policies and standards for their residents and/or users, as well as procedures for handling violations.

See: <http://communitystandards.mst.edu>

## S&T Police Department Parking

All student-operated vehicles should have either a valid campus parking permit or student registration decal affixed properly to the vehicle. Missouri S&T Parking, Security and Traffic Safety Regulations, as adopted by the Parking, Security and Traffic Safety Committee and approved by the chancellor, provide for the payment of established fees for parking privileges and set fees for violation of those regulations. The university police department has the responsibility of enforcing parking regulations at Missouri S&T.

The size of the student body, faculty, and staff, coupled with the fact that a large number of students live off-campus, leads to a relatively large number of motor vehicles on and near the campus. This traffic load, in turn, complicates parking for the campus citizen and creates a hazard for vehicles and pedestrians. The committee has prescribed the rules governing the classification and use of parking lots, the qualifications for parking on those lots, and the rules for application, issuance, and use of parking permits.

Specific information on current regulations and other details pertaining to parking can be obtained at the University Police Department, G-10 Campus Support Facility, 573-341-4303. The regulations may also be found at: <http://police.mst.edu/parking/parking>.

## Missouri S&T Parking: Rules in Capsule Form

1. All parking on campus requires either a purchased permit or payment at a meter. Decals (permit and registration stickers) must be affixed to the outside of the rear window or bumper on the driver's side of the vehicle. Temporary tags shall be affixed to the inside rear window on the driver's side of the vehicle or hung on rear-view mirror.
2. All vehicles shall be parked **HEADING** into the parking spaces. (Do not back into or pull through the space.)
3. A visitor is anyone **OTHER THAN** an employee, student or member of their family.
4. Regulations pertaining to area permits and metered parking are enforced **YEAR ROUND** from 7:30 a.m. to 4:30 p.m. except on Saturdays, Sundays and official university holidays. Other regulations are enforced at all times.

5. Permit and metered parking at Thomas Jefferson Residence Hall and the Multi-Purpose Building shall be enforced 24 hours a day 7 days a week.
6. Employees and students lending their vehicle to a visitor will be responsible for any violations occurring on campus.
7. Parking permit owners shall park only in the area to which the purchased permit allows access.
8. Employees and students without parking permits shall use only metered spaces.
9. Specially marked disabled parking, driveways, yellow curbs and zones, spaces marked for 24 hour enforcement, fire lanes, vehicle types and areas not designated as a parking area, etc., shall be enforced 24 hours a day seven days a week.
10. University driveways, yellow curbs and zones, and any other area not specifically designated as a parking area shall not be used at any time.
11. The Director of University Police, with the concurrence of the Parking Committee Chair, shall have the authority to suspend all or part of the parking regulations for specific periods of time.

The full and complete set of Missouri S&T Parking Rules and Regulations can be found on our website, <http://police.mst.edu/parking/parking/>.

## Lost and Found

The university police department is the central "lost and found" repository for the campus. Any lost and found items should be turned into the university police for reclamation purposes. If an item is lost, information should be filled out with university police, 573-341-4300, or can be reported by accessing: <http://police.mst.edu/aboutus/services/lost/> in case the item is turned in at a later date.

## Campus Security

### Missouri State Uniform Crime Reporting (UCR) Statistics

Every law enforcement agency in the state is required to report crime data monthly to the Missouri State Highway Patrol (MSHP). MSHP creates and maintains computer files of the Missouri data and supplies information not only to the Federal Bureau of Investigations (FBI) for use in national crime statistics, but also to local agencies and organizations. To access crime data for the Missouri S&T police department submitted to the MSHP visit the MSHP Statistical Analysis Center: [http://www.msdp.dps.missouri.gov/MSHPWeb/SAC/data\\_and\\_statistics\\_ucr.html](http://www.msdp.dps.missouri.gov/MSHPWeb/SAC/data_and_statistics_ucr.html).

### Jeanne Clery Disclosure of Campus Security Policy and Campus Crime Statistics Act (CLERY)

As required by the U.S. Department of Education, the CLERY Act requires higher education institutions to make public certain crime data. Review the annual CLERY report submitted by the Missouri S&T police department online: <http://police.mst.edu/info/clery/>. A paper copy of the report can be requested by contacting the Missouri S&T police department at 573-341-4300 or by responding to the department which is located in G-10 Campus Support Facility.

### Daily Crime Report

The CLERY Act also requires that crime information be made available to the public within two working days. Review the Daily Crime Report in

the lobby of the Missouri S&T police department located in G-10 Campus Support Facility or at <http://police.mst.edu/crimeinfo/ucr/>.

## University Police

The mission of the Missouri S&T police department is to support the academic and campus community in fulfilling its commitment to teaching, research, and service. The functions performed by the Missouri S&T police department include many services offered by a small municipal police agency, as well as certain service functions unique to the university setting. The Missouri S&T police department has an authorized strength of 23 full-time employees, including 12 state-commissioned police officers, six security guard, two parking control officers and four administrative staff members. Missouri S&T police officers are empowered under Chapter 172.350 of the Missouri Revised Statutes. As such the police officers are commissioned and armed. Additionally all Missouri S&T police officers possess Rolla City Police commissions as well. Police officers patrol on foot and by vehicle all properties owned by the Missouri University of Science and Technology 24 hours seven days a week. The security guards perform additional security checks on the main campus during evening and night hours. In addition to the full-time staff, the department employs six campus service officers (CSO's), who are students that assist on a part-time basis. Missouri S&T police department also has a Reserve Police Officer Program where part-time officers are used on an as-needed basis.

Duties of the Missouri S&T police department include, but are not limited to, preventative patrols, the investigation of crimes, crime prevention through active campus involvement, service to students and others in emergencies, special event coverage, overseeing parking lot operations, and the enforcement of state laws, city ordinances, and university rules and regulations.

The university police are dispatched from the Rolla 911 Call Center. To have a university police officer respond to your location you may call 911 or the non-emergency line for the university police, 573-341-4300.

## Reporting Crimes at Missouri S&T

All crime victims are highly encouraged to report incidents to the Missouri S&T police department regardless of how seemingly insignificant the crime. Missouri S&T policy requires employees to promptly report all criminal acts occurring on campus. To report a crime, the victim or witness need only call the Missouri S&T police department. A police officer will meet with the person to gather information and prepare an official report. A log of all reported crimes is posted at the Missouri S&T police department (G10 Campus Support Facility) and on our website, <http://police.mst.edu/crimeinfo/ucr/>, under crime statistics to meet CLERY Act requirements.

## Security of Campus

Accountability of the security of campus facilities originates with the department chair. Areas of responsibility include, but are not limited to, both interior and exterior entryways, exits, and windows, and items of value within the department. Areas not under a specific department shall be under the responsibility of the next higher level within the division.

The department chair is ultimately answerable for security problems existing within his/her area of control, but can designate a dependable and reliable individual(s) areas of security responsibility.

A particularly sensitive area in building access control is the issuance of keys by departments to faculty, staff, and students. Department key

issuance and control shall comply with guidelines set forth in BPM-404 Keys to University Buildings: [http://www.umsystem.edu/ums/rules/bpm/bpm400/manual\\_404](http://www.umsystem.edu/ums/rules/bpm/bpm400/manual_404).

Buildings shall be secured during the evening hours at the earliest reasonable time. Any facility open for an extended period after normal operating hours for that building shall require a permit to be open for the hours specified on the permit.

During the academic year in which residence halls are open, those halls shall be secured during the evening hours according to housing department regulations. Faculty, staff, and students are encouraged to prevent access by unauthorized personnel, in both residence halls and other campus buildings, by verifying any door entered or exited has closed and locked.

Maintenance of campus facilities involving security problem areas, such as broken locks, windows, door, etc., shall involve reporting the security problem as soon as possible to the physical facilities department, who shall rectify the security breach within a timely manner.

## **RAVE Guardian**

Missouri S&T University purchased an add-on phone app for the campus community. The app is named Rave Guardian and is available for free at the app store for anyone who has a Missouri S&T email address. The app has several different valuable components including a safety timer, a method to text message the university police, an icon to reach the university police with the touch of a button, and the ability to call the 911 call center with the touch of a button. For further information on the Rave Guardian app please visit the website: <http://ravemobilesafety.com> or contact the university police department via email [police@mst.edu](mailto:police@mst.edu) or via phone 573-341-4300.

## **Alcohol/Illegal Drugs Policies:**

### **Alcoholic Beverages**

The use or possession of any alcoholic beverage is prohibited on all university property, except in the president's residence and the chancellors' residences, and the sale, use, or possession may, by appropriate university approval be allowed in approved university alumni centers or faculty clubs, and for single events and reoccurring similar events in designated conference, meeting, or dining facilities provided by university food services, subject to all legal requirements. Further information pertaining to alcoholic beverages can be obtained from the S&T Alcohol Handbook: <http://chancellor.mst.edu/media/administrative/chancellor/documents/policy/I-90.pdf>.

### **Illegal Drugs**

University of Missouri regulations prohibit the unlawful possession, use, distribution, and sale of alcohol and illicit drugs by university students and employees on university-owned property and at university or supervised activities. Local, state, and federal laws also prohibit the unlawful possession, use, distribution, and sale of alcohol and illicit drugs. Violation of the University of Missouri regulations and federal and state laws can result in disciplinary action up to and including expulsion for students and discharge for employees.

A variety of resources exist for drug and/or alcohol counseling, treatment, or rehabilitation program. For detailed information concerning university and community resources, students and employees may contact the Substance Abuse Prevention Program, 107 Norwood Hall, 573-341-4292. Confidential consultation, assessment, short term counseling, and

referral services are available free of charge to faculty, staff, and students. A variety of prevention of education programs are also offered.

## **Victim of Sexual Assault Information**

The following information is provided to assist a person who has been the victim of a sexual assault.

### **Emergency Medical Examination/Evidence Collection**

Receiving medical care immediately following a rape, attempted rape, or sexual assault is extremely important for your well-being. It is essential that you obtain:

- Emergency medical exam if you are injured.
- A general medical exam to ensure that you haven't obtained injuries that you are unaware of or unable to determine.
- A medical/legal examination for the collection of evidence if you think there is any possibility you will want to prosecute the offender. The exam must be conducted within 48 hours of the assault and you must NOT clean up before the exam to avoid loss or contamination of evidence.
- Testing for sexually transmitted diseases. AIDS, and possible pregnancy (as part of follow-up treatment).

For medical emergencies, call 911 to have an ambulance dispatched.

Other sources of medical information for victims include Missouri S&T student health services (available during business hours).

### **Emotional Support**

The need for emotional support and assistance after a rape, attempted rape, or sexual assault is great. In the aftermath of such a violation and loss of control, it may be difficult to consider what steps to take.

Contact a close friend or family member to talk with and assist in making decisions. Contact the Missouri S&T counseling center whose services are strictly confidential and contacting this support service does not obligate you to take any further action.

### **Reporting of Incident**

You may wish to report the assault in order to have the alleged offender apprehended and/or for the protection of self or others. If this is the case, successful apprehension and or prosecution of the offender depends greatly on a rapid and accurate report of the crime. Information about the assault can assist law enforcement authorities in providing and improving prevention strategies for the protection of the victim and others in the community.

You have the option of making a report for the purpose of assisting the police in protecting the community without obligation to participate in the prosecution. While the actual prosecution of the offender is pursued by the Phelps County prosecutor (not by the victim), prosecution is unlikely to occur without the consent and assistance of the victim. You have the right to choose not to contact the Missouri S&T police, but you are strongly encouraged to report the assault to the police department.

### **Anonymous or Third Party Reporting**

Even if you may not want to prosecute the offender to have it known you were the victim of an assault, you can choose to report the assault anonymously. Or somebody who you have told about the assault can report it. This type of reporting will provide the department with general information that may be useful in preventing additional assaults on

campus. To make an anonymous report, call the police department and request to speak with an officer.

## Disciplinary Actions

Whether or not you choose to report the assault to law enforcement or participate in criminal prosecution, you may decide to take action through the campus judicial system. If you were assaulted by another Missouri S&T student, on or off-campus, the accused may be charged under the University of Missouri Standard of Conduct. The judicial officer at Missouri S&T is available to discuss campus judicial procedures. While the judicial officer may investigate the complaint and impose appropriate discipline with or without the victim's consent, discussing a matter of sexual assault with her/him does not compel the victim to participate actively in pursuing disciplinary charges. The judicial officer's phone number is 573-341-4292.

## Contact with Offender

In situations where the accused and the accuser may be in close contact with each other because of class schedules and/or living arrangements, adjustments to housing or class schedules may be made. The director of residential life has the authority to give the accuser and/or accused the option of changing living arrangements. If the accuser and the accused refuse to change living arrangements, the director has the authority to change the living arrangements of either person. The judicial officer shall give the parties the option of changing class schedules to avoid contact. However, change of class schedules cannot be required until after disciplinary proceedings have concluded.

# Student Design and Experiential Learning Center (SDELC)

## 116 Kummer Design Center Chris Ramsey (Director)

### Learn. Succeed. Have Fun!

Experiential learning is the foundation of a broad-based Missouri S&T education.

The Student Design and Experiential Learning Center (SDLEC) serves as the business incubator and support center for fourteen multi-disciplinary, student-managed design teams.

The SDELC is housed in the Kummer Student Design Center, a new facility that provides design team members with advanced computer design labs and software, a complete manufacturing and testing center, business offices and logistical assets, along with the technical, marketing, communication and fundraising support necessary to prepare students for successful careers even before graduation.

Team membership is open to, and encouraged of, S&T students of all academic majors, not just engineering. Team-based learning blends traditional classroom instruction with the critical "outside-the-box" thinking necessary to be successful in a fast-paced development project.

Design team participants enjoy:

- 24-7 facility access
- Strong faculty, staff, business and community support
- Networking opportunities with employers and university competitors
- Specialized training

- Global experience

Visit our website at: [design.mst.edu](http://design.mst.edu) (<http://design.mst.edu>), our blog at [experiencethis.mst.edu](http://experiencethis.mst.edu) (<http://experiencethis.mst.edu>), call 573-341-7546, or e-mail [sdelc@mst.edu](mailto:sdelc@mst.edu) for more information or to learn how to join a team.

## Student Diversity Initiatives

The mission of the student diversity initiatives (SDI) office is to actively increase the number and diversity of prepared and motivated first through twelfth-grade students through STEM enrichment-focused camps and workshops; to recruit, support and retain female and traditionally underrepresented minority students in science, technology, engineering and math (STEM) fields through educational and professional development resources.

Through programs and partnerships, SDI supports diversity-related programming and promotes awareness about female and multicultural related issues; SDI helps foster an academic and professional environment that supports the students of Missouri S&T and strengthens the campus community.

## Student Diversity Program

The mission of student diversity program (SDP) is to actively recruit and retain academically talented students from ethnic populations that are historically under-represented in higher education. In conjunction with the university's mission, SDP's ultimate goal is to create an environment that provides the development/guidance and academic support needed to be successful at Missouri S&T; while equipping our students with the knowledge and skills needed to transition effectively into society.

SDP, through its programs, partnerships and ongoing assessments of the learning, styles and personality traits will foster an academic environment that will ensure our students success. Through execution of these initiatives, the university will develop a pool of committed and gifted Missouri S&T's ambassadors that could be utilized to recruit other underrepresented minority students to the campus.

Activities include (but are not limited to) academic recognition events, off and on campus recruitment programs, mentoring, leadership and professional development and scholarships. Such scholarships as the Minority Engineering and Science scholarships are to increase minority representation representation in math, engineering, science or technology degree programs.

## Women's Program

Women's program mission is to serve as an educational and professional development resource center for all students and promote awareness of female and diversity-related issues to the campus.

Women's program provides activities and programs for students to learn about diversity in leadership from the female perspective. Our goal is to encourage student involvement and strategic leadership in campus and community organizations through participation in: guest lectures, workshops, professional development, networking skills, scholarships, student organizations (SWE) and mentoring/advising. The ultimate goal is to enable students to assume leadership and management positions after completing their degree.

For more information about events, programs and scholarships, visit our website at <https://sdi.mst.edu/>.



You may contact us directly at 573-341-7286 or via e-mail at [sdi@mst.edu](mailto:sdi@mst.edu). Student Diversity Initiatives, 605 W. 11<sup>th</sup> Street.

## Student Health Services

The goal of Missouri S&T Student Health Services is to provide for healthy students and a healthy campus population.

Student Health offers a wide range of primary health care for currently enrolled students at Missouri S&T. Multiple providers are available to deliver care for acute illness and injury. The Student Health fee covers visits with the providers, but some procedures, labs and medications may require a small fee. It is highly recommended that all students have some form of health insurance to cover for services not provided at Student Health. An Aetna group policy is available and information on this plan may be obtained at the Cashier's Office or the Student Health Complex.

There are certain requirements that need to be met before you can complete enrollment and move onto campus. Failure to meet these requirements will result in a hold on your registration process.

To submit your information, please follow the instructions on the Student Health website <http://studenthealth.mst.edu/>.

At a minimum, students must submit records including:

- **Two Measles, Mumps, Rubella Vaccines (MMR).** The first one must be done after age 12 months; the second at least 30 days later.
- **One Meningitis Vaccine,** given after age 16. Missouri Senate Bill 754 states, "each student attending a public institution of higher education who lives in on-campus housing **must receive the meningococcal vaccine** unless he or she has a medical or religious exemption". Vaccination strongly recommended for all university students. You will not be allowed to move into campus housing if we have not received your meningitis immunization documentation. More information about the meningitis vaccine and disease can be found on the Student Health Website
- **Tuberculosis Screening Form for New Students.** This form must be completed by all students and can be found on the SHS website, <http://studenthealth.mst.edu/>. Student Health staff will review and contact you within five days if further testing is necessary.

For more information contact:

Student Health Services  
910 W. 10th St.  
Rolla, MO 65409  
573-341-4284  
[mstshs@mst.edu](mailto:mstshs@mst.edu)

## Student Organizations

Student life encourages active engagement in our community in means which complement classroom learning, <http://studentlife.mst.edu>.

## Academic and Departmental

Actuarial Science Club, American Chemical Society WT Schrenk Chapter, American Concrete Institute, American Foundry Society, American Institute of Aeronautics and Astronautics, American Institute of Chemical Engineering, American Nuclear Society, American Rock Mechanics Association, American Society for Engineering Management and Institute of Industrial Engineers, American Society of Civil Engineers, American Society of Heating, Refrigerating and Air-Conditioning Engineers,

American Society of Mechanical Engineers, Architectural Engineering Institute, Associated General Contractors, Association for Computing Machinery, Association for Computing Machinery Women, Association of Environmental and Engineering Geologists, Blacksmithing Club of Rolla, C.L. Dake Geological Society, Computer Society Student Branch of the IEEE, French Club, Future Business Leaders of America, Gaffers Guild, HELIX Life Science Club, History Club, Institute of Electrical and Electronic Engineers, Institute of Transportation Engineers, International Council on Systems Engineering, International Society for Explosives Engineers, International Society for Pharmaceutical Engineering, Material Advantage, Mathematical Association of America, MBA Association, Miner Choir Guild, National Sand Stone and Gravel Association, Phi Sigma, SCRUBS, Society of Exploration Geophysicists, Society of Manufacturing Engineers, Society of Mining, Metallurgy, and Exploration, Society of Petroleum Engineers, Society of Physics Students, Student Missouri State Teachers Association, YTech Commies, Water Environment Federation Association of Environment Engineers and Science Professors, Women as Leaders, Women in Mining, Women in Nuclear

## Honor and Professional

Alpha Chi Sigma, Alpha Nu Sigma, Alpha Psi Omega, Alpha Sigma Mu, American Association of Drilling Engineers, Blue Key, Chi Epsilon, Epsilon Mu Eta, Eta Kappa Nu, Industrial Designers Society of America, Kappa Kappa Psi, Kappa Mu Epsilon, Keramos, National Residence Hall Honorary, National Society of Black Engineers, Omega Chi Epsilon, Order of Omega, Phi Alpha Theta, Phi Eta Sigma, Phi Sigma Pi, Pi Epsilon Tau, Pi Tau Sigma, Psi Chi, Sigma Gamma Epsilon, Sigma Gamma Tau, Sigma Tau Delta, Society of American Military Engineers, Society of Hispanic Professional Engineers, Society of Women Engineers, Tau Beta Pi, Tau Beta Sigma

## Intercultural

African Student Association, Association for Black Students, Chinese Students and Scholars, India Association, International Student Club, Iranian Students Association, Korean Students Association, Libyan Student Association, Malaysian Students Organization, Saudi Students Association, Taiwanese Student Association, Thai Students Association, Turkish Students Association

## Media and Publication

KMNR Radio Station (89.7 FM), Miner Multi-Media, Missouri Miner, Rollamo, Southwinds

## Programming

St. Pat's Celebration Committee, Student Union Board

## Governing

Associated Students of the University of Missouri (ASUM), Council of Graduate Students, Downtown Hall Association, Greek Independent Board, Interfraternity Council, Miner Village Hall Association, Panhellenic Council, Residence Hall Association (RHA), Residential Commons Hall Association, Student Council, Thomas Jefferson Residence Hall Association, University Commons Hall Association

## Recreation and Sports

Aerial Swing Dancing, Anglers, Archery Club, Backpacking Club, Ballet and Dance Club, Boffer Club, Chess Club, Climbing Club, Club Baseball, Cycling Club, Disc Golf Club, Fencing Club, Gaming Association, In-Line



Roller Hockey Club, Lacrosse Club, Longboarding Club, Paintball Club, Radio Control Club, Rolla Aikido Club, Rugby Club, Spelunkers Club, Taekwondo Club, Tennis Club, The Miner Wrestling Club, Trap and Skeet Club, Ultimate Club, Volleyball Club, Water Polo Club, Youn Wha Ryu

## Faith Based and Spiritual

All Nations Christian Fellowship, Baptist Student Union, Campus Crusade for Christ, Catholic Newman Center, Chi Alpha, Christian Campus Fellowship, Common Call Campus Ministry, Fellowship of Christian Athletes, Geeks for God, Hillel of Missouri S&T, Koinonia (Student Fellowship of Church of Christ), Latter-Day Saint Student Association, Lutheran Student Fellowship, Muslim Student Association, Restoration Campus Ministries, Voices of Inspiration

## Service

Alpha Phi Omega (APO), FIRST Alumni Association, Habitat for Humanity, Intercollegiate Knights (IK), Lambda Sigma Pi, Missouri S&T Chapter of Optimists International, Omega Sigma, Project Lead the Way Alumni Association

## Social and Special Interest

Academic Competition Team, BBQ Club, Black Man's Think Tank, Blue Sabres, College Democrats, College Republicans, Collegiate Eagle Scout Association, Delta Omicron Lambda, Ducks Unlimited, Eco Miners, Fraternal Order of Leaders, Free Thinkers Society, Greeks Advocating Mature Management of Alcohol (GAMMA), Humans Versus Zombies (HvZ), Independents, M-Club, Military Aerospace Society, Miners in Space, National Society of Leadership and Success, Perfect 10 Improv, Photography Club, PsyCo, Radio Club (Amateur), S&T Riders' Society, Secular Student Alliance, Show Me Anime, Spectrum, Student Veterans Association, STAT-Students Today Alumni Tomorrow, Technical Innovators & Entrepreneurs, Toastmasters International, Video Game Development, Warriors of Stonehenge

## Student Design Groups

Advanced Aero-Vehicle Group, Concrete Canoe Team, Engineers Without Borders, Formula Electric SAE, Formula SAE, Human Powered Vehicle Team, International Genetically Engineered Machines (iGEM), Mars Rover Design Team, Miner Baja SAE, Nuclear Science Design Team, Robotics Competition Team, Solar Car Team, Solar House Team, Steel Bridge Team

## Fraternities

Alpha Epsilon Pi, Alpha Phi Alpha, Beta Sigma Psi, Delta Lambda Phi, Delta Sigma Phi, Delta Tau Delta, Kappa Alpha, Kappa Alpha Psi, Kappa Sigma, Lambda Chi Alpha, Omega Psi Phi, Phi Beta Sigma, Phi Kappa Theta, Pi Kappa Alpha, Pi Kappa Phi, Sigma Chi, Sigma Nu, Sigma Phi Epsilon, Sigma Pi, Sigma Tau Gamma, Tau Kappa Epsilon, Theta Xi, Triangle

## Sororities

Chi Omega, Delta Sigma Theta, Kappa Delta, Missouri S&T Gamma Phi Lambda Colony, Phi Sigma Rho, Zeta Tau Alpha

For more information about any recognized organization, or how to get involved on campus, contact the department of student life at 573-341-6771, [stulife@mst.edu](mailto:stulife@mst.edu) or <http://studentlife.mst.edu>.

## Volunteerism and Service

At Missouri S&T, we realize that our impact goes far beyond our campus. As a result, the office of student life is committed to contributing to the betterment of our local, surrounding, and global communities. We do this by offering students a variety of opportunities to become actively engaged through service. All of which is possible due to the mutually beneficial partnership that exists between community organizations and the University. Annual events such as the Civic Engagement Fair, Make A Difference Day, Martin Luther King Day of Service, and the Miner Challenge Alternative Spring Break program are some of the volunteerism highlights of the academic year. Learn how to get involved in volunteer activities by joining our listserv at <http://studentlife.mst.edu/volunteerism/volvementhomepage/> or by watching campus announcements for opportunities scheduled throughout the year. For more information on how you can get involved in volunteerism and service, please contact the Department of Student Life, 218 Havener Center, at 573-341-6771 or [stulife@mst.edu](mailto:stulife@mst.edu).

## Student Success Programs

Student Success Programs, an office of enrollment management, coordinates the New Student Programs office, Student Success Center, Student Veterans Resource Center and the university's ID card service. Student Success Programs will empower students and their families with vital information and contacts to enhance students' academic, personal and professional success at Missouri S&T. The goals of the program are achieved through a coordinated sequence of events which provide constructive interactions between students, students' families, faculty, staff, and community leaders.

## New Student Programs

New Student Programs is responsible for the campus orientation programs, which includes Preview, Registration, and Orientation (PRO); opening week orientation; transfer transitions orientation; veterans orientation, opening week; mentors; and PRO leaders. New Student Programs serves to orient and welcome new students to Missouri S&T; facilitates the transition to college life through interaction with faculty/staff members, peers and upperclassmen; provides information concerning academics; resources on campus; builds the foundation for future success; and introduces the concepts of professional development and leadership.

During a one-day PRO session in the spring or summer, incoming students take placement exams; learn more about student success; campus resources; living options; obtain their miner card (campus ID); activate computer accounts; and meet with an academic advisor to determine students' fall class schedules. Opening week orientation takes place the week before fall classes. This program includes new student convocation, participation in student mentor groups, academic workshops, team projects, and activities that will assist with a positive transition to S&T.

**PRO Leaders** are a selected group of student leaders for the New Student Program's office with primary duties consisting of assisting with planning and executing programs for new students and their families during PRO days, transfer transitions, and opening week.

## Burns & McDonnell Student Success Center

The Student Success Center is to serve all Missouri S&T students as a campus resource that will provide high quality customer service, effective information, and support as students persist in their journey towards their educational goals.

The Student Success Center is a centralized location, 198 Toomey Hall, designed for students to visit and feel comfortable about utilizing the campus resources available. The Student Success Center was developed as a campus wide initiative to foster a sense of responsibility and self-directness to all S&T students by providing peer mentors, caring staff, and approachable faculty and administrators who are student-centered and supportive of student success.

The objectives of the Student Success Center are to: coordinate and support programs and retention efforts that foster student success at Missouri S&T; collaborate with academic and non-academic departments on resources available to help enrich students' educational experiences; guide students on the path to success by providing referrals to appropriate campus departments and resources to help them achieve at the best of their ability and reach their educational goals.

## Student Veterans Resource Center

The Student Veterans Resource Center (SVRC) is designed to empower and educate all student veterans/military on utilizing the campus tools and resources to be successful students. The SVRC was developed as a campus wide initiative dedicated to our student veterans by providing a comfortable and resourceful study area; success coaches; peer mentors; knowledgeable and caring staff; effective programs and events; approachable faculty and administrator who are supportive of student success for all veterans on the S&T campus.

**Veterans' Consuls** are a selected group of student leaders assisting the Student Success Center and the Student Veterans Resource Center with duties consisting of: Planning and executing success programs; Developing success plans for students; Serving as a mentor for current students; Referring students to resources.

## Miner Card

The miner card (campus ID card), is required for all students. The miner card features: student's photograph, name, signature, and emergency contact phone numbers. Students should treat their miner card with the same care as you would an ATM or credit card. The miner card can be used at the The S&T Store, Gale Bullman Multi-Purpose Building (athletics), Missouri S&T Library, building/room access, on-campus dining, entitles students to sporting and theater special events, discounts at restaurants and businesses. Lost or found miner card should be reported to the miner card ID office in 106 Centennial Hall or by calling 573-341-4996.

The miner card is the property of the Missouri University of Science and Technology and is non-transferable. This card provides the valid bearer with privileged access to designated university facilities and services. It should be carried at all times and presented upon request.

## Teacher Education Program

### Elementary Teacher Education Program

The elementary education program is endorsed by the Missouri Department of Elementary and Secondary Education (DESE) and is fully accredited. Students will earn a bachelor of arts degree in multidisciplinary studies with a teaching certificate for elementary education. Graduates of this program will have the knowledge of science, technology, engineering and mathematics (STEM) to share with first through sixth grade students.

### Secondary Teacher Education Program

If preparing for secondary school teaching, you are required to have a teaching major. The major may be in one of the following areas: biological science, chemistry, economics, English, history, mathematics, physics, and psychology.

While your program of study may be strengthened by taking certain elective courses, such electives should be taken after consultation with your academic program advisor, the director of education and/or looking on website <http://teachereducation.mst.edu>.

## General Education Requirements

General education requirements are intended to provide you with the intellectual knowledge and skills for basic education. This body of knowledge and skills is arranged according to two broad categories: systems of symbolic thought and communication represented by linguistic and mathematical studies, and systems of intellectual inquiry represented by basic academic disciplines. In addition, you must complete one course in cultural diversity, and the general education requirements may be fulfilled at the same time.

The following are generic requirements for all education students. However, any degree requirement not included in these general education requirements must be included in the professional requirements or subject matter requirements for each degree program.

### I. Symbolic Thought & Communications

1. **Linguistic studies** (nine semester hours): You are required to take two courses in written communication and one course in oral communication. You must have a grade of "C" or above in each course.
2. **Mathematical** (three semester hours). The course must be college algebra or above with a "C" or above in each course.

### II. Systems of Intellectual Inquiry

1. **Humanities**: At least one course each from two of the following areas required: art, music, philosophy, literature, and theater.
2. **Natural science**: One course in biological sciences and one in physical science is required. One of these two courses must include a laboratory.
3. **Social and behavioral science**: One course in each of the following areas is required:
  - A. American history
  - B. American government
  - C. General psychology

## Secondary Education

In addition to the prescribed general education courses, if you are preparing to become a secondary school teacher you must complete the following secondary professional education courses:

EDUC 1040	Perspectives In Education	2
EDUC 1104	Teacher Field Experience	2
EDUC 1164	Aiding Elementary, Middle And Secondary Schools	2
EDUC 1174	School Organization & Adm For Elementary & Secondary Teachers	2
EDUC 2102/ PSYCH 2300	Educational Psychology	3
EDUC 3216	Teaching Reading in Content Area	3
EDUC 3280	Teaching Methods And Skills In The Content Areas	6
EDUC 4298	Student Teaching Seminar	1
EDUC 4299	Student Teaching	12
EDUC 4310/ PSYCH 4310	Psychology Of The Exceptional Child	3
ENGLISH 3170	Teaching And Supervising Reading and Writing	3
PSYCH 3310	Developmental Psychology	3

The required courses of at least one teaching major.

You may major in English with English certification (9-12); economics, history or psychology with social studies certification (9-12); mathematics with mathematics certification (9-12); biological sciences with biology certification (9-12); chemistry with chemistry certification (9-12); or physics with physics certification (9-12).

You must meet Missouri S&T degree requirements and, in addition, course requirements for certification. The necessary course requirement arrangements will be coordinated through the education office. Please pick up a sheet from the education office for your discipline area.

## The Honors Academy

The Missouri S&T Honors Academy offers students the opportunity to be a part of a community of outstanding scholars who are seeking an enhanced educational experience.

At Missouri S&T, Honors Academy students are recognized for their academic excellence and are provided with individualized attention and opportunities to establish leadership development skills, interact with faculty members, and participate in special projects including undergraduate research, service learning, and other beneficial experiences.

## Qualifications

Incoming freshmen are eligible to apply if:

- ACT score is 29 or higher/SAT is 1440 or above
- Rank in the top ten percent of their high school class or have a minimum GPA of 3.5

Incoming transfer students and students currently enrolled at Missouri S&T are eligible to apply if they have the following:

- A minimum GPA of 3.5
- A minimum of 24 graded, college-level credits

## New Student Honors Seminar

To participate in Honors Academy, students participate in New Student Honors Seminar their first year at Missouri S&T. New Student Seminar

meets monthly throughout the fall and spring semester. Students have the opportunity to hear from speakers across the campus. To participate, students must apply to the Honors Academy (<http://ugs.mst.edu/honors>) once admitted, the office of academic support will enroll the student in the no cost, no credit Honors Seminar. (Transfer students may join New Student Honors Seminar during either the fall or spring semester.)

## Honors Academy (Sophomore-Senior Year)

Following their first year, Honors Academy students must maintain a minimum GPA of 3.5 to continue their participation in the program. Honors Academy students will enroll in and complete 15 credit hours of "Honors" course work to include 12 hours of "Honors" course work and three hours of Senior Project. The "Honors" course designation is based on extra work conducted in regular Missouri S&T courses wherein the instructor agrees to approve and oversee the effort.

Course requirements: One course must be outside of the major field of study. During the senior year, Honors Academy students will complete three hours of Senior Thesis/Project, write a thesis and present their findings to the Honors Committee. No more than three credit hours may be individual study courses.

## Honors Distinctions

Honors Academy students who graduate with a 3.5 GPA or better and have at least 15 credit hours of "Honors" course credits and present their thesis findings will earn the distinction of "Honors Academy Fellow" at graduation. This distinction will be noted on their diploma, transcript, and commencement program. For more information, please contact the office of academic support at 573-341-7276.

## Veteran Affairs

### Veteran Access, Choice and Accountability Act of 2014, Section 702

The university is compliant with the requirements of PL 113-146 the Veteran Access, Choice and Accountability Act of 2014, Section 702. Section 702 targets educational assistance through ensuring in-state tuition/in-district rates to uniformed services veterans and their qualified dependents covered under this Section.

These new requirements will ensure that our Nation's recently discharged Veterans, and their eligible family members, will not have to bear the cost of out-of-state charges while using their well-deserved education benefits.

The following individuals shall be charged the in-state/in-district rate, or otherwise considered a resident, for tuition purposes:

- A veteran using educational assistance under either chapter 30 (Montgomery G.I. Bill – Active Duty Program) or chapter 33 (Post-9/11 G.I. Bill), of title 38, United States Code, who lives in the state of Missouri while attending a school located in the state of Missouri (regardless of his/her formal state of residence) and enrolls in the school within three years of discharge from a period of active duty service of 90 days or more.
- Anyone using transferred Post-9/11 GI Bill benefits (38 U.S.C. § 3319) who lives in the state of Missouri while attending a school located in the state of Missouri (regardless of his/her formal state of residence) and enrolls in the school within three years of the

transferor's discharge from a period of active duty service of 90 days or more.

- Anyone described above while he or she remains continuously enrolled (other than during regularly scheduled breaks between courses, semesters, or terms) at the same school. The person so described must have enrolled in the school prior to the expiration of the three year period following discharge or release as described above and must be using educational benefits under either chapter 30 or chapter 33, of title 38, United States Code.
- Anyone using benefits under the Marine Gunnery Sergeant John David Fry Scholarship (38 U.S.C. & 3311(b)(9)) who lives in Missouri while attending a school located in Missouri (regardless of his/her formal State of residence).
- Anyone using transferred Post-9/11 G.I. Bill benefits (38 U.S.C. & 3319) who lives in Missouri while attending a school located in Missouri (regardless of his/her formal state of residence) and the transferor is a member of the uniformed service who is serving on active duty.

For more information contact the VA representative at:

Office of the Registrar  
103 Parker Hall, 300 W. 13th St.  
Rolla, MO 65409-0930  
573-341-4181  
registrar@mst.edu

## Writing Center

### Mission

The Writing Center supports the development of writing skills among undergraduate students across disciplines. Writing is important for professionals in all fields, and Missouri S&T graduates report that communication skills have been crucial to their professional success. Writing, however, is not a skill that can be acquired in a single course or semester; rather, writing proficiency develops throughout a college career and over the course of a lifetime. Improvement comes only with practice and constructive criticism. Writing Center services offer feedback, guidance, resources, and encouragement to help students become better writers so that they can succeed both academically and professionally.

### Writing Consultations

The most important way we support student writers is through peer writing consultations, a key part of the academic experience at Missouri S&T. Many hundreds of students schedule consultations each semester, often for multiple assignments. Our consultants are undergraduate students who represent a wide range of majors. They have been identified by professors and Writing Center staff as among the best student writers on campus. Each consultant receives intensive and ongoing training to help other students become strong writers as well. Consultants work individually with students on all types of documents, including essays, research papers, laboratory reports, proposals, résumés, and more. They can help at any stage of the writing process, from understanding the assignment to organizing ideas and revising drafts. Consultants are trained to help students identify areas for improvement and teach them how to make those improvements most effectively. Consultations are free, and students can schedule consultations for as many drafts or documents as they wish throughout the semester.

## Additional Services

The Writing Center offers a range of writing resources in addition to consultations. We maintain a library of citation style guides, grammar handbooks, and information on writing specific types of documents; these are available for student use at any time during office or consultation hours. We also offer a series of handouts on specific writing topics; these are free, and many are available on our website. Writing Center staff periodically offer workshops and presentations related to writing; a schedule of these presentations can be found on our website. Finally, a computer learning center located in 114 Campus Support facility (adjacent to the Writing Center) is equipped with writing, editing, and desktop publishing software, as well as printers, scanners, and Smartboard technology. This facility is available to students when not in use for classes or workshops.

Writing Center facilities and services are available to all Missouri S&T undergraduates free of charge. The Writing Center is located in 113 Campus Support Facility. Its hours vary each semester, and they are posted on our website at <http://writingcenter.mst.edu>. Students may drop in whenever the Writing Center is open, but they are encouraged to use our online scheduling tool to make appointments.

# MINORS

---

You can elect to combine a recognized minor program with your bachelor of arts or bachelor of science degree programs in the following areas:

- adaptive leadership (p. 200)
- aerospace engineering (p. 47)
- American studies (p. 137)
- applied mathematics (p. 179)
- art (p. 60)
- automation engineering (p. 121)
- bioinformatics (p. 62)
- biological sciences (p. 62)
- biomedical engineering (p. 178)
- business (p. 68)
- business analytics and data science (p. 171)
- chemistry (p. 84)
- cognitive neuroscience (p. 232)
- communication studies (p. 242)
- computer engineering (p. 101)
- computer science (p. 107)
- creative writing (p. 137)
- cybersecurity management and information assurance (p. 171)
- digital supply chain management (p. 171)
- economics (p. 113)
- electrical engineering (p. 121)
- electronic and social commerce (p. 68)
- energy technology
- engineering management (p. 130)
- enterprise resource planning (p. 141)
- entrepreneurship (p. 68)
- ethics
- explosives engineering (p. 146)
- film and literature (p. 60)
- finance (p. 148)
- French (p. 149)
- geological engineering (p. 150)
- geology (p. 157)
- German (p. 149)
- global studies (p. 165)
- global sustainable economics (p. 113)
- history (p. 166)
- human-computer interaction and user experience (p. 171)
- humanitarian engineering and science (p. 150)
- industrial/organizational psychology (p. 232)
- information science & technology (p. 171)
- international economics (p. 113)
- Latin American studies for technical applications (p. 176)
- leadership communication (p. 242)
- literature (p. 137)
- literature and film (p. 137)
- management (p. 68)
- marketing (p. 177)
- mathematics (p. 179)
- military aerospace studies (p. 53)
- mineral process engineering (p. 202)
- mining engineering (p. 202)
- mobile business and technology (p. 171)
- multiculturalism & diversity (p. 210)
- music (p. 211)
- nuclear engineering (p. 211)
- petroleum engineering (p. 217)
- philosophy (p. 221)
- philosophy of technology (p. 221)
- physics (p. 225)
- political science (p. 229)
- pre-law (p. 232)
- pre-MBA (p. 68)
- pre-medicine (p. 231)
- psychology (p. 232)
- psychology for health care (p. 232)
- psychology of leadership (p. 232)
- psychometrics (p. 232)
- Russian (p. 149)
- science, technology & humanity (p. 229)
- sociology
- Spanish (p. 149)
- studio art (p. 60)
- sustainability (p. 245)
- technical communication (p. 137)
- theatre (p. 249)
- writing (p. 137)



# CERTIFICATES

---

- explosives engineering (p. 146)
- explosives technology (p. 146)
- technical writing (p. 246)

# TEACHER CERTIFICATIONS

---

## Elementary Education Certification

- multidisciplinary studies (p. 210)

## Secondary Education Certification

- applied mathematics (p. 179)
- biological sciences (p. 62)
- chemistry (p. 84)
- economics (p. 113)
- English (p. 137)
- history (p. 166)
- physics (p. 225)
- psychology (p. 232)

# DEGREE PROGRAMS

---

Missouri S&T offers bachelor of science (BS) and bachelor of arts (BA) degrees. You can major in engineering, science, business, or the liberal arts. You can get a background for law or medicine or other professional studies.

In many disciplines there are emphasis areas which are areas of concentration within a degree program. If you choose an emphasis area, you will take some of your elective hours in specified courses in that area. Your advisor can guide you toward the election of courses you should take if you choose an emphasis area.

Degree programs and emphasis areas are listed below. Degree programs are in capitals, emphasis areas are lower case subheads followed by degree abbreviation if restricted to that degree.

## AEROSPACE ENGINEERING (BS)

### APPLIED MATHEMATICS (BS)

- Actuarial Science
- Algebra/Discrete Mathematics
- Applied Analysis
- Computational Mathematics
- Secondary Education
- Statistics

### ARCHITECTURAL ENGINEERING (BS)

- Construction Engineering & Project Management
- Construction Materials
- Environmental Systems for Buildings
- Structural Engineering

### BIOLOGICAL SCIENCES (BA, BS)

- Pre-Medicine (BA)
- Secondary Education (BA)

### BUSINESS AND MANAGEMENT SYSTEMS (BS)

- E-commerce
- Enterprise Resource Planning
- Finance
- Human Computer Interaction
- Management Information Systems
- Marketing

### CERAMIC ENGINEERING (BS)

### CHEMICAL ENGINEERING (BS)

- Biochemical Engineering

### CHEMISTRY (BA, BS)

- Biochemistry (BS)
- Polymer & Coatings Science (BS)
- Pre-Medicine (BS)
- Secondary Education (BA)

### CIVIL ENGINEERING (BS)

- Construction Engineering
- Environmental Engineering

- Geotechnical Engineering
- Materials Engineering
- Structural Engineering
- Transportation Engineering
- Water Resources Engineering

### COMPUTER ENGINEERING (BS)

- Computational Intelligence
- Computer Architecture & Embedded Systems
- Integrated Circuits & Logic Design
- Networking, Security, & Dependability

### COMPUTER SCIENCE (BS)

### ECONOMICS (BA, BS)

- Economics/Business (BS)
- Secondary Education (BA)

### ELECTRICAL ENGINEERING (BS)

- Circuits & Electronics
- Communications & Signal Processing
- Computer Engineering
- Controls & Systems
- Electromagnetics
- Optics & Devices
- Power & Energy

### ENGINEERING MANAGEMENT (BS)

- Industrial Engineering
- Management of Technology
- Manufacturing Engineering
- Packaging Engineering
- Quality Engineering

### ENGLISH (BA)

- Secondary Education

### ENVIRONMENTAL ENGINEERING (BS)

### GEOLOGICAL ENGINEERING (BS)

- Engineering Geology & Geotechnics
- Environmental Protection & Hazardous Waste
- Groundwater Hydrology & Contaminant Transport
- Petroleum, Energy & Natural Resources
- Quarry Engineering

### GEOLOGY AND GEOPHYSICS (BS)

- Geochemistry
- Geology
- Geophysics
- Groundwater & Environmental Geochemistry
- Petroleum Geology

### HISTORY (BA, BS)

- Secondary Education (BA)

**INFORMATION SCIENCE & TECHNOLOGY (BS)**

Enterprise Resource Planning  
Human Computer Interaction

**MECHANICAL ENGINEERING (BS)**

Control Systems  
Energy Conversion  
Environmental Systems  
Instrumentation  
Manufacturing Processes  
Materials Science  
Mechanical Design and Analysis  
Thermal Science

**METALLURGICAL ENGINEERING (BS)**

Chemical Metallurgy  
Manufacturing Metallurgy  
Physical Metallurgy

**MINING ENGINEERING (BS)**

Coal  
Explosives Engineering  
Mining & the Environment  
Mining Health & Safety  
Quarry Engineering  
Sustainable Development

**MULTIDISCIPLINARY STUDIES (BA)****NUCLEAR ENGINEERING (BS)****PETROLEUM ENGINEERING (BS)****PHILOSOPHY (BS)****PHYSICS (BS)**

Applied Physics  
Geophysics  
Secondary Education

**PSYCHOLOGY (BA, BS)**

Cognitive Neuroscience  
Human Resources/Personnel  
Human Services  
Psychology of Leadership  
Secondary Education  
Usability of Technology

**TECHNICAL COMMUNICATION (BS)**

## Bachelor of Arts Degree

### General Requirements

This degree can be earned in the following areas: biological sciences, chemistry, economics, English, history, multidisciplinary studies, philosophy, and psychology.

A minimum of 120 credit hours is required for a bachelor of arts degree with an average of at least two grade points per credit hour to be

obtained. At least 45 hours of the student's work must be taken of the upper-class (course numbered 3000 or above) level.

Requirements for the bachelor of arts degree follow:

### I. Basic Skills and Concepts <sup>(a)</sup>

1. Composition: ENGLISH 1120 and one additional three hour composition course <sup>(b)</sup> 6 hrs.
2. Western Civilization (HISTORY 1100 and HISTORY 1200) 6 hrs.
3. Foreign languages, <sup>(c)(d)</sup> 12 hours of a single foreign language or 16 hours (8+8) of two foreign languages.
  - A. At least three semesters of basic study in a single foreign language or two semesters in each of two foreign languages: French, German, Russian, Spanish, or an approved substitute language.
  - B. One year of basic study in one foreign language, either French, German, Russian, Spanish, or an approved substitute, and a humanities or social sciences course taught in a foreign country and employing the language of that country.
  - C. One year of basic study in each of two foreign languages: French, German, Russian, Spanish, or an approved substitute language.

### II. General Education Requirements

1. Sciences (12 hrs.): At least one course taken in each of the biological (biological sciences), physical (chemistry, geology and geophysics, and physics), and mathematical <sup>(e)</sup> (mathematics/ statistics and computer science) sciences, but not to include MATH 1101 or COMP SCI 1010. A laboratory also may count – at the discretion of the student's major department – toward the total requirement.
2. Humanities (12 hrs.): At least one course in each of the three areas of literature (English and American), philosophy, and fine arts (art, music and theater), but not to include studio and performance offerings. This requirement is exclusive of courses in the student's major field.
3. Social Sciences (12 hrs.): Courses in at least two of the following areas: economics, political science, psychology, and sociology. This requirement is exclusive of courses in the student's major field.

### III. Major Field Requirements

1. Specific major field requirements in each discipline are given in the entry of that discipline.
2. A cumulative grade point average of 2.0 must be earned in all course work taken in the major field. Upper-class (3000- and 4000-level) courses completed with grades of "D" may not be included in the major field without the approval of the chairman of the department concerned.
3. At least nine hours of upper-class work in the major field must be completed in residence at Missouri S&T.

### IV. Minor Field Requirements

1. Specific minor field requirements in each discipline are given in the entry of that discipline.
2. A cumulative grade point average of 2.0 must be earned in all course work required in the minor field.
3. A least six hours of work in the minor field must be completed in residence at Missouri S&T.

## V. Elective Credits

1. In consultation with his or her advisor, each student will elect sufficient additional courses to complete a minimum of 120 credit hours.
2. Basic ROTC (military science and aerospace studies) may be taken in the freshman and sophomore years. Up to 12 credit hours (depending on the student's major) of advanced courses in ROTC may be credited toward a degree.

## Notes

- (a) For transfer students these requirements may be met by equivalent course work completed at other institutions.
- (b) An entering student may quiz out of ENGLISH 1120 Exposition And Argumentation (3 hours) on the basis of Advanced Placement (AP) standing, through various examinations offered by the College-Level Examinations Program (CLEP subject exams) through the Missouri S&T placement examination program based on Missouri College English Test (MCET) and Cooperative School and College Ability Test (SCAT) scores.
- (c) This requirement cannot be satisfied through foreign civilization courses which are taught in English. A student who has studied French or Spanish prior to enrolling in courses at Missouri S&T will be required to take a placement exam that will determine the appropriate course for his/her level of preparation. Students may not enroll in or receive credit for a course taken below their placement level. All course placement requires instructor's approval. A student may receive foreign language credit by examination with a score of 3, 4, or 5 on the language or literature AP exam or with a score in the 75th percentile or above on the CLEP exam.
- (d) Upon approval of the department chair students seeking teacher certification may substitute 11-16 hours of certification courses for their foreign language requirement. Students electing to make this substitution must complete the certification program to receive their chosen bachelors of arts degree.
- (e) The mathematics/statistics requirement may be satisfied by (1) examination or (2) the presentation of 2.5 high school units, including 1.5 units of algebra and excluding general mathematics. The student will not, however, receive hour credit so he or she must take another course to fulfill the 12 hours.

## VI. General Education Communications Requirements

Each department will provide students with opportunities to enhance their writing and speaking skills (beyond the required class) by requiring that they complete at least two communications intensive courses (CI), at least one of which should be in the student's major. Communication intensive (CI) courses may be focused on writing, speaking, or combinations thereof. Two communications emphasized (CE) courses may be used at the equivalent of one CI course (for example, four CE courses would substitute for two CI courses, but an appropriate substitute for the one CI course in the student's major). These requirements will be formally tracked and monitored by the degree audit to ensure that each graduating student is meeting the communications component of the general education requirement.

## VII. Experiential Learning Requirement

All students at Missouri S&T are required to participate in appropriate experiential learning activities. Experiential learning refers to learning stimulated by a variety of structured activities that differ significantly from the traditional lecture format. Experiential learning activities are designed to require students to go beyond mastering basic skills

and knowledge in the application of that material to problem solving challenges. These activities involve collaboration and reflective learning and allow students to learn in environments that align with their aptitudes.

## Bachelor of Science Degree

This degree can be earned in the following areas: aerospace engineering, architectural engineering, biological sciences, business and management systems, ceramic engineering, chemical engineering, chemistry, civil engineering, computer engineering, computer science, economics, information science and technology, electrical engineering, engineering management, environmental engineering, geological engineering, geology and geophysics, mathematics, mechanical engineering, metallurgical engineering, mining engineering, nuclear engineering, petroleum engineering, physics, psychology, and technical communications.

## Accreditation

Missouri S&T bachelor's level engineering programs in aerospace engineering, architectural engineering, ceramic engineering, chemical engineering, civil engineering, computer engineering, electrical engineering, engineering management, environmental engineering, geological engineering, mechanical engineering, metallurgical engineering, mining engineering, nuclear engineering, and petroleum engineering are accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>.

Missouri law requires that all applicants for registration as professional engineers be graduates of engineering programs accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>, or possess an education which includes at the minimum a baccalaureate degree in engineering and which, in the opinion of the registration board, equals or exceeds the education received by a graduate of a program accredited by EAC/ABET. Applicants who receive advanced degrees from Missouri S&T engineering programs, but do not have undergraduate engineering degrees, may not be eligible for registration in Missouri. Such applicants may wish to consider studying toward a bachelor's degree in their chosen engineering field. If so they should consult with their department chairman regarding specific requirements. All eligible graduates are strongly encouraged to seek professional engineer registration.

Missouri S&T bachelor's level computer science program is accredited by the Computing Accreditation Commission of ABET, <http://www.abet.org>.

## Minimum Requirements

A minimum of 120 credit hours is required for a Bachelor of Science degree with an average of at least two grade points per credit hour to be obtained. The following general education requirements must be met:

1. Communications
  - A. ENGLISH 1120
  - B. One writing intensive course in major OR two writing emphasized courses in major
  - C. One writing intensive course out of major OR two writing emphasized courses out of major
2. Humanities plus Social Sciences
  - A. 21 credit hours (must be content approved by the department and school)
3. Mathematics and Science
  - A. Total of 18 credit hours



- B. College algebra or higher
- C. May include up to 3 credit hours of psychology

## Experiential Learning Requirement

All students at Missouri S&T are required to participate in appropriate experiential learning activities. Experiential learning refers to learning stimulated by a variety of structured activities that differ significantly from the traditional lecture format. Experiential learning activities are designed to require students to go beyond mastering basic skills and knowledge in the application of that material to problem solving challenges. These activities involve collaboration and reflective learning and allow students to learn in environments that align with their aptitudes.

## Dual Bachelor's Degree

Combination curricula leading to two baccalaureate degrees can be arranged in any two fields. The amount of additional credit required for the second baccalaureate degree will be based on the student's educational background and determined for each case by the academic department which offers the curriculum leading to the second degree. The chair of the department will submit a list of the specific course and credit hour requirements, together with the student's transcript, to the provost for approval. This list will then be forwarded to the registrar and constitute the official requirement for the second degree. Since the B.A. degree is unspecified as to major there will be no dual bachelor of arts degree offerings. A student entering Missouri S&T with a baccalaureate degree must take a minimum of 30 hours to receive another bachelor's degree.

When requirements for a degree in two departments have been completed without either degree being awarded, both degrees may be awarded at the same commencement.

## Engineering Degree Requirements

All engineering degree programs must be consistent with the following minimum requirements.

The requirements of the degree program shall consist of 128-132 credit hours. Additional hours may be required for specific choices of electives or emphasis areas. Courses that are at a lower level of coverage than the required courses in the curriculum (e.g. algebra, trigonometry, intro to physics, etc.) may not be counted toward the degree program credit hours. An average of at least two grade points per credit hour must be obtained for all credits counted toward the degree. In addition, an average of at least two grade points per credit hour must be obtained for all credits taken in the student's major department.

The degree program shall include all courses in the common engineering freshman year, as listed in the current catalog under the Freshman Engineering Program.

The degree program shall include a minimum of 21 credit hours as follows:

- ENGLISH 1120
- HISTORY 1200 or HISTORY 1300 or HISTORY 1310 or POL SCI 1200
- ECON 1100 or ECON 1200
- Communication elective: ENGLISH 1160 or ENGLISH 1600/TCH COM 1600 or ENGLISH 3560 or SP&M S 1185
- The remaining minimum of 9 additional credit hours must be chosen from disciplines in the humanities and social sciences.

\*Humanities courses are defined as those in : art, English, and technical communication, etymology, foreign languages, music, philosophy, speech and media studies, and theatre. Social sciences courses are defined as those in: economics, history, political science, and psychology. Some curricula may require the completion of a specified number of upper-level humanities/social sciences (H/SS) courses. Upper-level H/SS courses are defined as those at the 2000-level or above, and that require as a prerequisite the successful completion of a lower-level H/SS course. Study abroad courses may count as upper-level H/SS courses, even if they do not have a prerequisite. H/SS courses numbered 2001, 3001, and 4001 (experimental courses) may also be used to complete these elective requirements.

Courses in business, education, information science and technology, or any other discipline not listed above will not satisfy the humanities/social sciences elective requirement, although such courses may count toward general education requirements. Transfer credits from other universities in sociology and general humanities may count as humanities or social science electives.

\*ENGLISH 1160, ENGLISH 1600/TCH COM 1600, ENGLISH 3560, and SP&M S 1185 do **not** count toward the remaining minimum of 9 additional credit hours in humanities/social sciences electives

## Aerospace Engineering

The aerospace engineering program is offered in the department of mechanical and aerospace engineering. In aerospace engineering, you will apply the laws of physics and mathematics to problems of aircraft flight and space vehicles in planetary atmospheres and adjoining regions of space. Maybe you will design space shuttles, rockets, or missiles. Possibly you might design military, transport, and general aviation aircraft, a V/TOL (vertical/ take-off and landing) aircraft, or a UAV (unmanned aerial vehicle). You could design a spacecraft to travel to Mars or to a more distant planet.

You'll be able to tackle problems in the environmental pollution of air and water, or work on wind effects on buildings and structures, or wind energy harnessing. Designing all types of transportation systems, including high speed vehicles, urban rapid transit systems, and undersea craft might be some of the challenges you will undertake.

Your professional training in aerospace engineering will be directed generally toward the analysis and design of aerospace vehicles, including aircraft, missiles, and spacecraft with special emphasis on the fundamental treatment of aerospace science.

You will accomplish your goals through your basic training in aerodynamics, dynamics, stability and control, structures, and propulsion including cross-linkage among these areas. You will use this knowledge to design, build, and flight test aerospace systems.

Your studies at Missouri S&T will include both basic science and engineering science, mathematics, and liberal arts courses as well as advanced aerospace engineering courses. Within aerospace engineering, you can choose nine hours of technical electives in a special interest area such as aerodynamics, structures, composites, flight dynamics, controls, propulsion, and aeroelasticity.

Your design courses will be integrated with Missouri S&T's computer graphics system to unify the graphical capabilities of the computer into your design experience. Undergraduate research opportunities are also

available through the NASA Space Grant Consortium and the OURE program.

Classes and laboratories are held in Toomey Hall. Laboratory facilities include a Mach 1.5 to 4 supersonic blow down wind tunnel with a five-inch diameter jet with instrumentation for Schlieren photography, pressure, temperature, and turbulence measurements. A large subsonic wind tunnel, capable of speeds up to 300 miles per hour, has a test section 48 inches wide, 32 inches high, and 11 feet long. Other facilities include a flight simulation laboratory, space systems engineering laboratory, aerospace structural test equipment, propulsion component analysis systems, and shock tubes.

## Mission Statement

We will provide a rigorous, productive, and relevant academic learning environment for students, faculty, and staff in the mechanical and aerospace engineering department by continually focusing on our core missions of teaching, research, and service.

We will ensure that graduating students are well-educated and sufficiently prepared in the fundamentals of mechanical and aerospace engineering practice and science, such that they have the ability to solve open-ended problems in these disciplines and the capabilities required in order to become competent, productive, and well-rounded professionals.

We will emphasize scholarship, graduate education, and the development of new knowledge and skills in the traditional areas associated with mechanical and aerospace engineering. Additionally, we will develop cross-cutting multi-disciplinary efforts such that we are widely recognized by local, national, and international research and business communities as respected leaders in research, innovation, and discovery.

We will render meritorious service to our profession through active participation and engagement in service activities in our professional communities at all levels (local, national, and international), as well as in fulfilling campus and departmental governance, outreach, and service activities.

## Missouri S&T Aerospace Engineering Program Objectives

The overall educational objective of the aerospace engineering program is to prepare graduates for careers in the aerospace engineering profession and related disciplines, and/or receive an advanced graduate degree within three to five years from their graduation. Specifically, the expected professional accomplishments of the program graduates within five years from their graduation are that:

- They are employed by industry, a government agency, or in academia, or are in private practice.
- They have demonstrated competence and are successfully contributing to the aerospace science, technology, or engineering workforce.
- They have found that their education at Missouri S&T was valuable preparation for their careers.

## Aerospace Program Outcomes:

Students graduating from the Missouri S&T aerospace engineering program should have:

1. an ability to apply knowledge of mathematics, science, and engineering
2. an ability to design and conduct experiments, as well as to analyze and interpret data
3. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. an ability to function on multidisciplinary teams
5. an ability to identify, formulate, and solve engineering problems
6. an understanding of professional and ethical responsibility
7. an ability to communicate effectively
8. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
9. a recognition of the need for, and an ability to engage in life-long learning
10. a knowledge of contemporary issues
11. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

## Bachelor of Science Aerospace Engineering

Entering freshmen desiring to study aerospace engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state an aerospace engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering Program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major.

A Cumulative GPA of 2.5, and math science GPA of 2.25 are the minimum requirements for admission to the aerospace engineering program.

Students must comply with the requirements specified in the current online catalog published by the registrar. For the bachelor of science degree in aerospace engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in aerospace engineering. Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen to satisfy the following requirements:

1. All students are required to take one American history course/ political science course, one economics course, one humanities course, and ENGLISH 1120. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200.
2. Depth requirement. Three credit hours must be taken in humanities or social sciences at the 2000-level or above and must be selected from "The Approved List of Humanities and Social Science Courses for Engineering Degrees" maintained by the office of undergraduate studies. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 1180 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the

4000 level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.

- One course should be in the ethics area.
- The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to ENGLISH 1120, and a literature course.
- Any specific departmental requirements in the general studies area must be satisfied.
- Special topics and special problems and honors seminars are allowed only by petition to and approval by the student's department chairman.

The aerospace engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application. Indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

## Free Electives Footnote:

### Freshman Year

First Semester	Credits	Second Semester	Credits
FR ENG 1100	1	MECH ENG 1720	3
CHEM 1310 & CHEM 1319 & CHEM 1100 <sup>1</sup>	6	MATH 1215 <sup>4</sup>	4
ENGLISH 1120	3	PHYSICS 1135 <sup>4</sup>	4
MATH 1214	4	H/SS Economics elective <sup>3</sup>	3
H/SS History Elective <sup>2</sup>	3		
	17		14

### Sophomore Year

First Semester	Credits	Second Semester	Credits
COMP SCI 1970 or 1971 <sup>9</sup>	2	AERO ENG 2780	2
COMP SCI 1980 or 1981 <sup>9</sup>	1	AERO ENG 2360 <sup>4</sup>	3
CIV ENG 2200 <sup>4</sup>	3	MECH ENG 2519 <sup>4</sup>	3
MATH 2222 <sup>4</sup>	4	MATH 3304 <sup>4</sup>	3
PHYSICS 2135 <sup>4</sup>	4	CIV ENG 2210 <sup>4</sup>	3
AERO ENG 2861 <sup>4</sup>	3	AERO ENG 2790	2
	17		16

### Junior Year

First Semester	Credits	Second Semester	Credits
AERO ENG 3613 <sup>4</sup>	3	AERO ENG 3251 <sup>4</sup>	3
AERO ENG 3131 <sup>4</sup>	3	AERO ENG 3361	3
AERO ENG 3877	3	AERO ENG 3171	3
ELEC ENG 2800	3	AERO ENG 4882	2
Electives-Advanced Math/Cmp Sc <sup>5</sup>	3	Elective/Ethics <sup>10</sup>	3
		Elective/Communications <sup>7</sup>	3
	15		17

### Senior Year

First Semester	Credits	Second Semester	Credits
AERO ENG 4535	3	AERO ENG 4781 or 4791	3

AERO ENG 4253	3	Electives-Technical <sup>6</sup>	3
AERO ENG 4780 or 4790	2	Electives-Technical <sup>6</sup>	3
AERO ENG 4883	2	AERO ENG 4885	1
Electives-Technical <sup>6</sup>	3	Electives-Hum/Soc Sci	3
Elective upper level/Hum/Soc Sci <sup>8</sup>	3	Elective/Literature	3
	16		16

Total Credits: 128

- CHEM 1310, CHEM 1319 and CHEM 1100 or an equivalent training program approved by Missouri S&T.
- Must be one of the following: POL SCI 1200, HISTORY 1200, HISTORY 1300, or HISTORY 1310.
- Must be one of the following: ECON 1100 or ECON 1200.
- A grade of "C" or better in CHEM 1310, MATH 1214, MATH 1215, MATH 2222, MATH 3304, PHYSICS 1135, PHYSICS 2135, CIV ENG 2200, CIV ENG 2210, and computer programming elective, AERO ENG 2360, AERO ENG 2861, and MECH ENG 2519, as prerequisite for follow-up courses in the curriculum and for graduation.
- Must be one of the following: AERO ENG 5830, COMP SCI 3200, MATH 3103, MATH 3108, STAT 3113, STAT 3115, or any 5000-level math or computer science course approved by the student's advisor.
- Electives must be approved by the student's advisor. Nine hours of technical electives must be in mechanical and aerospace engineering. Three hours of departmental technical electives must be at the 5000-level. AERO ENG 3877 and the 5000-level Asteroid Mining course co-listed with geological engineering are not to be used for 5000-level technical elective.
- This course can be selected from ENGLISH 1160, ENGLISH 3560, SP&M S 1185, or the complete four-course sequence in advanced ROTC (MIL ARMY 3250, MIL ARMY 3500, MIL ARMY 4250, and MIL ARMY 4500; or MIL AIR 3110, MIL AIR 3120, MIL AIR 4110 and MIL AIR 4120).
- Choose 2000-or higher-level course from the approved list. One of the other courses taken in humanities/social science should be a prerequisite for this course.
- Computer science requirement can be satisfied by taking COMP SCI 1570 and COMP SCI 1580.
- Must be a course on engineering ethics, business ethics, bio ethics, social ethics, or any ethics course approved by the student's advisor.

**Note:** All aerospace engineering students must take and pass the aerospace engineering assessment exam prior to graduation.

## Minor in Aerospace Engineering

A student who receives a bachelor of science degree in an accredited engineering program from Missouri S&T may receive a minor in aerospace engineering by completing the 15 hours of courses listed below. Students must satisfy the prerequisite requirements for each course. The department granting the bachelor of science degree shall determine whether or not courses taken for the minor may also be used to fulfill the requirements of the B.S. degree.

AERO ENG 2861	Aerospace Vehicle Performance	3
AERO ENG 3613	Aerospace Mechanics I	3
AERO ENG 3131	Aerodynamics I	3
AERO ENG 3251	Aerospace Structures I	3
AERO ENG 3000-level 3-hour lecture course (student choice)		3

**S N Balakrishnan**, Curators Professor  
PHD University of Texas Austin

**Victor Birman**, Professor  
PHD Technion, Haifa, Israel

**Douglas A Bristow**, Associate Professor  
PHD University of Illinois Urbana-Champaign

**K Chandrashekhara**, Curators Professor  
PHD Virginia Polytechnic Institute

**Donald Cronin**, Emeritus Professor  
PHD California Institute of Technology

**Kyle Jordan DeMars**, Assistant Professor  
PHD University of Texas Austin

**L R Dharani**, Curators Professor  
PHD Clemson University

**Lian Duan**, Assistant Professor  
PHD Princeton University

**Walter Eversman**<sup>1</sup>, Professor Emeritus  
PHD Stanford University

**Fathi Finaish**, Emeritus Professor  
PHD University of Colorado

**Serhat Hosder**, Associate Professor  
PHD Virginia Polytechnic Institute

**K M Isaac**, Professor  
PHD Virginia Polytechnic Institute

**Leslie Koval**<sup>1</sup>, Emeritus Professor  
PHD Cornell University

**Shen Ching Lee**<sup>1</sup>, Emeritus Professor  
PHD University of Washington

**Terry Lehnhoff**<sup>1</sup>, Emeritus Professor  
PHD University of Illinois

**Gearoid P MacSithigh**, Associate Professor  
PHD University of Minnesota

**Warner Meeks**, Assistant Teaching Professor  
PHD Missouri University of Science and Technology

**Robert Oetting**<sup>1</sup>, Emeritus Professor  
PHD University of Maryland

**Henry J Pernicka**, Associate Professor  
PHD Purdue University

**David W Riggins**, Professor  
PHD Virginia Polytechnic Institute

**Joshua Lucas Rovey**, Associate Professor  
PHD University of Michigan

**Jillian Schmidt**, Assistant Teaching Professor  
PHD University of Minnesota

**Charles S Wojnar**, Assistant Professor  
PHD California Institute of Technology

**Donald C Wunsch II**, Professor<sup>1</sup>  
PHD University of Washington

**AERO ENG 2001 Special Topics** (LAB 1.0 and LEC 1.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**AERO ENG 2360 Dynamics** (LEC 3.0)

The principles of mechanics are used to model engineering systems. Kinematics of particle motion, kinematics of plane- and three-dimensional motions of rigid bodies. Kinetics of particles and of rigid bodies. Energy and momentum methods. Prerequisite: Grade of "C" or better in each of Civ Eng 2200, Math 2222. (Co-listed with Mech Eng 2360).

**AERO ENG 2780 Introduction to Aerospace Design** (LAB 1.0 and LEC 1.0)

Introduction to methodology of aerospace vehicle design and principles of layout to meet a given specification, mission objective, component sizing, design iteration and building & performance testing of models. Prerequisite: A grade of "C" or better in Aero Eng 2861.

**AERO ENG 2790 Introduction to Spacecraft Design** (LAB 1.0 and LEC 1.0)

Intro. to basics of spacecraft design, including design requirements, subsystem definition, and vehicle design synthesis. Lab work includes design and fabrication of a small spacecraft payload that is flight tested on a high altitude balloon to 100,000 feet. Post-flight data reduction and analysis. Field trip will be required for balloon launch/retrieval. Prerequisite: A grade "C" or better in Aero Eng 2861.

**AERO ENG 2861 Aerospace Vehicle Performance** (LEC 3.0)

Nature and theory of lift, drag, performance, and stability and control of aerospace vehicles. Prerequisite: "C" or better grade in both Math 1215 and Physics 1135.

**AERO ENG 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**AERO ENG 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**AERO ENG 3002 Cooperative Engineering Training** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry with credit arranged through departmental co-op adviser. Grade received depends on quality of reports submitted and work supervisor's evaluation.

**AERO ENG 3010 Seminar in Aerospace Engineering** (RSD 1.0)

Discussion of current topics.

**AERO ENG 3131 Aerodynamics I** (LEC 3.0)

A study of the fundamental concepts of fluid mechanics as applied to aerodynamic applications with both differential and control volume analysis. Theory and application of viscous and inviscid incompressible flow including boundary layer theory and two dimensional airfoil theory. Prerequisites: A grade of "C" or better in each of Aero Eng 2861, Math 1214, Math 1215, Math 2222 and Physics 1135.

**AERO ENG 3171 Aerodynamics II** (LEC 3.0)

Three dimensional incompressible wing theory. Compressible one dimensional flow with normal and oblique shock waves, heat addition, and friction. Compressible transonic, and supersonic linearized flow theory. Supersonic wings and wing/fuselage configurations. Prerequisite: "C" or better in Aero Eng 3131 and Mech Eng 2519.



**AERO ENG 3251 Aerospace Structures I** (LEC 3.0)

An introduction to various loads on aerospace vehicles. Basic theory and analysis of typical aerospace and related vehicle structures subjected to steady loading. An overview of various failure theories including yielding, buckling, fracture and fatigue. Design of thin walled structures. Introduction to advanced composite materials. Prerequisites: "C" or better in Math 1214 (or 1208), 1215 (or 1221), 2222, Physics 1135 and Civ Eng 2210.

**AERO ENG 3361 Flight Dynamics and Control** (LEC 3.0)

Static stability and control of conventional aircraft and implications in aircraft design. Six degrees of freedom time dependent equations of motion and their linearized solutions. Consideration of stability vs maneuverability, and the dynamic modes of motion of the aircraft. Prerequisites: Aero Eng 3613, Aero Eng 3131, and accompanied or preceded by Aero Eng 2780.

**AERO ENG 3613 Aerospace Mechanics I** (LEC 3.0)

Introduction to celestial mechanics and an analytical study of space flight. Emphasis is placed on satellite orbits and general theory of gyroynamics. Prerequisites: Math 3304; a grade of "C" or better in each of Aero Eng 2360 (or Mech Eng 2360), Math 1214 (or 1208), 1215 (or 1221), 2222, and Physics 1135.

**AERO ENG 3877 Principles of Engineering Materials** (LEC 3.0)

Examination of engineering materials with emphasis on selection and application of materials in industry. Particular attention is given to properties and applications of materials in extreme temperature and chemical environments. A discipline specific design project is required. (Not a technical elective for undergraduate metallurgy or ceramic majors) (Co-listed with Chem Eng 5300, Physics 4523, Met Eng 5810, Cer Eng 5810).

**AERO ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**AERO ENG 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**AERO ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**AERO ENG 4133 Introduction to Aerothermochemistry** (LEC 3.0)

Principles of thermochemistry in reacting flow including an introduction to fundamentals of quantum mechanics, statistical mechanics and statistical thermodynamics. Applications in flow through nozzles and shock waves, combustion, aerodynamic heating, ablation and propulsion. Prerequisites: Aero Eng 3131, Aero Eng 3171.

**AERO ENG 4253 Aerospace Structures II** (LEC 3.0)

Introduction to the finite element method for static and dynamic analysis of aerospace structures. Analysis of beams, trusses and frames. Plane stress and plane strain analysis. Isoparametric elements and numerical integration. Free vibration and time dependent problems. Prerequisite: Aero Eng 3251.

**AERO ENG 4535 Aircraft and Space Vehicle Propulsion** (LEC 3.0)

Analysis of aircraft and missile propulsion systems; fundamentals of jet propulsion including air breathing and rocket engines. Introduction to advanced propulsion systems for space flights such as nuclear, thermonuclear, and plasma jets. Prerequisite: Mech Eng 3131, or Aero Eng 3171.

**AERO ENG 4780 Aerospace Systems Design I** (LEC 2.0)

Consideration of the creative design process with emphasis on aeronautical-aerospace systems. Short design problems to illustrate the process. Selection of design projects for Aero Eng 4781. Information gathering for the design projects which will be completed in Aerospace Systems Design II. Fall semester. Prerequisites: Aero Eng 3251, 3361, 3171.

**AERO ENG 4781 Aerospace Systems Design II** (LAB 3.0)

Preliminary design of aerospace systems. Project to integrate the knowledge of different aerospace engineering areas through synthesis and analysis. The creative design will include a consideration of such factors as performance reliability, cost, human factors, energy and ecology. Spring semester. Prerequisite: Aero Eng 4780.

**AERO ENG 4790 Spacecraft Design I** (LEC 3.0)

Fundamentals of spacecraft design. Systems engineering, subsystem analysis and design. Gantt charts, organizational charts. Oral presentations and technical documentation. Term project to involve design and development of actual flight hardware, continuing into Spacecraft Design II. Prerequisites: Aero Eng 3251, 3361, and 3171 for Aero Eng majors; consent of instructor for non-Aero Eng majors.

**AERO ENG 4791 Spacecraft Design II** (LAB 3.0)

As a continuation of Aero Eng 4790, detailed spacecraft design is performed, leading to procurement of components. As schedules permit, spacecraft fabrication and test commence. Development of labs to facilitate spacecraft test, operation, and data analysis continues. Prerequisites: Aero Eng 4790 for Aero Eng majors; consent of instructor for non-Aero Eng majors.

**AERO ENG 4882 Experimental Methods in Aerospace Engineering I** (LAB 2.0)

Introduction to experimental methods in low-speed aerodynamics, flight simulation, and aircraft structures. Measurements of drag, boundary layer flows, and aerodynamic forces and moments. Flight simulations, and structural testing of aircraft components. Statistical methods and probability distributions in data analysis and interpretation. Prerequisites: Aero Eng 3131 and Elec Eng 2800.

**AERO ENG 4883 Experimental Methods in Aerospace Engineering II** (LAB 2.0)

Laboratory investigations related to aerospace engineering. Investigations include high-speed aerodynamics, flow visualization measurements in turbulent flow, aircraft vibration and flutter, propeller acoustics, flight simulation, propulsion systems, flame measurements, and control experiments. Statistical error analysis. Prerequisites: Aero Eng 3251, 3361, 3171, & 4882.

**AERO ENG 4885 Assessment** (LEC 1.0)

This course is an overview and assessment of the required aerospace engineering courses that the students took. Prerequisites: Aero Eng 3171, Aero Eng 3361, Aero Eng 4535, Aero Eng 4253.

**AERO ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**AERO ENG 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title. (Co-listed with Mech Eng 5001).

**AERO ENG 5131 Intermediate Thermofluid Mechanics** (LEC 3.0)

Derivation of Navier-Stokes equations, analytical solutions of viscous flows; flow in pipes, flow networks; intermediate treatment of boundary layer theory; micro-fluidics and MEMS; introduction to numerical methods for solving fluid flows; and, preliminary treatise on turbulence. Prerequisite: Mech Eng 3131 or Aero Eng 3131. (Co-listed with Mech Eng 5131).



**AERO ENG 5139 Computational Fluid Dynamics** (LEC 3.0)

Introduction to the numerical solution of the Navier-Stokes equations, by finite difference methods, in both stream function-vorticity and primitive variable formulations. Course format emphasizes student development of complete computer programs utilizing a variety of solution methods. Prerequisites: Comp Sci 1570 or 1970 or 1971; one course in fluid mechanics. (Co-listed with Mech Eng 5139).

**AERO ENG 5169 Introduction to Hypersonic Flow** (LEC 3.0)

A study of the basic principles of hypersonic flow. Inviscid and viscous hypersonic flow. Application of numerical methods. High temperature flow. Consideration of real gas and rarefied flow. Applications in aerodynamic heating and atmospheric entry. Prerequisites: Aero Eng 3171.

**AERO ENG 5171 V/Stol Aerodynamics** (LEC 3.0)

Basic concepts of V/STOL flight. Take-off transition and landing performance, thrust vectoring. Propeller and helicopter aerodynamics. Unblown and blown flaps. Boundary layer control. Lift fans and ducted propellers. Wing-propeller interaction and thrust augmentation. Prerequisite: Aero Eng 3171.

**AERO ENG 5212 Introduction to Finite Element Analysis** (LEC 3.0)

Variational formulation of the governing equations. Finite element model, interpolation functions, numerical integration, assembly of elements and solution procedures. Applications to solid mechanics, fluid mechanics and heat transfer problems. Two-dimensional problems. Computer implementation and use of commercial finite element codes. Prerequisite: Mech Eng 3708 or Aero Eng 4253 or consent of instructor for majors that do not require either of these courses, or graduate standing. (Co-listed with Mech Eng 5212).

**AERO ENG 5220 Advanced Mechanics of Materials** (LEC 3.0)

Comprehensive insight into mechanics of materials. Topics to include: theories of failure, torsion of noncircular sections, shear flow and shear center, unsymmetric bending, bending of curved members, beams on elastic foundation and pressurization of thick walled cylinders. Prerequisites: Civ Eng 2210, Math 3304. (Co-listed with Mech Eng 5220).

**AERO ENG 5222 Introduction to Solid Mechanics** (LEC 3.0)

Review of basic concepts in continuum mechanics. Finite elasticity: some universal solutions for isotropic materials, application of special mechanical models. Linear elasticity: compatibility, stress functions, superposition, special examples such as extension, torsion, bending, and plane problems. Elements of plasticity. Prerequisite: Eng Mech 5211. (Co-listed with Mech Eng 5222).

**AERO ENG 5229 Smart Materials and Sensors** (LAB 1.0 and LEC 2.0)

Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multi-disciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior standing and Math 3304. (Co-listed with Mech Eng 5229, Elec Eng 5270 and Civ Eng 5118).

**AERO ENG 5234 Stability of Engineering Structures** (LEC 3.0)

Solution of stability problems with applications to columns, plates and shell structures. Torsional and lateral buckling of columns. Buckling under high temperatures. Effect of imperfections introduced by a technological process on stability. Design issues related to stability requirements. Prerequisites: Civ Eng 2210; Math 3304; and Mech Eng 2350 or Mech Eng 2360 or Aero Eng 2360. (Co-listed with Mech Eng 5234).

**AERO ENG 5236 Fracture Mechanics** (LEC 3.0)

Linear elastic and plastic mathematical models for stresses around cracks; concept of stress intensity; strain energy release rates; correlation of models with experiment; determination of plane stress and plane strain parameters; application to design. Prerequisite: Civ Eng 2210. (Co-listed with Mech Eng 5236).

**AERO ENG 5238 Fatigue Analysis** (LEC 3.0)

The mechanism of fatigue, fatigue strength of metals, fracture mechanics, influence of stress conditions on fatigue strength, stress concentrations, surface treatment effects, corrosion fatigue and fretting corrosion, fatigue of joints components and structures, design to prevent fatigue. Prerequisite: Civ Eng 2210. (Co-listed with Mech Eng 5238).

**AERO ENG 5282 Introduction to Composite Materials & Structures** (LEC 3.0)

Introduction to fiber-reinforced composite materials and structures with emphasis on analysis and design. Composite micromechanics, lamination theory and failure criteria. Design procedures for structures made of composite materials. An overview of fabrication and experimental characterization. Prerequisite: Civ Eng 2210. (Co-listed with Mech Eng 5282).

**AERO ENG 5307 Vibrations I** (LEC 3.0)

Equations of motion, free and forced vibration of single degree of freedom systems. Natural frequencies, resonance, modes of vibration and energy dissipation are studied. The vibration of continuous systems is introduced. Prerequisites: Mech Eng 3411 and 3313, or Aero Eng 3613 and Math 3304. (Co-listed with Mech Eng 5307).

**AERO ENG 5309 Engineering Acoustics I** (LEC 3.0)

Introduction to acoustical theory and measurement with emphasis on mechanical and aerospace engineering applications. Plane and spherical wave propagation, resonators and filters, absorption, room acoustics, human response to noise, noise legislation, noise control. Use of common instrumentation in several projects. Prerequisites: Mech Eng 3411 & 3313, or Aero Eng 3613 & Math 3304. (Co-listed with Mech Eng 5309).

**AERO ENG 5313 Intermediate Dynamics of Mechanical and Aerospace Systems** (LEC 3.0)

Principles of dynamics are applied to problems in the design of mechanical and aerospace systems; basic concepts in kinematics and dynamics; dynamics of systems of particles; dynamics of rigid bodies, three-dimensional effects in machine elements; dynamic stability, theory and applications; methods of analytical dynamics. Prerequisite: Mech Eng 3313 or Aero Eng 3613. (Co-listed with Mech Eng 5313).

**AERO ENG 5353 Aeroelasticity** (LEC 3.0)

Study of phenomena involving interactions among inertial, aerodynamic, and elastic forces and the influence of these interactions on aircraft and space vehicle design. Some aeroelastic phenomena are: divergence, control effectiveness, control reversal, flutter, buffeting, dynamic response to rapidly applied loads, aeroelastic effects on load distribution, and static and dynamic stability. Prerequisites: Aero Eng 3251 and 3171.

**AERO ENG 5361 Flight Dynamics-Stability And Control** (LEC 3.0)

Review of static stability, dynamic equations of motion, linearized solutions, classical control design and analysis techniques, introduction to modern control. Prerequisite: Aero Eng 3361.

**AERO ENG 5449 Robotic Manipulators and Mechanisms** (LEC 2.0 and LAB 1.0)

Overview of industrial applications, manipulator systems and geometry. Manipulator kinematics; hand location, velocity and acceleration. Basic formulation of manipulator dynamics and control. Introduction to machine vision. Projects include robot programming, vision-aided inspection and guidance, and system integration. Prerequisites: Mech Eng 3313; Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972 or Comp Sci 1570. (Co-listed with Mech Eng 5449).

**AERO ENG 5478 Mechatronics** (LEC 2.0 and LAB 1.0)

This course will introduce students to the basics of mechatronics (i.e., the integration of mechanical, electrical, computer, and control systems). Students will learn the fundamentals of sensors and actuators for mechanical systems, computer interfacing, microcontrollers, real-time software, and control. Prerequisite: Mech Eng 4479 or equivalent. (Co-listed with Mech Eng 5478, Elec Eng 5870 and Comp Eng 5820).

**AERO ENG 5481 Mechanical and Aerospace Control Systems** (LEC 3.0)

Synthesis of mechanical and aerospace systems to perform specific control functions. Response and stability are studied. Singular value analysis for stability margins is introduced. Prerequisite: Mech Eng 4479 or Aero Eng 3361. (Co-listed with Mech Eng 5481).

**AERO ENG 5519 Advanced Thermodynamics** (LEC 3.0)

After a short review of classical thermodynamics, the elements of chemical reactions, chemical equilibrium, statistical thermodynamics, and the basic concepts of kinetic theory are presented. Prerequisite: Mech Eng 2519. (Co-listed with Mech Eng 5519).

**AERO ENG 5525 Intermediate Heat Transfer** (LEC 3.0)

Analytical study of conduction; theory of thermal radiation and applications; energy and momentum equations in convective heat transfer and review of empirical relations. Current topics are included. Prerequisite: Mech Eng 3525. (Co-listed with Mech Eng 5525).

**AERO ENG 5527 Combustion Processes** (LEC 3.0)

Application of chemical, thermodynamic, and gas dynamic principles to the combustion of solid, liquid, and gaseous fuels. Includes stoichiometry, thermochemistry, reaction mechanism, reaction velocity, temperature levels, and combustion waves. Prerequisite: Mech Eng 3521. (Co-listed with Mech Eng 5527).

**AERO ENG 5535 Aerospace Propulsion Systems** (LEC 3.0)

Study of atmospheric and space propulsion systems with emphasis on topics of particular current interest. Mission analysis in space as it affects the propulsion system. Power generation in space including direct and indirect energy conversion schemes. Prerequisite: Aero Eng 4535.

**AERO ENG 5570 Plasma Physics I** (LEC 3.0)

Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Mech Eng 5570, Nuc Eng 4370, Physics 4543).

**AERO ENG 5614 Spaceflight Mechanics** (LEC 3.0)

Further topics in orbital mechanics. Time equations, Lambert's problem, patched-conic method, orbital maneuvers, orbit determination, orbit design, re-entry problem. Prerequisite: Aero Eng 3613.

**AERO ENG 5715 Concurrent Engineering** (LEC 3.0)

Students will be introduced to the concurrent engineering approach to product development. They will learn to set up quantitative requirements and then use a quantitative rating process to identify the critical requirements relating to the desired product. The interaction between design, manufacturing, assembly, cost, and supportability will be covered. The students will form teams and practice the concurrent engineering process for simple products. Prerequisites: Mech Eng 3313 or Aero Eng 3131 and Civ Eng 2210 (Co-listed with Mech Eng 5715).

**AERO ENG 5758 Integrated Product Development** (LAB 1.0 and LEC 2.0)

Students in design teams will simulate the industrial concurrent engineering development process. Areas covered will be design, manufacturing, assembly, cost, and product support. Using a 3-D solid modeling program, students will design, analyze, and send the data base to the automated machine shop where the parts will be manufactured. The parts will then be assembled, tested and analyzed for their performance. Prerequisites: Aero Eng 3251 or Mech Eng 3708 for Design; Mech Eng 3313 for Assembly; Accompanied or preceded by Mech Eng 5653 for Manufacturing; Eng Mgt 5711 or 5714 for Cost/Product Support.

**AERO ENG 5760 Probabilistic Engineering Design** (LEC 3.0)

The course deals with uncertainties in engineering analysis and design at three levels - uncertainty modeling, uncertainty analysis, and design under uncertainty. It covers physics-based reliability analysis and reliability-based design, robustness assessment and robust design, their integration with design simulations, and their engineering applications. Prerequisite: Mech Eng 3708 or Aero Eng 3361. (Co-listed with Mech Eng 5760).

**AERO ENG 5830 Applied Computational Methods** (LEC 3.0)

Detailed study of computational methods for efficient solution of selected fluids, structures, thermodynamics, and controls problems in aerospace and mechanical engineering. Besides basic numerical techniques, topics covered include gradient-based optimization and uncertainty quantification. Prerequisite: Comp Sci 1570 or 1970 or 1981; Math 3304. (Co-listed with Mech Eng 5830).

## Aerospace Studies

### Air Force ROTC

The Air Force Reserve Officer Training Corps (ROTC) program is administered by the department of aerospace studies. The mission of Air Force ROTC is to develop quality leaders for the Air Force; it is the Air Force's largest officer commissioning source. Air Force ROTC offers a number of opportunities for Missouri S&T students who wish to become commission officers by offering professional, academic, and military training. Leadership, communication, and basic military skills are the focus of the ROTC program. In addition to helping a student succeed during college, Air Force ROTC also fosters self-confidence and self-discipline.

Opportunities in the Air Force are excellent, with over 100 possible career fields available. Career field availability depends on academic discipline, medical condition, desires of the individual, and needs of the Air Force. As newly commissioned Second Lieutenants on active duty, Air Force ROTC graduates can serve worldwide, performing challenging and rewarding duties in highly technical, scientific, and operational areas. A few of these include developmental engineer, pilot, combat system operator, remote pilot, scientist, cyber operations, intelligence operations,

space operations, civil engineer, combat control officer, acquisitions, and maintenance.

Although Air Force ROTC is set up as a four-year program, students can choose a four, three and a half, or three year course of study. The first two years of the program, called the general military course (GMC), cover basic introductory military topics as well as communication and leadership. The final two years of the program, called the professional officer course (POC), cover topics such as leadership, management, doctrine, international events, communication, and officership. In addition to the academic ROTC class, all cadets attend a two hour leadership laboratory each week and two hours of physical training. Leadership laboratory provides cadets with the knowledge and practical command and staff leadership experience in preparation for active duty as Air Force officers. It is largely cadet planned, directed, and centered.

Air Force ROTC scholarships, which generally cover full tuition and fees, are available to qualified cadets. A monthly stipend is given during the academic year to each cadet on scholarship and contracted members of the POC. Students who receive an AFROTC scholarship also receive an annual supplemental scholarship from Missouri S&T. Finally, scholarship recipients receive a \$300 book allowance each semester. ROTC scholarship recipients are eligible to receive other Missouri S&T scholarships.

Cadets usually attend the leadership evaluation, assessment, and development (LEAD) course for the summer between their sophomore and junior year, before enrollment into the POC. Entrance into the POC is based on an extensive evaluation and selection process during the sophomore year, and is dependent on completion of the LEAD course. Cadets who complete the POC in good standing and earn their academic degree are commissioned as Second Lieutenants and serve on active duty for four or more years, depending on their assigned Air Force career field.

The Air Force ROTC unit at Missouri S&T is organized as an objective wing, with associate groups, squadrons, and flights. Freshmen and sophomore cadets receive instruction from POC cadets in basic military customs and courtesies, drill movements, and many other facets of Air Force operations. Additionally, they are offered the opportunity to visit Air Force bases and discuss career opportunities with Air Force members. Junior and senior cadets are assigned and rotated through various leadership positions, gaining experience in management procedures.

## Military Aerospace Studies Minor

Air Force Reserve Officer Training Corps (ROTC) is administered by the Department of Aerospace Studies. Although Air Force ROTC is set up as a four-year program, students can choose a four, three and a half, or three year course of study. The first two years of the program, called the General Military Course (GMC), cover basic introductory military topics as well as communication and leadership. The final two years of the program, called the Professional Officer Course (POC), cover topics such as leadership, management, doctrine, international events, quality, communication, and officership. To fulfill the requirements for the proposed Aerospace Studies minor, students will complete all of the following classes for a total of 16 credit hours.

MIL AIR 1110	Foundations Of The U.S. Air Force I	1
MIL AIR 1120	Foundations Of The U.S. Air Force II	1
MIL AIR 2110	The Evolution Of USAF Air And Space Power I	1
MIL AIR 2120	The Evolution Of USAF Air And Space Power II	1
MIL AIR 3110	Air Force Leadership Studies I	3
MIL AIR 3120	Air Force Leadership Studies II	3

MIL AIR 4110	National Security Affairs/Preparation For Active Duty I	3
MIL AIR 4120	National Security Affairs/Preparation For Active Duty II	3

**Kathleen M Ice**, Lecturer  
MASTERS McKendree University

**Christopher O Logsdon**, Lecturer  
MASTERS St. Mary's University

**Brent J. Unger**, Lecturer  
MASTERS University of Missouri-Columbia

### **MIL AIR 1100 Leadership Laboratory** (LAB 0.50 and LEC 0.50)

The course involves a study of Air Force customs and courtesies, drill and ceremonies, career opportunities in the Air Force and the life and work of an Air Force junior officer. Students develop their leadership potential in a practical supervised training laboratory, which typically includes field trips to Air Force installations throughout the United States.

### **MIL AIR 1110 Foundations Of The U.S. Air Force I** (LAB 0.50 and LEC 0.50)

This survey course is designed to introduce students to the Air Force and ROTC. Topics include: military customs and courtesies, uniform wear, officership qualities, professionalism, Air Force core values, equal opportunity and treatment, officer benefits and opportunities and an introduction to communication skills. Leadership Lab is mandatory for cadets planning on a career in the Air Force.

### **MIL AIR 1120 Foundations Of The U.S. Air Force II** (LEC 0.50 and LAB 0.50)

This survey course is a continuation of Mil Air 1110. Covered topics include: origin of the Air Force, mission and organization of the Air Force, organization of a standard Air Force base, and further communication skills development. Leadership Lab is also mandatory for cadets.

### **MIL AIR 2110 The Evolution Of USAF Air And Space Power I** (LEC 0.50 and LAB 0.50)

This course is designed to examine the general aspects of air and space power through a historical perspective...covering a time period from the first balloons to the beginning of the space age. It provides students with a knowledge level understanding of the general elements and employment of air and space power from an institutional doctrinal and historical perspective. Examples of the importance of AF core values in historical events and in past AF leaders are pointed out. Continued development of communication skills is also emphasized. Leadership Lab is mandatory for cadets planning on a career in the Air Force.

### **MIL AIR 2120 The Evolution Of USAF Air And Space Power II** (LEC 0.50 and LAB 0.50)

This course is a continuation of Mil Air 2110. It covers a time period in Air Force history from the beginning of the space age in the early 1960's to the present...with a continued emphasis on recognizing how past leaders and events have shaped our current Air Force organization and doctrine. Communication skills exercises are continued. Leadership Lab is also mandatory for cadets.

### **MIL AIR 3110 Air Force Leadership Studies I** (LEC 2.5 and LAB 0.50)

This course introduces students to the leadership and management skills required of an Air Force junior officer. Special topics include leadership ethics, the Air Force personnel and evaluation systems, and management fundamentals. Through the use of classroom tools that include case studies, Air Force leadership and management situations are examined and practical applications of studies concepts are exercised. The principles and theories of ethical behavior as well as the complete understanding of the individual responsibility and authority of an Air Force officer are stressed. This course includes a Leadership Lab that provides the students the opportunity to apply leadership and management principles.

**MIL AIR 3120 Air Force Leadership Studies II** (LEC 2.5 and LAB 0.50)

This course is a continuation of Mil Air 3110. Emphasis is placed on professional knowledge, communication skills, and ethical behavior. Varied Air Force-peculiar formats and situations are offered to apply learned listening, writing, and speaking skills. This course includes a Leadership Lab that provides the students the opportunity to apply leadership and management principles.

**MIL AIR 4110 National Security Affairs/Preparation For Active Duty I** (LEC 2.5 and LAB 0.50)

This course examines national security policies, processes, and issues along with Air Force strategy and doctrine. Special topics include Air Force roles and missions, the roles of various federal government departments, military organizations and functions, and the concept of joint operations. Within this structure, continued emphasis is given to refining communication skills. This course includes a Leadership Laboratory that provides advanced leadership experiences, giving students the opportunity to apply the leadership and management principles of this course.

**MIL AIR 4120 National Security Affairs/Preparation For Active Duty II** (LEC 2.5 and LAB 0.50)

Continuation of Mil Air 4110. This final course of the Air Force ROTC curriculum examines officership, advanced leadership ethics, military law, current Air Force issues, regional studies, core values, and preparation for active duty. This course includes a Leadership Laboratory that provides leadership experiences, giving students the opportunity to apply the leadership and management principles of this course.

## Architectural Engineering

**Emphasis areas include structural engineering, construction engineering and project management, environmental systems for buildings, and construction materials.**

Architectural engineers plan, design, and supervise construction of many essential facilities and structures for residential, commercial, industrial and institutional buildings. These building systems include electrical, communications and control, lighting, heating, ventilating, air conditioning, fire protection, plumbing, and structural systems. Architectural engineers are problem solvers applying the latest in high-tech equipment and sophisticated procedures to address challenges concerning our environment and infrastructure. The diversity of architectural engineers complements the use of multiple systems to the intent and purpose of the project's design.

The bachelor of science in architectural engineering (BSAE) degree requires satisfactory completion of 128 credit hours. In your first two years, you will complete mathematics, physics, English, architectural design and other prerequisite courses. In your third and fourth years, most of your course work will be in engineering sciences. Also in your fourth year you will complete engineering design courses in general and specific areas.

Courses in structural, electrical, mechanical and lighting design are directed toward providing reliable and efficient structures such as stadiums, retail complexes, office buildings and airports. Courses in construction engineering include studies in construction techniques, cost estimating, quality control/quality assurance, and contract administration. History, architectural design and humanities provide the necessary tools to appreciably coexist in the fabric of society.

Architectural engineering is a broad field of endeavor. Because of this breadth, courses are required in each of the above areas. Although

you, as a architectural engineer, may specialize within a given area, by the very nature of the profession you will be required to interact with specialists in the other areas. You will find that you will be working with architects and engineers in the other disciplines in the planning, design, and construction of complex facilities.

Architectural engineers also must be effective in communicating with the public. You may be expected to work with property owners, concerned citizens, city officials, attorneys, and even medical doctors for concerns related to public health measures. The results of your work as a architectural engineer will be seen everywhere. Projects in which you will become involved must be economical, appreciable to self and community, and provide a reasonable life expectancy. Use of computer hardware and software is a key component of the BSAE program of study.

## Mission Statement

The architectural engineering program will provide students with the tools necessary to solve architectural engineering problems critical to our society's well-being. This will be accomplished through a comprehensive, forward-looking and broad-based architectural engineering curriculum emphasizing fundamentals, practical applications, oral and written communication skills, computer applications skills, and professional practice issues and ethics. The program will prepare graduates for entry into the architectural engineering profession, for life-long learning, and to function as architectural engineers in a global society.

## Architectural Engineering Program Educational Objectives

Consistent with the mission statement, graduates of the Missouri S&T architectural engineering program will demonstrate, within a few years of graduation:

1. technical competency
2. an ability to communicate effectively
3. continuing professional development
4. managerial competence
5. an ability to work in teams
6. professional responsibility

## Program Outcomes

Consistent with the program educational objectives listed above, the Missouri S&T architectural engineering program graduates will have:

1. an ability to apply knowledge of mathematics, science, and engineering
2. an ability to design and conduct experiments, as well as to analyze and interpret data
3. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. an ability to function on multi-disciplinary teams
5. an ability to identify, formulate, and solve engineering problems
6. an understanding of professional and ethical responsibility
7. an ability to communicate effectively
8. an understanding of the impact of engineering solutions in a global, economic, architectural, and social context



9. a recognition of the need for, and an ability to engage in life-long learning
10. a knowledge of contemporary issues including architectural principles and the historical development and significance of architecture
11. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

## Architectural Engineering Bachelor of Science

Entering freshmen desiring to study Architectural Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Architectural Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major.

For the Bachelor of Science degree in Architectural Engineering a minimum of 129 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. An average of at least two grade points per credit hour must also be maintained in all courses taken in Architectural Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1. All students are required to take one American history course, one economics course, one humanities course, and ENGLISH 1120. The history course is to be selected from HISTORY 1200 (preferred), HISTORY 1300, or HISTORY 1310. The economics course may be either ECON 1100 or ECON 1200. Art 3203 is required and fulfills the ABET humanities requirement.
2. Depth requirement. Three credit hours must be taken in humanities or social sciences at the 2000-level or above. This will be satisfied by taking the required History 2510 and 3550. All courses taken to satisfy the depth requirement must be taken after graduating from high school.
3. The Gen Ed course is to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to ENGLISH 1120.
4. Special topics and special problems and honors seminars are allowed only by petition to and approval by the student's department chair.

The Architectural Engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

Freshman Year			
First Semester	Credits	Second Semester	Credits
CHEM 1100	1	MATH 1215	4
FR ENG 1100 <sup>2</sup>	1	General Ed Elective <sup>1</sup>	3
MATH 1214	4	MECH ENG 1720	3
ENGLISH 1120	3	PHYSICS 1135	4
General Ed Elective <sup>1</sup>	3		
CHEM 1310 & CHEM 1319	5		
	17		14

Sophomore Year			
First Semester	Credits	Second Semester	Credits
CIV ENG 2200 <sup>2</sup>	3	STAT 3113	3
MATH 2222	4	CIV ENG 2210 <sup>2</sup>	3
PHYSICS 2135	4	CIV ENG 2211	1
CIV ENG 2401 <sup>2</sup>	3	ARCH ENG 2103	3
ARCH ENG 2003	3	ART 3203	3
		MATH 3304	3
		MECH ENG 2350	2
	17		18

Junior Year			
First Semester	Credits	Second Semester	Credits
ARCH ENG 3201 <sup>2</sup>	3	ARCH ENG 3805	3
CIV ENG 3330 <sup>2</sup>	3	ARCH ENG 5872	3
MECH ENG 2527	3	CIV ENG 3116	3
ARCH ENG 3803	3	HISTORY 2510	3
ARCH ENG 3804	3	ARCH ENG 3220	3
CIV ENG 3715	3		
	18		15

Senior Year			
First Semester	Credits	Second Semester	Credits
ARCH ENG 4010	1	ARCH ENG 4097	3
ARCH ENG 3210	3	ARCH ENG Technical Elective <sup>3,4</sup>	3
ARCH ENG 4448	3	CIV ENG 4729	3
ARCH ENG Technical Elective <sup>3,4</sup>	3	General Education Elective <sup>1</sup>	3
HISTORY 4550	3	Basic Science Elective <sup>5</sup>	3
ENG MGT 1210	2		
	15		15

Total Credits: 129

- <sup>1</sup> All general education electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog.
- <sup>2</sup> A grade of 'C' or better required to satisfy graduation requirements.
- <sup>3</sup> A grade of 'C' or better may be required in ARCH ENG technical elective prerequisite courses. Refer to the Missouri S&T undergraduate catalog for this prerequisite information.
- <sup>4</sup> Choose technical electives from approved lists under Emphasis Areas for Architectural Engineering Students. A maximum of 3 credits of independent study (ARCH ENG 5000 or ARCH ENG 4099) may be used as a technical elective. Additional independent study course may be taken but will not count towards the B.S. Architectural Engineering degree.



- <sup>5</sup> Each student is required to take three hours of basic science electives in consultation with his/her academic advisor. This course must be selected from the following: Chem 1301, Geo 1111, Geo 2610, Bio Sci 1213, Bio Sci 1943, Phys 1505, or Phys 2305

**Note:** All Architectural Engineering students must take the Fundamentals of Engineering examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree, however, it is the first step toward becoming a registered professional engineer. This requirement is part of the Missouri S&T assessment process as described in Assessment Requirements found elsewhere in this catalog. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.

## Emphasis Areas and Course Listings by Area for Architectural Engineering Students

### Area I, Structural Engineering

ARCH ENG 5001	Special Topics	6
ARCH ENG 5203	Applied Mechanics In Structural Engineering	3
ARCH ENG 5205	Structural Analysis II	3
ARCH ENG 5260	Analysis And Design Of Wood Structures	3
ARCH ENG 5207	Computer Methods of Structural Analysis	3
ARCH ENG 5210	Advanced Steel Structures Design	3
ARCH ENG 5220	Advanced Concrete Structures Design	3
ARCH ENG 5222	Prestressed Concrete Design	3
ARCH ENG 5729	Foundation Engineering II	3
ARCH ENG 5231	Infrastructure Strengthening with Composites	3
ARCH ENG 5206	Low-Rise Building Analysis And Design	3
ARCH ENG 5208	Structural Dynamics	3

### Area II, Construction Engineering and Project Management

ARCH ENG 5442	Construction Planning and Scheduling Strategies	3
ARCH ENG 5445	Construction Methods	3
ARCH ENG 5446	Management Of Construction Costs	3
ARCH ENG 5448	Green Engineering: Analysis of Constructed Facilities	3
ARCH ENG 5449	Engineering and Construction Contract Specifications	3
ENG MGT 5110	Managerial Decision Making	3
ENG MGT 5613	Value Analysis	3
ENG MGT 5711	Total Quality Management	3

### Area III, Environmental Systems for Buildings

ARCH ENG 5001	Special Topics	0-6
ARCH ENG 5642	Sustainability, Population, Energy, Water, and Materials	3
ARCH ENG 5665	Indoor Air Pollution	3
ARCH ENG 5850	Residential Renewable Energy Systems	3
ENG MGT 5513	Energy and Sustainability Management Engineering	3

### Mechanical Emphasis Courses

MECH ENG 5309	Engineering Acoustics I	3
MECH ENG 5566	Solar Energy Technology	3
MECH ENG 5575	Mechanical Systems For Environmental Control	3

### Electrical Emphasis Courses

ELEC ENG 3340	Basic Programmable Logic Controllers	3
ELEC ENG 5150	Photovoltaic Systems Engineering	3
COMP ENG 2210 & COMP ENG 2211	Introduction to Digital Logic and Computer Engineering Laboratory	4

### Area IV, Construction Materials

ARCH ENG 5203	Applied Mechanics In Structural Engineering	3
CIV ENG 5113	Composition And Properties Of Concrete	3
CIV ENG 5118	Smart Materials And Sensors	3
CIV ENG 5156	Concrete Pavement Design	3
CER ENG 5810	Principles Of Engineering Materials	3

### Architectural Engineering Courses

ARCH ENG 2103	Architectural Materials And Methods Of Construction	3
ARCH ENG 3804	Architectural Design II	3
ARCH ENG 3805		3
ART 3203	Architectural Design I	3

### Architectural Engineering Courses (cross-list with existing civil engineering courses)

ARCH ENG 2003	Engineering Communications and Computations	2
ARCH ENG 2001	Special Topics	0-6
ARCH ENG 3000	Special Problems	1-6
ARCH ENG 3001	Special Topics	0-6
ARCH ENG 2002	Cooperative Engineering Training	1
ARCH ENG 4010	Senior Seminar: Engineering In A Global Society	1
ARCH ENG 3201	Structural Analysis I	3
ARCH ENG 3210	Structural Design in Metals	3
ARCH ENG 3220	Reinforced Concrete Design	3
ARCH ENG 4447	Ethical, Legal and Professional Engineering Practice	2
ARCH ENG 4448	Fundamentals Of Contracts And Construction Engineering	3
ARCH ENG 4097	Senior Design Project	3
ARCH ENG 5000	Special Problems	6
ARCH ENG 5001	Special Topics	6
ARCH ENG 5205	Structural Analysis II	3
ARCH ENG 5260	Analysis And Design Of Wood Structures	3
ARCH ENG 5207	Computer Methods of Structural Analysis	3
ARCH ENG 5210	Advanced Steel Structures Design	3
ARCH ENG 5220	Advanced Concrete Structures Design	3
ARCH ENG 5222	Prestressed Concrete Design	3
ARCH ENG 5445	Construction Methods	3
ARCH ENG 5446	Management Of Construction Costs	3
ARCH ENG 5449	Engineering and Construction Contract Specifications	3
ARCH ENG 5231	Infrastructure Strengthening with Composites	3
ARCH ENG 4099	Undergraduate Research	6

### Civil Engineering Courses (required courses, emphasis area, and/or technical electives)

CIV ENG 3715	Fundamentals of Geotechnical Engineering	3
CIV ENG 3116	Construction Materials, Properties And Testing	3
CIV ENG 4729	Foundation Engineering	3
CIV ENG 3330	Engineering Fluid Mechanics	3
CIV ENG 5113	Composition And Properties Of Concrete	3
CIV ENG 5117	Asphalt Pavement Design	3
CIV ENG 5729	Foundation Engineering II	3
CIV ENG 5441	Professional Aspects Of Engineering Practice	3
CIV ENG 5445	Construction Methods	3
CIV ENG 5446	Management Of Construction Costs	3
CIV ENG 5449	Engineering and Construction Contract Specifications	3

**Daniel R Abbott**, Lecturer  
MS University of Missouri-Rolla

**Stuart W Baur**, Associate Professor<sup>4</sup>  
PHD University of Missouri-Rolla

**Jerry R Bayless**, Professor Emeritus<sup>1</sup>  
MS Missouri School of Mines

**Joel G Burken**, Curators Distinguished Professor<sup>1,5</sup>  
PHD University of Iowa

**Mohamed Abdelmonem ElGawady**, Associate Professor  
DE Swiss Federal Institute of Technology

**Kelvin Todd Erickson**, Professor<sup>1</sup>  
PHD Iowa State University

**Walter Eversman**, Professor Emeritus<sup>1</sup>  
PHD Stanford University

**Dimitri Feys**, Assistant Professor  
PHD Ghent University, Belgium

**Roger Allen LaBoube**, Professor Emeritus<sup>1</sup>  
PHD University of Missouri-Rolla

**Cesar Mendoza**, Associate Professor  
PHD Colorado State University

**Glenn Morrison**, Professor<sup>1</sup>  
PHD University of California-Berkeley

**John J Myers**, Professor<sup>1</sup>  
PHD University of Texas-Austin

**David N Richardson**, Associate Professor<sup>1</sup>  
PHD University of Missouri-Rolla

**William P Schonberg**, Professor<sup>1</sup>  
PHD Northwestern University

**Jeffrey W. Schramm**, Associate Professor  
PHD Lehigh University

**William Eric Showalter**, Associate Teaching Professor<sup>1,6</sup>  
PHD Purdue University

**Lesley Haynes Sneed**, Associate Professor<sup>1</sup>  
PHD Purdue University

**Richard Wesley Stephenson**, Professor Emeritus<sup>1</sup>  
PHD Oklahoma State University

**Jeffery S Thomas**, Associate Teaching Professor<sup>1</sup>  
PHD Missouri Science & Technology

**ARCH ENG 2001 Special Topics** (IND 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**ARCH ENG 2002 Cooperative Engineering Training** (IND 1.0)  
On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation.

**ARCH ENG 2003 Engineering Communications and Computations** (LEC 2.0 and LAB 1.0)

Programming and software tools (including computer aided design and drafting, computer-based mathematics, word processing, spreadsheet, and presentation software) with application to and emphasis on written, graphical, and oral communication in professional civil and architectural engineering practice. (Co-listed with Civ Eng 2003).

**ARCH ENG 2103 Architectural Materials And Methods Of Construction** (LAB 1.0 and LEC 2.0)

A study of the origin and properties of construction materials, methods of construction, and installation. Materials include mineral based, wood, steel, concrete, masonry, asphalt, and gypsum as components of architectural engineering. Prerequisites: Chem 1310, Chem 1319 and Sophomore standing.

**ARCH ENG 2803 Architectural Design I** (LEC 1.0 and LAB 2.0)

Introduction to the interaction between architecture and the engineering disciplines. Theories of building and site design, technology as an integral component of design, plan and spatial organization, structural clarity, formal composition, and environmental context are considered as principle form determinants. Prerequisite: Sophomore standing.

**ARCH ENG 3000 Special Problems** (IND 1.0-6.0)

(Variable) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ARCH ENG 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ARCH ENG 3201 Structural Analysis I** (LAB 1.0 and LEC 2.0)

Loads on Structures. Analysis of statically determinate and indeterminate beams, frames and trusses. Influence lines and moving loads. Computation of deflections. Development and use of theorems of displacement methods including slope-deflection and moment distribution to analyze statically indeterminate structures. Computer solutions. Prerequisites: Civ Eng 2200, Civ Eng 2210 each with a grade of "C" or better. (Co-listed with Civ Eng 3201).

**ARCH ENG 3210 Structural Design in Metals** (LEC 2.0 and LAB 1.0)

The analysis and design of structural elements and connections for buildings, bridges and specialized structures utilizing structural metals. Both elastic and plastic designs are considered. Prerequisite: Arch Eng 3201 with grade of "C" or better. (Co-listed with Cv Eng 3210).

**ARCH ENG 3220 Reinforced Concrete Design** (LAB 1.0 and LEC 2.0)

The analysis and design of reinforced concrete beams, slabs, columns, retaining walls and footings by the elastic and ultimate strength methods including and introduction to the design of prestressed concrete. Introduction to use of computers as a design aid tool. Prerequisite: Arch Eng 3201 with grade of "C" or better. (Co-listed with Civ Eng 3220).

**ARCH ENG 3803 Building Electrical Systems** (LEC 3.0)

The design of interior and exterior building electrical systems, including power loads, branch circuits and switching. Work includes study of applicable NFPA 70 (NEC) and related building codes. Prerequisites: Math 3304 and Physics 2135.

**ARCH ENG 3804 Architectural Design II** (LAB 2.0 and LEC 1.0)

A continuation of Architectural Engineering Design I with an increased focus on problems and models associated with detail development, principles of acoustic design and building construction as a form determinant. Prerequisite: Art 3203.

**ARCH ENG 3805 Building Lighting Systems** (LEC 3.0)

Design and specifications for interior and exterior building illumination systems. Work includes study of applicable NFPA 70 (NEC) and related building codes. Prerequisites: Arch Eng 3803 and Arch Eng 3804.

**ARCH ENG 4010 Senior Seminar: Engineering In A Global Society** (RSD 1.0)

Discussion of contemporary issues: public safety, health, and welfare; the principles of sustainable development; lifelong learning; impact of engineering solutions in a global and societal and political context; relationships with owners, contractors, and the public; public service; the Code of Ethics; and the Missouri licensing Statutes and Board Rules. Prerequisite: Senior standing. (Co-listed with Civ Eng and Env Eng 4010).

**ARCH ENG 4097 Senior Design Project** (LEC 3.0)

Open-ended building design project involving one or more areas of engineering. Planning design projects, philosophy of design, and the application of engineering principles to design problems. Prerequisite: Arch Eng 4448 or Civ Eng 4448. (Co-listed with Civ Eng 4097 and Env Eng 4097).

**ARCH ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged by instructor.

**ARCH ENG 4447 Ethical, Legal and Professional Engineering Practice** (LEC 2.0)

Discussions of law concerning contracts, torts, agencies, real property, partnerships and corporations. The purposes and implications of the engineering registration law, the effect of legal, ethical and marketing considerations of the practice of Architectural Engineering. Prerequisite: Junior standing. (Co-listed with Civ Eng 4447).

**ARCH ENG 4448 Fundamentals Of Contracts And Construction Engineering** (LEC 3.0)

A study of the concepts and techniques used in large construction projects for the preparation of engineer service contracts, the development of a project manual, detailed and conceptual cost estimating, and construction scheduling analysis. Prerequisite: Senior Standing. (Co-listed with Civ Eng 4448).

**ARCH ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ARCH ENG 5001 Special Topics** (LAB 1.0 and LEC 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ARCH ENG 5203 Applied Mechanics In Structural Engineering** (LEC 3.0)

A study of basic relationships involved in the mechanics of structures. Topic include basic elasticity, failure criteria, fundamental theories of bending and buckling of plates and cylindrical shells for practical application in analysis and design of bridge building floors and shell roofs. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Civ Eng 5203).

**ARCH ENG 5205 Structural Analysis II** (LEC 3.0)

Classical displacement and force methods applied to structures of advanced design. Analysis of indeterminate structures such as continuous beams, arches, cables, and two and three dimensional frames, and trusses. Analysis of indeterminate structures involving temperature and support settlements effects. Prerequisites: Civ Eng 3201 or Arch Eng 3201. (Co-listed with Civ Eng 5205).

**ARCH ENG 5206 Low-Rise Building Analysis And Design** (LEC 3.0)

Characterization of various design loads, load combinations, general methodology of structural designs against lateral loads, code-oriented design procedures, distribution of lateral loads in structural systems, application of the International Building Code in design of loadbearing wall systems, building frame system and moment-resisting frame systems. Prerequisite: Preceded and/or accompanied by Civ -Arch Eng 3210 or Civ-Arch Eng 3220. (Co-listed with Civ Eng 5206).

**ARCH ENG 5207 Computer Methods of Structural Analysis** (LEC 3.0)

Force and displacement matrix methods and computer methods applied to structural analysis. Analysis of indeterminate structures such as continuous beams, and two and three dimensional frames and trusses. Analysis of indeterminate structures involving temperature and support settlements effects using computer methods formulation. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Civ Eng 5207).

**ARCH ENG 5208 Structural Dynamics** (LEC 3.0)

This course deals with fundamental concepts and structural responses under dynamic loads. Hand calculations and computer methods are developed. Specific topics include resonance, beating phenomenon, equation of motion, dynamic properties, frequencies and mode shapes, and modal and Ritz analyses. Prerequisites: Mech Eng 2350 or equivalent; Civ/Arch Eng 3201 or equivalent. (Co-listed with Civ Eng 5208).

**ARCH ENG 5210 Advanced Steel Structures Design** (LEC 3.0)

The design of structural steel systems into a final integrated structure. Plate girders, composite systems, stability, connections, rigid frames, single and multistory buildings, and similar type problems of interest to the student. Use of the computer as a tool aid in the design will be emphasized. Prerequisite: Arch Eng 3210 with a grade of "C" or better. (Co-listed with Civ Eng 5210).

**ARCH ENG 5220 Advanced Concrete Structures Design** (LEC 3.0)

The design of structural concrete systems into a final integrated structure. Two-way slabs, long columns, connections, and discontinuity regions, deflections and cracking of beams and slabs, ACI design criteria, and similar type problems of interest to the student. Use of the computer as a tool to aid in the design will be emphasized. Prerequisite: Arch Eng 3220 with a grade of "C" or better. (Co-listed with Civ Eng 5220).

**ARCH ENG 5222 Prestressed Concrete Design** (LEC 3.0)

Behavior of steel and concrete under sustained load. Analysis and design of pre-tensioned and post-tensioned reinforced concrete members and the combining of such members into an integral structure. Prerequisite: Arch Eng 3220 with a grade of "C" or better. (Co-listed with Civ Eng 5222).

**ARCH ENG 5231 Infrastructure Strengthening with Composites** (LEC 3.0)

The course presents composite materials and includes principles of reinforcing and strengthening for flexure, shear, and ductility enhancement in buildings and bridges. It covers the design of existing members strengthened with externally bonded laminates and near surface mounted composites. Case studies are discussed. Prerequisites: Arch Eng / Civ Eng 3201, Arch Eng / Civ Eng 3220. (Co-listed with Civ Eng 5231).

**ARCH ENG 5260 Analysis And Design Of Wood Structures** (LEC 3.0)

A critical review of theory and practice in design of modern wood structures. Effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design; development of design criteria and their application to plane and three dimensional structures. Prerequisite: Arch Eng 3201 with a grade of "C" or better. (Co-listed with Civ Eng 5260).

**ARCH ENG 5270 Structural Masonry Design** (LEC 3.0)  
Review of the theory and practice of analyzing low-rise masonry structures, materials and assembly types, constructability considerations, structural masonry components, repair and strengthening, and model code requirements to ensure adequate load resisting buildings. Prerequisites: Arch Eng 3201 or Civ Eng 3201. (Co-listed with Civ Eng 5270).

**ARCH ENG 5442 Construction Planning and Scheduling Strategies** (LEC 3.0)  
The goal of this course is to assist participants in gaining an understanding of schedule control techniques and the application of tools such as Primavera Software. Content areas to be addressed include: development of baseline schedules, progress monitoring and updating, recovery schedules, resource application and leveling. Prerequisite: Civ Eng or Arch Eng 4448. (Co-listed with Civ Eng 5442).

**ARCH ENG 5445 Construction Methods** (LEC 3.0)  
Introduction to construction planning selection of equipment and familiarization with standard methods for horizontal and vertical construction. Application of network analysis and schedules to project control. Prerequisite: Arch Eng 4448 with a grade of "C" or better. (Co-listed with Civ Eng 5445).

**ARCH ENG 5446 Management Of Construction Costs** (LEC 3.0)  
Management of construction projects from inception to completion: estimates, role of network preplanning, project monitoring and control. Prerequisite: Arch Eng 4448 with a grade of "C" or better. (Co-listed with Civ Eng 5446).

**ARCH ENG 5448 Green Engineering: Analysis of Constructed Facilities** (LEC 3.0)  
Environmentally sound design and construction practices. Includes design issues, material selection and site issues that can reduce the impact on the environment caused by the construction process. LEED certification covered in depth. Prerequisites: Civ Eng 4448 or Arch Eng 4448; and Junior Standing. (Co-listed with Civ Eng 5448).

**ARCH ENG 5449 Engineering and Construction Contract Specifications** (LEC 3.0)  
Legal and business aspects of contracts and contracting procedure in the construction industry. Topics include formulation of contracts in common law, engineering services contracts, and construction project contract documents and contract administration issues. Prerequisite: Arch Eng 4448 with a grade of "C" or better. (Co-listed with Civ Eng 5449).

**ARCH ENG 5642 Sustainability, Population, Energy, Water, and Materials** (LEC 3.0)  
This course will examine the concepts regarding the continued advancement of humankind while maintaining our ecological niche on earth. Key topics include: population growth, poverty, and impacts of development; energy consumption, sources, storage, conservation and policy; water quality and quantity; materials and building; and policy implications. Prerequisite: Senior or graduate standing. (Co-listed with Env Eng 5642 and Civ Eng 5642).

**ARCH ENG 5665 Indoor Air Pollution** (LEC 3.0)  
By developing a practical understanding of indoor air pollution sources, physics, chemistry and consequences, students will learn how radon, cigarette smoke, VOCs from furnishings, and so forth affect indoor air quality and apply engineering analyses to specify ventilation rates, choose furnishings and minimize occupant exposure to pollutants. Prerequisite: Civ Eng 2601 or Mech Eng 5571 or Graduate Status. (Co-listed with Civ Eng 5665 and Env Eng 5665).

**ARCH ENG 5729 Foundation Engineering II** (LEC 3.0)  
Classical earth pressure theories. Analysis of shallow and deep foundations to include bearing capacity and settlement of footings, rafts, piles, and drilled piers. Analysis of stability and design of retaining walls and anchored bulkheads. Prerequisites: Civ Eng 4729 with a grade of "C" or better. (Co-listed with Civ Eng 5729).

**ARCH ENG 5850 Residential Renewable Energy Systems** (LAB 1.0 and LEC 2.0)  
Applications of renewable energy systems for residential use will be covered, including system selection and sizing. Economic and life cycle analysis will be used to evaluate solar, geothermal and wind power systems. Prerequisites: Senior standing and consent of instructor, or Mech Eng 2527 or Civ Eng 3842.

**ARCH ENG 5872 Environmental Controls** (LEC 3.0)  
Theory and applications of principles of heating, ventilating, and air conditioning equipment and systems; design problems. Physiological and psychological factors relating to environmental control. Prerequisites: Mech Eng 3521 and accompanied or preceded by Mech Eng 3525; or Mech Eng 2527 and Civ Eng 3330. (Co-listed with Mech Eng 5571).

Art

The study of art can broaden and intensify your experiences and help you gain a better perspective on the world.

Missouri S&T offers courses in art appreciation, art history, study of film, art in the community, and sculpture and applied courses in design, painting, and photography. Non-credit courses are available from time to time in other applied art or special interest courses.

Art Minor

The art minor offers students the opportunity to pursue an area of focus in studio art, art history, and film studies.

**Requirements:**  
The minor requires 15 hours, including ART 1180, which is a required course. Students may take additional hours from these offerings:

ART 1185	Study Of Film	3
ART 3222	Revolution And Romanticism In The Arts 1785 - 1832	3
ART 3250	Thematic Studies In Film & Literature	3
Any 3000-level philosophy course		
Topics course from the following series:		
ART 2001	Special Topics	
ART 3001	Special Topics	
ART 4001	Special Topics	
PHILOS 4333	American Philosophy	3

In addition, students may take up to six hours of studio classes.

Film and Literature Minor

The film and literature minor is an interdisciplinary and inter-textual course of study in which students will explore the connections between different mediums, increasing the pleasure and understanding of each.

**Requirements:**  
The minor requires 12 hours, including the following required courses: ART 1185 Study Of Film (3 hours) and the core course ENGLISH 2230 Literature And Film (3 hours) .



In addition, students will take 6 hours of electives in the field of literature and film studies. These electives can include but are not limited to:

ENGLISH 2248	Thematic Studies in Literature and Film	3
ART 3250	Thematic Studies In Film & Literature	3

## Studio Art Minor

The studio art minor offers students the opportunity to pursue an area of focus in painting, drawing, photography, etc.

### Requirements:

The minor requires 15 hours, including ART 1180 Art Appreciation, which is a required course. Students may take additional 12 hours from these offerings:

ART 1120	Drawing I	3
ART 1140	Painting I	3
ART 1164	Sculpture	3
ART 2130	Advanced Drawing	3
ART 2150	Advanced Painting	3
ART 3203	Architectural Design I	3
ART 3221	Fundamentals in Photography	3

**Stuart W Baur**, Associate Professor<sup>4</sup>  
PHD University of Missouri-Rolla

**Lucille Joan Myers**, Assistant Teaching Professor  
MED Lesley University-Cambridge

**Leo Soisson**, Assistant Teaching Professor  
MFA Southern Illinois University-Edwardsville

**Andrew Max Tohline**, Assistant Professor  
PHD Ohio University

### **ART 1120 Drawing I** (LEC 3.0)

Principles of drawing: placement, proportion, perspective, chiaroscuro, values, line, form, texture, and techniques. Applied problems to develop perceptual observation.

### **ART 1140 Painting I** (LEC 3.0)

Basic exploration of acrylic and water color painting techniques and methods. Still life, landscape and figure.

### **ART 1164 Sculpture** (LEC 3.0)

Solving problems in shallow and BAS relief and small clay sculpture, study of contemporary and classical proportion, faux bronze and plaster casting.

### **ART 1180 Art Appreciation** (LEC 3.0)

A basic introductory course designed to familiarize students who have little or no knowledge of the arts with fundamental knowledge necessary for intelligent approach to experiencing the visual arts; painting, sculpture, and architecture.

### **ART 1185 Study Of Film** (LEC 2.0 and LAB 1.0)

A study of classic and contemporary films with emphasis on director's technique and philosophy. Films by Fellini, Antonioni plus Bergman, Chaplin, etc. will be viewed and discussed. \$30 lab fee required.

### **ART 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### **ART 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

### **ART 2130 Advanced Drawing** (LEC 3.0)

Advanced application of drawing principles: cast and life drawing. Exercises in representational rendering. Prerequisite: Art 1120.

### **ART 2150 Advanced Painting** (LEC 3.0)

Advanced exploration of oil painting techniques and methods. Still life, landscape, and figure. Prerequisite: Art 1140.

### **ART 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### **ART 3001 Special Topics** (LEC 1.5 and LAB 1.5)

This course is designed to give the department an opportunity to test a new course. Variable title.

### **ART 3100 Advanced Art Studio** (LAB 1.5 and LEC 1.5)

This course is for the advanced student in Sculpture, Painting or Drawing with similar topics in various chosen mediums. Prerequisites: Art 1120, Art 1140, or Art 1164.

### **ART 3203 Architectural Design I** (LEC 1.0 and LAB 2.0)

Introduction to the interaction between architecture and art. A series focused on the history of architecture as it relates to styles and functions. Theories of building and site design, plan and spatial organization, formal composition, and environmental context are considered as principle form determinants. Prerequisite: Sophomore standing.

### **ART 3219 Art For Elementary Teachers** (LEC 3.0)

Considers the vital role of art activities and creative experiences in the growth and development of children at their level. Prerequisite: Educ 1040. (Co-listed with Educ 2219).

### **ART 3221 Fundamentals in Photography** (LEC 3.0)

In this course the student will learn the basics of photographic composition and the use of the digital camera. A brief history of photography will provide context for the student's own development. Prerequisite: Art 1180 or Art 1185 (required for Art minor credit) or Sp&M S 1185 or Sp&M S 2181 (required for Speech minor credit). (Co-listed with Sp&M S 3221).

### **ART 3222 Revolution And Romanticism In The Arts 1785 - 1832** (LEC 3.0)

This course will investigate the great revolution of thought, perception, language, through art during the period between 1785 and 1832. Artists, writers, and musicians to be studied include: Blake, David, Wordsworth, and Beethoven. The role of art and artists to the French Revolution will be stressed. Prerequisite: Introductory level Art or History course.

### **ART 3245 Thomas Hart Benton And The Tradition Of American Art** (LEC 3.0)

Missouri artist Tom Benton lived amidst controversy and acclaim from the 1920's to the 1970's. The American tradition from which Benton grew will be studied, then his own work and his subsequent influence. Prerequisite: Art 1185 or Art 1180.

### **ART 3250 Thematic Studies In Film & Literature** (LEC 3.0)

Different thematic relationships between film & literature (e.g., Poe & Hitchcock, Shakespeare on Film, etc.) will be studied. Prerequisite: Art 1185.

### **ART 3260 Exploring Digital Art** (LEC 1.5 and LAB 1.5)

An exploration of digital art as a medium for making art as well as understanding visual culture from the past, present, and ideas for the future. A multidisciplinary approach will combine digital arts with design thinking and humanities in a creative and scholarly atmosphere.



**ART 3275 Foundations of Media Communication** (LEC 3.0)  
The course explores the historical, social, and psychological impact of media through study and practice of academic and non-academic theories of effective media communication. The course supplies an integrated critical framework for application in student's day-to-day consumption of media. Prerequisite: Sp&M S 1185. (Co-listed with Sp&M S 3275).

**ART 3276 Thematics Studies in Film and Philosophy** (LEC 3.0)  
A study of special topics at the intersection of film and philosophy. Topics vary but may include films on the nature of reality, films on the problem of evil, films on concepts of consciousness and the self, and more. Prerequisites: Art 1185 or one philosophy course, or junior standing. (Co-listed with Philos 3276).

**ART 4000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ART 4001 Special Topics** (IND 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**ART 4320 French and Francophone Cinema** (LEC 3.0)  
A survey of French and Francophone cinema. Prerequisites: French 2170 (Co-listed with French 4320).

## Arts, Languages & Philosophy

**W Lance Haynes**, Professor  
PHD University of Minnesota

**ALP 2001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**ALP 4397 Multidisciplinary Studies Capstone** (LEC 3.0)  
Individually designed by the student and advisor with the approval of the advisory committee, this course is to reflect the student's ability to synthesize methods and knowledge from each focus area in his/her program into an academically coherent product. Prerequisite: Senior status.

## Bioinformatics Minor Curriculum

Bioinformatics is the rapidly-developing field that applies computational methods to address biological questions, and includes new advances in computer science, mathematics, and biology. Students entering the field of bioinformatics should have some training in each of these fields.

The minor is designed for students pursuing a B.S. who would have the necessary prerequisites for the required courses. Students pursuing a B.A. may participate if the prerequisites for the required courses are fulfilled. Each department (biological sciences, computer science, mathematics) will designate a minor advisor. The student's minor advisor will be chosen from outside of their major area of study.

Required courses:

BIO SCI 1113	General Biology	3
BIO SCI 2213	Cell Biology	3
or BIO SCI 2223	General Genetics	
BIO SCI 4323	Molecular Genetics	3
COMP SCI 1570	Introduction To Programming	4
& COMP SCI 1580	and Introduction To Programming Laboratory	
COMP SCI 1510		3

COMP SCI 2300	File Structures And Introduction To Database Systems	3
BIO SCI 5323/ COMP SCI 5700	Bioinformatics (It is strongly recommended that this course be taken after the other BIO SCI and COMP SCI requirements.)	3
STAT 4001	Special Topics	0-6
or STAT 5346	Regression Analysis	
or STAT 5353	Statistical Data Analysis	

One additional course, either at the 2000-level or above in MATH or COMP SCI, or at the 3000-level or above in BIO SCI, outside of the major area of study, and as agreed upon by the minor advisor. 3+

## Biological Sciences

Biology encompasses the study of life and living organisms. Biology embraces a vast and rapidly expanding body of knowledge and inquiry, including:

- Biochemistry, cellular biology, and molecular biology
- Anatomy and physiology of cells, tissues, organs, and organ systems
- Evolution, natural history, and biodiversity of all forms of life
- Ecology of organisms, populations, communities and ecosystems

Biology draws on the physical sciences (chemistry, physics, mathematics, and earth sciences), as well as informational and behavioral sciences, for analysis and interpretation of life processes and interrelationships.

The study of biology provides an academic foundation for career and postgraduate opportunities in:

- Research (in academic, industrial, government, chemical, agriculture, pharmaceutical, and environmental labs)
- Education (teaching and graduate study)
- Healthcare (human medicine, dentistry, pharmacy, veterinary medicine, physical therapy, etc)

The core curriculum required of all biological sciences majors consists of basic course work in introductory biology, biodiversity, cellular biology, evolution, genetics, and ecology. A variety of advanced courses offer greater depth and specific information leading to proficiency and preparation for employment and other postgraduate activities.

At Missouri S&T, faculty members active in research teach biological sciences courses. Classes are small, providing exceptional opportunity for discussion and individual attention. Most undergraduate students participate in research, learning techniques and developing skills that will prepare them for postgraduate opportunities. A background in mathematics and physical sciences, together with supporting course work in the humanities and social sciences, provides a well-rounded educational experience and enhanced understanding.

Missouri S&T students who have received their B.S. degrees in biological sciences have an excellent record of success. Average performance on nationally normed achievement examinations has been very high, and acceptance of Missouri S&T students in professional schools of medicine, dentistry and pharmacy, and subsequent performance of our students in these schools, remains exceptional. Missouri S&T biological sciences graduates have been accepted into prestigious graduate study programs in many areas, including biochemistry, microbiology, immunology, molecular genetics and genetic engineering, marine biology, cell and mammalian physiology, human physiology, environmental science, plant physiology, and evolution. Employment opportunities are varied, and the prospects for graduates in the biological sciences remain promising. The educational experiences and depth of understanding

gained by Missouri S&T biology students provide preparation and a competitive edge for a broad variety of jobs and graduate study programs.

The biological sciences department offers bachelor of science and bachelor of arts degrees. Most students pursue a B.S. degree, which prepares students for careers in biology or postgraduate study including medical school, graduate school, and other options. Two emphasis areas are also offered under the B.A. option: pre-medicine and secondary education.

## Bachelor of Arts Biological Sciences Degree Requirements

Specific requirements for the B.A. degree in biological sciences include a minimum of 120 semester hours of credit, including 30 hours of biology core courses. A "C" or better is required for all Biological Science courses.

### Core Courses

BIO SCI 1201	Biological Sciences Freshman Seminar	1
BIO SCI 1113	General Biology	3
or BIO SCI 1213	Principles of Biology	
BIO SCI 1219	General Biology Lab	2
BIO SCI 1223	Biodiversity	3
BIO SCI 1229	Biodiversity Lab	1
BIO SCI 2213	Cell Biology	3
BIO SCI 2219	Cell Biology Laboratory	1
BIO SCI 2223	General Genetics	3
BIO SCI 2233	Evolution	3
BIO SCI 2263	Ecology	3
BIO SCI 4010	Seminar	1

Advanced courses, 2000 level or higher (at least one with laboratory and one 3000 or 4000 level)

### Chemistry

CHEM 1310	General Chemistry I	9
& CHEM 1319	and General Chemistry Laboratory	
& CHEM 1320	and General Chemistry II	
& CHEM 1100	and Introduction To Laboratory Safety & Hazardous Materials	
CHEM 2210	Organic Chemistry I	8
& CHEM 2220	and Organic Chemistry II	

### Mathematics & Physical Science

Various courses in mathematics, physics, and/or geology chosen in consultation with academic advisor. (Note: Proficiency in College Algebra must be demonstrated by a grade of "C" or better in a College Algebra course or by examination)

**Computer Science/Statistics (Select one of the following:)** 3-4

COMP SCI 1570	Introduction To Programming	
& COMP SCI 1580	and Introduction To Programming Laboratory	
or COMP SCI 197	Introduction To Programming Methodology	
& COMP SCI 198	and Programming Methodology Laboratory	
STAT 3111	Statistical Tools For Decision Making	
STAT 5425	Introduction to Biostatistics	

### General Requirements for BA

English Composition		6
ENGLISH 1120	Exposition And Argumentation	
One additional composition course		
Western Civilizations		6
HISTORY 1100	Early Western Civilization	
HISTORY 1200	Modern Western Civilization	
Foreign Language (three semesters of a foreign language)		12
Humanities (including one class in each of literature, philosophy, and fine arts)		12

Social Sciences (including classes in two of the following three subjects: economics, political science, psychology)	12
--	----

**Elective credits:** In consultation with his or her advisor, each student will elect sufficient additional courses to complete a minimum of 120 credit hours.

## Bachelor of Arts Biological Sciences Pre-Medicine Emphasis Area Degree Requirements

The student will fulfill the requirements for a bachelor of arts in biological sciences as outlined above. The following classes are also required:

CHEM 2219	Organic Chemistry I Lab	2
& CHEM 2229	and Organic Chemistry II Lab	
2 semesters of Physics and labs:		8-10
PHYSICS 1145	College Physics I	
& PHYSICS 1119	and General Physics Laboratory	
or PHYSICS 1111	General Physics I	
& PHYSICS 1119	and General Physics Laboratory	
PHYSICS 2145	College Physics II	
& PHYSICS 2119	and General Physics Laboratory	
or PHYSICS 2111	General Physics II	
& PHYSICS 2119	and General Physics Laboratory	

The following classes are highly recommended:

BIO SCI 3333	Human Anatomy and Physiology I	3
BIO SCI 3339	Human Anatomy Physiology I Lab	1
BIO SCI 3343	Human Anatomy and Physiology II	3
BIO SCI 3349	Human Anatomy and Physiology II Laboratory	1
CHEM 4610	General Biochemistry	3

## Bachelor of Arts Biological Sciences Secondary Education Emphasis Area Degree Requirements

You may earn a B.A. degree in biological sciences from Missouri S&T and certification to teach at the secondary level in the schools of Missouri with this emphasis area. This program can be completed in four academic years, and student teaching is arranged with public schools within 30 miles of the Rolla campus.

Students interested in this emphasis area should consult with the advisor for biological sciences education majors in the biological sciences department.

In order to successfully complete this emphasis area, students must have at least a 22 ACT, maintain a cumulative GPA of at least 2.5, and attain at least a 2.5 GPA average for all biology courses. Current Missouri S&T or transfer students who wish to pursue this emphasis area must meet both these GPA requirements to be accepted into the program. Students must also meet all requirements listed under the teacher education program in this catalog. Students who do not meet all the teacher certification requirements will not be eligible for the secondary education emphasis area, even if they have completed all required course work.

A degree in this emphasis area requires 131 credit hours. The required courses are provided below. A minimum grade of “C” is required by the department in all biological sciences courses counted toward this degree.

<b>Humanities: 18 semester hours</b>		
ENGLISH 1120	Exposition And Argumentation	3
ENGLISH 1160	Writing And Research	3
or ENGLISH 3560	Technical Writing	
SP&M S 1185	Principles Of Speech	3
At least one course in each of the following: Literature, Philosophy and Fine Arts		
<b>Social Sciences: 15 semester hours</b>		
HISTORY 3530	History of Science	3
HISTORY 1100	Early Western Civilization	3
HISTORY 1200	Modern Western Civilization	3
POL SCI 1200	American Government	3
PSYCH 1101	General Psychology	3
<b>Mathematics/Physical Science: 9 semester hours</b>		
MATH 1103	Fundamentals Of Algebra	3
PHYSICS 1145	College Physics I	3
GEOLOGY 1110	Physical And Environmental Geology	3
<b>Computer Science/Statistics: 3 semester hours</b>		
3 semester hours of Computer Science or Statistics		3
<b>Chemistry: 17 semester hours</b>		
CHEM 1310	General Chemistry I	9
& CHEM 1319	and General Chemistry Laboratory	
& CHEM 1320	and General Chemistry II	
& CHEM 1100	and Introduction To Laboratory Safety & Hazardous Materials	
CHEM 2210	Organic Chemistry I	8
& CHEM 2220	and Organic Chemistry II	
<b>Biological Sciences: 27 semester hours</b>		
BIO SCI 1201	Biological Sciences Freshman Seminar	1
BIO SCI 1213	Principles of Biology	5
& BIO SCI 1219	and General Biology Lab	
BIO SCI 1223	Biodiversity	4
& BIO SCI 1229	and Biodiversity Lab	
BIO SCI 1173	Introduction to Environmental Sciences	3
BIO SCI 2213	Cell Biology	4
& BIO SCI 2219	and Cell Biology Laboratory	
BIO SCI 2223	General Genetics	3
BIO SCI 2233	Evolution	3
BIO SCI 2263	Ecology	3
BIO SCI 4010	Seminar	1
<b>Education: 42 semester hours</b>		
EDUC 1040	Perspectives In Education	2
EDUC 1104	Teacher Field Experience	2
EDUC 1164	Aiding Elementary, Middle And Secondary Schools	2
EDUC 1174	School Organization & Adm For Elementary & Secondary Teachers	2
EDUC 3216	Teaching Reading in Content Area	3
EDUC 3280	Teaching Methods And Skills In The Content Areas	6
EDUC 4298	Student Teaching Seminar	1
EDUC 4299	Student Teaching	12
ENGLISH 3170	Teaching And Supervising Reading and Writing	3
PSYCH 2300	Educational Psychology	3
PSYCH 3311	Psychological & Educational Development Of The Adolescent	3
PSYCH 4310	Psychology Of The Exceptional Child	3

## Bachelor of Science Biological Sciences Degree Requirements

A minimum of 130 credit hours is required for a Bachelor of Science degree in Biological Science.

A minimum grade of “C” is required for each Biological Science course used to fulfill the B.S. degree requirements.

These requirements for the B.S. degree are in addition to credit that is received for basic ROTC.

The Biological Science B.S. degree must include 49 semester hours of biological sciences course work, to include:

BIO SCI 1201	Biological Sciences Freshman Seminar	1
BIO SCI 1113	General Biology	3
or BIO SCI 1213	Principles of Biology	
BIO SCI 1219	General Biology Lab	2
BIO SCI 1223	Biodiversity	3
BIO SCI 1229	Biodiversity Lab	1
BIO SCI 2213	Cell Biology	3
BIO SCI 2219	Cell Biology Laboratory	1
BIO SCI 2223	General Genetics	3
BIO SCI 2233	Evolution	3
BIO SCI 2263	Ecology	3
BIO SCI 4010	Seminar	1
Advanced biological sciences or approved course work in other departments for a total of 49 credit hours of biology-related classes to include at least one laboratory course from the following:		25
BIO SCI 3319	Microbiology Lab	
or BIO SCI 3339	Human Anatomy Physiology I Lab	
or BIO SCI 3349	Human Anatomy and Physiology II Laboratory	
or BIO SCI 4329	Molecular Genetics Laboratory	
19 semester hours of chemistry to include general chemistry		19
CHEM 1310	General Chemistry I	
& CHEM 1319	and General Chemistry Laboratory	
& CHEM 1320	and General Chemistry II	
& CHEM 1100	and Introduction To Laboratory Safety & Hazardous Materials	
CHEM 2210	Organic Chemistry I	
& CHEM 2219	and Organic Chemistry I Lab	
& CHEM 2220	and Organic Chemistry II	
& CHEM 2229	and Organic Chemistry II Lab	
2 semesters of College (Engineering) Physics and labs		8
PHYSICS 1145	College Physics I	
& PHYSICS 1119	and General Physics Laboratory	
or PHYSICS 1131	Engineering Physics I	
PHYSICS 2145	College Physics II	
& PHYSICS 2119	and General Physics Laboratory	
or PHYSICS 2135	Engineering Physics II	
Math and Statistics		8-9
MATH 1208	Calculus With Analytic Geometry I	
or MATH 1214	Calculus For Engineers I	
or MATH 1212	Business Calculus	
STAT 5425	Introduction to Biostatistics	
12 semester hours of humanities, excluding foreign language, and to include:		12
ENGLISH 1120	Exposition And Argumentation	
& ENGLISH 1160	and Writing And Research (entering students will normally take ENGLISH 1120 either semester of the first year)	
9 hours of social sciences, to include		9
HISTORY 1200	Modern Western Civilization (or equivalent)	
or HISTORY 1301	American History To 1877	
or HISTORY 1311	American History Since 1877	

or POL SCI 1200 American Government

Total Credits

105-106

**Elective credits:** In consultation with his or her advisor, each student will elect sufficient additional courses to complete a minimum of 130 credit hours.

## Biological Sciences Minor Curriculum

A student wishing to minor in biological sciences must take a minimum of 20 hours of biological sciences course work. This course of study should include at least one laboratory or field course, at least two courses at the 3000 level or above, and be approved by a BioSci faculty advisor.

## Bioinformatics Minor

Students majoring in biological sciences are eligible to pursue a minor in bioinformatics. See the description of the bioinformatics minor here (p. 62).

**Ronald L Frank**, Associate Professor  
PHD Ohio State University

**Chen Hou**, Assistant Professor  
PHD University of Missouri-Columbia

**Yue-Wern Huang**, Professor  
PHD University of Wisconsin Madison

**Melanie R Mormile**, Professor  
PHD University of Oklahoma, Norman

**Dev K. Niyogi**, Associate Professor  
PHD University of Colorado Boulder

**Julie A Semon**, Assistant Professor  
PHD Tulane University

**Katie B Shannon**, Associate Teaching Professor  
PHD Harvard Medical School

**Matthew Scott Thimgan**, Assistant Professor  
PHD The University of North Carolina at Chapel Hill

**Ann E West**, Adjunct Assistant Professor  
PHD University of Colorado Boulder

**David J Westenberg**, Associate Professor  
PHD University of California-Los Angeles

**Terry J Wilson**, Associate Teaching Professor  
MASTER Missouri State University

**BIO SCI 1001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**BIO SCI 1103 Microbes And Man -- Introductory Microbiology** (LEC 3.0)  
An introduction to the study of microorganisms in nature, especially as they affect humans. Consideration of the involvement of microorganisms in disease, decomposition, nutrition, agriculture, food processing and preservation, industrial applications and waste treatment.

**BIO SCI 1113 General Biology** (LEC 3.0)  
A comprehensive study of the general principles of the biology of plants, animals, and protists including population biology and regulation mechanisms. Prerequisite: Entrance requirements.

**BIO SCI 1163 Biotechnology in Film** (LEC 3.0)  
Popular films that use biology-based plots influence society by disseminating facts and providing misinformation. Popular movies serve as the basis for discussing the biotechnology behind popular movie plots and examining the relationship between public perceptions and biotechnology.

**BIO SCI 1173 Introduction to Environmental Sciences** (LEC 3.0)  
An introduction to environmental science, with an emphasis on biological aspects of current environmental problems. Topics range from chemical toxicity to global climate change. Environmental challenges facing local species and ecosystems will be emphasized.

**BIO SCI 1201 Biological Sciences Freshman Seminar** (RSD 1.0)  
An introduction to the study of biology at Missouri S&T. Students will consider personal and professional opportunities within the various areas of biology and become acquainted with Biological Sciences faculty and departmental and campus facilities. Required of freshman Biological Sciences majors. Prerequisite: Biological Sciences majors only.

**BIO SCI 1213 Principles of Biology** (LEC 3.0)  
A comprehensive study of the general principles of the biology of plants, animals, and protists including population biology and regulation mechanisms. An in-depth study of the fundamental principles governing all living organisms from the molecular to the population level. Required for Biological Sciences majors. Cannot also receive credit for Bio Sci 1113. Prerequisite: Biological Science majors only.

**BIO SCI 1219 General Biology Lab** (LEC 1.0 and LAB 1.0)  
The laboratory work accompanying general biology consists of experiments designed to supplement and extend lectures in General Biology and Principles of Biology. Prerequisite: Preceded or accompanied by either Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 1223 Biodiversity** (LEC 3.0)  
This course provides a survey of all life, but emphasizes diversity of eukaryotes including protists, fungi, plants, and animals. Emphasis is on form, function, ecology, and evolution of plants and animals and other organisms.

**BIO SCI 1229 Biodiversity Lab** (LAB 1.0)  
This lab course is designed to accompany instruction in the Biodiversity class. Lab and field explorations of the varieties of life, with an emphasis is on form, function, ecology, and evolution of plants and animals and other organisms. Prerequisite: Preceded or accompanied by Biodiversity (Bio Sci 1223).

**BIO SCI 1943 Introduction to Human Anatomy and Physiology I** (LEC 3.0)  
First semester of a two-semester sequence dealing with the structure and function of human organ systems. Includes the study of cells, tissues, and the integumentary, skeletal, muscular and nervous systems. Prerequisite: Any high school or college Biology course.

**BIO SCI 1953 Introduction to Human Anatomy and Physiology II** (LEC 3.0)  
Second semester of a two-semester sequence of the study of the structure and function of human organ systems, including the endocrine, cardiovascular, lymphatic, respiratory, digestive, urinary and reproductive systems. Prerequisite: Bio Sci 1943.

**BIO SCI 1983 Introduction to Biological Design and Innovation** (LAB 3.0)  
Students will identify problems in biomedical sciences, and then design and implement innovative solutions using advanced techniques. Students will present and defend their proposals and results. Prerequisite: Bio Sci 1993.



**BIO SCI 1993 Introduction to Biomedical Problems** (LEC 3.0)

Problem based learning approach to issues in medical science. Students will work in groups and individually to answer problems related to diagnostic testing and evaluation of diseases and other medical conditions. Prerequisite: Bio Sci 1953.

**BIO SCI 2001 Special Topics** (LEC 1.0 and LAB 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**BIO SCI 2213 Cell Biology** (LEC 3.0)

The structure and function of eukaryotic and prokaryotic cells. Emphasis on macromolecules, organelles, metabolic pathways, bioenergetics, cell signaling, the cell cycle, and gene expression. Prerequisites: Preceded or accompanied by CHEM 1320.

**BIO SCI 2219 Cell Biology Laboratory** (LAB 1.0)

Laboratory course to accompany Cell Biology (Bio Sci 2213). Laboratory work includes microscopy, biochemical assays, enzymology, and genetic analysis (PCR, mapping, electrophoresis, transfection, sequencing). Prerequisite: Preceded or accompanied by Bio Sci 2213.

**BIO SCI 2223 General Genetics** (LEC 3.0)

The study of the principles of heredity and reasons for variation in living organisms. Includes Mendelian principles, molecular, population, and evolutionary genetics with examples from a diverse array of species. Prerequisite: Bio Sci 1113 or 1213.

**BIO SCI 2233 Evolution** (LEC 3.0)

A survey of the genetic and environmental mechanisms associated with organic evolution.

**BIO SCI 2242 Cave Biology** (LAB 1.0 and LEC 1.0)

In Cave Biology, we will study cave organisms and cave ecosystems. We will cover such topics as growth of speleothems, caves as a natural laboratory, behavior of cave animals, and regressive characteristics of cave species. We will investigate the relationship between Karst topography (caves, springs, sinkholes) and underground water contamination. Prerequisites: Any Geology, Environmental Engineering, or Biological Sciences class except Bio Sci 1201.

**BIO SCI 2243 Sleep: Function and Dysfunction** (LEC 3.0)

Students will learn the genes, proteins, and anatomy that govern sleep regulation. The course will also cover how sleep deprivation changes the body and degrades health and performance as well as sleep disorders that may disrupt sleep. Prerequisite: Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 2252 Vegetation of the Ozarks** (LEC 1.0 and LAB 1.0)

The Vegetation of the Ozarks class is an intense, outdoor educational experience focusing on the plants and plant communities of the Missouri Ozarks. The five day long course teaches participants to identify much of the flora of the region and provides practice and instruction in the use of dichotomous keys for plant identification. Prerequisites: Bio Sci 1213 or Bio Sci 1113.

**BIO SCI 2263 Ecology** (LEC 3.0)

Relationships between organisms and the environment. Topics include the influence of environmental factors on individual organisms, population dynamics, interspecific associations, and entire ecosystems. Prerequisite: Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 2264 Field Ecology** (LEC 1.0 and LAB 1.0)

Field-based class designed to teach students applications of ecological research. Students will study distribution and abundance of organisms in aquatic and terrestrial systems in the Ozarks. Class includes lectures and field sampling in the Rolla area. Prerequisite: Any Bio Sci course.

**BIO SCI 2333 Nutrition** (LEC 3.0)

This introductory course provides an overview of the principles of nutritional science. Topics include the description and functions of nutrients, how nutrients are digested and absorbed, effects of nutrient imbalances, food sources, nutrient interactions, dietary guidelines, and the role of nutrition in weight management, health and disease. Prerequisites: Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 2353 Zoology** (LEC 3.0)

Survey class that explores the diversity of animal life. Emphasis on the morphology, physiology, development, ecology, and phylogeny of animals and protozoans.

**BIO SCI 2359 Zoology Laboratory** (LAB 1.0)

Bio Sci 2359 is designed to accompany Bio Sci 2353 and consists of laboratory and field explorations of the diversity of animal life. Prerequisite: Preceded or accompanied by Bio Sci 2353.

**BIO SCI 2372 Issues in Public Health** (LEC 3.0)

Issues in Public Health investigates chronic and infectious diseases and the impact of globalization on such diseases, environmental toxins, and controversies in public health. Students will develop an awareness of current public health issues and trends in order to make informed arguments and personal choices. Prerequisite: Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 2383 Plant Biology** (LEC 3.0)

An intermediate class covering plant form and function. Topics include the cellular structures unique to plants, their life cycles, and the mechanisms they use to survive, reproduce, and convert solar energy into a form usable by all other organisms. Prerequisite: Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 2389 Plant Biology Laboratory** (LAB 1.0)

Bio Sci 2389 is designed to accompany Bio Sci 2383 and consists of experiments that will supplement and extend the lectures in Bio Sci 2383. Among the topics to be covered are photosynthesis, diversity, respiration, anatomy and development, hormones, and transpiration. Prerequisites: Bio Sci 1219, preceded or accompanied by Bio Sci 2383.

**BIO SCI 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**BIO SCI 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**BIO SCI 3110 Introduction to Biomedical Engineering** (LEC 3.0)

This course will provide an introduction to the interdisciplinary field of biomedical engineering. The molecular, cellular, physiological and engineering principles that govern the field will be covered. Applications will include biomaterials, tissue engineering, biomechanics, bioimaging, bioinstrumentation, bio-nanotechnology and artificial organs. Prerequisite: Junior standing or above. (Co-listed with Cer Eng 3110 and Chem Eng 3210).

**BIO SCI 3313 Microbiology** (LEC 3.0)

General introduction to the culture and study of microorganisms, their physiology, structure, and contribution to biology. Prerequisite: Chem 1320.

**BIO SCI 3319 Microbiology Lab** (LAB 2.0)

General introduction to the techniques used for the culture and identification of microorganisms, their physiology, structure, and contribution to biology. Prerequisite: Preceded or accompanied by Bio Sci 3313.



**BIO SCI 3333 Human Anatomy and Physiology I** (LEC 3.0)

First semester of a two-semester sequence dealing with the structure and function of human organ systems. Includes the study of cells, tissues, and the integumentary, skeletal, muscular and nervous systems. Prerequisites: BIO SCI 1113 or BIO SCI 1213; BIO SCI 2213.

**BIO SCI 3339 Human Anatomy Physiology I Lab** (LAB 1.0)

Laboratory accompanying Human Anatomy and Physiology I (Bio Sci 3333). This course may be taken separately at a later date. Prerequisite: Preceded or accompanied by Bio Sci 3333.

**BIO SCI 3343 Human Anatomy and Physiology II** (LEC 3.0)

Second semester of a two-semester sequence of the study of the structure and function of human organ systems, including the endocrine, cardiovascular, lymphatic, respiratory, digestive, urinary and reproductive systems. Prerequisites: BIO SCI 1113 or BIO SCI 1213; BIO SCI 2213.

**BIO SCI 3349 Human Anatomy and Physiology II Laboratory** (LAB 1.0)

Laboratory accompanying Human Anatomy and Physiology II (Bio Sci 3343). This course may be taken separately at a later date. Prerequisite: Preceded or accompanied by Bio Sci 3343.

**BIO SCI 3483 Biomedical Problems** (LEC 3.0)

This course will use a problem-based learning approach to examine biological aspects of various medical conditions. Students will work in groups and individually to answer problems related to diagnostic testing and evaluation of diseases and other medical conditions. Prerequisites: Bio Sci 3333 or 3343.

**BIO SCI 3783 Biological Design and Innovation I** (LAB 3.0)

Students identify significant problems in biological/biomedical sciences, and then design and implement innovative solutions using advanced techniques. Students present and defend proposals and results. Prerequisite: At least two 2000 level or higher Biology courses.

**BIO SCI 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**BIO SCI 4010 Seminar** (RSD 1.0)

Students will work in groups to propose, research, develop, complete, and present service-learning projects that are related to the biological sciences. Prerequisites: Senior standing.

**BIO SCI 4099 Undergraduate Research** (IND 1.0-3.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours for graduation credit. Subject and credit to be arranged with the instructor. Prerequisite: Consent of instructor.

**BIO SCI 4313 Introduction to Environmental Microbiology** (LEC 3.0)

Environmental Microbiology is an interdisciplinary study of how microorganisms can impact humans and applied to solve problems such as water treatment and environmental cleanup of contaminants. This course differs from Bio Sci 6313 as no NSF-style report or presentation is required. Prerequisite: Bio Sci 3313.

**BIO SCI 4323 Molecular Genetics** (LEC 3.0)

A study of the properties and functions of DNA that make this macromolecule unique in the universe. Examples of replication, transcription, translation, repair, and regulation will be examined in viruses, prokaryotes, and eukaryotes. Prerequisites: Bio Sci 2223 and Bio Sci 2213.

**BIO SCI 4329 Molecular Genetics Laboratory** (LAB 2.0)

This course provides experience in the use of a variety of DNA manipulation techniques that are common to molecular studies. These include DNA extraction, restriction mapping, Southern blotting, recombinant plasmid construction, DNA sequencing and analysis, and polymerase chain reaction. Prerequisite: Preceded or accompanied by Bio Sci 4323.

**BIO SCI 4333 Exercise Physiology** (LEC 3.0)

Covers cardiovascular, pulmonary, and metabolic responses to aerobic and anaerobic muscular activities, work capacities, nutritional factors in performance, and role of exercise in health. Prerequisite: Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 4343 Comparative Chordate Anatomy** (LEC 2.0 and LAB 2.0)

An integrated, comparative study of chordate structures and systems, with emphasis on evolution, development and function. Includes examination of gross anatomy and histology of selected forms. Prerequisites: Bio Sci 1223, Bio Sci 1229.

**BIO SCI 4353 Cancer Cell Biology** (LEC 3.0)

Advanced biology course examining cellular processes that go awry during tumorigenesis. We will discuss cell cycle controls, signal transduction pathways, DNA repair, telomerase, apoptosis, cell migration and adhesion that are altered in cancer cells. Prerequisite: Bio Sci 2213.

**BIO SCI 4363 Freshwater Ecology** (LEC 3.0)

The ecology of streams, lakes, and wetlands. The course will cover the physical and chemical characteristics of freshwater environments, the diversity of life in freshwaters, biogeochemical processes, and threats to freshwater systems. Prerequisite: Bio Sci 2263.

**BIO SCI 4383 Toxicology** (LEC 3.0)

A study of natural and man-made toxicants, various possible routes of exposure, absorption, distribution, biotransformation, specific target sites, and mechanisms involved in elicitation of toxic effects, as well as detoxification and excretion. Prerequisites: Bio Sci 2213, Bio Sci 2223, at least Junior standing.

**BIO SCI 4393 Immunology** (LEC 3.0)

A study of the principles of immunology, including biological and biochemical aspects of the immune response, immunochemistry, serology, immunoglobulin and T-cell mediated allergies, tumor and transplantation immunology, autoimmune diseases, and the role of immunity in host defense. Prerequisites: Chem 2220 or Chem 4620 and Bio Sci 2213.

**BIO SCI 4493 General Virology** (LEC 3.0)

An overview of the field of virology, including plant, animal, and bacterial viruses. Discussions will include morphology, classification, virus-host interactions, genetics, clinical and industrial aspects of viruses, and viruses as model systems for basic biological studies. Prerequisites: Bio Sci 1113 or 1213; Bio Sci 2213, 3313, Chem 1310, 1320, 2210.

**BIO SCI 4666 Nanobiotechnology** (LEC 3.0)

Nanotechnology has emerged to change human economy and society in many aspects. Applications of nanotechnology in life science is termed nanobiotechnology. This course describes recent development of nanobiotechnology in basic biological research as well as biomedical applications. Prerequisite: Bio Sci 2213 or Bio Sci 2223.

**BIO SCI 5000 Special Problems** (IND 0.0-6.0)

Graduate problems or readings on specific subjects or projects in the department. Prerequisite: Consent of the instructor.

**BIO SCI 5001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**BIO SCI 5010 Graduate Seminar** (RSD 0.0-6.0)

Presentation and discussion of current topics in Applied and Environmental Biology.

**BIO SCI 5040 Oral Examination** (IND 0.0)

(Variable) After completion of all other program requirements, oral examinations for on-campus M.S./PH.D students may be processed during intercession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**BIO SCI 5099 Graduate Research** (IND 0.0-15)

Investigation of an advanced nature leading to the preparation of a thesis or dissertation.

**BIO SCI 5210 Biomaterials I** (LEC 3.0)

This course will introduce senior undergraduate students to a broad array of topics in biomaterials, including ceramic, metallic, and polymeric biomaterials for in vivo use, basic concepts related to cells and tissues, host reactions to biomaterials, biomaterials-tissue compatibility, and degradation of biomaterials. Prerequisite: Senior undergraduate standing. (Co-listed with Chem Eng 5200, MS&E 5310).

**BIO SCI 5240 Tissue Engineering I** (LEC 3.0)

The course will introduce senior undergraduate students to the principles and clinical applications of tissue engineering including the use of biomaterials scaffolds, living cells and signaling factors to develop implantable parts for the restoration, maintenance, or replacement of biological tissues and organs. Prerequisite: Senior standing. (Co-listed with MS&E 5210).

**BIO SCI 5313 Pathogenic Microbiology** (LEC 3.0)

A study of medically important microorganisms. Students will learn about the properties that enable organisms to cause disease as well as the disease process within the host. Special emphasis will be placed on recent advances in the molecular genetics of host pathogen interaction. Prerequisite: Bio Sci 2213 or Civ Eng 2601.

**BIO SCI 5323 Bioinformatics** (LEC 3.0)

The course will familiarize students with the application of computational methods to biology, as viewed from both perspectives. It will introduce problems in molecular, structural, morphological, and biodiversity informatics, and will discuss principles, algorithms, and software to address them. Prerequisites: A grade of "C" or better in both one of Bio Sci 1113 or Bio Sci 1213 and one of Comp Sci 1570 and Comp Sci 1580 or Comp Sci 1971 and Comp Sci 1981. (Co-listed with COMP SCI 5700).

**BIO SCI 5333 Genomics** (LEC 3.0)

This course offers a general overview of the field of genomics. Topics covered include genome sequencing and annotation, transcriptomics, proteomics, metabolomics, genomic variation, and an overview of human, and several animal, plant, and microbial genome projects. Prerequisite: BIO SCI 4323.

**BIO SCI 5353 Developmental Biology** (LEC 3.0)

Study of the patterns of development of the vertebrate embryo, the molecular mechanisms of tissue induction, and interactions among developing tissues. Prerequisite: Bio Sci 2213.

**BIO SCI 5423 Advanced Biodiversity** (LEC 3.0)

This course focuses on the enhancement and reduction of biodiversity and modern techniques of measuring and monitoring it. Topics include biogeography, community structure, competition, predation, food webs, geology-biology relationships, environmental change, and human impact. Additional costs and a week-long field trip are required. Prerequisite: Bio Sci 2233 or Bio Sci 2263.

**BIO SCI 5433 Neurobiology** (LEC 3.0)

An intermediate course in cellular neurobiology. Emphasis will be placed on the unique properties of neurons and other excitable cells. Topics covered include the structure and biophysical properties of neurons, synaptic transmission, neurochemistry, signal transduction, neuropharmacology and neurodevelopment. Prerequisite: Bio Sci 2213.

**BIO SCI 5463 Global Ecology** (LEC 3.0)

This class covers ecological topics at large scales, emphasizing global scales. Topics include global energy balance, biogeochemical cycles of water, carbon, nitrogen, and other biologically important elements, and global biodiversity. Students will focus on primary literature related to global ecology. Prerequisite: Bio Sci 2263.

**BIO SCI 5533 Pharmacology** (LEC 3.0)

The basic principles of drug action, pharmacokinetics, pharmacodynamics and toxicity. We will emphasize the actions of drugs used to treat cardiovascular and nervous system disorders. Students will review the primary literature to prepare both written and oral reports on drug actions. Prerequisite: Bio Sci 2213.

## Business and Management Systems

Business and management systems is an undergraduate degree based on broad, foundational core courses. Professionals in this field analyze organizational needs to provide technology-enabled management and operations.

Today's business environments have a critical need for professionals who have an understanding of information technologies; are capable of operating in an electronic environment; and are able to synthesize, analyze, and learn from vast amounts of information. These individuals are needed to realize technology's great potential to support business processes, decision making, and communication.

As a business and management systems major, you will take courses that are rigorous and oriented toward building the foundation necessary for lifetime learning. Studying at Missouri S&T, you will benefit from the world-class computer environment and your association with excellent students from around the country and the world. Students in the program are strongly encouraged to participate in summer internships or co-ops with companies before they graduate. There are many opportunities and students benefit greatly in terms of their education and the edge they have seeking full-time employment once they graduate.

## Bachelor of Science Business and Management Systems

In Business and Management Systems, the Bachelor of Science degree consists of 120 credit hours. All undergraduate students in Business and Management Systems are required to complete a General Education Requirements Core, including courses in Humanities, Social Sciences, Mathematics, Science, and Communication Skills.

A common departmental core of courses in Management and Information Technology helps provide students with skills to succeed in a fast-

changing and globalized environment. Business Core courses and Business Electives provide students with comprehensive knowledge in business disciplines.

A minimum grade of "C" is required in the Business Core, Business Electives, Management, and Information Technology courses. Students have 9 credit hours for free electives.

Freshman Year			
First Semester	Credits	Second Semester	Credits
PSYCH 1101	3	MATH 1140	3
BUS 1810 <sup>1</sup>	1	IS&T 1750	3
BUS 1110	3	ENGLISH 1600 or TCH COM 1600	3
ENGLISH 1120	3	ECON 1200	3
Science Elective <sup>3</sup>	3	Science Elective <sup>3</sup>	3
Laboratory w/ Science Elective <sup>3</sup>	1		
	14		15
Sophomore Year			
First Semester	Credits	Second Semester	Credits
BUS 1210	3	FINANCE 2150	3
MATH 1212	4	IS&T 1552	3
IS&T 1551	3	ERP 2110	3
ECON 1100	3	POL SCI 1200	3
SP&M S 1185	3	History Elective	3
	16		15
Junior Year			
First Semester	Credits	Second Semester	Credits
MKT 3110	3	BUS 5580	3
IS&T 4654	3	ENGLISH 2560 or TCH COM 2560	3
STAT 3111	3	BUS 3220	3
Business Elective	3	Business Electives	6
Free Elective	3		
	15		15
Senior Year			
First Semester	Credits	Second Semester	Credits
BUS 2910	3	BUS 5980 <sup>1</sup>	3
BUS 5360	3	BUS 4675	3
MKT 5310	3	Business Elective	3
Business Elective	3	Fine Art, Social Science, or Humanities Elective <sup>2</sup>	3
Free Elective	3	Free Elective	3
	15		15
Total Credits: 120			

A grade of "C" or better is required in the following courses for graduation: IS&T 1551, IS&T 1552, IS&T 1750, IS&T 4654, ERP 2110, FIN 2150, MKT 3110, MKT 5310, ECON 1100, ECON 1200, BUS 1110, BUS 1210, BUS 2150, BUS 2910, BUS 3220, BUS 4675, BUS 5360, BUS 5580, BUS 5980, and all Business Electives.

<sup>1</sup> Writing intensive course

<sup>2</sup> Any course in the following areas not used for other degree requirements: Art, economics, English, foreign language, history, literature, music, philosophy, political science, psychology, sociology, theater.

<sup>3</sup> Any course in the following areas: Biology, Chemistry, Geology, Geological Engineering, Physics.

## Areas of Concentration

All students are required to complete twelve credit hours chosen from 2000, 3000, 4000, or 5000-level courses in business, economics, finance, enterprise resource planning, information science & technology, or marketing. A "C" or better grade is required in all twelve credit hours. If the student chooses to designate an area of concentration for these courses, focusing at least 3 courses (9 credits) in one area, he or she may do so. Students are not required to choose a concentration area. Areas of concentration are:

### E-Commerce

IS&T 5652	Advanced Web Development	3
IS&T 4641	Digital Commerce and the Internet of Things	3
IS&T 4642	E-Commerce Architecture	3
IS&T 4257	Network Economy	3
IS&T 5168	Law and Ethics in E-Commerce	3

### Enterprise Resource Planning

Any 9 hours of ERP-designated courses at the 4000-level or above.

### Finance

FINANCE 5160	Corporate Finance II	3
FINANCE 5260	Investments I	3
ECON 4720	International Finance	3
Any other finance course at the 3000-level or above.		

ECON 4410, and ECON 5337 cannot be used toward this concentration.

### Human-Computer Interaction

IS&T 5652	Advanced Web Development	3
IS&T 5885	Human-Computer Interaction	3
IS&T 5886	Prototyping Human-Computer Interactions	3
IS&T 5887	Human-Computer Interaction Evaluation	3

### Management

BUS 5470	Human Resource Management	3
BUS 4111	Business Negotiations	3
IS&T 5251	Technological Innovation Management and Leadership	3

### Marketing

MKT 3210	Consumer Behavior	3
MKT 4150	Customer Focus and Satisfaction	3
MKT 4580	Marketing Strategy	3
ERP 4610	Customer Relationship Management in ERP Environment	3
MKT 5320	Marketing for Non-Profits	3

## Minors

You must see the department advisor and complete a minor application before beginning your minor. Requirements change over time. You will be held to the requirements in force at the time you apply for the minor. Postponing your application for the minor may result in you having to take additional courses to complete the minor. At least six (6) hours of the minor course work must be taken in residence at Missouri S&T.

## Minor in Business

The minor in business and management systems requires the following 15 hours of coursework:

FINANCE 2150	Corporate Finance I	3
ECON 1100	Principles Of Microeconomics	3
or ECON 1200	Principles Of Macroeconomics	
BUS 1110	Introduction to Management and Entrepreneurship	3
BUS 1210	Financial Accounting	3
MKT 3110	Marketing	3

## Minor in Cybersecurity Management and Information Assurance

This minor requires the following 15 hours of coursework:

The following three courses are required:

BUS 5910	Privacy and Information Security Law	3
IS&T 4780	Human and Organizational Factors in Cybersecurity	3
IS&T 3333	Data Networks and Information Security	3

Two of the following three courses must also be taken:

ERP 5240	Enterprise Application Development and Software Security	3
IS&T 4335	Fundamentals of Mobile Technology for Business	3
IS&T 4641	Digital Commerce and the Internet of Things	3

## Minor in Digital Supply Chain Management

The minor in digital supply chain management requires the following 15 hours of coursework:

BUS 5360	Business Operations	3
or MECH ENG 3653	Manufacturing	
ERP 5310	Supply Chain Management Systems in an ERP Environment	3
ERP 4610	Customer Relationship Management in ERP Environment	3
or MECH ENG 5760/ Probabilistic Engineering Design		
AERO ENG 5760		
Two courses from the following list: *		6
ERP 5410	Use of Business Intelligence	
ERP 5110	Enterprise Resource Planning Systems Design and Implementation	
MECH ENG 5708	Rapid Product Design And Optimization	
MECH ENG 5656	Design For Manufacture	
MECH ENG 5757/ ENG MGT 5515	Integrated Product And Process Design	
MECH ENG 5763	Principles And Practice Of Computer Aided Design	

\* Non business and information technology students must select ERP 5110 as one of the two electives.

## Minor in Electronic and Social Commerce

The minor in electronic and social commerce requires the following 15 hours of coursework:

IS&T 4641	Digital Commerce and the Internet of Things	3
Four courses from the following list:		12
IS&T 4335	Fundamentals of Mobile Technology for Business	
IS&T 5251	Technological Innovation Management and Leadership	
IS&T 5652	Advanced Web Development	
IS&T 5168	Law and Ethics in E-Commerce	
IS&T 5885	Human-Computer Interaction	
IS&T 5886	Prototyping Human-Computer Interactions	
MKT 5310	Digital Marketing and Promotions	

MKT 4580	Marketing Strategy	
----------	--------------------	--

## Minor in Enterprise Resource Planning (ERP)

The minor in ERP requires the following 15 hours of coursework:

BUS 1210	Financial Accounting	3
ERP 2110	Introduction to Enterprise Resource Planning	3
ERP 5110	Enterprise Resource Planning Systems Design and Implementation	3
Six credit hours of electives from any other ERP-designated courses at the 4000-level or above		6
Total Credits		15

## Minor in Entrepreneurship

The minor in entrepreneurship requires the following 15 hours of coursework:

BUS 1110	Introduction to Management and Entrepreneurship	3
BUS 5980	Business Models for Entrepreneurship and Innovation	3
MKT 5310	Digital Marketing and Promotions	3
Two courses from the following list:		6
BUS 4150	Customer Focus and Satisfaction	
BUS 5580	Strategic Management	
IS&T 4641	Digital Commerce and the Internet of Things	
IS&T 4654	Web and Digital Media Development	
IS&T 4335	Fundamentals of Mobile Technology for Business	
IS&T 5251	Technological Innovation Management and Leadership	
IS&T 6654	Advanced Web and Digital Media Development	
IS&T 5886	Prototyping Human-Computer Interactions	
ENG MGT 5511	Technical Entrepreneurship	
ENG MGT 5411	Engineering Design Optimization	

## Minor in Finance

The minor in finance requires the following 15 hours of coursework:

ECON 1100	Principles Of Microeconomics	3
or ECON 1200	Principles Of Macroeconomics	
FINANCE 2150	Corporate Finance I	3
Three additional FINANCE electives at the 3000 level or above (Undergraduate Research is acceptable)		9
Total Credits		15

## Minor in Information Science and Technology

The minor in information science and technology requires the following 15 hours of coursework:

IS&T 1750	Introduction to Management Information Systems	3
IS&T 1551	Implementing Information Systems: User Perspective	3
IS&T 1552	Implementing Information Systems: Data Perspective	3
ERP 2110	Introduction to Enterprise Resource Planning	3
One other IS&T or ERP course at the 2000-level or above.		3
Total Credits		15

## Minor in Management

The minor in management requires the following 15 hours of coursework:

BUS 1110	Introduction to Management and Entrepreneurship	3
Four courses from the following list:		12
BUS 2910	Business Law	
BUS 3115	Introduction to Teambuilding and Leadership	
BUS 4111	Business Negotiations	
BUS 4150	Customer Focus and Satisfaction	
BUS 5360	Business Operations	

BUS 5470	Human Resource Management
BUS 5580	Strategic Management
IS&T 4261	Information Systems Project Management
ENG MGT 3320	Introduction to Project Management

## Minor in Marketing

The minor in marketing requires the following 15 hours of coursework:

ECON 1100	Principles Of Microeconomics	3
or ECON 1200	Principles Of Macroeconomics	
MKT 3110	Marketing	3
Three courses from the following list:		9
MKT 3210	Consumer Behavior	
MKT 5310	Digital Marketing and Promotions	
MKT 4150	Customer Focus and Satisfaction	
MKT 4580	Marketing Strategy	
ERP 4610	Customer Relationship Management in ERP Environment	
Other marketing electives approved by the department (MKT 3000 and above)		

## Minor in Mobile Business and Technology

The minor in mobile business and technology requires the following 15 hours of coursework:

IS&T 4641	Digital Commerce and the Internet of Things	3
IS&T 4335	Fundamentals of Mobile Technology for Business	3
ERP 5240	Enterprise Application Development and Software Security	3
Two courses from the following list:		6
IS&T 3333	Data Networks and Information Security	
IS&T 5652	Advanced Web Development	
IS&T 5886	Prototyping Human-Computer Interactions	
ERP 4610	Customer Relationship Management in ERP Environment	
ERP 5310	Supply Chain Management Systems in an ERP Environment	
ERP 5210	Performance Dashboard, Scorecard and Data Visualization	

## Pre MBA Minor

The minor in pre MBA will prepare students to enter an accredited MBA program at Missouri S&T or elsewhere. This minor requires the following 39 hours of coursework:

PSYCH 1101	General Psychology	3
MATH 1208	Calculus With Analytic Geometry I	5
or MATH 1212	Business Calculus	
or MATH 1214	Calculus For Engineers I	
ECON 1300/STAT 1111	Business And Economic Statistics I	3
or STAT 1115	Statistics For The Social Sciences I	
or STAT 3111	Statistical Tools For Decision Making	
or STAT 3113	Applied Engineering Statistics	
or STAT 3115	Engineering Statistics	
or STAT 3117	Introduction To Probability And Statistics	
ECON 1100	Principles Of Microeconomics	3
ECON 1200	Principles Of Macroeconomics	3
BUS 1110	Introduction to Management and Entrepreneurship	3
BUS 1210	Financial Accounting	3
BUS 3220	Managerial Accounting	3
BUS 2910	Business Law	3
BUS 5360	Business Operations	3
MKT 3110	Marketing	3
FINANCE 2150	Corporate Finance I	3
IS&T 1750	Introduction to Management Information Systems	3

**Eric Anderson**, Adjunct Instructor  
JD University of Missouri-Columbia

**Carla Pauline Bates**, Assistant Teaching Professor  
MASTER Missouri S&T

**Robert T Berry**, Adjunct Instructor  
PHD University of Kansas

**Darryl Lee Brinkmann**, Adjunct Instructor  
MASTER Sangamon State University

**Langtao Chen**, Assistant Professor  
PHD Georgia State University

**Yu Hsien Chiu**, Associate Teaching Professor  
MASTER University of Wisconsin-Milwaukee

**Craig C Claybaugh**, Associate Professor  
PHD University of Wisconsin-Milwaukee

**Cassandra Carlene Elrod**, Associate Professor  
PHD University of Missouri-Rolla

**Li-Li Eng**, Associate Professor  
PHD University of Michigan Ann Arbor

**Hanqing Fang**, Assistant Professor  
PHD Mississippi State University

**Caroline Fisher**, Professor Emeritus  
PHD Bowling Green State University

**Barry B Flachsbart**, Professor  
PHD Stanford University

**Nobuyuki Fukawa**, Associate Professor  
PHD Louisiana State University

**Richard H Hall**, Professor  
PHD Texas Christian University

**Edward J Harvey**, Lecturer  
MBA University of Missouri-Columbia

**Michael Gene Hilgers**, Professor  
PHD Brown University

**Ray Kluczny**, Associate Professor Emeritus  
PHD Arizona State University

**Kellie Kowalski**, Adjunct Instructor  
MASTER Northern Arizona University

**Bih-Ru Lea**, Associate Professor  
PHD Clemson University

**Gina Mowery**, Adjunct Instructor  
MASTER University of Phoenix

**Fiona Fui-Hoon Nah**, Professor  
PHD University of British Columbia

**Keng Leng Siau**, Professor  
PHD University of British Columbia

**Sarah Margaret Stanley**, Assistant Professor  
PHD Saint Louis University



**Nathan W Twyman**, Assistant Professor  
PHD University of Arizona

**Wen-Bin Yu**, Associate Professor  
PHD University of Louisville

**Hongxian Zhang**, Assistant Professor  
PHD University of Texas at San Antonio

***BUS 1000 Special Problems*** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

***BUS 1001 Special Topics*** (IND 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

***BUS 1110 Introduction to Management and Entrepreneurship*** (LEC 3.0)

The course provides an introduction to the basic concepts of management and entrepreneurship to provide an awareness of what functions and challenges are faced by managers and entrepreneurs in today's global environment. Applications of the concepts to the organization, operations, and resources are discussed. Appropriate for all majors.

***BUS 1210 Financial Accounting*** (LEC 3.0)

This course is an introduction to financial accounting and its significant role in making sound business decisions. Emphasis is on what accounting information is, why it is important, and how it is used to make strategic economic decisions.

***BUS 1810 Introduction to College Success*** (LEC 1.0)

This course teaches essential skills for success in Business and Information Technology and a student's future career. The course creates a sense of community in the department and prepares the student for the business world.

***BUS 1811 Introduction to College Success II*** (LAB 0.50)

A continuation of BUS 10. Students learn essential skills for success in Business and Information Technology. The course creates a sense of community in the department and prepares the students for the business world.

***BUS 2000 Special Problems*** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

***BUS 2001 Special Topics*** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

***BUS 2002 Cooperative Training in Business*** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry with credit arranged through departmental co-op advisor. Grade received depends on quality of reports submitted and work supervisors's evaluation. Prerequisite: Completed 30 hours toward degree.

***BUS 2910 Business Law*** (LEC 3.0)

This course is an introduction to the nature and meaning of law and the legal environment of business. Topics include the legal process, sources of law, and institutions.

***BUS 3105 Management and Business Law Essentials*** (LEC 1.5)

This course is an introduction to the essentials of management and business law for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Senior or Junior Standing; 3.0 GPA required.

***BUS 3115 Introduction to Teambuilding and Leadership*** (LEC 3.0)

This course covers an introduction to leadership styles, principles, models, issues, and applications through analytical and intellectual examination. Key components of teams are introduced, with opportunities to practice and develop both leadership and teambuilding skills.

***BUS 3205 Accounting Essentials*** (LEC 1.5)

This course is an introduction to the essentials of financial and managerial accounting for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Senior or Junior standing; 3.0 GPA required.

***BUS 3220 Managerial Accounting*** (LEC 3.0)

Emphasizes internal use of accounting information in establishing plans and objectives, controlling operations, and making decisions involved with management of an enterprise (the determination of costs relevant to a specific purpose such as inventory valuation, control of current operation, or special decisions). Prerequisites: Bus 1210 or Eng Mgt 2211.

***BUS 3305 Operations Management Essentials*** (LEC 1.5)

This course is an introduction to the essentials of operations management for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Senior or Junior Standing; 3.0 GPA required.

***BUS 3705 Management Information Systems Essentials*** (LEC 1.5)

This course is an introduction to the essentials of management information systems for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Senior or Junior Standing; 3.0 GPA required.

***BUS 3805 Mathematics and Statistics Essentials*** (LEC 1.5)

This course is an introduction to the essentials of mathematics and statistics for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Senior or Junior Standing; 3.0 GPA required.

***BUS 4000 Special Problems*** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

***BUS 4001 Special Topics*** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

***BUS 4099 Undergraduate Research*** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**BUS 4111 Business Negotiations** (LEC 3.0)

The purpose of this course is to understand the practices and processes of negotiation for negotiating successfully in a variety of settings. The course is designed to be relevant to the broad spectrum of negotiation problems faced by managers, consultants, etc. Because almost everyone negotiates all the time, this course is relevant to almost any student. Prerequisites: At least Junior status.

**BUS 4150 Customer Focus and Satisfaction** (LEC 3.0)

Major emphasis is given to the concept of customer focus, with coverage of techniques for obtaining customer needs, measuring customer satisfaction, developing products and services to satisfy customers, and maximizing the benefits of customer feedback. A semester long HoQ project will be done. Prerequisites: MKT 3110 or MKT 3105 or ENG MGT 3510. (Co-listed MKT 4150).

**BUS 4675 International Business** (LEC 3.0)

This survey course will deal with business concepts, analytical processes and philosophical bases for international business operations. Emphasis is on environmental dynamics, multinational business organizations, cultural and economic constraints, unique international business practices and international operations, strategy and policy.

**BUS 4970 Senior Business Design I** (LEC 1.0)

In this course, students will become familiar with the principles of entrepreneurship; learn about the basic purpose, content and structure of business plans; and develop business presentation skills through practice. At the end of the semester, student teams will give presentations to a bank in an attempt to secure a loan to run the business the following semester. Prerequisite: Senior Standing.

**BUS 4980 Senior Business Design II** (LEC 2.0)

In this course, students will be expected to carry out the business plans created in Bus 4970. Progress reports are submitted roughly every 3 weeks during the semester. At the end of the semester, students terminate the business organization and profits are donated to a non-profit organization in the team's name. Prerequisite: Bus 4970.

**BUS 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Prerequisite: Admission to the MBA program.

**BUS 5001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

**BUS 5040 Oral Examination** (IND 0.0)

After completion of all other requirements, oral examinations for on-campus M.B.A./Ph.D. students may be processed during intersession. Off-campus M.B.A. students must be enrolled in oral examination and must have paid an oral examination fee at the time defense/oral examination (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**BUS 5080 Practicum** (IND 0.0-6.0)

This course is similar to the Bus 5085 Internship course. The difference is that this course is intended for students who are already employed by an organization for whom they wish to continue working. Prerequisite: Bus Core.

**BUS 5085 Internship** (IND 0.0-6.0)

Students apply critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employer. Activities will vary depending on the student's background and the setting. Requires major report and formal presentation to sponsoring organization. Prerequisite: Graduate standing.

**BUS 5099 Research** (IND 0.0-9.0)

Research investigation of an advanced nature leading to a major report suitable for publication in a journal or in a conference proceedings. Prerequisite: Permission of the instructor.

**BUS 5105 Graduate Management and Business Law Essentials** (LEC 1.5)

This course is an introduction to the essentials of management and business law for running a business. It's designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit cannot be applied to any major or minor in Business, IS&T, or Economics. Additional case study or report required. Prerequisite: Bachelor Degree.

**BUS 5115 Teambuilding and Leadership in Business Settings** (LEC 3.0)

This course covers leadership styles, principles, models, issues, and applications through analytical and intellectual examination. Key components of teams are introduced, with opportunities to practice and develop both leadership and teambuilding skills. Case studies required.

**BUS 5205 Graduate Accounting Essentials** (LEC 1.5)

This course is an introduction to the essentials of financial and managerial accounting for running a business. It's designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit cannot be applied to any major or minor in Business, IS&T, or Economics. Additional case or report required. Prerequisite: Bachelor Degree.

**BUS 5230 Financial Statement Analysis** (LEC 3.0)

Analysis and interpretation of financial statements for profitability analysis, credit analysis, and other business analyses that rely on financial data. Introduces emerging roles of accounting analytics. Illustrates data analytics concepts and techniques to detect earning management, predict fraud, and to provide insights into other business strategies. Prerequisite: FINANCE 2150 or Graduate Standing.

**BUS 5305 Graduate Operations Management Essentials** (LEC 1.5)

This course is an introduction to the essentials of operations management for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit cannot be applied to any major or minor in Business, IS&T, or Economics. Additional case study or report required. Prerequisite: Bachelor Degree.

**BUS 5360 Business Operations** (LEC 3.0)

This course examines the concepts, processes, and institutions that are fundamental to an understanding of business operations within organizations. Emphasis is on the management and organization of manufacturing and service operations and the application of quantitative methods to the solution of strategic, tactical and operational problems. Prerequisites: BUS 1210 or ENG MGT 2211; at least Junior standing; and one of the following: STAT 1111, STAT 1115, STAT 1116, STAT 3111, STAT 3113, STAT 3115, or STAT 3117.

**BUS 5470 Human Resource Management** (LEC 3.0)

The course examines employee selection, performance appraisal, training and development, compensation, legal issues, and labor relations. Prerequisite: Bus 1110.

**BUS 5580 Strategic Management** (LEC 3.0)

Study of the formulation and implementation of corporate, business and functional strategies designed to achieve organizational objectives. Case studies and research reports may be used extensively. Prerequisites: MKT 3110 or Eng Mgt 3510; Finance 2150 or Eng Mgt 3200; Senior standing.

**BUS 5705 Graduate Management Information Systems Essentials** (LEC 1.5)

This course is an introduction to the essentials of management information systems for running a business. It is designed for students planning to enter the MBA program. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Additional case or report required. Prerequisite: Bachelor Degree.

**BUS 5805 Graduate Mathematics and Statistics Essentials** (LEC 1.5)

This course is an introduction to the essentials of mathematics and statistics for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit cannot be applied to any major or minor in Business, IS&T, or Economics. Additional case study or report required. Prerequisite: Bachelor Degree.

**BUS 5896 Project Research** (IND 0.0-9.0)

The research project will involve students applying research techniques and discipline specific knowledge working on a project designed by the advisor, often working with a business organization. Requires major report and formal presentation to sponsoring organization. Prerequisite: Permission of the instructor.

**BUS 5910 Privacy and Information Security Law** (LEC 3.0)

Explores issues concerning the use, disclosure, and protection of information (personal, organizational, health, and financial) from a legal perspective. A focus on understanding, planning, protecting, and responding to data breaches and other information risk and threats. Case studies based on litigation are reviewed and analyzed. Assumes MIS familiarity.

**BUS 5980 Business Models for Entrepreneurship and Innovation** (LEC 3.0)

This course uses problem based learning to expand student insight into the nature, development, and application of business models. It increases the practical skills and knowledge required to generate original models of value creation for both entrepreneurial start-ups and corporate innovation. Prerequisite: Senior or graduate standing.

## Ceramic Engineering

The ceramic engineering program is offered under the department of materials science and engineering.

Ceramic engineers produce materials vital to many advanced and traditional technologies: electronic and optical assemblies, aerospace parts, biomedical components, nuclear components, high temperature, corrosion resistant assemblies, fuel cells, and electronic packaging. Ceramic engineers generally work with inorganic, nonmetallic materials processed at high temperatures. In the classroom, ceramic engineering students learn the relationships between engineering properties and the chemistry and structure of ceramic materials and go on to apply these scientific principles to the design of new formulations and manufacturing processes. If you are interested in the “why” behind material properties, ceramic engineering will definitely interest you.

Ceramic engineering usually appeals to those who have a strong interest in finding practical applications of the basic sciences, especially chemistry and physics, and can be described as one of the disciplines where ‘science and engineering intersect’. Design occurs at the atomic or microstructural level of solid materials. The Missouri S&T department of ceramic engineering specializes in glass and optical materials, electronic materials, and high temperature materials, but the same scientific and engineering principles that are learned can be applied to the design of new materials for other applications, including biomaterials, high strength materials, materials for energy generation, etc.

Most ceramic engineering classes and laboratories are held in McNutt Hall, but other research laboratories on campus are available to our students. Equipment exists for X-ray investigation of materials, for detection of thermally induced changes in chemistry and structure, for high temperature processing, and for measuring a wide variety of electronic, optical, magnetic, mechanical and thermal properties. The Graduate Center for Materials Research makes additional research equipment available to ceramic engineers, including electron microscopes, optical, infrared, and X-ray spectrometers, thermal analyzers, and high temperature/controlled atmosphere furnaces. Students may broaden their experience by assisting faculty in research projects, either for academic credit or for pay.

Undergraduate student organizations are very active and participation in local and national activities is encouraged. Cooperative education and internships are available with companies and research agencies around the country. Additional information about the department is available at <http://mse.mst.edu/>.

## Mission Statement

The department will train the future industrial and academic leaders in ceramic engineering by providing a comprehensive, forward-looking and broad-based curriculum, which emphasizes fundamental principles, practical applications, oral and written communication skills, and professional practice and ethics. The department is distinguished by a nationally recognized graduate program that emphasizes research of significance to the state of Missouri and the nation while providing a stimulating educational environment.

The program educational objectives of the ceramic engineering program:

- Our graduates will be leaders in the science, technology, and management of ceramic engineering
- Our graduates will serve their profession and society
- Our graduates will continually enhance their professional skills and educational background

The specific outcomes of the ceramic engineering program are:

- Ability to apply mathematical, science and engineering principles to ceramic systems
- An ability to utilize experimental, statistical and computational methods to solve ceramic problems
- Ability to design a system, component, or process to meet desired needs
- Ability to function of diverse teams
- Ability to identify, formulate, and solve engineering problems
- Understanding of professional and ethical responsibility
- Ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global and societal context
- Recognition of the need for, and an ability to engage in life-long learning
- knowledge and understanding of contemporary issues
- Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- Integrated understanding of scientific and engineering principles of ceramic structure
- Integrated understanding of scientific and engineering principles of ceramic properties

- Integrated understanding of scientific and engineering principles of ceramic processing
- Integrated understanding of scientific and engineering principles of ceramic performance
- Ability to apply and integrate knowledge of structure, properties, processing and performance to ceramic selection and process design

## Bachelor of Science Ceramic Engineering

Entering freshmen desiring to study ceramic engineering will be admitted to the Freshman Engineering Program. They will be permitted to state a ceramic engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering Program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major.

For the bachelor of science degree in ceramic engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. A student must maintain an average of at least two grade points per credit hour in ceramic engineering.

Each student's program of study must contain a minimum of 18 credit hours of course work from the humanities and the social sciences areas and should be chosen according to the following rules:

1. All students are required to take one history course and one economics course. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200.
2. Of the remaining hours, 12 credit hours must be taken in humanities or social sciences from the approved list of humanities and social science (HSS) courses posted on the undergraduate studies website (<http://ugs.mst.edu/>). Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 4000-level.
3. Special topics, special problems courses and honors seminars are allowed only by petition to and approval by the student's department chair.

Freshman Year			
First Semester	Credits	Second Semester	Credits
FR ENG 1100	1	MATH 1215	4
CHEM 1310	4	CHEM 1320	3
CHEM 1319	1	PHYSICS 1135	4
MATH 1214	4	H/SS Elective	3
ENGLISH 1120	3	MECH ENG 1720	3
H/SS Elective	3		
16		17	

Sophomore Year			
First Semester	Credits	Second Semester	Credits
CER ENG 2110	3	CER ENG 2120	3
CER ENG 2210	2	CER ENG 2325	2
CER ENG 2315	2	CER ENG 3230	3
MATH 2222	4	MATH 3304 <sup>1</sup>	3
PHYSICS 2135	4	H/SS Elective	3

CIV ENG 2200		3	
15		17	
Junior Year			
First Semester	Credits	Second Semester	Credits
CER ENG 3315	2	CER ENG 3325	2
CER ENG 3220	3	CER ENG 3410	3
CIV ENG 2210	3	PHYSICS 2305	3
CER ENG 3210	3	H/SS Elective	3
H/SS Elective	3	Advanced Chemistry Elective <sup>3</sup>	3
Technical Elective <sup>2</sup>	2	CER ENG 4410	3
16		17	
Senior Year			
First Semester	Credits	Second Semester	Credits
CER ENG 4096	3	CER ENG 4097	3
CER ENG 4310	3	CER ENG 4220	3
CER ENG 4250	3	CER ENG 4240	3
Technical Elective <sup>2</sup>	3	Statistics Elective <sup>1</sup>	3
H/SS Elective	3	Technical Elective <sup>2</sup>	3
15		15	

Total Credits: 128

**Note 1:** Students may substitute MATH 1208 and MATH 1221 for MATH 1214 and MATH 1215, respectively.

- <sup>1</sup> All ceramic engineering students must take MATH 3304 and one statistics course (3000-level or higher).
- <sup>2</sup> Technical electives must be selected from upper level engineering and science courses with the advisor's approval.
- <sup>3</sup> All ceramic engineering students must select an advanced chemistry elective with the advisor's approval. The courses that can be considered are CHEM 2210, CHEM 2310, CHEM 3410, CHEM 4310, CHEM 4810, or CHEM 3420.

## Specific Degree Requirements

1. Total number of hours required for a degree in ceramic engineering is 128.
2. The assumption is made that a student admitted in the department has completed 34 hours credit towards graduation. The academic program of students transferring from colleges outside Missouri S&T will be decided on a case-by-case basis.

**Richard K Brow**, Curators Professor  
PHD Pennsylvania State University

**Fatih Dogan**, Professor  
PHD Technical University of Berlin

**William G Fahrenholtz**, Curators Professor  
PHD University of New Mexico

**Gregory E Hilmas**, Curators Professor  
PHD University of Michigan-Ann Arbor

**Wayne Huebner**, Professor  
PHD University of Missouri-Rolla

**Mohamed N Rahaman**, Professor  
PHD University of Sheffield (UK)



**Mary R Reidmeyer**, Associate Teaching Professor  
PHD University of Missouri-Rolla

**Jeffrey D Smith**, Associate Professor  
PHD University of Missouri-Rolla

**Jeremy Lee Watts**, Research Assistant Professor  
PHD Missouri S&T

**CER ENG 2002 Cooperative Training** (IND 1.0-3.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted at work supervisor's evaluation.

**CER ENG 2110 Atomic Structure Of Crystalline Ceramics** (LEC 3.0)

The crystal-chemical principles used to design and manufacture materials with specified properties are developed and applied to oxides, clays, silicates and other nonmetallic compounds.

**CER ENG 2120 Introduction To Glass Science And Technology** (LEC 3.0)

A study of the atomic-level structure of oxide glasses and the relationships between composition, properties and structure of glass-forming systems. Simple rate processes will be introduced to explain temperature-dependent properties. Prerequisite: "C" or better grade in Cer Eng 2110.

**CER ENG 2210 Ceramics In The Modern World** (LEC 2.0)

An introduction to traditional and modern applications of ceramics providing a broad overview of all aspects of current ceramic technology.

**CER ENG 2240 Applied Glass Forming** (LAB 1.0 and LEC 1.0)

Examines the properties and behavior of molten glass along with basic forming techniques, including off-hand shaping, molding and casting. Prerequisites: A grade of "C" or better in either Cer Eng 2210 or Met Eng 1210. Freshman standing or sophomore standing only.

**CER ENG 2315 Ceramic Materials Laboratory I-Characterization Of Materials** (LAB 2.0)

Laboratory experience in collection, beneficiation, and characterization of ceramic raw materials; granulation, compaction, and sintering of particulate materials; and characterization at an introductory level. Standard laboratory practice including safety, report writing, and error analysis are also emphasized. Prerequisite: Sophomore standing.

**CER ENG 2325 Ceramic Materials Laboratory II Glass And Ceramic Processing** (LAB 2.0)

Laboratory experience in design, processing, and characterization of glasses and ceramics. Glasses are formulated, melted and characterized to correlate composition and properties. Clay-based ceramics are formulated to meet performance specifications, prepared by slip casting/extrusion, and fired. Prerequisite: "C" or better grade in Cer Eng 2315.

**CER ENG 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable Title.

**CER ENG 3110 Introduction to Biomedical Engineering** (LEC 3.0)

This course will provide an introduction to the interdisciplinary field of biomedical engineering. The molecular, cellular, physiological and engineering principles that govern the field will be covered. Applications will include biomaterials, tissue engineering, biomechanics, bioimaging, bioinstrumentation, bio-nanotechnology and artificial organs. Prerequisite: Junior standing or above. (Co-listed with Bio Sci 3110 and Chem Eng 3210).

**CER ENG 3210 Thermal Processes In Ceramics** (LEC 3.0)

Considerations in rate controlled processes in the fabrication of ceramics, packing of powders, comminution and calcination, drying and firing of ceramic ware, polymorphic transformations, sintering, grain growth and hot pressing, relationships of fabrication techniques to physical properties.

**CER ENG 3220 Phase Equilibria** (LEC 3.0)

The study of unary, binary and ternary inorganic, phase equilibrium systems with examples for solving practical engineering problems. Prerequisite: "C" or better grade in Chem 1320 or Met Eng 1210.

**CER ENG 3230 Thermodynamics of Materials** (LEC 3.0)

Basic thermodynamic concepts are applied to materials. Calculations involving enthalpy, entropy, and Gibbs' free energy are studied. Inter-relationships among properties are emphasized. Fundamental concepts of phase equilibria are presented. Prerequisite: "C" or better grade in either Met Eng 1210 or Chem 1320.

**CER ENG 3315 Ceramic Processing Lab I** (LAB 2.0)

The first half of a two-semester sequence that gives students practical knowledge of the methods and techniques used in the fabrication of ceramics. Prerequisite: "C" or better grade in Cer Eng 2325.

**CER ENG 3325 Ceramic Processing Lab II** (LAB 2.0)

The second half of a two-semester sequence that gives students practical knowledge of the methods and techniques used in the fabrication of ceramics. Prerequisite: "C" or better grade in Cer Eng 3315.

**CER ENG 3410 Characterization Of Inorganic Solids** (LEC 3.0)

X-ray diffraction analysis is emphasized including lattice parameter determination, qualitative and quantitative analysis methods, and sources of error. In addition, the basic principles of other common characterization techniques including electron microscopy, thermal analysis, and energy dispersive spectroscopy are discussed. Prerequisite: "C" or better grade in either Cer Eng 2110 or Met Eng 2110 or a similar introductory course on structure of solids.

**CER ENG 3417 Characterization Of Inorganic Solids Laboratory** (LAB 1.0)

Practical aspects of x-ray diffraction analysis will be emphasized; students will gain hands-on experience in qualitative and quantitative analysis techniques, use of electronic databases, and operation of modern powder diffractometers. Prerequisite: Preceded or accompanied by Cer Eng 3410.

**CER ENG 3517 The Engineering Design Process** (LEC 2.0)

Introduction to elements of design process including strategic, planning, project, management, modelling, materials selection, engineering economics, safety, environmental issues and ethics. Prerequisite: Junior standing.

**CER ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CER ENG 4001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CER ENG 4096 Materials Senior Design I** (LEC 3.0)

Overview of the methods, approaches, and techniques required to execute materials related capstone senior design projects. Formation of teams, assignment of projects, review of department curriculum concepts and topics, and comprehensive project management skills needed to complete projects will be used as means to learn the design process. Prerequisites: Met Eng 3125 and Met Eng 2125, or Cer Eng 3315 with a "C" or better. (Co-listed with Met Eng 4096).



**CER ENG 4097 Materials Senior Design II** (LAB 3.0)

A continuation of the Materials Senior Design I. Students working in groups will complete a capstone design project including process and product simulation and/or fabrication, safety aspects, environmental impact and capital and operating economics. Prerequisite: "C" or better in either Cer Eng 4096 or Met Eng 4096. (Co-listed with Met Eng 4097).

**CER ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**CER ENG 4220 Mechanical Properties Of Ceramics** (LEC 3.0)

This course will treat the theory and testing practice related to design based on the mechanical properties of ceramics. The course also includes laboratory experiments for the characterization of the mechanical properties of ceramics. Prerequisite: A grade of "C" or better in Civ Eng 2210.

**CER ENG 4240 Electrical Properties Of Ceramics** (LEC 3.0)

The application of ceramic chemistry and physics to the development and evaluation of electronic, dielectric, magnetic, and optical properties. Emphasis is placed on the relationships between properties and crystal structure, defects, grain boundary nature, and microstructure. Prerequisite: "C" or better in Physics 2305.

**CER ENG 4250 Thermal Properties Of Ceramics** (LEC 3.0)

This course will teach the crystal physics underlying heat capacity, internal energy, phonon and photon conduction, and thermal expansion. These properties will be used to rationalize the behavior of a wide variety of ceramic materials in severe thermal environments. Prerequisite: Senior Standing.

**CER ENG 4310 Ceramic Processing** (LEC 3.0)

Powder, colloidal and sol-gel processing, forming methods, drying, sintering and grain growth. Relation of processing steps to densification and microstructure development. Prerequisite: Senior standing.

**CER ENG 4410 Introduction to Integrated Computational Materials Engineering** (LEC 2.0 and LAB 1.0)

This course will provide an introduction to different computational tools for studying materials at different length scales. Several atomistic, microscale, and continuum models will be introduced and bridging between different modeling scales will be discussed. This course has a computational laboratory to build models and run simulations. Prerequisites: A grade of "C" or better in both Cer Eng 3220 and Math 3304, and in either Cer Eng 2110 or Met Eng 2110.

**CER ENG 4510 International Engineering and Design** (LEC 3.0)

A multi-disciplinary engineering course focused on sustainable design and technology transfer to developing countries. Course includes elements of traditional capstone design classes. Experiential learning through competitions and/or field work is a major component of the class. Prerequisites: Senior standing, instructor approval, Geo Eng 5211, Geo Eng 5247. (Co-listed with Geo Eng 5092 and Met Eng 4510).

**CER ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CER ENG 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CER ENG 5002 Cooperative Training** (IND 1.0-3.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted at work supervisor's evaluation.

**CER ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**CER ENG 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**CER ENG 5115 X-Ray Diffraction Analysis** (LEC 2.0 and LAB 1.0)

Theory and practical aspects of x-ray diffraction analysis are covered including diffraction theory, qualitative and quantitative analysis techniques, electronic databases, and operation of modern powder diffractometers. Students cannot receive credit for both Cer Eng 3417 and Cer Eng 5115. Prerequisite: Preceded or accompanied by Cer Eng 3410.

**CER ENG 5220 Advanced Mechanical Properties of Ceramics** (LEC 3.0 and LAB 1.0)

An advanced course to treat the theory and testing practice related to design based on the mechanical properties of ceramics. The course also includes a laboratory consisting of experiments for the characterization of the mechanical properties of ceramics. Prerequisites: Graduate standing.

**CER ENG 5230 Glass Science And Engineering** (LEC 3.0)

The development, manufacturing methods, applications, and properties of flat, fiber, container, chemical, and special purpose glasses. Composition/property relationships for glasses and nucleation-crystallization processes for glass-ceramics are also covered. Prerequisite: "C" or better grade in Cer Eng 2120.

**CER ENG 5250 Refractories** (LEC 3.0)

The manufacture, properties, uses, performance, and testing of basic, neutral and acid refractories. Prerequisite: Cer Eng 3230.

**CER ENG 5260 Dielectric And Electrical Properties Of Oxides** (LEC 3.0)

The processes occurring in inorganic materials under the influence of an electric field are considered from basic principles. Emphasis is placed on application to real systems. Prerequisite: "C" or better grade in Cer Eng 4210.

**CER ENG 5310 Advanced Ceramic Processing** (LEC 3.0)

Materials, processing and design of microelectronic ceramics are covered. Introduction to devices, triaxial ceramics, high aluminas, tape fabrication, metallizations, thick film processing and glass-to-metal seals. Prerequisites: Cer Eng 3210 & 3325.

**CER ENG 5810 Principles Of Engineering Materials** (LEC 3.0)

Examination of engineering materials with emphasis on selection and application of materials in industry. Particular attention is given to properties and applications of materials in extreme temperature and chemical environments. A discipline specific design project is required. (Not a technical elective for undergraduate metallurgy or ceramic majors) (Co-listed with Aero Eng 3877, Chem Eng 5300, Physics 4523, Met Eng 5810).

# Chemical & Biochemical Engineering

## Emphasis area at bachelor of science level in biochemical engineering

Chemical engineering is the branch of engineering which deals with changing the composition, energy content and state of aggregation of materials. As a chemical engineering student, you will consider the fundamental properties and nature of matter (chemistry), the forces that act on matter (physics) and the precise expressions of the relationships between them (mathematics). Extensive use is made of computers in the application of these sciences to engineering problems.

As a chemical engineer, you may study ways in which pure water can be obtained from the sea; design processes to produce fertilizers, rubber, fibers, and fuels; or team up with other engineers and scientists to develop specialized polymeric materials for use in artificial arms, legs and other human organs. You may be instrumental in finding supplemental food sources for man, such as protein from petroleum, wood, or the sea. You might help develop new processes for the application of biochemistry, energy conservation, or environmental control, such as reducing undesirable substances in the air. Or, you might have a hand in the creation of strong lightweight materials to be used in aircraft construction. Your opportunities will be unlimited.

At Missouri S&T, you will have laboratories available which offer training in qualitative and quantitative analysis, basic organic and physical chemistry, physics, unit operations, biochemical engineering, design and automatic process control.

Your studies will give you a broad technical basis with an emphasis on material balances, energy balances, separation processes, rate processes, unit operations, process economics safety and design.

Among its facilities, the department features digital data acquisition and control equipment for research and instruction which allows simultaneous utilization of the system by several people. A full complement of hardware exists for input and output of signals to and from process equipment and instrumentation. The campus computer network makes available a wide variety of professional software. Also included is equipment to measure thermodynamic and physical properties, study biochemical engineering processes, polymers, surface phenomena, fluid mechanics, membranes, chemical kinetics and diffusion.

## Mission Statement

The chemical and biochemical engineering department:

1. Prepares chemical engineers for successful careers of leadership and innovators in chemical engineering and related fields
2. Expands the knowledge base of chemical engineering through its scholarly pursuits
3. Develops technology to serve societal needs
4. Benefits the public welfare through service to chemical engineering and related professions

## BScE Program Educational Objectives:

Program graduates:

1. Become successful in their chosen career path
2. Undertake responsibility or leadership roles in their industry, business and/or community

3. Work in teams to improve the economic environment of their industry sector and/or community
4. Maintain career skills through life-long learning

## Bachelor of Science Chemical Engineering

Entering freshmen desiring to study chemical engineering will be admitted to the Freshman Engineering Program. They will be permitted, if they wish, to state a chemical engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering Program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major.

For the bachelor of science degree in chemical engineering a minimum of 129 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in chemical engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1. All students are required to take one American history course, one economics course, one humanities course, and ENGLISH 1120. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200. The humanities course must be selected from the approved lists for art, English, foreign languages, music, philosophy, speech and media studies, or theater.
2. Depth requirement. Three credit hours must be taken in humanities or social sciences at the 1000 level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 1180 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 3000 level or above. All courses taken to satisfy the depth requirement must be taken after graduating from high school.
3. The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to ENGLISH 1120.
4. Any specific departmental requirements in the general studies area must be satisfied.
5. Special topics and special problems and honors seminars are allowed only by petition to and approval by the student's department chairman.

The chemical engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and

design are presented and discussed through classroom and laboratory instruction.

Freshman Year			
First Semester	Credits	Second Semester	Credits
FR ENG 1100	1	MECH ENG 1720	3
CHEM 1310	4	CHEM ENG 1100, or COMP SCI 1972 and COMP SCI 1982, or COMP SCI 1971 and COMP SCI 1981	3
CHEM 1319	1	CHEM 1320	3
ENGLISH 1120	3	MATH 1215	4
HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3	PHYSICS 1135	4
MATH 1214	4		
CHEM 1100	1		
		17	17

Sophomore Year			
First Semester	Credits	Second Semester	Credits
CHEM ENG 2100 <sup>1</sup>	3	CHEM ENG 2310 <sup>2</sup>	1
CHEM 2210	4	CHEM ENG 2110 <sup>1</sup>	3
MATH 2222	4	Humanities and Social Sciences Elective <sup>4</sup>	3
PHYSICS 2135	4	Humanities and Social Sciences Elective <sup>4</sup>	3
CHEM ENG 2300	3	MATH 3304	3
		Science Elective <sup>5</sup>	4
		18	17

Junior Year			
First Semester	Credits	Second Semester	Credits
CHEM ENG 3120 <sup>1</sup>	3	CHEM ENG 3141	2
CHEM ENG 3101	4	CHEM ENG 3131	3
CHEM ENG 3111	3	CHEM ENG 3150	3
ECON 1100 or 1200	3	STAT 3113	3
Upper level Humanities or Social Science Elective <sup>4</sup>	3	ENGLISH 1160 or 3560	3
		16	14

Senior Year <sup>3</sup>			
First Semester	Credits	Second Semester	Credits
CHEM ENG 4110	3	CHEM ENG 4097 <sup>2</sup>	3
CHEM ENG 5XXX-Chem Eng Elective <sup>6</sup>	3	CHEM ENG 5XXX-Chem Eng Elective <sup>6</sup>	3
CHEM ENG 4101 <sup>2</sup>	3	CHEM ENG 4130 <sup>2</sup>	3
CHEM ENG 4140	3	Chem Eng 5xxx –Chem Eng Elective <sup>6</sup>	3
CHEM ENG 4091	3	Chem Eng 5xxx -Chem Eng Elective <sup>6</sup>	3
		15	15

Total Credits: 129

**Note:** The minimum number of hours required for a degree in chemical engineering is 129.

A cumulative grade point average of 2.50 or better and a "C" or better in Chem 1310, Chem 1319, Chem 1320, Math 1214, Math 1215 and Physics 1135 are required to be admitted into the chemical engineering major.

<sup>1</sup> A grade of "C" or better is required in Chem Eng 2100 & Chem Eng 2110 in order to enroll in Chem Eng 3120 .

<sup>2</sup> Communications emphasized course (See bachelor of science degree, general education communications requirement).

<sup>3</sup> Chemical engineering majors are encouraged to take the fundamentals of engineering exam prior to graduation. It is the first step toward becoming a registered professional engineer.

<sup>4</sup> From approved list published on the website of Undergraduate Studies. The prerequisites for the upper level course must be completed with a passing grade.

<sup>5</sup> CHEM 2510, or CHEM 4610 and CHEM 4619, or BIO SCI 2213 and BIO SCI 2219, or CHEM 2220 and CHEM 2289, or Bio Sci 3313 and Bio Sci 3319, or CHEM 3420 and CHEM 3459.

<sup>6</sup> Any Chem Eng 5xxx and any class from the approved list published in the Chemical Engineering web site but only 3 cr. hr of Chem. Eng. 4000, Chem Eng 4099 or Chem Eng 4099. Students may have no more than three hours from approved, out-of-department elective.

## Chemical Engineering Biochemical Engineering Emphasis

Freshman Year			
First Semester	Credits	Second Semester	Credits
FR ENG 1100	1	MECH ENG 1720	3
CHEM 1310	4	CHEM ENG 1100, or COMP SCI 1972 and COMP SCI 1982, or COMP SCI 1971 and COMP SCI 1981	3
CHEM 1319	1	CHEM 1320	3
ENGLISH 1120	3	MATH 1215	4
HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3	PHYSICS 1135	4
MATH 1214	4		
CHEM 1100	1		
		17	17

Sophomore Year			
First Semester	Credits	Second Semester	Credits
CHEM ENG 2100 <sup>1</sup>	3	CHEM ENG 2110 <sup>1</sup>	3
CHEM 2210	4	STAT 3113	3
MATH 2222	4	CHEM ENG 2310 <sup>2</sup>	1
PHYSICS 2135	4	Science Elective <sup>5</sup>	4
CHEM ENG 2300	3	MATH 3304	3
		18	14

Junior Year			
First Semester	Credits	Second Semester	Credits
CHEM ENG 3120 <sup>1</sup>	3	ECON 1100 or 1200	3
CHEM ENG 3101	4	Science Elective <sup>5</sup>	4
Humanities or Social Sciences Elective <sup>4</sup>	3	CHEM ENG 3141	2
Science Elective <sup>5</sup>	4	CHEM ENG 3131	3
CHEM ENG 3111	3	ENGLISH 1160 (or English 3560)	3
		CHEM ENG 3150	3
		17	18

Senior Year <sup>3</sup>			
First Semester	Credits	Second Semester	Credits
CHEM ENG 4110	3	CHEM ENG 4210	3
Upper Level Humanities or Social Sciences Elective <sup>4</sup>	3	CHEM ENG 4097 <sup>2</sup>	3
CHEM ENG 4091	3	Humanities or Social Science Elective <sup>4</sup>	3
CHEM ENG 4220 <sup>2</sup>	3	CHEM ENG 4201 <sup>2</sup>	3

CHEM ENG 5250	3	CHEM ENG 4241	3
	15		15
Total Credits: 131			

**Note:** The minimum number of hours required for a degree in chemical engineering with an emphasis in biochemical engineering is 131.

A cumulative grade point average of 2.50 or better and a "C" or better in Chem 1310, Chem 1319, Chem 1320, Math 1214, Math 1215 and Physics 1135 are required to be admitted into the chemical engineering major.

- <sup>1</sup> A grade of "C" or better is required in Chem Eng 2100 & Chem Eng 2110 in order to enroll in Chem Eng 3120.
- <sup>2</sup> Communications emphasized course (See bachelor of science degree, general education communications requirement).
- <sup>3</sup> Chemical engineering majors are encouraged to take the fundamentals of engineering exam prior to graduation. It is the first step toward becoming a registered professional engineer.
- <sup>4</sup> From approved list published on the website of Undergraduate Studies. The prerequisites for the upper level course must be completed with a passing grade.
- <sup>5</sup> A minimum of 12 credit hours in Science Electives are required. Select three courses from Chem 2220, Chem 4610, Chem 4620, BioSci 2213, BioSci 3313, and BioSci 4323; and a minimum of two laboratory courses from Chem 2229 or Chem 2289, Chem 4619, BioSci 2219, BioSci 3319, and BioSci 4329.

## Honors in Chemical and Biochemical Engineering

CBE requires the student to complete a three semester long project with 6 or 9 credit hours of CHEM ENG 4099H-Undergraduate Research Honors, three hours counting towards the technical elective and up to 6 towards free electives. CHEM ENG 4099H cannot be taken without a GPA of 3.5. It is necessary to start and finish with the same advisor. The report has to be validated by a committee consisting of at least the project advisor and the CBE honors program advisor. A form has to be sent to the department chair to start and another to complete the process.

Honors projects have no known solutions and in that, the successful completion of the project shows the ability of the candidates to solve problems. The three semesters make the study in-depth. And the report will contribute towards building good technical writing abilities. This report can be shown to all technical people to make a point about the lasting skills that have been achieved along with the B.S. degree.

**Muthanna Hikmat Al Dahhan**, Professor  
DSc Washington University

**Baojun Bai**, Associate Professor  
PHD New Mexico Institute of Mining

**Dipak Barua**, Assistant Professor  
PHD North Carolina State University

**Sutapa Barua**, Assistant Professor  
PHD Arizona State University

**Hank Foley**, Joint Appointment with University of Missouri-Columbia  
PHD Penn State University

**Daniel Forciniti**, Professor  
PHD North Carolina State University

**Chang-Soo Kim**, Associate Professor  
PHD Kyungpook National University

**Xinhua Liang**, Assistant Professor  
PHD University of Colorado-Boulder

**Athanasios I Liapis**, Professor  
PHD Swiss Federal Institute of Technology

**Douglas K Ludlow**, Professor  
PHD Arizona State University

**Christi Luks**, Associate Teaching Professor  
PHD University of Tulsa

**Parthasakha Neogi**, Professor  
PHD Carnegie Mellon University

**Joontaek Park**, Assistant Professor  
PHD University of Florida

**Fateme Rezaei**, Assistant Professor  
PHD Monash University - Melbourne, Australia

**Ali Rownaghi**, Assistant Research Professor  
PHD University Putra - Malaysia

**Peter J Ryan**, Associate Teaching Professor  
PHD University of Massachusetts-Amherst

**Michael Stephen Schmidt**, Adjunct Professor  
MS University of Missouri-Rolla

**Oliver Clifford Sitton**, Associate Professor  
PHD University of Missouri-Rolla

**Joseph D Smith**, Professor  
PHD Brigham Young University

**Jee-Ching Wang**, Associate Professor  
PHD Pennsylvania State University

**David J Westenberg**, Associate Professor  
PHD University of California-Los Angeles

**Silviya Petrova Zustiak**, Joint Appointment with St.. Louis University  
PHD University of Maryland Baltimore County

**CHEM ENG 1100 Computers And Chemical Engineering** (LAB 1.0 and LEC 2.0)

Introduction to chemical engineering, both its intellectual and professional opportunities. Students are introduced to computer programming and software packages while performing meaningful chemical engineering calculations.

**CHEM ENG 2001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course.



**CHEM ENG 2100 Chemical Engineering Material & Energy Balances** (LAB 1.0 and LEC 2.0)

The application of mathematics, physics and chemistry to industrial chemical processes. The use of equations of state, chemical reaction stoichiometry, and the conservation of mass and energy to solve chemical engineering problems. Prerequisites: Chem 1320 or Geology 3410; Math 1215 or Math 1221; preceded or accompanied by Physics 1135.

**CHEM ENG 2110 Chemical Engineering Thermodynamics I** (LEC 3.0)

Development and application of the laws and fundamental relationships of thermodynamics to industrial chemical processes. Emphasis is placed on the estimation of thermophysical property values for applications in chemical process engineering. Prerequisites: Preceded by Math 2222; Preceded or accompanied by Chem Eng 2100.

**CHEM ENG 2300 Chemical Process Materials** (LEC 3.0)

Fundamentals of the chemistry of materials. Classification, properties, selection, and processing of engineering materials. Introduction to polymers, electronic materials, biomaterials, and nanomaterials. Prerequisites: Physics 1135.

**CHEM ENG 2310 Professional Practice And Ethics** (LEC 1.0)

Preparation for post-graduate activities including resume writing and job searching. Professional attitudes, practice, licensure, and ethics in the chemical engineering profession. Discussions led by visiting industrialists and other invited speakers. Discussion of professional development including professional and graduate programs. Generally offered fall semester only. Prerequisite: At least sophomore standing.

**CHEM ENG 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CHEM ENG 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course.

**CHEM ENG 3002 Cooperative Engineering Training** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation.

**CHEM ENG 3100 Chemical Engineering Fluid Flow** (LEC 3.0)

Mass, energy, and momentum balance concepts in fluid flow are studied to provide a basis for study of flow measurement, fluid behavior, turbulent flow, dimensional analysis of fluid flows, and the study of some practical flow processes such as : filtration, fluidization, compressible flow, pipe networks. Prerequisites: Chem Eng 2100 and Math 3304; Chem Eng majors only.

**CHEM ENG 3101 Fundamentals of Transport in Chemical and Biochemical Engineering** (LEC 4.0)

This course covers the fundamentals of momentum, energy, and mass transport. Phenomenological mechanisms of molecular transport, fluid static, analysis of a fluid in motion laminar and turbulent flow are covered. The general differential equations for momentum, energy and mass transfer are presented and solved for a variety of chemical engineering problems. Prerequisites: Math 3304 and Chem Eng 2110. Admitted to the Chemical Engineering Program.

**CHEM ENG 3110 Chemical Engineering Heat Transfer** (LEC 2.0)

Process principles of heat transfer in the chemical process industry. Steady and unsteady state heat conduction and radiation heat transfer. Free and forced convection and condensation and boiling heat transfer. Practical heat exchanger design. Prerequisites: Math 2222 and preceded or accompanied by Chem Eng 3100. Chem Eng majors only.

**CHEM ENG 3111 Numerical Computing in Chemical and Biochemical Engineering** (LAB 1.0 and LEC 2.0)

The students are introduced to the concepts of engineering problem formulation, model building, and multi scale models. Matlab, spreadsheet and polymath computing are used to solve chemical engineering problems involving systems of linear and non linear algebraic equations, and ordinary and partial differential equations. Prerequisites: Math 3304 and either both Comp Sci 1971 and Comp Sci 1981 or both Comp Sci 1972 and Comp Sci 1982. Admitted to the Chemical Engineering Program.

**CHEM ENG 3120 Chemical Engineering Thermodynamics II** (LEC 3.0)

Physical, chemical and reaction equilibrium. Study of the thermophysical relationships of multicomponent, multiphase equilibrium. Application of equilibrium relationships to the design and operation of chemical mixers, separators and reactors. Prerequisites: Grade of "C" or better in Chem Eng 2100 and Chem Eng 2110; Chem Eng majors only.

**CHEM ENG 3130 Staged Mass Transfer** (LEC 3.0)

Principles of equilibrium stage operations applied to distillation, liquid-liquid extraction, absorption, and leaching. Methods for estimating pressure drop and stage efficiencies are also studied. Quantitative solutions to practical problems are stressed. Prerequisites: Chem Eng 3120, admitted to Chem Eng program.

**CHEM ENG 3131 Separations in Chemical and Biochemical Engineering** (LEC 3.0)

Flash and column distillation. McCabe-Thiele method, plate efficiencies. Azeotropes. Batch distillation. Absorption and stripping. Washing and leaching. Prerequisites: Chem Eng 3101, Chem Eng 3111, and Chem Eng 3120. Admitted to the Chemical Engineering Program.

**CHEM ENG 3140 Continuous Mass Transfer** (LEC 3.0)

Fundamentals of diffusion and mass transfer applied to absorption, extraction, humidification, drying and filtration. Design and rating of continuous chemical separators. Prerequisites: Preceded or accompanied by Chem Eng 3130. Chem Eng majors only.

**CHEM ENG 3141 Process Operations in Chemical and Biochemical Engineering** (LEC 2.0)

Design and selection of pumps, fans, compressors, valves, and ejectors. Design and selection of heat exchangers, condensers and reboilers. Design of mixing equipment, sterilizers, sedimentation vessels, centrifuges, and filtration and ultrafiltration units. Prerequisites: Chem Eng 3101 and Chem Eng 3120. Admitted to the Chemical Engineering Program.

**CHEM ENG 3150 Chemical Engineering Reactor Design** (LEC 3.0)

The study of chemical reaction kinetics and their application to the design and operation of chemical and catalytic reactors. Prerequisites: Preceded or accompanied by either Chem Eng 3140 or Chem Eng 3200 or preceded by both Chem Eng 3111 and Chem Eng 3101. Admitted to Chem Eng program.

**CHEM ENG 3160 Molecular Chemical Engineering** (LEC 3.0)

Introduction to the molecular aspects of chemical thermodynamics, transport processes, reaction dynamics, and statistical and quantum mechanics. Prerequisites: Chem Eng 3120, admitted to Chem Eng program.



**CHEM ENG 3200 Biochemical Separations** (LEC 3.0)

The fundamentals of mass transfer are introduced and applied to various unit operations employed in the separation of chemical and biochemical compounds. Prerequisites: Chem Eng 3120. Chem Eng majors only.

**CHEM ENG 3210 Introduction to Biomedical Engineering** (LEC 3.0)

This course will provide an introduction to the interdisciplinary field of biomedical engineering. The molecular, cellular, physiological and engineering principles that govern the field will be covered. Applications will include biomaterials, tissue engineering, biomechanics, bioimaging, bioinstrumentation, bio-nanotechnology and artificial organs. Prerequisite: Junior standing or above. (Co-listed with Cer Eng 3110 and Bio Sci 3110).

**CHEM ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CHEM ENG 4001 Special Topics** (LEC 3.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM ENG 4091 Chemical Process Design I** (LEC 1.0 and LAB 2.0)

Economic analysis of a chemical process including capital requirements, operating costs, earnings, and profits. The economic balance is applied to chemical engineering operations and processes. Optimization and scheduling techniques are applied to process evaluation. Preliminary process design and use of simulation software. Prerequisites: Either (Chem Eng 3150, Chem Eng 3131 and Chem Eng 3141) or (Chem Eng 3150 and preceded or accompanied by Chem Eng 5250).

**CHEM ENG 4096 Chemical Engineering Economics** (LEC 2.0)

Economic analysis of a chemical process including capital requirements, operating costs, earnings, and profits. The economic balance is applied to chemical engineering operations and processes. Optimization and scheduling techniques are applied to process evaluation. Prerequisite: Preceded or accompanied by Chem Eng 3130.

**CHEM ENG 4097 Chemical Process Design II** (LAB 2.0 and LEC 1.0)

Engineering principles involved in the design and layout of chemical process equipment. Material and energy balances, equipment selection and design, and preconstruction cost estimation are performed for a capstone design project. Communication emphasized course. Prerequisites: Chem Eng 3130 and Chem Eng 3150; preceded or accompanied by either Chem Eng 4091 or both Chem Eng 4110 and Chem Eng 4096.

**CHEM ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**CHEM ENG 4100 Chemical Engineering Laboratory I** (LAB 1.0 and LEC 1.0)

Experiments associated with unit operations involving fluid flow and heat transfer. Principles of data and uncertainty analysis are introduced with emphasis on model building. Communication skills are stressed. This is a communication emphasized course. Prerequisites: Chem Eng 3100 and Chem Eng 3110.

**CHEM ENG 4101 Chemical Engineering Laboratory I** (LEC 1.0 and LAB 2.0)

Experiments associated with unit operations involving fluid flow and heat transfer. Principles of data and uncertainty analysis are introduced with emphasis on model building. Communication skills are stressed. This is a communication emphasized course. Prerequisites: Chem Eng 3141.

**CHEM ENG 4110 Chemical Engineering Process Dynamics And Control** (LEC 3.0)

Study of the dynamics of chemical processes and the instruments and software used to measure and control temperature, pressure, liquid level, flow, and composition. Generally offered fall semester only. Prerequisites: Preceded or accompanied by any one of Chem Eng 4100 or Chem Eng 4130 or Chem Eng 4200; or preceded by Chem Eng 3150, Chem Eng 3131 and Chem Eng 3141; or preceded by Chem Eng 3150 and preceded or accompanied by Chem Eng 5250.

**CHEM ENG 4120 Process Dynamics And Control Laboratory** (LAB 1.0)

Application of concepts of industrial process dynamics and control using experiments that demonstrate different control and sensing devices and software. This is a communications emphasized course. Prerequisite: Preceded or accompanied by Chem Eng 4110.

**CHEM ENG 4130 Chemical Engineering Laboratory II** (LAB 2.0 and LEC 1.0)

Experiments illustrating the unit operations of continuous and staged separation. Experimental design methods are extended to include the principles of regression and model building. Communication skills are stressed. This is a communication emphasized course. Prerequisites: Chem Eng 3130 and Chem Eng 3140; or Chem Eng 3141 and Chem Eng 3131 and preceded or accompanied by Chem Eng 3150.

**CHEM ENG 4140 Chemical Process Safety** (LEC 3.0)

The identification and quantification of risks involved in the processing of hazardous and/or toxic materials are studied. Prerequisite: Preceded or accompanied by Chem Eng 3150.

**CHEM ENG 4150 Chemical Process Flowsheeting** (LEC 2.0 and LAB 1.0)

The development, implementation, and evaluation of methods for determining the mathematical model of a chemical process, ordering the equations in the mathematical model, and solving the model. Prerequisite: Math 3304 or graduate standing.

**CHEM ENG 4200 Biochemical Separations Laboratory** (LAB 2.0)

Introduction to the unit operations employed in the separation of chemicals and biochemicals. The experiments illustrate the staged and continuous separation systems that are involved. This is a communications emphasized course. Prerequisite: Chem Eng 3200.

**CHEM ENG 4201 Biochemical Separations and Control Laboratory** (LAB 2.0 and LEC 1.0)

Introduction to the unit operations employed in the separation of chemicals and biochemicals. The experiments illustrate the staged and continuous separation systems that are involved. Application of concepts of industrial process dynamics and control. Communications emphasized. Prerequisites: Chem Eng 5250.

**CHEM ENG 4210 Biochemical Reactors** (LEC 3.0)

Application of chemical engineering principles to biochemical reactors. Emphasis on cells as chemical reactors, enzyme catalysis and disposable technology. Prerequisite: Chem Eng 3150 or graduate standing.

**CHEM ENG 4220 Biochemical Reactor Laboratory** (LEC 1.0 and LAB 2.0)

Introduction to the unit operations involved with the production of biochemicals. The experiments emphasize the isolation of proteins and enzymes from tissue and bacteria cells. This is a communications emphasized course. Prerequisites: Chem Eng 3200 and preceded or accompanied by Chem Eng 4210; or preceded or accompanied by Chem Eng 5250 and Chem Eng 4210.

**CHEM ENG 4230 Bioprocess Safety** (LEC 1.0)

This course covers a risk assessment, biohazard containment and inactivation practices, and other biosafety issues relevant to industrial bioprocessing. Considerations relating to the release of genetically modified organisms are also discussed. Prerequisites: Preceded or accompanied by Chem Eng 4210.

**CHEM ENG 4241 Process Safety in the Chemical and Biochemical Industries** (LEC 3.0)

This course covers risk assessment, biohazard containment and inactivation practices, and other biosafety issues relevant to industrial bioprocessing. Considerations relating to the release of genetically modified organisms are also discussed. Prerequisites: Preceded or accompanied by Chem Eng 4210.

**CHEM ENG 4300 Patent Law** (LEC 3.0)

A presentation of the relationship between patent law and technology for students involved with developing and protecting new technology or pursuing a career in patent law. Course includes an intense study of patentability and preparation and prosecution of patent applications. Prerequisite: Senior or graduate standing. (Co-listed with Eng Mgt 5514).

**CHEM ENG 4310 Interdisciplinary Problems In Manufacturing Automation** (LAB 1.0 and LEC 2.0)

The course will cover material necessary to design a product and the fixtures required to manufacture the product. Participants will gain experience with CAD/CAM software while carrying out an actual manufacturing design project. (Co-listed with Mech Eng 5644, Eng Mgt 5315).

**CHEM ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CHEM ENG 5001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM ENG 5010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

**CHEM ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**CHEM ENG 5096 Industrial Chemical Processes** (LEC 3.0)

Detailed study of various industrial chemical manufacturing processes including underlying chemistry, reaction pathways and separation processes. Prerequisite: Chem Eng 3130 or Chem 2210, or graduate standing. (Co-listed with Chem 5250).

**CHEM ENG 5097 Intermediate Process Design** (LEC 3.0)

Study of newer unit operations, fluidization, chromatographic absorption, new developments in operations previously studied. Comparison of operations which might be selected for the same end result in an industrial process. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5100 Intermediate Transport Phenomena** (LEC 3.0)

The similarities of flow of momentum, heat and mass transfer and the applications of these underlying principles are stressed. Course is primarily for seniors and beginning graduate students. Prerequisite: Chem Eng 3140 or Chem Eng 3200 or graduate standing.

**CHEM ENG 5110 Intermediate Chemical Reactor Design** (LEC 3.0)

A study of homogeneous and heterogeneous catalyzed and noncatalyzed reaction kinetics for flow and batch chemical reactors. Application to reactor design is stressed. Prerequisite: Chem Eng 3150 or graduate standing.

**CHEM ENG 5120 Interfacial Phenomena In Chemical Engineering** (LEC 3.0)

The course deals with the effects of surfaces on transport phenomena and on the role of surface active agents. Topics include fundamentals of thermodynamics, momentum, heat and mass transfer at interfaces and of surfactants. Some applications are included. Prerequisite: Chem Eng 3140 or Chem Eng 3200 or graduate standing.

**CHEM ENG 5130 Risk Assessment and Reduction** (LEC 3.0)

Safe, secure manufacturing facilities protect the health of employees and the public, preserve the environment, and increase profitability. Methods for systematically identifying hazards and estimating risk improve the safety performance and security of manufacturing facilities. Prerequisite: Senior or Graduate Standing. (Co-listed with Eng Mgt 4312).

**CHEM ENG 5140 Intermediate Chemical Process Safety** (LEC 3.0)

The identification and quantification of risks involved in the processing of hazardous and/or toxic materials are studied. Methods to design safety systems or alter the chemical process to reduce or eliminate the risks are covered. Prerequisite: Graduate Standing.

**CHEM ENG 5150 Intermediate Chemical Process Flowsheeting** (LEC 2.0 and LAB 1.0)

The development, implementation, and evaluation of methods for determining the mathematical model of a chemical process, ordering the equations in the mathematical model, and solving the model. Projects on special topics and presentations related to the course materials will be included. Prerequisite: graduate standing.

**CHEM ENG 5160 Introduction to Molecular Modeling and Simulation** (LEC 3.0)

An introduction to the concepts of molecular-based modeling and simulations, their connections to other engineering approaches and their role in multiscale modeling. Major methodologies such as molecular dynamics and lattice and off-lattice Monte Carlo, and special case studies are discussed. Prerequisite: Chem Eng 3160.

**CHEM ENG 5161 Intermediate Molecular Engineering** (LEC 3.0)

Molecular aspects of chemical thermodynamics, transport processes, reaction dynamics, and statistical and quantum mechanics. Prerequisites: Chem Eng 3120 or graduate standing.

**CHEM ENG 5170 Physical Property Estimation** (LEC 3.0)

Study of techniques for estimating and correlating thermodynamic and transport properties of gases and liquids. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5180 Industrial Pollution Control** (LEC 3.0)

The study of water, air, and thermal pollution control methods and the application of these methods to the solution of pollution problems in the chemical industry. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5190 Plantwide Process Control** (LEC 3.0)

Synthesis of control schemes for continuous and batch chemical plants from concept to implementation. Multiloop control, RGA, SVD, constraint control, multivariable model predictive control, control sequence descriptions. Design project involving a moderately complicated multivariable control problem. Prerequisites: Chem Eng 4110 or Elec Eng 3320 or Elec Eng 3340 or graduate standing. (Co-listed with Elec Eng 5350).

**CHEM ENG 5200 Biomaterials I** (LEC 3.0)

This course will introduce senior undergraduate students to a broad array of topics in biomaterials, including ceramic, metallic, and polymeric biomaterials for in vivo use, basic concepts related to cells and tissues, host reactions to biomaterials, biomaterials-tissue compatibility, and degradation of biomaterials. Prerequisite: Senior undergraduate standing. (Co-listed with Bio Sci 5210, MS&E 5310).

**CHEM ENG 5210 Intermediate Biochemical Reactors** (LEC 3.0)

Application of chemical engineering principles to biochemical reactors. Emphasis on cells as chemical reactors, enzyme catalysis and production of monoclonal antibodies. Projects on special topics and presentations related to the course materials will be included. Prerequisite: Preceded or accompanied by Chem Eng 3150 or graduate standing.

**CHEM ENG 5220 Intermediate Engineering Thermodynamics** (LEC 3.0)

Review thermodynamic principles for pure fluids and mixtures. Emphasis on applications for the chemical industry and use of fundamental relations and equations of state. Prerequisite: Senior or graduate standing.

**CHEM ENG 5230 Bioprocess Safety** (LEC 1.0)

This course covers a risk assessment, biohazard containment and inactivation practices, and other biosafety issues relevant to industrial bioprocessing. Considerations relating to the release of genetically modified organisms are also discussed. Prerequisites: Graduate standing.

**CHEM ENG 5241 Intermediate Process Safety in the Chemical and Biochemical Industries** (LEC 3.0)

This course covers risk assessment, biohazard containment and inactivation practices, and other biosafety issues relevant to industrial bioprocessing. Considerations relating to the release of genetically modified organisms are also discussed. Prerequisites: Chem Eng 3150 or graduate standing.

**CHEM ENG 5250 Isolation and Purification of Biologicals** (LEC 3.0)

Isolation and purification of biologicals with emphasis on biopharmaceuticals. Principles and applications of chromatography, lyophilization, and product formulation. Use of ultrafiltration and diafiltration in the processing of protein products. Disposable technology. Prerequisites: Chem Eng 3131 and Chem Eng 3141.

**CHEM ENG 5300 Principles Of Engineering Materials** (LEC 3.0)

Examination of engineering materials with emphasis on selection and application of materials in industry. Particular attention is given to properties and applications of materials in extreme temperature and chemical environments. A discipline specific design project is required. (Not a technical elective for undergraduate metallurgy or ceramic majors) (Co-listed with Aero Eng 3877, Physics 4523, Met Eng 5810, Cer Eng 5810).

**CHEM ENG 5305 Hazardous Materials Management** (LAB 1.0 and LEC 2.0)

Major themes: hazard identification and characterization; safety, health and environmental management; and the protection of safety, health and environment. Students will have an understanding of work place and environmental hazards in order to be able to facilitate their management and control. The course will include an intensive 30 hour hands-on workshop. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5310 Structure And Properties Of Polymers** (LEC 3.0)

A study of the parameters affecting structure and properties of polymers. Syntheses, mechanisms, and kinetic factors are emphasized from the standpoint of structural properties. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5315 Corrosion And Its Prevention** (LEC 3.0)

A study of the theories of corrosion and its application to corrosion and its prevention. Prerequisite: A grade of "C" or better in either Chem Eng 3120 or Cer Eng 3230. (Co-listed with Met Eng 4230).

**CHEM ENG 5320 Introduction to Nanomaterials** (LEC 3.0)

Introduction to the fundamentals of nanomaterials and recent developments on nanomaterials. Topics include physical and chemical properties, synthesis, processing, and applications of nanomaterials. Example nanomaterials include nanoparticles, nanotubes, and nanowires. Prerequisite: Chem Eng 2300, or Met Eng 1210 or Chem 1320.

**CHEM ENG 5330 Alternative Fuels** (LEC 3.0)

Global energy outlook and available resources are discussed. Alternative energy options and their technologies are covered. Associated environmental concerns and technology are assessed. Special emphases are placed on renewable energies, transportation fuels, energy efficiencies, and clean technologies. Prerequisite: Chem Eng 3130 or senior or graduate standing.

**CHEM ENG 5340 Principles Of Environmental Monitoring** (LEC 3.0)

This course introduces the fundamentals of particle technology, including particle characterization, transport, sampling, and processing. In addition, students will learn about the basic design of some industrial particulate systems and environmental and safety issues related to particulate handling. Prerequisites: Chem Eng 3100 and Physics 2135, or graduate standing.

**CHEM ENG 5350 Environmental Chemodynamics** (LEC 3.0)

Interphase transport of chemicals and energy in the environment. Application of the process oriented aspects of chemical engineering and science to situations found in the environment. Prerequisite: Chem Eng 3140 or Chem Eng 3200 or graduate standing.

**CHEM ENG 5360 Pollution Prevention Via Process Engineering** (LEC 3.0)

To arrive at environmentally benign process design, each processing system will be considered as an inter-connection of elementary units. Systematic methods capitalizing on synergistic process integrations will be employed. Linear, nonlinear and integer optimization, mass/heat exchange networks, and reactor and reaction networks will be used. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5370 Intermediate Process Dynamics And Control** (LEC 3.0)

A study of the dynamic properties of engineering operations and the interrelationships which result when these operations are combined into processes. Formulation of equations to describe open-loop and closed-loop systems. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5380 Intermediate Separation Processes** (LEC 3.0)

Fundamentals of separation operations such as extraction and distillation; rates of diffusion in equilibrium stages and continuous contactors; efficiencies; multistage contactors; performance of equipment; phase equilibrium data; multicomponent separation. Prerequisite: Chem Eng 3130 or graduate standing.

## Chemistry

**Emphasis areas at bachelor of science level in biochemistry, polymer and coatings science, and pre-medicine chemistry. Emphasis area at bachelor of arts level in secondary education.**

Chemistry is the study of the elements, the compounds they form and the reactions they undergo.

The program of study encompasses the full range of the subject plus mathematics, physics, and, if desired, biology. Students may also

pursue special interests such as analytical, biological, electrochemical, environmental, inorganic, nuclear, organic, physical or polymer chemistry.

The B.A. offers a general education degree with a chemistry focus. The B.A. degree may be appropriate for students in pre-professional programs (pre-medicine, pre-veterinary, pre-dentistry, pre-pharmacy, chemical sales and marketing).

Chemists tackle a broad range of challenges, from environmental cleanup and pollution prevention to creating the materials that will take humans to Mars. A bachelor's degree in chemistry will provide many career possibilities. It has been called the central science because it occupies a pivotal place in many disciplines. As such it serves as the foundation for many other professions such as medicine, biotechnology, ceramics, chemical engineering, polymers, materials, metallurgy and environmental sciences.

All students are encouraged to participate in research programs during their undergraduate career. Such participation can lead to valuable experience and the possibility of publications, awards and recognition in the chemistry work place. Students may opt to participate in the campus wide "Opportunities for Undergraduate Research Experience" (OURE). Through OURE they can receive academic credit and a stipend for conducting a research project of mutual interest to the student and a faculty member.

Schrenk Hall is home to the department and where most chemistry classes and laboratories are held. The department has a broad range of modern instrumentation and equipment to prepare the student for the future.

## Bachelor of Arts Chemistry

### Freshman Year

First Semester	Credits	Second Semester	Credits
CHEM 1310	4	CHEM 1320	3
CHEM 1319	1	CHEM 1510	2
CHEM 1100	1	HISTORY 1100	3
MATH 1208	5	MATH 1221	5
ENGLISH 1120	3	Humanities Electives	3
	14		16

### Sophomore Year

First Semester	Credits	Second Semester	Credits
CHEM 2210	4	CHEM 2220	4
CHEM 2219	1	CHEM 2229	1
Electives	5	Elective	4
HISTORY 1200	3	ENGLISH 1160	3
Humanities Elective	3	Social Elective	3
	16		15

### Junior Year

First Semester	Credits	Second Semester	Credits
CHEM 2510	4	Chem Electives (see list below)	4
PHYSICS 1111	4	PHYSICS 2111	4
PHYSICS 1119	1	PHYSICS 2119	1
STAT 3113	3	Electives	6
Elective	3		
	15		15

### Senior Year

First Semester	Credits	Second Semester	Credits
CHEM 3410, or 3430, or 3420	3	CHEM 4010	1
CHEM 3419 or 3429	1	Humanities Elective	3
Humanities Elective Literature	3	Social Sciences Elective	3
Social Electives	6	Electives	6
Elective	3		
	16		13

Total Credits: 120

Students must complete a minimum of 120 credit hours for the bachelor of arts in chemistry degree. Students may have to take more than the minimum number of coursework hours to comply with the B.A. requirements due to variations in minor degree and foreign language requirements within an individual's program of study.

Elective credits include a required minor in one of the following areas: English, economics, history, philosophy, psychology, sociology, communications, speech, media, political science, music, mathematics, statistics, foreign language, computer science, biology, or art. See Undergraduate catalog for courses required for specific minor. All chemistry majors are encouraged to do research through CHEM 4099. A total of 9 credits of a modern foreign language must also be taken as part of the electives above.

Chem Elective must be from one or more of the following: CHEM 4210, CHEM 4297, CHEM 4410, CHEM 4510, CHEM 4610, CHEM 4619, CHEM 4620, CHEM 4710, CHEM 4810, CHEM 4819, CHEM 4850. This program of study allows students to design, in conjunction with their chemistry advisor, a program for many disciplines including pre-law, business, pre-dentistry, pre-veterinary medicine, as well as pre-medicine. An example of such a program is shown for pre-medical studies:

BIO SCI 1113	General Biology	3
BIO SCI 1219	General Biology Lab	2
BIO SCI 2213	Cell Biology	3
BIO SCI 2219	Cell Biology Laboratory	1
CHEM 4610	General Biochemistry	3
CHEM 4619	General Biochemistry Laboratory	2

A grade of "C" or better is required for each Chemistry course counted towards the degree.

## Bachelor of Arts Chemistry Secondary Education Emphasis Area

### Freshman Year

First Semester	Credits	Second Semester	Credits
CHEM 1310	4	CHEM 1320	3
CHEM 1319	1	CHEM 1510	2
CHEM 1100	1	POL SCI 1200	3
MATH 1208	5	MATH 1221	5
ENGLISH 1120	3	ENGLISH 1160	3
PSYCH 1101	3		
	17		16

### Sophomore Year

First Semester	Credits	Second Semester	Credits
CHEM 2210	4	CHEM 2220	4



CHEM 2219	1	CHEM 2229	1
PHYSICS 1111	4	PHYSICS 2111	4
PHYSICS 1119	1	PHYSICS 2119	1
EDUC 1140	2	STAT 3113	3
EDUC 1104	2	EDUC 1174	2
BIO SCI 1113	3	PSYCH 3311	3
17		18	

Junior Year

First Semester	Credits	Second Semester	Credits
CHEM 2510	4	CHEM 3410, or 3430, or 3420	3
PHYSICS 1605	3	CHEM 3419 or CHEM 3439	1
PSYCH 2300	3	SP&M S 1185	3
HISTORY 1300 or 1310	3	HISTORY 2530	3
EDUC 1164	2	EDUC 3280	6
Humanities Elective	3	Humanities Elective	3
18		19	

Senior Year

First Semester	Credits	Second Semester	Credits
Chemistry Elective	4	EDUC 4298	1
CHEM 4010	1	EDUC 4299	12
PSYCH 4310	3		
EDUC 2216	3		
EDUC 2251	3		
Humanities Elective	3		
17		13	

Total Credits: 135

Students must complete a minimum of 135 credit hours for the Bachelor of Arts in Chemistry degree with a Secondary Education Emphasis Area. The degree program is intended to culminate in a Certification Recommendation for an initial Missouri teaching certification. Students should also consult the Secondary Teacher Education Program section for Teacher Certification requirements through the Education department.

For this Bachelor of Arts degree program, the minor degree and foreign language requirements of the typical program of study are waived and there are other course substitutions in lieu of education coursework and requirements. A total of nine humanities credit hours are required to be selected from ENGLISH 1221 or ENGLISH 1222 , PHILOS 1105 , ART 1180 , MUSIC 1150 , or THEATRE 1190 .

Four hours of a Chemistry Elective must be selected from one or more of the following: CHEM 4210 , CHEM 4297 , CHEM 4410 , CHEM 4510 , CHEM 4610 , CHEM 4619 , CHEM 4620 , CHEM 4710 , CHEM 4810 , CHEM 4819 , CHEM 4850 , and CHEM 4099 . CHEM 4099 may not count for more than 3 hr credit toward the degree. All chemistry majors are encouraged to do research through CHEM 4099 .

A grade of “C” or better is required for each Chemistry course counted towards the degree.

## Bachelor of Science Chemistry

A minimum of 127 credit hours is required for a Bachelor of Science degree in Chemistry and an average of at least two grade points per

credit hour must be obtained. These requirements for the B.S. degree are in addition to credit received for algebra, trigonometry, and basic ROTC.

The Chemistry science curriculum requires nine semester hours in humanities and must include ENGLISH 1160 or ENGLISH 3560 . A minimum of nine semester hours is required in social sciences, including either HISTORY 1300 , HISTORY 1310 , HISTORY 1200 , or POL SCI 1200 . Specific requirements for the bachelor degree are outlined in the sample program listed below.

Freshman Year

First Semester	Credits	Second Semester	Credits
CHEM 1310	4	CHEM 1320	3
CHEM 1319	1	CHEM 1510	2
CHEM 1100	1	MATH 1215	4
CHEM 1110	1	Electives	6
MATH 1214	4		
ENGLISH 1120	3		
HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3		
17		15	

Sophomore Year

First Semester	Credits	Second Semester	Credits
CHEM 2210	4	CHEM 2220	4
CHEM 2219	1	CHEM 2229	1
MATH 2222	4	CHEM 3410	3
Electives	3	PHYSICS 2135	4
PHYSICS 1135	4	Select one of the following sequences:	3
		COMP SCI 1971 & COMP SCI 1981	
		COMP SCI 1972 & COMP SCI 1982	
		COMP SCI 1570 & COMP SCI 1580	
16		15	

Junior Year

First Semester	Credits	Second Semester	Credits
CHEM 2310	3	CHEM 2319	1
CHEM 2510	4	CHEM 2320	3
CHEM 3430	3	CHEM 3420	3
STAT 3113 or 3115	3	CHEM 3459	2
ENGLISH 1160 or 3560	3	Electives	6
16		15	

Senior Year

First Semester	Credits	Second Semester	Credits
CHEM 3510	4	CHEM 4010 or 4099	1
CHEM 4010 or 4099	1	CHEM 4297	3
CHEM 4610	3	Electives	12
CHEM 4810	3		
Electives	6		
17		16	

Total Credits: 127

Notes:



**Grade Requirements:** A minimum grade of "C" is required for each chemistry course counted towards the degree.

**ROTC:** Basic ROTC may be taken in the freshman and sophomore year, but does not count towards the degree.

**Electives:** There are thirty-three (33) hours of electives, not to include Math courses that are prerequisite to calculus. Twelve (12) hours must be 2xxx, 3xxx, 4xxx (or 5xxx or higher with permission) level in chemistry or another technical area with permission of department. Six (6) elective hours must be completed in the social sciences. Six (6) elective hours are required in the humanities. Three (3) of the humanities hours must be literature.

## Chemistry Biochemistry Emphasis Area

### Freshman Year

First Semester	Credits	Second Semester	Credits
CHEM 1310	4	CHEM 1320	3
CHEM 1319	1	CHEM 1510	2
CHEM 1100	1	MATH 1215	4
CHEM 1110	1	BIO SCI 2213	3
ENGLISH 1120	3	BIO SCI 2219	1
MATH 1214	4	Electives	3
HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3		
	17		16

### Sophomore Year

First Semester	Credits	Second Semester	Credits
CHEM 2210	4	CHEM 2220	4
CHEM 2219	1	CHEM 2229	1
MATH 2222	4	CHEM 3410	3
PHYSICS 1135	4	PHYSICS 2135	4
Electives	3	Select one of the following sequences:	3
		COMP SCI 1971 & COMP SCI 1981	
		COMP SCI 1972 & COMP SCI 1982	
		COMP SCI 1570 & COMP SCI 1580	
	16		15

### Junior Year

First Semester	Credits	Second Semester	Credits
CHEM 2310	3	CHEM 2319	1
CHEM 3430	3	CHEM 2320	3
CHEM 4610	3	CHEM 2510	4
CHEM 4619	2	CHEM 3420	3
STAT 3113 or 3115	3	CHEM 3459	2
ENGLISH 1160 or 3560	3	CHEM 4620	3
	17		16

### Senior Year

First Semester	Credits	Second Semester	Credits
CHEM 3510	4	CHEM 4010 or 4099	1
CHEM 4010 or 4099	1	CHEM 4297	3
CHEM 4810	3	Electives	12

BIO SCI 4323	3
Electives	3
	14
	16

Total Credits: 127

### Notes:

**Grade Requirements:** A minimum grade of "C" is required for each chemistry course counted towards the degree.

**ROTC:** Basic ROTC may be taken in the freshman and sophomore years, but does not count towards the degree.

**Electives:** There are twenty-one (21) hours of electives, not to include Math courses that are prerequisite to calculus. Six (6) elective hours must be completed in the social sciences. Six (6) elective hours are required in the humanities. Three (3) of the humanities hours must be literature.

## Polymer & Coatings Science Emphasis Area

### Freshman Year

First Semester	Credits	Second Semester	Credits
CHEM 1310	4	CHEM 1320	3
CHEM 1319	1	CHEM 1510	2
CHEM 1100	1	MATH 1215	4
CHEM 1110	1	Electives	6
MATH 1214	4		
ENGLISH 1120	3		
HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3		
	17		15

### Sophomore Year

First Semester	Credits	Second Semester	Credits
CHEM 2210	4	CHEM 2220	4
CHEM 2219	1	CHEM 2229	1
MATH 2222	4	CHEM 3410	3
PHYSICS 1135	4	PHYSICS 2135	4
Electives	3	Select one of the following sequences:	3
		COMP SCI 1971 & COMP SCI 1981	
		COMP SCI 1972 & COMP SCI 1982	
		COMP SCI 1570 & COMP SCI 1580	
	16		15

### Junior Year

First Semester	Credits	Second Semester	Credits
CHEM 2510	4	CHEM 3420	3
CHEM 3430	3	CHEM 3459	2
CHEM 4810	3	CHEM 4099	3
STAT 3113 or 3115	3	CHEM 4819	3
ENGLISH 1160 or 3560	3	CHEM 4850	3
	16		14

Senior Year			
First Semester	Credits	Second Semester	Credits
CHEM 2310	3	CHEM 2319	1
CHEM 3510	4	CHEM 2320	3
CHEM 4610	3	CHEM 4297	3
PHYSICS 4523	3	Electives	10
Electives	4		
	17		17
Total Credits: 127			

**Notes:**

**Grade Requirements:** A minimum grade of “C” is required for each chemistry course counted towards the degree.

**ROTC:** Basic ROTC may be taken in the freshman and sophomore years, but does not count towards the degree.

**Undergraduate Research:** The undergraduate research CHEM 4099 must be done in Polymers and Coatings Science.

**Electives:** There are twenty-three (23) hours of electives, not to include Math courses that are prerequisite to calculus. Six (6) elective hours must be completed in the social sciences. Six (6) elective hours are required in the humanities. Three (3) of the humanities hours must be literature.

**Pre-medicine Emphasis Area**

Freshman Year			
First Semester	Credits	Second Semester	Credits
CHEM 1310	4	CHEM 1320	3
CHEM 1319	1	CHEM 1510	2
CHEM 1100	1	MATH 1215	4
CHEM 1110	1	BIO SCI 1113	3
MATH 1214	4	BIO SCI 1219	2
HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3	ENGLISH 1120	3
	14		17

Sophomore Year			
First Semester	Credits	Second Semester	Credits
CHEM 2210	4	CHEM 2220	4
CHEM 2219	1	CHEM 2229	1
MATH 2222	4	CHEM 3410	3
PHYSICS 1135	4	PHYSICS 2135	4
BIO SCI 2213	3	Select one of the following sequences:	3
BIO SCI 2219	1	COMP SCI 1971 & COMP SCI 1981	
		COMP SCI 1972 & COMP SCI 1982	
		COMP SCI 1570 & COMP SCI 1580	
	17		15

Junior Year			
First Semester	Credits	Second Semester	Credits
CHEM 3430	3	CHEM 2510	4
CHEM 4610	3	CHEM 3420	3

CHEM 4619	2	CHEM 4620	3
CHEM 4010 or 4099	1	STAT 3113 or 3115	3
BIO SCI 3333	3	BIO SCI 3343	3
BIO SCI 3339	1	BIO SCI 3349	1
ENGLISH 1160 or 3560	3		
	16		17

Senior Year			
First Semester	Credits	Second Semester	Credits
CHEM 2310	3	CHEM 2319	1
CHEM 3510	4	CHEM 2320	3
CHEM 3459	2	CHEM 4297	3
CHEM 4010 or 4099	1	Electives	8
CHEM 4810	3		
Electives	3		
	16		15
Total Credits: 127			

**Notes:**

**Grade Requirements:** A minimum grade of “C” is required for each chemistry course counted towards the degree.

**ROTC:** Basic ROTC may be taken in the freshman and sophomore years, but does not count towards the degree.

**Electives:** There are eleven (11) hours of electives, not to include Math courses that are prerequisite to calculus. Three (3) elective hours must be completed in the social sciences. Three (3) elective hours are required in the humanities, which must be literature.

**Minor in Chemistry**

A minor in chemistry requires a minimum of 19 hours of chemistry course work selected in conjunction with a chemistry faculty advisor. The required courses are CHEM 1100 , CHEM 1310 , CHEM 1319 , CHEM 1320 , CHEM 2210 and either CHEM 2219 or CHEM 2289 . Five additional hours of chemistry are to be selected from CHEM 1510 or other Chem 2000, 3000, and 4000-level courses. A minimum grade of "C" is required for each course counted toward the minor.

**Cynthia Pearl Bolon**, Lecturer  
PHD University of Missouri-Rolla

**Terry Lynn Bone**, Lecturer  
PHD University of Missouri-Rolla

**Amitava Choudhury**, Assistant Professor  
PHD Indian Institute of Science

**Richard Dawes**, Assistant Professor  
PHD University of Manitoba

**Nuran Ercal**, Professor  
PHD Hacettepe University, Turkey

**Gary Grubbs**, Assistant Professor  
PHD University of North Texas

**Shubhender Kapila**, Professor  
PHD Dalhousie University, Halifax

**Nicholas Leventis**, Curators Professor  
PHD Michigan State University

**Gary John Long**, Professor  
PHD Syracuse University

**Yinfa Ma**, Curator Teaching Professor  
PHD Iowa State University

**Paul Ki Souk Nam**, Associate Professor  
PHD University of Missouri-Columbia

**Manashi Nath**, Assistant Professor  
PHD Indian Institute of Science

**V Prakash Reddy**, Associate Professor  
PHD Case Western Reserve University

**Emmalou Theresa Satterfield**, Assistant Teaching Professor  
MASTER Missouri S&T

**Thomas Schuman**, Associate Professor  
PHD University of Alabama-Huntsville

**Honglan Shi**, Associate Research Professor  
PHD Missouri S&T

**Chariklia Sotiriou-Leventis**, Professor  
PHD Michigan State University

**Pericles Stavropoulos**, Associate Professor  
PHD Imperial College, London, UK

**Jay A Switzer**, Professor  
PHD Wayne State University

**Michael R Van De Mark**, Associate Professor  
PHD Texas A&M University

**Risheng Wang**, Assistant Professor  
PHD New York University

**Philip D Whitefield**, Professor  
PHD University of London (UK)

**Jeffrey G. Winiarz**, Associate Professor  
PHD SUNY at Buffalo

**Klaus Hubert Woelk**, Associate Professor  
PHD University of Bonn-Germany

**CHEM 1000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department.  
Consent of instructor required.

**CHEM 1001 Special Topics** (IND 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM 1100 Introduction To Laboratory Safety & Hazardous Materials** (LEC 1.0)  
A systematic study of safe laboratory operations and pertinent regulations of state and federal agencies.

**CHEM 1110 Introduction To Chemistry** (LEC 1.0)  
Introduction to chemistry, its intellectual and professional opportunities. Students will be acquainted with various areas of chemistry and with departmental and campus facilities useful to their future studies. Required of all freshman chemistry majors; encouraged for undergraduate transfer chemistry majors.

**CHEM 1111 Invitational Seminar** (LEC 1.0)  
'This invitational seminar will introduce the student to research in chemistry. A series of seminars will be presented by faculty and outside speakers on current topics in chemical research. Prerequisite: Chem 1310 or Chem 1351.

**CHEM 1301 General Chemistry For Non-Science Majors** (LEC 3.0)  
A one semester introduction to chemistry designed to acquaint the student with the philosophy of the chemist's approach to problem solving and the contribution of chemistry to society. Prerequisite: Entrance requirements.

**CHEM 1310 General Chemistry I** (RSD 2.0 and LEC 2.0)  
A comprehensive study of general chemistry concepts with focus on the atomic and molecular nature of matter. Fundamental scientific principles will be applied to solve chemistry problems and describe macroscopic physical properties. Prerequisite: Entrance requirements.

**CHEM 1319 General Chemistry Laboratory** (LAB 1.0)  
The laboratory work accompanying general chemistry consists of experiments designed to supplement lectures in Chem 1310. Prerequisite: Preceded or accompanied by both Chem 1310 and Chem 1100.

**CHEM 1320 General Chemistry II** (LEC 3.0)  
In-depth analysis of chemical reactions with an introduction to thermodynamics and kinetics including applications to electrochemistry and nuclear chemistry. Prerequisites: Chem 1310 with a grade of "C" or better and Chem 1319.

**CHEM 1351 Accelerated General Chemistry** (LEC 3.0 and RSD 1.0 and LAB 1.0)  
An accelerated version of Chem 1310, Chem 1319, and Chem 1320. Four lectures and three laboratory hours per week. Students who do not meet these entrance requirements must take Chem 1310, 1319, & 1320. Prerequisite: Preceded or accompanied by Chem 1100 or an equivalent training program approved by S&T. A minimum score of 60 for the sum of the MMPT and the ACT N. SCI. test scores with neither score below 27.

**CHEM 1510 Qualitative Analysis** (LAB 2.0)  
This course is to accompany the study of the metals in general chemistry and is devoted to the qualitative separation and detection of the metals. Prerequisite: Preceded or accompanied by both Chem 1320 and Chem 1100.

**CHEM 1550 Elementary Quantitative Chemical Analysis** (LEC 2.0)  
A treatise of the fundamental principles of analytical chemistry and their application in analytical methods. Prerequisite: Preceded or accompanied by Chem 1320 or to be accompanied by Chem 1559.

**CHEM 1559 Elementary Quantitative Chemical Analysis** (LAB 2.0)  
The application of the principles of analytical chemistry in gravimetric and volumetric determinations. Prerequisite: To be accompanied by Chem 1550 and preceded or accompanied by Chem 1100.

**CHEM 2000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CHEM 2001 Special Topics** (RSD 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM 2002 Cooperative Work Training** (IND 1.0-3.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental advisor. Grade received on quality of reports submitted and work supervisor's evaluation.

**CHEM 2010 Seminar** (IND 0.0-6.0)

Discussion of current topics.

**CHEM 2100 Master Student** (LEC 1.0)

Master Student is an orientation course for new and transfer students that addresses transition needs.

**CHEM 2210 Organic Chemistry I** (LEC 4.0)

This course consists of four parts: 1) Structure, bonding, and nomenclature; 2) hydrocarbons (alkanes, alkenes, and alkynes), conjugated systems, ultraviolet and visible spectroscopy, stereochemistry, resonance, and molecular orbital theory; 3) substitution and elimination reactions, and 4) identification of organic compounds via infrared and NMR spectroscopy. Prerequisites: Chem 1310, 1319, 1320; or Chem 1351.

**CHEM 2219 Organic Chemistry I Lab** (LAB 1.0)

Laboratory involves purification techniques, simple and multistep synthesis and spectroscopic identification of organic functional groups. Prerequisites: Preceded or accompanied by Chem 2210 and Chem 1100.

**CHEM 2220 Organic Chemistry II** (LEC 4.0)

This course consists of three parts. The first part will cover aromaticity and reactions of aromatic compounds, the second part will cover carbonyl compounds, amines and their reactions, and the third part will cover bioorganic compounds that include carbohydrates, aminoacids, peptides, proteins, lipids, nucleosides, nucleotides, and nucleic acids. Prerequisites: Grade of "C" or better in Chem 2210.

**CHEM 2229 Organic Chemistry II Lab** (LAB 1.0)

Continuation of Chem 2219. Prerequisites: Chem 2219 or Chem 2289, preceded or accompanied by both Chem 2220 and Chem 1100.

**CHEM 2289 Organic Chemistry Lab** (LAB 1.0)

The use of organic chemical laboratory procedures. For chemical engineering majors only. Prerequisites: Preceded or accompanied by both Chem 2210 and Chem 1100.

**CHEM 2310 Inorganic Chemistry I** (LEC 3.0)

A study of modern concepts of atomic structure, chemical bonding, thermodynamics and kinetics as related to the periodic relationship of the elements. Reference to topics of current interests as applied to the above areas.

**CHEM 2319 Inorganic Chemistry Laboratory** (LAB 1.0)

Synthesis and characterization of inorganic chemicals, high and low temperature syntheses, inert atmosphere and vacuum manipulations, electrochemistry, magnetochemistry, spectroscopy (NMR, IR, UV/VIS), superconductivity. Prerequisites: Preceded or accompanied by Chem 2310 and Chem 1100.

**CHEM 2320 Inorganic Chemistry II** (LEC 3.0)

A study of coordination chemistry, organometallics, bioinorganic and solid-state inorganic chemistry. Reference to topics of current interest as applied to the above areas. Prerequisites: CHEM 2310.

**CHEM 2510 Analytical Chemistry I** (LEC 3.0 and LAB 1.0)

A study of analytical chemistry including an introduction to experimental error, statistics, principles of gravimetric and combustion analysis, chemical equilibrium, acid - base titrations, and electro-analytical determinations. Prerequisites: Chem 1320 and preceded or accompanied by Chem 1100.

**CHEM 3100 Lab Safety and Environmental Safety** (LEC 1.0)

A systematic study of safe laboratory operations and pertinent regulations of state and federal agencies. This course is primarily intended for secondary education science teachers. Credit will not be given for both Chemistry 1100 and Chemistry 2100. Prerequisite: Entrance requirements for the MST program.

**CHEM 3319 MST General Chemistry Lab** (LAB 1.0)

The laboratory work accompanying the MST chemistry courses consists of experiments designed to supplement the lecture work in chemistry. This course is primarily intended for secondary education science teachers. Credit will not be given for both Chemistry 1319 and Chemistry 2319. Prerequisite: Entrance requirements for the MST program and preceded or accompanied by either Chem 1100 or Chem 2100.

**CHEM 3410 Chemical Thermodynamics I** (LEC 3.0)

A study of the laws of thermodynamics and their applications to the states of matter, solutions, and equilibria. Prerequisites: Physics 1111 or Physics 1135; accompanied or preceded by either Math 1215 or Math 1221.

**CHEM 3419 Physical Chemistry Laboratory I** (LAB 1.0)

Some typical operations of experimental physical chemistry. Prerequisites: Preceded or accompanied by both Chem 3410 and Chem 1100.

**CHEM 3420 Introduction To Quantum Chemistry** (LEC 3.0)

A study of molecular structures and spectroscopy, statistical thermodynamics, kinetic theory, chemical kinetics, crystals, and liquids. Prerequisites: Physics 2135 or Physics 2111; preceded or accompanied by Math 2222.

**CHEM 3429 Physical Chemistry Laboratory II** (LAB 1.0)

A continuation of Chem 3419. Prerequisites: Preceded or accompanied by both Chem 3420 and Chem 1100.

**CHEM 3430 Chemical Kinetics I** (LEC 3.0)

A study of kinetic theory, chemical kinetics, electromotive force and ionic equilibria. Prerequisite: Chem 3410.

**CHEM 3459 Accelerated Physical Chemistry Laboratory** (LAB 2.0)

A combined and accelerated version of Chem 3419 and Chem 3429 consisting of exploratory physical chemistry experiments. Prerequisites: Preceded or accompanied by both Chem 3420 and Chem 1100.

**CHEM 3510 Analytical Chemistry II** (LEC 3.0 and LAB 1.0)

A study of analytical chemistry including separation techniques for chemical and biochemical analysis, atomic - molecular mass spectrometry, atomic - molecular spectroscopy, surface analysis with electron spectroscopy, X-ray and mass spectrometry. Prerequisites: Chem 1100, Chem 2510, Chem 2220 and Chem 3410.

**CHEM 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Prerequisite: Preceded or accompanied by Chem 1100 or an equivalent training program approved by S&T. Consent of instructor required.

**CHEM 4001 Special Topics** (LEC 1.0 and LAB 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM 4010 Undergraduate Seminar** (RSD 1.0)

Written and oral presentations of current topics in chemistry. This course may serve as part of the capstone requirement for chemistry majors.

**CHEM 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Does not lead to the preparation of a thesis. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Preparation of a written, detailed report is required of the student. Prerequisite: Must meet departmental requirements for instruction in laboratory safety. Consent of instructor required.

**CHEM 4210 Intermediate Organic Chemistry I** (LEC 3.0)

An advanced course designed to give the student a mastery of the fundamentals of organic chemical reactions and theory. Prerequisite: Chem 2220.

**CHEM 4220 Intermediate Organic Chemistry II** (LEC 3.0)

A systematic study of organic reactions, their mechanisms and synthetic applications. Prerequisite: Chem 2220.

**CHEM 4297 Organic Synthesis And Spectroscopic Analysis** (LAB 2.0 and LEC 1.0)

Advanced methods for the multistep synthesis and characterization of organic compounds. Modern instrumental methods of identification of organic compounds. Prerequisites: Chem 1100, Chem 2220, Chem 2229.

**CHEM 4310 Selected Topics In Inorganic Chemistry** (LEC 3.0)

A study of inorganic chemistry with emphasis on physical methods. General subjects covered include: molecular structure, bonding, complexes, spectroscopy, and reaction rates.

**CHEM 4410 Chemical Thermodynamics II** (LEC 3.0)

A study of the laws of thermodynamics with application to chemical systems. Emphasis is placed on partial molal functions. Prerequisites: Chem 3420.

**CHEM 4420 Chemical Kinetics II** (LEC 3.0)

Advanced treatments of topics in physical chemistry including statistical mechanics and kinetics. Prerequisites: Chem 3420.

**CHEM 4510 Instrumental Methods Of Chemical Analysis** (LEC 3.0 and LAB 1.0)

Principles and analytical applications of molecular spectroscopy, chromatographic separations, mass spectrometry, and radiochemistry. A brief overview of instrument electronics, signal generation and processing, and automated analysis is also provided. Prerequisites: Chem 3510 and Chem 3430.

**CHEM 4610 General Biochemistry** (LEC 3.0)

A resume of the important aspects of quantitative and physical chemistry in biochemical processes. General subjects covered include: proteins, nucleic acids, enzymes, carbohydrates and lipids. Prerequisite: Chem 2220.

**CHEM 4619 General Biochemistry Laboratory** (LAB 2.0)

Experiments are integrated with the lectures and cover the chemical and physical properties of proteins, enzymes, nucleic acids, carbohydrates and lipids. Prerequisites: Preceded or accompanied by both Chem 4610 and Chem 1100.

**CHEM 4620 Metabolism** (LEC 3.0)

A continuation of Chem 4610. Catabolism and anabolism of carbohydrates, lipids, proteins, and nucleic acids. Photosynthesis, oxidative phosphorylation and membranes. Prerequisite: Chem 4610.

**CHEM 4630 Introduction to Bio-Nanotechnology** (LEC 3.0)

This course will educate on the interdisciplinary areas of bio-nanotechnology. Goal is for students to understand how biomacromolecules such as nucleic acids, proteins, and lipids self-assemble to form the functional units of an intact cell. Emphasis will be on current application in DNA/protein nanotechnology, drug delivery and environmental biosensors. Prerequisite: At least junior standing.

**CHEM 4710 Principles Of Environmental Monitoring** (LEC 3.0)

This course provides an overview of environmental monitoring methodologies. Discussion covers thermodynamic and kinetic processes that affect chemical transport and fate in the environment. Federal environmental regulations and remediation technologies are also covered with specific examples. Prerequisites: Chem 2210; Physics 1111 or Physics 1135.

**CHEM 4810 Chemistry And Inherent Properties Of Polymers** (LEC 3.0)

A basic study of the organic chemistry of natural and synthetic high polymers, their inherent properties and their uses in plastic, fiber, rubber, resin, food, paper and soap industries. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with MS&E 4810).

**CHEM 4819 Polymer Science Laboratory** (LEC 1.0 and LAB 2.0)

Lectures and laboratory experiments dealing with polymerization reactions, solution properties and bulk or solid properties will be presented. Each student will prepare polymers and carry out all characterization experiments on actual samples. Prerequisite: Chem 4810 or MS&E 4810 and preceded or accompanied by Chem 1100. (Co-listed with MS&E 4819).

**CHEM 4850 Fundamentals Of Protective Coating I** (LEC 3.0)

Study of the basic principles of protective coatings with particular reference to the paint and varnish industry. Classifications, manufacture, properties and uses of protective coatings. Prerequisite: Chem 1320. (Co-listed with MS&E 4850).

**CHEM 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Prerequisite: Preceded or accompanied by Chem 1100 or an equivalent training program approved by S&T. Consent of instructor required.

**CHEM 5001 Special Topics** (LEC 1.0 and LAB 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM 5099 Master Research** (IND 0.0-6.0)

Master level research with the intent to lead to the preparation of a master degree thesis. Not more than six (6) credit hours allowed for graduate credit. Subject and credit to be arranged with the instructor. Preparation of a written, detailed report culminating in a thesis is required of the student. Prerequisite: Must meet departmental training requirements for laboratory safety. Consent of instructor required.

**CHEM 5100 Laboratory Safety & Hazardous Materials** (LEC 1.0)

A systematic study of safe laboratory operations and pertinent regulations of state and federal agencies. Prerequisites: Graduate standing.

**CHEM 5210 Fundamentals of Organic Reactions** (LEC 3.0)

An advanced course designed to give the student a mastery of the fundamentals of organic chemical reactions and theory. Graduate students are required to demonstrate a higher level of learning on assessments. Prerequisite: Chem 2220.

**CHEM 5220 Synthetic Organic Chemistry** (LEC 3.0)

A systematic study of organic reactions, their mechanisms and synthetic applications. Graduate students are expected to demonstrate a higher level of proficiency during assessments. Prerequisite: Chem 2220.



**CHEM 5250 Industrial Chemical Processes** (LEC 3.0)

Detailed study of various industrial chemical manufacturing processes including underlying chemistry, reaction pathways and separation processes. Prerequisite: Chem Eng 3130 or Chem 2210, or graduate standing. (Co-listed with Chem Eng 5096).

**CHEM 5310 Introduction to Inorganic Chemistry** (LEC 3.0)

A study of inorganic chemistry with emphasis on physical methods. General subjects covered include: molecular structure, bonding, complexes, spectroscopy, and reaction rates. Graduate students are required to demonstrate a higher level of proficiency during assessments.

**CHEM 5410 Advanced Chemical Thermodynamics** (LEC 3.0)

A study of the laws of thermodynamics with application to chemical systems. Emphasis is placed on partial molal functions. Credit will not be given for both Chem 5410 and Chem 4410. Prerequisites: Chem 3420.

**CHEM 5420 Elemental Quantum Chemistry** (LEC 3.0)

A study of molecular structures and spectroscopy, statistical thermodynamics, kinetic theory, chemical kinetics, crystals, and liquids. Prerequisites: Math 2222; Physics 2135 or Physics 2111.

**CHEM 5430 Advanced Chemical Kinetics** (LEC 3.0)

Introductory graduate treatment of special topics of physical chemistry including statistical mechanics and kinetics. Prerequisites: Chem 3430.

**CHEM 5510 Introduction to Chemical Analysis** (LEC 3.0 and LAB 1.0)

Principles and analytical applications of molecular spectroscopy, chromatographic separations, mass spectrometry, and radiochemistry. A brief overview of instrument electronics, signal generation and processing, and automated analysis is also provided. Graduate students are expected to achieve a higher level of proficiency on application and assessments compared to Chem 4510 students. Prerequisites: Chem 1100, Chem 2510, Chem 2220, Chem 3430.

**CHEM 5610 Biochemistry** (LEC 3.0)

A resume of the important aspects of quantitative and physical chemistry in biochemical processes. General subjects covered include: proteins, nucleic acids, enzymes, carbohydrates and lipids. Credit may not be given for both Chem 5610 and Chem 4610. Prerequisite: Chem 2220.

**CHEM 5619 Biochemistry Laboratory** (LAB 2.0)

Experiments are integrated with the lectures and cover the chemical and physical properties of proteins, enzymes, nucleic acids, carbohydrates and lipids. Credit may not be given for both Chem 5619 and Chem 4619. Prerequisites: Preceded or accompanied by Chem 5610 and Chem 1100 or an equivalent training program approved by S&T.

**CHEM 5620 Biochemical Metabolism** (LEC 3.0)

A continuation of Chem 5610. Catabolism and anabolism of carbohydrates, lipids, proteins, and nucleic acids. Photosynthesis, oxidative phosphorylation and membranes. Credit may not be given for both Chem 5620 and Chem 4620. Prerequisite: Chem 4610 or 5610.

**CHEM 5630 Biochemical Nanotechnology** (LEC 3.0)

This course will educate on the interdisciplinary areas of bio-nanotechnology. Student will investigate the potential of nanoscience in advanced applications including DNA/protein nanotechnology, drug delivery, environmental biosensor and emerging biotechnology industries. Credit may not be given for both Chem 5630 and Chem 4630. Prerequisite: At least junior standing.

**CHEM 5710 Environmental Monitoring** (LEC 3.0)

This course provides an overview of environmental monitoring methodologies. Discussion covers thermodynamic and kinetic processes that affect chemical transport and fate in the environment. Federal environmental regulations and remediation technologies are also covered with specific examples. Credit may not be given for both Chem 5710 and Chem 4710. Prerequisites: Chem 2210, Physics 2111.

**CHEM 5810 Introduction to Polymeric Materials** (LEC 3.0)

A basic study of the organic chemistry of natural and synthetic high polymers, their inherent properties and their uses in plastic, fiber, rubber, resin, food, paper and soap industries. Credit may not be given for both Chem 5810 and Chem 4810. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with MS&E 5810).

**CHEM 5819 Polymer Synthesis and Characterization Lab** (LAB 2.0 and LEC 1.0)

Laboratory experiments dealing with polymerization syntheses and solution, bulk and solid properties will be presented. Each student will prepare polymers and carry out all characterization experiments on actual samples. Credit may not be given for both Chem 5819 and Chem 4819. Prerequisite: Chem 4810 or MS&E 4810 or Chem 5810 or MS&E 5810 or Chem Eng 5310, preceded or accompanied by Chem 1100 or Chem 5100 or an equivalent training program approved by S&T. (Co-listed with MS&E 5819).

**CHEM 5850 Introduction to Coating Chemistry** (LEC 3.0)

Study of the basic principles of protective coatings with particular reference to the paint and varnish industry. Classifications, manufacture, properties and uses of protective coatings. Credit may not be given for both Chem 5850 and Chem 4850. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with MS&E 5850).

## Civil Engineering

**Emphasis areas at all levels in construction engineering, environmental engineering, water resources engineering, geotechnical engineering, structural engineering, materials engineering and transportation engineering.**

Civil engineers plan, design, and supervise construction of many essential facilities and structures such as bridges, dams, interstate highways, and buildings. Service to the community, its development and improvement are fundamental aspects of a civil engineering career. Civil engineers are problem solvers applying the latest in high-tech equipment and sophisticated procedures to address challenges concerning our environment and infrastructure.

Included in the study of civil engineering are courses in environmental engineering that are directly related to the solution of hazardous waste and pollution problems, to providing potable and economical water supply systems, and to maintaining a safe environment. Water resources engineering is related to hydraulic and hydrologic engineering, flood control, rainfall, and runoff prediction and the transport in flows. Studies in geotechnical engineering address the bearing capacities of soils, settlement of foundations, and the design of both deep and shallow foundations. Courses in structural analysis and design are directed toward providing reliable and economical structures such as bridges, buildings, port facilities, and intricate lock and dam facilities. The principles involved in this sequence of courses are also applicable to the design of automobiles, aircraft, spacecraft, and future space structures. Transportation engineering involves the movement of people and cargo from place to place, the design of airports and highways, and traffic studies to maintain efficient flows. Courses in construction

engineering include studies in construction techniques, cost estimating, quality control/quality assurance, and contract administration. Materials engineering involves the production, quality control, use, and property analysis of construction materials such as asphalt, concrete, aggregate, wood, masonry, and steel.

Civil engineering is a broad field of endeavor. Because of this breadth, courses are required in each of the above areas. Although you, as a civil engineer, may specialize within a given area, by the very nature of the profession you will be required to interact with specialists in the other areas. You also may find that you will work with engineers in other disciplines such as mechanical, electrical, or geological engineering in the planning, design, and construction of complex facilities.

Civil engineers also must be effective in communicating with the public. You may be expected to work with property owners, concerned citizens, city officials, attorneys, and even medical doctors for concerns related to public health measures.

The results of your work as a civil engineer will be seen everywhere. Projects in which you will become involved must be economical, provide an adequate factor of safety for the particular use, and provide a reasonable life expectancy. To do this adequately and within a reasonable time frame, you will find that, with the exception of your engineering training, the computer is one of the most important and valuable tools you will use to produce a proper design or to complete a specific project. You may expect that your courses taken in civil engineering will require the use of computer hardware and software related to the different areas of study.

## Mission Statement

The civil engineering program will prepare students for professional performance in the global society and for life-long learning and continued professional development in the civil engineering profession through a comprehensive, forward-looking and broad-based curriculum in civil engineering emphasizing fundamentals and practical applications, oral and written communication skills, computer applications skills, and professional practice issues and ethics.

## Civil Engineering Program Educational Objectives

1. Graduates of the civil engineering program are able to apply their scientific and technical knowledge base as they progress along their career in civil engineering as evidenced by:
  - A. having the preparedness and eligibility to pass the PE examination
  - B. having led a small design team
  - C. being able to independently assess others' work
  - D. being able to integrate their own work with the work of others
  - E. keeping up with technological advances
2. Graduates of the civil engineering program are able to identify, formulate, develop, and execute practical, innovative, high quality, and cost efficient solutions for civil engineering problems as evidenced by:
  - A. having led or managed a key project task from start to finish
  - B. having developed a cost-effective creative design or construction ideas that was ultimately adopted

- C. having completed the design and/or the construction of a significant project that was well put-together
3. Graduates of the civil engineering program are ethical professionals who are able to function as part of a professional enterprise while protecting human health and welfare and the environment in a global society as evidenced by:
    - A. an understanding of and the ability to apply design codes
    - B. a recognition and an understanding of the political and regulatory environments
    - C. having maintained active membership in professional societies
    - D. an awareness of current trends and future opportunities in local, regional, and global issues
    - E. an active involvement in organizations that promote global societal well-being
  4. Graduates of the civil engineering program are professionals whose growth through continuing education, professional development, and professional licensure has positioned them to have a positive impact on regional, national, and global professional communities as evidenced by:
    - A. a pursuit of advanced education
    - B. keeping up with continuing education requirements
    - C. having held positions of increasing responsibility in professional societies or their committees, etc.
    - D. having exhibited increasing responsibility in community involvement through participation in civic /social activities and organizations
    - E. positive experiences involving networking with clients
  5. Graduates of the civil engineering program are professionals who develop individual and team skills to maximize the benefits of their engineering education by applying it in actual situations as evidenced by:
    - A. an ability to communicate clearly across disciplines as well as across company divisions
    - B. assignment to a leadership or management role
    - C. an ability to resolve conflicts in a group or team setting
    - D. an ability to apply their knowledge in practical situations
    - E. involvement with company marketing and sales operations

## Program Outcomes

Consistent with the program educational objectives listed above, the Missouri S&T civil engineering program graduate will have:

1. an ability to apply knowledge of mathematics, science, and engineering
2. an ability to design and conduct experiments, as well as to analyze and interpret data
3. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. an ability to function on multi-disciplinary teams
5. an ability to identify, formulate, and solve engineering problems
6. an understanding of professional and ethical responsibility
7. an ability to communicate effectively

8. an understanding of the impact of engineering solutions in a global, economic, environmental, and social context
9. a recognition of the need for, and an ability to engage in life-long learning
10. a knowledge of contemporary issues
11. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
12. be able to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of science
13. be able to design a system, component, or process in more than one civil engineering context
14. be able to explain basic concepts in management, business, public policy, and leadership

## Civil Engineering Bachelor of Science

Entering freshmen desiring to study Civil Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Civil Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major.

For the Bachelor of Science degree in Civil Engineering a minimum of 129 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. An average of at least two grade points per credit hour must also be attained in all courses taken in Civil Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1. All students are required to take one American history course, one economics course, one humanities course, and ENGLISH 1120 . The history course is to be selected from HISTORY 1200 , HISTORY 1300 , HISTORY 1310 , or POL SCI 1200 . The economics course may be either ECON 1100 or ECON 1200 . The humanities course must be selected from the approved lists for art, English, foreign languages, music, philosophy, speech and media studies, or theater.
2. Depth requirement. Three credit hours must be taken in humanities or social sciences at the 2000-level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 1180 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 4000-level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.
3. The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to ENGLISH 1120 .
4. Any specific departmental requirements in the general studies area must be satisfied.

5. Special topics and special problems and honors seminars are allowed only by petition to and approval by the student's department chair.

The Civil Engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

### Freshman Year

First Semester	Credits	Second Semester	Credits
FR ENG 1100 <sup>2</sup>	1	MECH ENG 1720	3
CHEM 1310 & CHEM 1319	5	MATH 1215	4
MATH 1214	4	PHYSICS 1135	4
ENGLISH 1120	3	General Ed Elective <sup>1</sup>	3
General Ed Elective <sup>1</sup>	3	General Ed Elective <sup>1</sup>	3
	16		17

### Sophomore Year

First Semester	Credits	Second Semester	Credits
CIV ENG 2401 <sup>2</sup>	3	MECH ENG 2350	2
CIV ENG 2003 <sup>2</sup>	3	STAT 3113	3
CIV ENG 2200 <sup>2</sup>	3	GEO ENG 1150	3
MATH 2222	4	CIV ENG 2210 <sup>2</sup>	3
PHYSICS 2135	4	CIV ENG 2211 <sup>2</sup>	1
		MATH 3304	3
	17		15

### Junior Year

First Semester	Credits	Second Semester	Credits
ENG MGT 1210 <sup>2</sup>	2	CIV ENG 3116 <sup>2</sup>	3
CIV ENG 3201 <sup>2</sup>	3	CIV ENG 3842 <sup>2</sup>	3
CIV ENG 3715 <sup>2</sup>	3	CIV ENG 3500 <sup>2</sup>	3
CIV ENG 3330 <sup>2</sup>	3	CIV ENG 3334 <sup>2</sup>	4
CIV ENG 2601 <sup>2</sup>	3	CIV ENG 3220 <sup>2</sup>	3
General Ed Elective <sup>1</sup>	3		
	17		16

### Senior Year

First Semester	Credits	Second Semester	Credits
CIV ENG 4010 <sup>2</sup>	1	CIV ENG 4097 <sup>2</sup>	3
(2) CIV ENG Depth Electives <sup>3,4</sup>	6	CIV ENG Tech Elective <sup>3,5</sup>	3
CIV ENG 4448 <sup>2</sup>	3	CIV ENG Depth Elective <sup>3,4</sup>	3
CIV ENG 3210 <sup>2</sup>	3	General Ed Elective <sup>1</sup>	3
General Ed Elective <sup>1</sup>	3	CIV ENG Tech Elective <sup>3,5</sup>	3
	16		15

Total Credits: 129

- <sup>1</sup> All general education electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog. One general education elective must be from ENGLISH 1160, ENGLISH 3560, or SP&M S 1185.
- <sup>2</sup> A grade of 'C' or better required to satisfy graduation requirements.
- <sup>3</sup> A grade of 'C' or better may be required in CE technical and depth elective prerequisite courses. Refer to the Missouri S&T undergraduate catalog for this prerequisite information.
- <sup>4</sup> Choose depth electives using Guidelines for Depth and Technical Electives.
- <sup>5</sup> Choose technical electives using Guidelines for Depth and Technical Electives.

**Note:** All Civil Engineering students must take the Fundamentals of Engineering examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree; however, it is the first step toward becoming a registered professional engineer. This requirement is part of the Missouri S&T assessment process as described in Assessment Requirements found elsewhere in this catalog. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.

## Guidelines for Depth and Technical Electives

Please consult the Department's Advising Center or your academic advisor for guidelines regarding the selection of depth and technical electives. A maximum total of 6 credit hours of independent study (CIV ENG 5000 or CIV ENG 4099 ) can be used as depth or technical electives in the B.S. Civil Engineering curriculum.

## Course Listings by Area

### Construction Engineering

CIV ENG 5442	Construction Planning and Scheduling Strategies	3
CIV ENG 5445	Construction Methods	3
CIV ENG 5446	Management Of Construction Costs	3
CIV ENG 5448	Green Engineering: Analysis of Constructed Facilities	3
CIV ENG 5449	Engineering and Construction Contract Specifications	3

### Materials Engineering

CIV ENG 5112	Bituminous Materials	3
CIV ENG 5113	Composition And Properties Of Concrete	3
CIV ENG 5117	Asphalt Pavement Design	3
CIV ENG 5156	Concrete Pavement Design	3

### Environmental Engineering

CIV ENG 3615	Water And Wastewater Engineering	3
CIV ENG 5605	Environmental Systems Modeling	3
CIV ENG 5619	Environmental Engineering Design	3
CIV ENG 5630	Remediation of Contaminated Groundwater and Soil	3
CIV ENG 5640	Environmental Law And Regulations	3
CIV ENG 5642	Sustainability, Population, Energy, Water, and Materials	3
CIV ENG 5650	Public Health Engineering	3
CIV ENG 5660	Introduction To Air Pollution	3
CIV ENG 5662	Air Pollution Control Methods	3
CIV ENG 5665	Indoor Air Pollution	3
CIV ENG 5670	Solid Waste Management	3

### Geotechnical Engineering

CIV ENG 4729	Foundation Engineering	3
--------------	------------------------	---

CIV ENG 5715	Intermediate Soil Mechanics	3
CIV ENG 5716	Geotechnical Earthquake Engineering	3
CIV ENG 5729	Foundation Engineering II	3
CIV ENG 5744	Geosynthetics in Engineering	3
CIV ENG 5750	Transportation Applications of Geophysics	3

### Water Resources Engineering

CIV ENG 5330	Unsteady Flow Hydraulics	3
CIV ENG 5331	Hydraulics Of Open Channels	3
CIV ENG 5333	Intermediate Hydraulic Engineering	3
CIV ENG 5335	Water Infrastructure Engineering	3
CIV ENG 5337	River Mechanics And Sediment Transport	3
CIV ENG 5338	Hydrologic Engineering	3

### Structural Engineering

CIV ENG 5001	Special Topics (Structural Masonry Design)	0-6
CIV ENG 5118	Smart Materials And Sensors	3
CIV ENG 5203	Applied Mechanics In Structural Engineering	3
CIV ENG 5208	Structural Dynamics	3
CIV ENG 5260	Analysis And Design Of Wood Structures	3
CIV ENG 5205	Structural Analysis II	3
CIV ENG 5206	Low-Rise Building Analysis and Design	3
CIV ENG 5207	Computer Methods of Structural Analysis	3
CIV ENG 5210	Advanced Steel Structures Design	3
CIV ENG 5220	Advanced Concrete Structures Design	3
CIV ENG 5222	Prestressed Concrete Design	3
CIV ENG 5231	Infrastructure Strengthening with Composites	3

### Transportation Engineering

CIV ENG 5250	Air Transportation	3
CIV ENG 5510	Geometric Design Of Highways	3
CIV ENG 5513	Traffic Engineering	3

**Daniel R Abbott**, Lecturer  
MS University of Missouri-Rolla

**Stuart W Baur**, Associate Professor<sup>4</sup>  
PHD University of Missouri-Rolla

**Jerry R Bayless**, Professor Emeritus<sup>1</sup>  
MS Missouri School of Mines

**Joel G Burken**, Curators Distinguished Professor<sup>1,5</sup>  
PHD University of Iowa

**Genda Chen**, Professor<sup>1</sup>  
PHD State University of New York-Buffalo

**Wen Deng**, Assistant Professor  
PHD Iowa State University

**Mohamed Abdelmonem ElGawady**, Associate Professor  
DE Swiss Federal Institute of Technology

**Dimitri Feys**, Assistant Professor  
PHD Ghent University, Belgium

**Mark W Fitch**, Associate Professor  
PHD University of Texas-Austin

**William Gillis**, Assistant Teaching Professor<sup>1,6</sup>  
PHD Missouri University of Science and Technology



**Kamal Khayat**, Professor<sup>1</sup>  
DE University of California-Berkeley

**Roger Allen LaBoube**, Professor Emeritus<sup>1</sup>  
PHD University of Missouri-Rolla

**Nicholas Ali Libre**, Assistant Teaching Professor  
PHD University of Tehran

**Hongyan Ma**, Assistant Professor  
PHD Hong Kong University of Science and Technology

**Cesar Mendoza**, Associate Professor  
PHD Colorado State University

**Glenn Morrison**, Professor<sup>1</sup>  
PHD University of California-Berkeley

**John J Myers**, Professor<sup>1</sup>  
PHD University of Texas-Austin

**Daniel B Oerther**, Professor<sup>1,5</sup>  
PHD University of Illinois-Urbana

**David N Richardson**, Associate Professor<sup>1</sup>  
PHD University of Missouri-Rolla

**William P Schonberg**, Professor<sup>1</sup>  
PHD Northwestern University

**William Eric Showalter**, Associate Teaching Professor<sup>1,6</sup>  
PHD Purdue University

**Lesley Haynes Sneed**, Associate Professor<sup>1</sup>  
PHD Purdue University

**Richard Wesley Stephenson**, Professor Emeritus<sup>1</sup>  
PHD Oklahoma State University

**Jeffery S Thomas**, Associate Teaching Professor<sup>1</sup>  
PHD Missouri Science & Technology

**Jianmin Wang**, Associate Professor<sup>1</sup>  
PHD University of Delaware

**Chenglin Wu**, Assistant Professor  
PHD, PHD University of Texas-Austin, Missouri University of Science and Technology

**Guirong Yan**, Assistant Professor  
PHD Harbin Institute of Technology, China

**Xiong Zhang**, Associate Professor<sup>1</sup>  
PHD Texas A&M University

**CIV ENG 2001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**CIV ENG 2002 Cooperative Engineering Training** (IND 1.0-3.0)  
On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation.

**CIV ENG 2003 Engineering Communications and Computations** (LAB 1.0 and LEC 2.0)

Programming and software tools (including computer aided design and drafting, computer-based mathematics, word processing, spreadsheet, and presentation software) with application to and emphasis on written, graphical, and oral communication in professional civil and architectural engineering practice. (Co-listed with Arch Eng 2003).

**CIV ENG 2200 Statics** (LEC 3.0)

Application of the principles of mechanics to engineering problems of equilibrium. Topics include resultants, equilibrium, friction, trusses, center of gravity and moment of inertia. Prerequisites: Physics 1135 or Physics 1111 with a grade of "C" or better; Math 1215 or Math 1221 with a grade of "C" or better; preceded or accompanied by Math 2222.

**CIV ENG 2210 Mechanics Of Materials** (LEC 3.0)

Application of the principles of mechanics to engineering problems of strength and stiffness. Topics include stress, strain, thin cylinders, torsion, beams, and combined stresses at a point. Prerequisite: Civ Eng 2200 with grade of "C" or better.

**CIV ENG 2211 Materials Testing** (LAB 1.0)

Designed to assist in the teaching of mechanics of materials. Topics include strain measurement, testing machines and properties of materials. Prerequisite: Preceded or accompanied by Civ Eng 2210.

**CIV ENG 2401 Fundamentals Of Surveying** (LAB 1.0 and LEC 2.0)

Surveying fundamentals: leveling, directions, angles, distances, errors, traverse calculations and basic adjustments. Fundamentals of horizontal curves. Lab exercises include leveling, traversing, horizontal circular curve layout and building layout. Prerequisite: Preceded or accompanied by Math 1214 (or 1208).

**CIV ENG 2601 Fundamentals Of Environmental Engineering And Science** (LAB 1.0 and LEC 2.0)

Course discusses fundamental chemical, physical, and biological principles in environmental engineering and science. Topics include environmental phenomena, aquatic pollution and control, solid waste management, air pollution and control, water and wastewater treatment systems, sustainability and life cycle analyses. Prerequisites: Chem 1310, Chem 1301, or Chem 1351; Math 1214, Math 1212, or Math 1208. (Co-listed with Env Eng 2601).

**CIV ENG 2602 Biological Fundamentals Of Environmental Engineering** (LEC 3.0)

Introduction to the function of organisms related to environmental engineering. The course focuses on both the application of organisms to removing contaminants and the effects of contaminants on organisms. Prerequisites: Bio Sci 1113 and preceded or accompanied by Civ/Env Eng 2601. (Co-listed with Env Eng 2602).

**CIV ENG 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CIV ENG 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CIV ENG 3116 Construction Materials, Properties And Testing** (LAB 1.0 and LEC 2.0)

A study of the origin, production, uses and general properties of construction materials accompanied by selected laboratory tests and demonstrations. Prerequisites: Civ Eng 2211 or Min Eng 3812; Civ Eng 3715 or both Geo Eng 1150 and Min Eng 3412.



**CIV ENG 3201 Structural Analysis I** (LAB 1.0 and LEC 2.0)

Loads on Structures. Analysis of statically determinate and indeterminate beams, frames and trusses. Influence lines and moving loads. Computation of deflections. Development and use of theorems of displacement methods including slope-deflection and moment distribution to analyze statically indeterminate structures. Computer solutions. Prerequisites: Civ Eng 2200, 2210 each with a grade of "C" or better. (Co-listed with Arch Eng 3201).

**CIV ENG 3210 Structural Design in Metals** (LEC 2.0 and LAB 1.0)

The analysis and design of structural elements and connections for buildings, bridges and specialized structures utilizing structural metals. Both elastic and plastic designs are considered. Prerequisite: Civ Eng 3201 with a grade of "C" or better. (Co-listed with Arch Eng 3210).

**CIV ENG 3220 Reinforced Concrete Design** (LAB 1.0 and LEC 2.0)

The analysis and design of reinforced concrete beams, slabs, columns, retaining walls and footings by the elastic and ultimate strength methods, including an introduction to the design of prestressed concrete. Introduction to use of computers as a design aid tool. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 3220).

**CIV ENG 3330 Engineering Fluid Mechanics** (LEC 3.0)

Study of fluids at rest and in motion. Topics include fluid properties, statics of fluids, and the control volume approach to conservation of mass, momentum and energy. Applications include flow in pipes, pipe systems, external flow, and fluid flow measurements. Prerequisites: Mech Eng 2350 or Mech Eng 2340, and MATH 3304, each with a grade of "C" or better.

**CIV ENG 3333 Engineering Hydrology** (LAB 1.0 and LEC 2.0)

A study of hydrologic processes as they relate to design of structures for control and management of water. Emphasizes characterization of precipitation processes, development of design hydrographs, rainfall/runoff frequency analysis, ground-water and wells. Prerequisites: Civ Eng 3330 with grade of "C" or better.

**CIV ENG 3334 Water Resources Engineering** (LEC 3.0 and LAB 1.0)

An introduction to the engineering of water resources; flow in closed conduits, pumps, flow in open channels, surface water hydrology, rainfall analysis, hydrograph analysis, flow routing; and ground-water hydrology. Prerequisites: Civ Eng 3330 and Stat 3113 with grades of "C" or better.

**CIV ENG 3335 Hydraulic Engineering** (LAB 1.0 and LEC 2.0)

A study of applied hydraulics to design of systems used for collection or distribution of water. Emphasis on open channel flow, hydraulic machinery, design of supply systems, drainage systems, and hydraulic transients. Prerequisites: Civ Eng 3330 with grade of "C" or better.

**CIV ENG 3500 Transportation Engineering** (LAB 1.0 and LEC 2.0)

A study of operating characteristics of transportation modes including highways, railways, inland waterways, airways, and pipelines. Consideration of traffic control devices, safety, system capacity, design of routes, planning of urban transportation systems, and economic evaluation of transportation alternatives. Prerequisites: Civ Eng 2401 and Civ Eng 2003.

**CIV ENG 3615 Water And Wastewater Engineering** (LEC 3.0)

A study of the engineering design principles dealing with the quantity, quality and treatment of water, and the quantity, characteristics, treatment and disposal of wastewater. Prerequisites: Civ Eng 2601 and at least junior standing. (Co-listed with Env Eng 3615).

**CIV ENG 3715 Fundamentals of Geotechnical Engineering** (LAB 1.0 and LEC 2.0)

Analysis of geotechnical systems including soil classification, index properties, permeability, compressibility and shear strength. Basic geotechnical engineering design principles as they apply to civil constructed facilities, such as analysis of foundations and earth structures. Laboratory determination of the basic properties of soils. Prerequisite: Geo Eng 1150 or Arch Eng 2103; Civ Eng 2210; and preceded or accompanied by Civ Eng 3330.

**CIV ENG 3842 Fundamentals of Building Systems** (LEC 3.0)

An examination of building life support systems and technology of interest to civil engineers in the planning, operation, and maintenance of buildings. Topics include human comfort, electrical, mechanical, water and waste, transportation, lighting, and other systems necessary for building utilization. Prerequisites: Physics 2135, Math 2222, and Junior Standing.

**CIV ENG 4010 Senior Seminar: Engineering In A Global Society** (RSD 1.0)

Discussion of contemporary issues: public safety, health, and welfare; the principles of sustainable development; lifelong learning; impact of engineering solutions in a global and societal and political context; relationships with owners, contractors, and the public; public service; the Code of Ethics; and the Missouri licensing Statutes and Board Rules. Prerequisite: Senior standing. (Co-listed with Arch Eng and Env Eng 4010).

**CIV ENG 4097 Senior Design Project** (LEC 3.0)

Open-ended design projects involving one or more areas of engineering. Planning design projects, philosophy of design, and application of engineering principles to design problems. Prerequisite: Civ Eng 4448 or Arch Eng 4448. (Co-listed with Arch Eng 4097 and Env Eng 4097).

**CIV ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**CIV ENG 4447 Ethical, Legal and Professional Engineering Practice** (LEC 2.0)

Discussions of laws concerning contracts, torts, agencies, real property, partnerships, and corporations. The purposes and implications of the engineering registration law, the effect of legal, ethical and marketing considerations of the practice of Civil Engineering. Prerequisite: Junior standing. (Co-listed with Arch Eng 4447).

**CIV ENG 4448 Fundamentals Of Contracts And Construction Engineering** (LEC 3.0)

A study of the concepts and techniques used in large construction projects for the preparation of engineer service contracts, the development of a project manual, detailed and conceptual cost estimating, and construction scheduling analysis. Prerequisite: Senior Standing. (Co-listed with Arch Eng 4448).

**CIV ENG 4729 Foundation Engineering** (LEC 3.0)

The effect of subsoil conditions on the behavior and choice of foundations. Topics include geotechnical explorations and the design of foundations, which includes the selection of foundation types, the analysis of bearing capacity and settlement of shallow/deep foundations, and retaining walls. Prerequisite: Civ Eng 3715.

**CIV ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CIV ENG 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CIV ENG 5010 Seminar** (LEC 1.0)

Discussion of current topics. Prerequisite: Senior standing.

**CIV ENG 5070 Teaching Engineering** (LEC 3.0)

Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mgt 5070, Env Eng 5070, Comp Eng 5070, Elec Eng 5070).

**CIV ENG 5112 Bituminous Materials** (LEC 2.0 and LAB 1.0)

Properties, types, and grades of bituminous materials are presented. Emphasis is placed on usage, distress, surface treatment design, and asphalt concrete mix properties, behavior, design manufacture, and construction. Prerequisite: Preceded or accompanied by Civ Eng 3116.

**CIV ENG 5113 Composition And Properties Of Concrete** (LEC 3.0)

Properties of plastic and hardened concrete and the influence of cements, aggregates, water and admixtures upon these properties. The microstructure of cement gel and other factors are related to the behavior of hardened concrete under various types of loading and environments, drying shrinkage, creep and relaxation, fatigue, fracture, and durability. Introduction to statistical quality control of concrete production. Prerequisite: Civ Eng 3116 with a grade of "C" or better.

**CIV ENG 5117 Asphalt Pavement Design** (LEC 3.0)

Structural design of flexible pavements including loading characteristics, properties of pavement components, stress distribution, and the effects of climatic variables on design criteria. Prerequisite: Civ Eng 3116 with a grade of "C" or better.

**CIV ENG 5118 Smart Materials And Sensors** (LEC 2.0 and LAB 1.0)

Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multidisciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior Standing and Math 3304. (Co-listed with Aero Eng 5229, Mech Eng 5229 and Elec Eng 5270).

**CIV ENG 5156 Concrete Pavement Design** (LEC 3.0)

Design of rigid pavements including loading characteristics, properties of pavement components, stress distribution, and the effects of climatic variables on design criteria. Prerequisite: Civ Eng 3116 with a grade of "C" or better.

**CIV ENG 5203 Applied Mechanics In Structural Engineering** (LEC 3.0)

A study of the basic relationships involved in the mechanics of structures. Topics include basic elasticity, failure criteria, fundamental theories of bending and buckling of plates and cylindrical shells for practical application in analysis and design of bridge, building floors, and shell roofs. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 5203).

**CIV ENG 5205 Structural Analysis II** (LEC 3.0)

Classical displacement and force methods applied to structures of advanced design. Analysis of indeterminate structures such as continuous beams, arches, cables, and two and three dimensional frames, and trusses. Analysis of indeterminate structures involving temperature and support settlements effects. Prerequisites: Civ Eng 3201 or Arch Eng 3201. (Co-listed with Arch Eng 5205).

**CIV ENG 5206 Low-Rise Building Analysis and Design** (LEC 3.0)

Characterization of various design loads, load combinations, general methodology of structural designs against lateral loads, code-oriented design procedures, distribution of lateral loads in structural systems, application of the International Building Code in design of loadbearing wall systems, building frame system and moment-resisting frame systems. Prerequisite: Preceded and/or accompanied by Civ -Arch Eng 3210 or Civ-Arch Eng 3220. (Co-listed with Arch Eng 5206).

**CIV ENG 5207 Computer Methods of Structural Analysis** (LEC 3.0)

Force and displacement matrix methods and computer methods applied to structural analysis. Analysis of indeterminate structures such as continuous beams, and two and three dimensional frames and trusses. Analysis of indeterminate structures involving temperature and support settlements effects using computer methods formulation. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 5207).

**CIV ENG 5208 Structural Dynamics** (LEC 3.0)

This course deals with fundamental concepts and structural responses under dynamic loads. Hand calculations and computer methods are developed. Specific topics include resonance, beating phenomenon, equation of motion, dynamic properties, frequencies and mode shapes, and modal and Ritz analyses. Prerequisites: Mech Eng 2350 or equivalent; Civ/Arch Eng 3201 or equivalent. (Co-listed with Arch Eng 5208).

**CIV ENG 5210 Advanced Steel Structures Design** (LEC 3.0)

The design of structural steel systems into a final integrated structure. Plate girders, composite systems, stability, connections, rigid frames, single and multistory buildings, and similar type problems of interest to the student. Use of the computer as a tool to aid in the design will be emphasized. Prerequisite: Civ Eng 3210 with a grade of "C" or better. (Co-listed with Arch Eng 5210).

**CIV ENG 5220 Advanced Concrete Structures Design** (LEC 3.0)

The design of structural concrete systems into a final integrated structure. Two-way slabs, long columns, connections, and discontinuity regions, deflections and cracking of beams and slabs, ACI design criteria, and similar type problems of interest to the student. Use of the computer as a tool to aid in the design will be emphasized. Prerequisite: Civ Eng 3220 with a grade of "C" or better. (Co-listed with Arch Eng 5220).

**CIV ENG 5222 Prestressed Concrete Design** (LEC 3.0)

Behavior of steel and concrete under sustained load. Analysis and design of pre-tensioned and post-tensioned reinforced concrete members and the combining of such members into an integral structure. Prerequisite: Civ Eng 3220 with a grade of "C" or better. (Co-listed with Arch Eng 5222).

**CIV ENG 5231 Infrastructure Strengthening with Composites** (LEC 3.0)

The course presents composite materials and includes principles of reinforcing and strengthening for flexure, shear, and ductility enhancement in buildings and bridges. It covers the design of existing members strengthened with externally bonded laminates and near surface mounted composites. Case studies are discussed. Prerequisites: Civ Eng / Arch Eng 3201, Civ Eng / Arch Eng 3220. (Co-listed with Arch Eng 5231).

**CIV ENG 5250 Air Transportation** (LEC 2.0 and LAB 1.0)

Runway configuration, airfield capacity, geometrics and terminal layout and design. Aircraft performance; navigation and air traffic control; airport planning and design; airline operations; aviation systems planning. Prerequisite: Civ Eng 3500 with a grade of "C" or better.

**CIV ENG 5260 Analysis And Design Of Wood Structures** (LEC 3.0)

A critical review of theory and practice in design of modern wood structures. Effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design; development of design criteria and their application to plane and three dimensional structures. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 5260).

**CIV ENG 5270 Structural Masonry Design** (LEC 3.0)

Review of the theory and practice of analyzing low-rise masonry structures, materials and assembly types, constructability considerations, structural masonry components, repair and strengthening, and model code requirements to ensure adequate load resisting buildings. Prerequisites: Arch Eng 3201 or Civ Eng 3201. (Co-listed with Arch Eng 5270).

**CIV ENG 5330 Unsteady Flow Hydraulics** (LEC 3.0)

The study of unsteady flow and its effect on closed water systems and in open channels. Prerequisites: Civ Eng 3330 with a grade of "C" or better.

**CIV ENG 5331 Hydraulics Of Open Channels** (LEC 3.0)

The phenomena accompanying the flow of water in open channels, such as uniform and varied flow, critical conditions, backwater curves, hydraulic jump, hydraulic drop and applications are studied in detail. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

**CIV ENG 5332 Transport Processes in Environmental Flows** (LEC 3.0)

Dynamics, mixing and contaminant transport in surface water bodies, including rivers and lakes. Buoyancy modifications to the mixing and dynamics of pollutant discharges and surface water bodies. Transport of sediments. Exchange processes at the air/water and sediment/water interfaces. Prerequisite: At least a "C" in Civ Eng 3330.

**CIV ENG 5333 Intermediate Hydraulic Engineering** (LEC 3.0)

Application of fluid mechanics principles to the design. Kinematics of fluid motion, conservation of mass, linear and angular momentum, and energy. Requirements for similarity of fluid flow. Introduction to dynamics of fluid flows and viscous incompressible flows. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

**CIV ENG 5335 Water Infrastructure Engineering** (LAB 1.0 and LEC 2.0)

Fundamental principles underlying comprehensive water infrastructure development; sanitary sewers, sanitary treatment facilities, stormwater sewers, stormwater detention, water power development, and hydraulic structures. The student is responsible for the planning and design of a water infrastructure development project. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

**CIV ENG 5337 River Mechanics And Sediment Transport** (LEC 3.0)

Formation of rivers and the laws governing river regulation and improvements, including navigation and flood protection. Principles governing sediment transport. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

**CIV ENG 5338 Hydrologic Engineering** (LEC 3.0)

A study of current up-to-date hydrologic techniques involving design of hydrologic input for bridges, culverts, reservoirs. Techniques involve extreme value statistics, model hydrographs, routing, etc. Prerequisite: Civ Eng 3334 with a grade of "C" or better.

**CIV ENG 5360 Water Resources And Wastewater Engineering** (LEC 3.0)

Application of engineering principles to the planning and design of multipurpose projects involving water resources development and wastewater collection/treatment/disposal/systems. Latest concepts in engineering analysis are applied to evaluation of alternative solutions. Prerequisites: Civ Eng 3333, 3335, 3615. (Co-listed with Env Eng 5360).

**CIV ENG 5404 Legal Aspects Of Boundary Surveying** (LEC 3.0)

The U.S. Public Land Survey System (USPLSS): original GLO survey instructions and procedures. Resurveys on the USPLSS law, standards, procedures with emphasis on Missouri. Rights in real property; statute, case and administrative law applied to boundaries. Simultaneous and sequence conveyances. Unwritten rights in real property. Riparian boundaries. Writing and interpreting boundary descriptions. Land surveyor duties and responsibilities. Prerequisite: Civ Eng 2401 with grade of "C" or better.

**CIV ENG 5406 Surveying Systems** (LEC 3.0)

Celestial observations for azimuths. Introduction to State Plane Coordinate systems. Theory and calculations. Route surveying and geometrics, horizontal, spiral and vertical curves. Surveying aspects of residential and commercial subdivision design: lot layout, rights of way, easements, setbacks, platting, planning and zoning constraints, application of surveying software. Instrumentation: total stations, electronic levels, instrument calibrations. Prerequisite: Civ Eng 2401 with grade of "C" or better.

**CIV ENG 5441 Professional Aspects Of Engineering Practice** (LEC 3.0)

A study of engineering registration laws, regulations, rules of professional responsibility and standards of practice. Review of causative factors of selected failures and their relationship to professional responsibility. Prerequisite: Senior standing.

**CIV ENG 5442 Construction Planning and Scheduling Strategies** (LEC 3.0)

The goal of this course is to assist participants in gaining an understanding of schedule control techniques and the application of tools such as Primavera Software. Content areas to be addressed include: development of baseline schedules, progress monitoring and updating, recovery schedules, resource application and leveling. Prerequisite: Civ Eng or Arch Eng 4448. (Co-listed with Arch Eng 5442).

**CIV ENG 5445 Construction Methods** (LEC 3.0)

Introduction to construction planning, selection of equipment and familiarization with standard methods for horizontal and vertical construction. Application of network analysis and schedules to project control. Prerequisite: Civ Eng 4448 with a grade of "C" or better. (Co-listed with Arch Eng 5445).

**CIV ENG 5446 Management Of Construction Costs** (LEC 3.0)

Management of construction projects from inception to completion: estimates, role of network preplanning, project monitoring and control. Prerequisites: Civ Eng 4448 with a grade of "C" or better. (Co-listed with Arch Eng 5446).

**CIV ENG 5448 Green Engineering: Analysis of Constructed Facilities** (LEC 3.0)

Environmentally sound design and construction practices. Includes design issues, material selection and site issues that can reduce the impact on the environment caused by the construction process. LEED certification covered in depth. Prerequisites: Civ Eng 4448 or Arch Eng 4448; and Junior Standing. (Co-listed with Arch Eng 5448).



**CIV ENG 5449 Engineering and Construction Contract Specifications** (LEC 3.0)

Legal and business aspects of contracts and contracting procedure in the construction industry. Topics include formulation of contracts in common law, engineering services contracts, and construction project contract documents and contract administration issues. Prerequisite: Civ Eng 4448 with a grade of "C" or better. (Co-listed with Arch Eng 5449).

**CIV ENG 5510 Geometric Design Of Highways** (LEC 2.0 and LAB 1.0)

Development and applications of concepts of geometric design for rural and urban highways. Design controls and criteria; elements of design, including sight distance, horizontal and vertical alignment; cross-section elements; highway types; intersection design elements; types of interchanges and interchange design elements; grade separations and clearance; development of visual elements. Prerequisite: Civ Eng 3500 with grade of "C" or better.

**CIV ENG 5513 Traffic Engineering** (LEC 3.0)

Driver, vehicle, and roadway characteristics; traffic control devices; traffic studies; intersection capacity, intersection design, traffic safety, and evaluation of traffic improvements. Traffic laws and ordinances, traffic engineering, traffic circulation, parking design, and forecasting traffic impacts. Prerequisite: Civ Eng 3500 with a grade of "C" or better.

**CIV ENG 5515 Advanced Traffic Signal Operations** (LEC 3.0)

This course will discuss the role and function of traffic signal components: the signal controller, conflict monitor, vehicle detectors, etc. The course also covers the layout of traffic signal hardware at an intersection and will discuss the phasing/timing of traffic signals in detail. Prerequisite: CIV ENG 5513.

**CIV ENG 5605 Environmental Systems Modeling** (LEC 3.0)

Introductory course in modeling environmental systems. Course will focus on contaminant fate and transport in the environment. Models will be developed that will include physical, chemical and biological reactions and processes that impact this fate. Prerequisites: Env Eng/Civ Eng 2601, Env Eng/Civ Eng 2602 and Env Eng/ Civ Eng 3603; or Graduate standing. (Co-listed with Env Eng 5605).

**CIV ENG 5619 Environmental Engineering Design** (LAB 1.0 and LEC 2.0)

Functional design of water and wastewater facilities and other environmental cleanup systems. Prerequisite: Civ Eng 3615 or Env Eng 3615. (Co-listed with Env Eng 5619).

**CIV ENG 5630 Remediation of Contaminated Groundwater and Soil** (LAB 1.0 and LEC 2.0)

Course covers current in-situ and ex-situ remediation technologies. Current literature and case studies are utilized to provide the focus for class discussions and projects. Prerequisites: Civ Eng 3615, Geo Eng 5237 or Graduate Standing. (Co-listed with Env Eng 5630).

**CIV ENG 5640 Environmental Law And Regulations** (LEC 3.0)

This course provides comprehensive coverage of environmental laws and regulations dealing with air, water, wastewater, and other media. The primary focus is permitting, reporting, and compliance protocols. The course topics include U.S. and international legal systems and judicial processes, liability, enforcement, Clean Air Act, Clean Water Act (NPDES permitting), Safe Drinking Water Act, OSGA, TSCA, RCRA, AND CERCLA. Case studies will be emphasized. (Co-listed with Env Eng 5640).

**CIV ENG 5642 Sustainability, Population, Energy, Water, and Materials** (LEC 3.0)

This course will examine the concepts regarding the continued advancement of humankind while maintaining our ecological niche on earth. Key topics include: population growth, poverty, and impacts of development; energy consumption, sources, storage, conservation and policy; water quality and quantity; materials and building; and policy implications. Prerequisite: Senior or graduate standing. (Co-listed with Env Eng 5642 and Arch Eng 5642).

**CIV ENG 5650 Public Health Engineering** (LEC 3.0)

A comprehensive course dealing with the environmental aspects of public health. Prerequisite: Civ Eng 2601 with a grade of "C" or better. (Co-listed with Env Eng 5650).

**CIV ENG 5660 Introduction To Air Pollution** (LEC 3.0)

Introduction to the field of air pollution dealing with sources, effects, federal legislation, transport and dispersion and principles of engineering control. Prerequisite: Civ Eng 3330; or graduate standing. (Co-listed with Env Eng 5660).

**CIV ENG 5662 Air Pollution Control Methods** (LEC 3.0)

Study of the design principles and application of the state-of-the-art control techniques to gaseous and particulate emissions from fossil fuel combustion, industrial and transportation sources. Prerequisite: Civ Eng 3330; or graduate standing. (Co-listed with Env Eng 5662).

**CIV ENG 5665 Indoor Air Pollution** (LEC 3.0)

By developing a practical understanding of indoor air pollution sources, physics, chemistry and consequences, students will learn how radon, cigarette smoke, VOCs from furnishings, and so forth affect indoor air quality and apply engineering analyses to specify ventilation rates, choose furnishings and minimize occupant exposure to pollutants. Prerequisite: Civ Eng 2601 or Mech Eng 5571 or Graduate Status. (Co-listed with Env Eng 5665 and Arch Eng 5665).

**CIV ENG 5670 Solid Waste Management** (LEC 3.0)

A systematic study of the sources, amounts and characteristics of solid wastes and methods used for their collection, reclamation, and ultimate disposal. Prerequisite: Civ Eng 2601 with grade of "C" or better; or graduate standing. (Co-listed with Env Eng 5670).

**CIV ENG 5702 Geomatics** (LEC 3.0)

Horizontal and vertical geodetic datums and networks. Theory, calculations and applications of State Plane Coordinate Systems. Introduction to Geographic and Land Information Systems: hardware and software issues; data quality and accuracy; resource, environmental, cadastral and governmental applications; databases; GIS/LIS trends. Introduction to Global Positioning Systems (GPS): Project planning, data collection, data processing and network adjustment applications, Kinematic and RealTime GPS applications, hardware and software options and costs. Prerequisite: Civ Eng 2401 with grade of "C" or better.

**CIV ENG 5715 Intermediate Soil Mechanics** (LEC 3.0)

General principles of soil mechanics and their applications, including mineralogy, soil structure, flow through porous media, shear strength, slope stability and consolidation. Prerequisites: Civ Eng 3715 with grade of "C" or better.

**CIV ENG 5716 Geotechnical Earthquake Engineering** (LEC 3.0)

Geotechnical earthquake hazards and mitigations, damage to structures, plate tectonics, seismicity, wave propagation, characterization of ground motions, theory of vibrations (1-DOF), effect of local soil conditions on ground response, development of design ground motions, liquefaction, dynamic lateral earth pressures and slope stability/deformation. Prerequisites: Civ Eng 3715 with a grade of "C" or better.

**CIV ENG 5729 Foundation Engineering II** (LEC 3.0)

Classical earth pressure theories. Analysis of shallow and deep foundations to include bearing capacity and settlement of footings, rafts, piles, and drilled piers. Analysis of stability and design of retaining walls and anchored bulkheads. Prerequisites: Civ Eng 4729 with a grade of "C" or better. (Co-listed with Arch Eng 5729).

**CIV ENG 5744 Geosynthetics in Engineering** (LEC 3.0)

Geotechnical principles are applied to design of geosynthetic systems for foundation support, earth retention, drainage, and disposal of hazardous conventional wastes. Geosynthetic testing and identification. Emphasis is on design of geosynthetic earth reinforcement, roadway stabilization, filters, and waste containment systems. Prerequisite: Civ Eng 3715 with grade of "C" or better.

**CIV ENG 5750 Transportation Applications of Geophysics** (LAB 1.0 and LEC 2.0)

Overview of geophysical and non-destructive test methods that are commonly used to investigate transportation structures and their foundations. Emphasis is placed on bridge system substructure, bridge system superstructure, pavement, roadway subsidence, subsurface characterization and vibration measurements. Prerequisite: Junior level standing or higher. (Co-listed with Geo Eng 5761 and Geophys 5761).

## Computer Engineering

**The following emphasis areas are offered at the bachelor of science level: computational intelligence, computer and architecture, embedded computer systems, integrated circuits and logic design, networking and software engineering, security and reliability.**

The computer engineering program is designed to prepare an engineer to work with software and hardware of computers. In the software world, high level languages and complex programs are often the solution to a problem. In the hardware world, designs also include many aspects of the physical world, like temperature or noise, and often must include compromises between many opposing factors. The ability of a computer engineer to work in both worlds is what distinguishes them from a computer scientist or from an electrical engineer who specializes in computers. Computer scientists typically have little training with hardware. Electrical engineers typically have little training with software. Our students are trained to work with both, since many computer systems cannot be built well without a clear understanding of both.

Computer engineers can be found just about anywhere there are computers. Computer engineers might build the integrated circuits (ICs) that go into your home video game or your cell phone. They might develop the microprocessor that goes into your home computer, deciding what instructions it executes and how it interfaces with memory. Computer engineers also build computer systems that use these integrated circuits – for example, they might put together the ICs to build the motherboard for your home computer or the video card that goes into that computer. Computer engineers also help computers work together, for example developing computer networks or working with parallel processing. Computer engineers also help build embedded computer systems. These are devices with a computer inside them that work directly with their environment. They could be as complicated as a satellite or as everyday as your car, your phone, or even your microwave oven. Computer engineers also build software. They might be found at companies like Microsoft, working strictly with software or helping complex software systems interface better with hardware. They might make computers “smarter” using concepts of computational intelligence.

Since computers are such an important part of our lives, the options for computer engineers are wide open.

Our ABET-accredited computer engineering program emphasizes both hands-on experience and training in fundamental concepts and theory. Students participate in many laboratories that include both hardware and software. Many lecture courses include one or more projects that require the student to build something “real” and make it work. All students take a 1-year design course for this reason in their final year in the program. While these projects are challenging, they are also fun and prepare a student to perform immediately on the job when they get out of school. Coursework also concentrates strongly on theory and fundamentals because this background is essential for our students to fully understand the systems they will work on to quickly learn new concepts as their job function changes and to adapt to the rapidly changing world of computers in the future.

Students complete the Freshman Engineering Program, thus obtaining basic science skills and an overview of the various degree programs at Missouri S&T, before entering the main program. This allows students time to consider different career options before they commit to a given degree program. The computer engineering program includes several courses in both electrical engineering and computer science. The program follows the electrical engineering program into the sophomore year, including courses like circuits and electronics, and then branches into computer science courses such as data structures and operating systems.

Students work closely with their advisors to carefully plan each semester class schedule in order to have the correct prerequisites for courses in the following semesters. Working with their advisor, they should also select electives in the program to provide the background in areas they wish to emphasize for their career path.

Double majors – particularly with electrical engineering and computer science – are a possibility. Students working with their advisor should be able to plan a program that allows them to quickly graduate with more than one degree by sharing some electives and carefully planning additional course work. Students considering taking several more classes should also consider the alternative of working towards an M.S. or Ph.D. degree in graduate school.

## Educational Mission

The electrical and computer engineering department strives to contribute to the state, nation, and world through the education of outstanding professionals and leaders in engineering. Our educational focus is on a broad, rigorous education in all areas of electrical and computer engineering with significant hands-on experiences. The program will provide students with an understanding of engineering problem solving at all levels and an appreciation for engineering as a profession.

## Objectives

The electrical and computer engineering degree programs will provide students the foundation to:

- Succeed in professional career placement and practice as engineers, scholars and entrepreneurs
- Grow their career through technical and professional activities and leadership roles
- Contribute to society and the economy through technical products, services, and knowledge



- Adapt to an ever-changing world through continue education, through graduate study, professional development activities, independent learning, or pursuit of follow-on degrees

The hallmarks of students capable of obtaining these objective are:

- **Technical Competency.** Graduates will have a sound knowledge of the fundamentals in electrical or computer engineering that allows them to analyze and solve technical problems, to apply hardware and software tools, to create and evaluate technical products, to learn independently, and to succeed in the workplace and in graduate school.
- **An Engineering Perspective.** Graduates will be capable of understanding complex projects including their evolution and abstraction and the optimization of associated decisions and risk, both locally and globally.
- **Professional Skills and Knowledge.** Graduates will have the ability to communicate well in both oral and written form, to interact in teams, to manage and lead technical projects, to manage their career, and to conduct themselves with an understanding of ethics, economics, and intellectual property.

Approved by the faculty February 25, 2015.

## Bachelor of Science Computer Engineering<sup>1</sup>

Entering freshmen desiring to study Computer Engineering will be admitted to the Freshman Engineering Program. They will be permitted to state a Computer Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major.

For the Bachelor of Science degree in Computer Engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in Computer Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1. All students are required to take one American history course, one economics course, one humanities course, and . The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200. The humanities course must be selected from the approved lists for art, English, foreign languages, music, philosophy, speech and media studies, or theater.
2. Depth requirement. Three credit hours must be taken in humanities or social sciences at the 2000 level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 1180 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the

4000 level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.

3. The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to ENGLISH 1120.
4. Any specific departmental requirements in the general studies area must be satisfied.
5. Special topics and special problems and honors seminars are allowed only by petition to and approval by the student's department chairman.

The Computer Engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design. These interrelations are presented and discussed through classroom and laboratory instruction.

### Free Electives Footnote:

Each student is required to take three hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of engineering and science must be at least three credit hours.

Freshman Year			
First Semester	Credits	Second Semester	Credits
FR ENG 1100 <sup>2</sup>	1	MECH ENG 1720	3
MATH 1214 <sup>3</sup>	4	MATH 1215 <sup>3</sup>	4
CHEM 1310	4	PHYSICS 1135 <sup>3,4</sup>	4
CHEM 1319	1	ECON 1100 or 1200	3
HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3	Elective-Hum or Soc (any level) <sup>5</sup>	3
ENGLISH 1120	3		
	16		17
Sophomore Year			
First Semester	Credits	Second Semester	Credits
ELEC ENG 2100 <sup>3,6,7</sup>	3	COMP ENG 2210 <sup>3,6,8</sup>	3
ELEC ENG 2101 <sup>3,6</sup>	1	COMP ENG 2211 <sup>3,6</sup>	1
MATH 2222 <sup>3</sup>	4	ELEC ENG 2120 <sup>3,7,9</sup>	3
COMP SCI 1570 <sup>3</sup>	3	MATH 3304 <sup>3</sup>	3
COMP SCI 1580 <sup>3</sup>	1	COMP SCI 1510 <sup>3</sup>	3
PHYSICS 2135 <sup>3,4</sup>	4	COMP SCI 1200 <sup>3</sup>	3
	16		16
Junior Year			
First Semester	Credits	Second Semester	Credits
COMP ENG 3110	3	COMP ENG Elective A <sup>3,14</sup>	3
COMP ENG 3150	3	ELEC ENG 3410 <sup>3,6,9</sup>	3
COMP ENG 3151 <sup>3,6,8</sup>	1	COMP SCI 3800 or 2500 <sup>3</sup>	3
ELEC ENG 2200 <sup>3,6,7</sup>	3	STAT 3117 <sup>12</sup>	3
ELEC ENG 2201 <sup>3,6,7</sup>	1	Communication Elective <sup>13</sup>	3
Mathematics Elective <sup>10</sup>	3		

SP&M S 1185 <sup>13</sup>	3		
	17		15
<b>Senior Year</b>			
<b>First Semester</b>	<b>Credits</b>	<b>Second Semester</b>	<b>Credits</b>
COMP ENG 5410 or COMP SCI 5600 <sup>3</sup>	3	COMP ENG Elective D <sup>3,15,16</sup>	3
COMP ENG Elective C <sup>3,15,16</sup>	3	COMP ENG Elective E <sup>3,15,16</sup>	3
COMP ENG 4096 <sup>3,17</sup>	1	COMP ENG 4097 <sup>3,17</sup>	3
Elective-Hum or Soc (any level) <sup>5</sup>	3	Elective-Hum or Soc (upper level) <sup>5</sup>	3
Engineering Science Elective <sup>11</sup>	3	Free Elective <sup>18</sup>	3
COMP ENG Elective B <sup>3,19</sup>	3		
	16		15
Total Credits: 128			

**Notes:** Student must satisfy the common engineering freshman year requirements and be admitted into the department.

- <sup>1</sup> The minimum number of hours required for a degree in Computer Engineering is 128.
- <sup>2</sup> Students that transfer to Missouri S&T after their freshman year are not required to enroll in Freshman Engineering Seminars.
- <sup>3</sup> A minimum grade of "C" must be attained in MATH 1214, MATH 1215, MATH 2222, and MATH 3304, PHYSICS 1135 and PHYSICS 2135 (or their equivalents), COMP SCI 1570, COMP SCI 1580, COMP SCI 1510, COMP SCI 1200, COMP SCI 2500 or COMP SCI 3800, COMP ENG 2210, COMP ENG 2211, COMP ENG 3150, COMP ENG 3551, COMP ENG 3110, COMP ENG 5410 or COMP SCI 5600, COMP ENG 4096, and ELEC ENG 2100, ELEC ENG 2101, ELEC ENG 2120, ELEC ENG 2200, ELEC ENG 2201, ELEC ENG 3410, and ELEC ENG 3411, and the COMP ENG electives A, B, C, D and E. Also, students may not enroll in other courses that use these courses as prerequisites until the minimum grade of "C" is attained.
- <sup>4</sup> Students may take PHYSICS 1111 and PHYSICS 1119 in place of PHYSICS 1135. Students may take PHYSICS 2111 and PHYSICS 2119 in place of PHYSICS 2135.
- <sup>5</sup> All electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog.
- <sup>6</sup> Students who drop a lecture course prior to the deadline to drop a class must also drop the corequisite lab course.
- <sup>7</sup> Students must earn a passing grade on the ELEC ENG Advancement Exam I (associated with ELEC ENG 2100) before they enroll in ELEC ENG 2120 or ELEC ENG 2200 and ELEC ENG 2201.
- <sup>8</sup> Students must earn a passing grade on the COMP ENG Advancement Exam (associated with COMP ENG 2210) before they enroll in any course with COMP ENG 2210 and COMP ENG 2211 as prerequisites.
- <sup>9</sup> Students must earn a passing grade on the ELEC ENG Advancement Exam II (associated with ELEC ENG 2120) before they enroll in ELEC ENG 3410 and ELEC ENG 3411.
- <sup>10</sup> Students must take one of the following courses: MATH 3103, MATH 3108, MATH 3109, MATH 5302, MATH 5603, MATH 5105, MATH 5106, MATH 5107, MATH 5108, MATH 4209, MATH 4211, MATH 5215, MATH 5222, MATH 5325, MATH 4530, MATH 5737, MATH 5351, MATH 5154, MATH 4096, MATH 5483, MATH 5585, STAT 5644, STAT 5346, STAT 5353.

- <sup>11</sup> Students must take MECH ENG 2340, MECH ENG 2519, MECH ENG 2527, PHYSICS 2311, PHYSICS 2401, CHEM 2210, BIO SCI 2213, or BIO SCI 2223. The following pairs of course are substitutions for any single course: CIV ENG 2200 and MECH ENG 2350, PHYSICS 2305 and PHYSICS 4311, PHYSICS 2305 and CER ENG 4240, or PHYSICS 2305 and NUC ENG 3205.
- <sup>12</sup> Students may replace STAT 3117 with STAT 3115 or STAT 5643.
- <sup>13</sup> Student must take English 3560 or English 1160. Students may replace SpMS 1185 with the ROTC sequence of Mil Army 4250 and 4500 or Mil Air 4110 and 4120
- <sup>14</sup> Comp Eng Elective A must be a 4000 or 5000-level Comp Eng, Elec Eng, or Comp Sci course with at least a 3-hour lecture component. This normally includes all Comp Eng and Elec Eng 4000 or 5000-level courses except Comp Eng or Elec Eng 4000, 4099, 4096, and 4097 or Comp Sci 5000, 4010, 5600, and 4099.
- <sup>15</sup> Comp Eng Electives C, D, and E must be 3000, 4000 or 5000-level courses from an approved list of science, mathematics, and engineering courses. In particular, this list includes all 3000, 4000 or 5000-level Comp Eng, Elec Eng and Comp Sci courses except required courses in Comp Eng, Elec Eng, and Comp Sci and except Comp Eng 4096 and 4097, Elec Eng 2800, 1002, 1003, 4096, and 4097, and Comp Sci 2002 and 4600/5600). Comp Eng Electives C, D, and E must include at least six hours of engineering or computer science courses.
- <sup>16</sup> COMP ENG Electives C, D, and E cannot include more than three hours of COMP ENG 4000, COMP ENG 4099, ELEC ENG 4000, or ELEC ENG 4099.
- <sup>17</sup> Students pursuing dual degrees in COMP ENG and ELEC ENG may take either COMP ENG 4096 or ELEC ENG 4096 and COMP ENG 4097 or ELEC ENG 4097. Students may not receive credit for both COMP ENG 4096 and ELEC ENG 4096 or COMP ENG 4097 and ELEC ENG 4097 in the same degree program.
- <sup>18</sup> Students are required to take at least three credit hours. Elec Eng 2800 level, ELEC ENG 4096, ELEC ENG 4097, COMP ENG 4096 and COMP ENG 4097 may not be used for free electives. No more than one credit hour of COMP ENG 3002 or ELEC ENG 3002 may be applied to the BS degree for free electives.
- <sup>19</sup> Comp Eng Elective B must be a 4000 or 5000 level COMP ENG course with at least a 3-hour lecture component, excluding COMP ENG 4096 and COMP ENG 4097.

## Emphasis Areas for Computer Engineering

**Note:** The following emphasis areas identify courses from which a student may opt to develop a specific emphasis. It is not required that students obtain an emphasis specialty within computer engineering.

### Computational Intelligence

#### Highly Recommended

COMP ENG 5310	Computational Intelligence	3
ELEC ENG 5370	Introduction to Neural Networks and Applications	3
COMP ENG 6310	Markov Decision Processes	3

#### Suggested

ELEC ENG 5330	Fuzzy Logic Control	3
COMP ENG 5450	Digital Image Processing	3
COMP ENG 5460	Machine Vision	3

### Computer Architecture and Embedded Systems

#### Highly Recommended

COMP ENG 5110	Principles of Computer Architecture	3
---------------	-------------------------------------	---

COMP ENG 5120	Digital Computer Design	3
COMP ENG 5151	Digital Systems Design Laboratory	3
COMP ENG 5160	Embedded Processor System Design	3
COMP ENG 5170	Real-Time Systems	3
<b>Suggested</b>		
COMP ENG 5610	Real-Time Digital Signal Processing	3
COMP ENG 5130	Advanced Microcomputer System Design	3
ELEC ENG 3100	Electronics I	3
COMP SCI 3100	Software Engineering I	3

## Integrated Circuits and Logic Design

### Highly Recommended

COMP ENG 2210	Introduction to Digital Logic	3
COMP ENG 5210	Introduction To VLSI Design	3
COMP ENG 5220	Digital System Modeling	3
COMP ENG 6210	Digital Logic	3

### Suggested

ELEC ENG 3100	Electronics I	3
COMP ENG 5110	Principles of Computer Architecture	3
COMP ENG 5151	Digital Systems Design Laboratory	3
COMP ENG 5120	Digital Computer Design	3
COMP ENG 5130	Advanced Microcomputer System Design	3
COMP ENG 5510	Fault-Tolerant Digital Systems	3

## Networking, Security, and Dependability

### Highly Recommended

COMP ENG 5420	Introduction to Network Security	3
COMP ENG 5430	Wireless Networks	3
COMP ENG 6440	Network Performance Analysis	3
COMP ENG 6510	Resilient Networks	3

### Suggested

COMP ENG 5510	Fault-Tolerant Digital Systems	3
---------------	--------------------------------	---

## Minor Curriculum

A minor in computer engineering will require the following:

Pass the ELEC ENG Advancement Exam I (ELEC ENG 2100 final) with a "C" or better \*

Pass the COMP ENG Advancement Exam (COMP ENG 2210 final) with a "C" or better \*\*

A "C" or better in the following courses:

COMP ENG 3150	Introduction to Microcontrollers and Embedded System Design
COMP ENG 3110	Computer Organization and Design
COMP ENG 5410	Introduction to Computer Communication Networks or COMP SCI 56C Computer Networks

Pass 3 hours of additional 4XXX-level or above COMP ENG or ELEC ENG or COMP SCI coursework with a "C" or better, excluding senior design, special problems, and undergraduate research. Transfer courses cannot be used to satisfy this requirement. The course choice for this requirement is subject to the approval of the minor advisor.

\* One opportunity will be given to pass the EL ENG Advancement Exam I if a student has prior course or experience in circuits. Otherwise, the student must pass ELEC ENG 2100.

\*\* One opportunity will be given to pass the COMP ENG Advancement Exam if a student has prior course or experience in digital circuits. Otherwise, the student must pass COMP ENG 2210.

**Levent Acar**, Associate Professor  
PHD Ohio State University

**Daryl G Beetner**, Professor<sup>1</sup>  
DSC Washington University

**Egemen K Cetinkaya**, Assistant Professor  
PHD University of Kansas

**Minsu Choi**, Associate Professor  
PHD Oklahoma State University

**Mariesa L Crow**, Professor<sup>1</sup>  
PHD University of Illinois-Urbana

**Mihail Cutitaru**, Assistant Teaching Professor  
PHD Old Dominion University

**Kristen Marie Donnell Hilgedick**, Assistant Professor  
PHD Missouri Univeristy of Science & Technology

**James L Drewniak**, Curators Professor  
PHD University of Illinois-Urbana

**Rohit Dua**, Assistant Teaching Professor  
PHD University of Missouri-Rolla

**Kelvin Todd Erickson**, Professor<sup>1</sup>  
PHD Iowa State University

**Jun Fan**, Associate Professor  
PHD University of Missouri-Rolla

**Mehdi Ferdowsi**, Associate Professor  
PHD Illinois Institute of Technology

**Steven Leslie Grant**, Associate Professor  
PHD Rutgers State University-College of Engineering

**Amardeep Kaur**, Assistant Teaching Professor  
PHD Missouri University of Science & Technology

**Victor Khilkevich**, Assistant Professor  
PHD Moscow Power Engineering Institute

**Chang-Soo Kim**, Associate Professor  
PHD Kyungpook National University

**Jonathan William Kimball**, Associate Professor<sup>1</sup>  
PHD University of Illinois-Urbana

**Kurt Louis Kosbar**, Associate Professor  
PHD University of Southern California

**Randy Hays Moss**, Professor<sup>1</sup>  
PHD University of Illinois-Urbana

**Theresa Avosuahi Odun-Ayo**, Assistant Teaching Professor  
PHD Missouri University of Science & Technology

**David Pommerenke**, Professor  
PHD Technical University Berlin

**Jagannathan Sarangapani**, Professor  
PHD University of Texas-Arlington

**Sahra Sedighsarvestani**, Associate Professor  
PHD Purdue University-W. Lafayette

**Pourya Shamsi**, Assistant Professor  
PHD University of Texas-Dallas

**Yiyu Shi**, Assistant Professor  
PHD University of California-LA

**Bijaya Shrestha**, Associate Teaching Professor  
PHD University of Missouri-Rolla

**Ronald Joe Stanley**, Associate Professor  
PHD University of Missouri-Columbia

**Theresa Mae Swift**, Assistant Teaching Professor  
PHD University of Missouri-Rolla

**Steve E Watkins**, Professor  
PHD University of Texas at Austin

**Cheng Hsiao Wu**, Professor  
PHD University of Rochester

**Donald C Wunsch II**, Professor<sup>1</sup>  
PHD University of Washington

**Chengshan Xiao**, Professor  
PHD University of Sydney-Australia

**Maciej J Zawodniok**, Associate Professor  
PHD University of Missouri-Rolla

**Yahong Rosa Zheng**, Associate Professor  
PHD Carleton University

**Reza Zoughi**, Professor  
PHD University of Kansas

**COMP ENG 1200 Introduction to Digital Electronics** (LEC 3.0)  
Introduction to electronics and digital circuit design including combinational logic and sequential circuits using circuit design tools, logic gates, integrated circuits and field programmable gate arrays. This course provides S&T equivalent credit for the Project Lead The Way Digital Electronics course.

**COMP ENG 2001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP ENG 2210 Introduction to Digital Logic** (LEC 3.0)  
Binary arithmetic, Boolean algebra, logic and memory elements, computer organization. Prerequisite: Sophomore standing. Comp Eng 2211 is also a co-requisite for Comp Eng and Elec Eng majors.

**COMP ENG 2211 Computer Engineering Laboratory** (LAB 1.0)  
Introduction to digital design techniques, logic gates, Medium Scale Integration (MSI) parts and flipflops, Timing analysis, Programming and use of Programmable Logic Devices (PLD). Prerequisite: Preceded or accompanied by Comp Eng 2210.

**COMP ENG 3000 Special Problems** (IND 1.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**COMP ENG 3001 Special Topics** (LEC 1.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP ENG 3002 Cooperative Engineering Training** (IND 1.0)  
On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation. Pass-fail grading option only. Prerequisite: Consent of the Electrical and Computer Engineering Department required.

**COMP ENG 3110 Computer Organization and Design** (LEC 3.0)  
Introduction to basic concepts of computer organization and design: metrics for computer performance, computer arithmetic, Von Neumann architecture, instruction implementation, control unit, pipelining, memory systems hierarchy, cache memories and basic I/O controllers. Prerequisites: COMP ENG 2210; preceded or accompanied by COMP ENG 3150.

**COMP ENG 3150 Introduction to Microcontrollers and Embedded System Design** (LEC 3.0)  
Microcontroller-based digital system design methodology and techniques. Topics include basic machine organization, interface design, and C and assembly language programming for real-time embedded systems. Prerequisites: COMP ENG 2210 and COMP SCI 1570 (or programming equivalent) each with grade of "C" or better.

**COMP ENG 3151 Digital Engineering Lab II** (LAB 1.0)  
Advanced digital design techniques, Microcontroller based design, hardware and software codesign. Prerequisites: Comp Eng 2210, Comp Eng 2211, and Comp Sci 1570 (or programming equivalent) each with grade of "C" or better. Preceded or accompanied by Comp Eng 3150.

**COMP ENG 4000 Special Problems** (IND 1.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**COMP ENG 4001 Special Topics** (LEC 0.0 and LAB 0.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP ENG 4096 Computer Engineering Senior Project I** (LAB 0.50 and RSD 0.50)  
A complete design cycle. Working in small teams, students will design, document, analyze, implement, and test a product. Topics include: Iteration in design, prototyping, group dynamics, design reviews, making effective presentations, concurrent design, designing for test, ethics and standards, testing and evaluation. Prerequisites: Comp Eng 2210, either Econ 1100 or Econ 1200, either English 3560 or English 1160, Comp Eng 3150, Comp Eng 3151, Comp Eng 3110, and Elec Eng 2200.

**COMP ENG 4097 Computer Engineering Senior Project II** (LAB 3.0)  
A continuation of Comp Eng 4096. Prerequisites: Comp Eng 4096 with a grade of "C" or better, Stat 3117 or Stat 3115 or Stat 5643, and Sp&M S 1185.

**COMP ENG 4099 Undergraduate Research** (IND 1.0-6.0)  
Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**COMP ENG 5000 Special Problems** (IND 1.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**COMP ENG 5001 Special Topics** (LEC 1.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.



**COMP ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**COMP ENG 5070 Teaching Engineering** (LEC 3.0)

Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mgt 5070, Env Eng 5070, Elec Eng 5070, Civ Eng 5070).

**COMP ENG 5099 Special Research And Thesis** (IND 1.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Prerequisite: Consent of the instructor required.

**COMP ENG 5110 Principles of Computer Architecture** (LEC 3.0)

Principles of performance measurement and instruction set design; advanced issues in pipelining; instruction level parallelism (dynamic scheduling, branch prediction, multi-issue processors); memory hierarchies for superscalar processors; multiprocessors; multi-threading; storage systems; and interconnection networks. Prerequisite: Comp Eng 3110.

**COMP ENG 5120 Digital Computer Design** (LEC 3.0)

Organization of modern digital computers; design of processors, memory systems and I/O units, hardware-software tradeoffs in different levels of computer system design. Prerequisites: COMP ENG 3150 and COMP ENG 3151.

**COMP ENG 5130 Advanced Microcomputer System Design** (LEC 3.0)

The design of digital systems based on advanced microprocessors. Introduction to microcomputer logic development systems. I/O interfaces. Assembly and high level language tradeoffs. Hardware and software laboratory projects required. Prerequisites: COMP ENG 5110.

**COMP ENG 5151 Digital Systems Design Laboratory** (LAB 1.0 and LEC 2.0)

Experimental studies of problems with high speed digital signals in circuits. Student designs, wires, tests, and programs a microprocessor based single board computer project. A FPGA design is programmed and tested. Prerequisites: COMP ENG 3150 or 5110.

**COMP ENG 5160 Embedded Processor System Design** (LEC 3.0)

Development of hardware and software for embedded systems, including real-time operating systems, advanced programming, communication schemes, hardware peripherals and sensors, control methodologies, printed-circuit board design, interrupts, microcontrollers, and hardware-software co-design. One or more team design projects. Prerequisites: COMP ENG 3150 or equivalent or 80x51 processor experience.

**COMP ENG 5170 Real-Time Systems** (LEC 3.0)

Introduction to real-time (R-T) systems and R-T kernels, also known as R-T operating systems, with an emphasis on scheduling algorithms. The course also includes specification, analysis, design and validation techniques for R-T systems. Course includes a team project to design an appropriate R-T operating system. Prerequisites: COMP ENG 3150 or COMP SCI 3800.

**COMP ENG 5210 Introduction To VLSI Design** (LEC 3.0)

An introduction to the design and analysis of digital integrated circuits (ICs). Topics include basic manufacturing techniques, transistor-level design and analysis of logic and memory circuits, logic timing, and parasitics. Computer aided design tools are used to develop circuits in the lab. Prerequisites: Elec Eng 2200 and Comp Eng 2210.

**COMP ENG 5220 Digital System Modeling** (LEC 3.0)

Digital system modeling for simulation, synthesis, and rapid system prototyping. Structural and behavioral models, concurrent and sequential language elements, resolved signals, generics, configuration, test benches, processes and case studies. Prerequisite: Comp Eng 2210 with a grade of "C" or better.

**COMP ENG 5230 Optical Computing** (LEC 3.0)

Introduction to the principles, subsystems, and architectures of optical computing. Topics include characteristics of optical devices; optical implementations of memory, logic elements, and processors; and computational structures. Prerequisite: Comp Eng 2210 or equivalent. (Co-listed with Elec Eng 5250).

**COMP ENG 5310 Computational Intelligence** (LEC 3.0)

Introduction to Computational Intelligence (CI), Biological and Artificial Neuron, Neural Networks, Evolutionary Computing, Swarm Intelligence, Artificial Immune Systems, Fuzzy Systems, and Hybrid Systems. CI application case studies covered include digital systems, control, power systems, forecasting, and time-series predictions. Prerequisite: Graduate Standing. (Co-listed with Elec Eng 5310 and Sys Eng 5211).

**COMP ENG 5410 Introduction to Computer Communication Networks** (LEC 3.0)

Design of computer networks with emphasis on network architecture, protocols and standards, performance considerations, and network technologies. Topics include: LAN, MAN, WAN, congestion/flow/error control, routing, addressing, broadcasting, multicasting, switching, and internetworking. A modeling tool is used for network design and simulation. Prerequisites: Comp Eng 3150 or computer hardware competency and Stat 3117 or Stat 3115 or Stat 5643 or equivalent.

**COMP ENG 5420 Introduction to Network Security** (LEC 3.0)

This course examines basic issues in network management, testing, and security; it also discusses key encryption, key management, authentication, intrusion detection, malicious attack, and insider threats. Security of electronic mail and electronic commerce systems is also presented. Prerequisite: Comp Eng 5410 or Comp Sci 5600.

**COMP ENG 5430 Wireless Networks** (LEC 2.0 and LAB 1.0)

Introduction to wireless communications and networking. Topics include transmission fundamentals, wireless channel, coding techniques and error control, satellite and cellular networks, cordless systems, mobile IP and management, multiple access techniques and wireless protocols, wireless LAN, IEEE 802.11, and adhoc and sensor networks. Prerequisites: Hardware competency, Elec Eng 3420 or Comp Eng 3150 and graduate standing. (Co-listed with Elec Eng 5430 and Sys Eng 5323.).

**COMP ENG 5450 Digital Image Processing** (LEC 3.0)

Fundamentals of human perception, sampling and quantization, image transforms, enhancement, restoration, channel and source coding. Prerequisites: At least one of the following: Elec Eng 3400, Elec Eng 3410, Elec Eng 3420, or prior exposure to Fourier Transforms and consent of the instructor. (Co-listed with Elec Eng 5450).

**COMP ENG 5460 Machine Vision** (LEC 3.0)

Image information, image filtering, template matching, histogram transformations, edge detection, boundary detection, region growing and pattern recognition. Complementary laboratory exercises are required. Prerequisites: At least one of the following: Elec Eng 3400, Elec Eng 3410, Elec Eng 3420, or prior exposure to Fourier Transforms and consent of the instructor. (Co-listed with Elec Eng 5460).

**COMP ENG 5510 Fault-Tolerant Digital Systems** (LEC 3.0)

Design and analysis of fault-tolerant digital systems. Fault models, hardware redundancy, information redundancy, evaluation techniques, system design procedures. Prerequisites: Comp Eng 2210 and Comp Eng 2211.

**COMP ENG 5610 Real-Time Digital Signal Processing** (LEC 2.0 and LAB 1.0)

Introduction to the use of programmable DSP chips. Includes real-time data acquisition, signal generation, interrupt-driven programs, high-level language, and assembly level routines. Applications to real-time systems are also presented. Prerequisite: Elec Eng 3400 or Elec Eng 3410.

**COMP ENG 5620 Signal Integrity in High-Speed Digital & Mixed Signal Design** (LEC 3.0)

Signal integrity ensures signals transmitted over a propagation path maintain sufficient fidelity for proper receiver operation. Compromised signal integrity is often associated with parasitics (e.g. unintentional inductance, capacitance). Theory and CAD tools used for signal integrity analysis of functioning designs. Prerequisites: Elec Eng 3600 or Comp Eng 3150, and Senior standing. (Co-listed with Elec Eng 5620).

**COMP ENG 5803 Mathematical Logic I** (LEC 3.0)

A mathematical introduction to logic with some applications. Functional and relational languages, satisfaction, soundness and completeness theorems, compactness theorems. Examples from Mathematics, Philosophy, Computer Science, and/or Computer Engineering. Prerequisite: Philos 3254 or Math 5105 or Comp Sci 2500 or Comp Eng 2210. (Co-listed with Comp Sci 5203, Philos 4354 and Math 5154).

**COMP ENG 5820 Mechatronics** (LEC 2.0 and LAB 1.0)

This course will introduce students to the basics of mechatronics (i.e., the integration of mechanical, electrical, computer, and control systems). Students will learn the fundamentals of sensors and actuators for mechanical systems, computer interfacing, microcontrollers, real-time software, and control. Prerequisite: Mech Eng 4479 or equivalent. (Co-listed with Mech Eng 5478, Aero Eng 5478 and Elec Eng 5870).

**COMP ENG 5880 Introduction to Robotics** (LEC 3.0)

This course provides an introduction to robotics, covering robot hardware, fundamental kinematics, trajectories, differential motion, robotic decision making, and an overview of current topics in robotics. Prerequisite: A "C" or better in both Math 3108 and Comp Sci 1510. (Co-listed with Comp Sci 5403 and Elec Eng 5880).

## Computer Science

The computer science department educates students in a broad range of areas. Students take courses in the design and implementation of software systems and the algorithms (problem solving techniques) used to solve "real world" problems in business, industry, and engineering or as preparation for graduate study. Students are given both the depth and breadth of computer science so necessary to keep them competitive in today's fast-changing world. While instruction and research are on the leading edge of computing, the department endeavors to keep class sizes small to promote proactive teaching practices and effective interactions between the students and faculty.

In addition to computer science courses, the department's undergraduate program requires students to be educated in a broad range of general education courses. All computer science seniors are expected to take the capstone course that gives them "real world" experience working in teams composed of fellow students and practicing computer scientists. These teams design, implement, test, and maintain actual software systems. (The sample curriculum shown below provides more detail.)

The computer science faculty has a broad range of scholarly interests which include computer security and privacy, databases and wireless systems, intelligent systems (artificial intelligence, machine learning, evolutionary computation), data mining, parallel and distributed processing, software engineering, computer networks, computer vision, mobile and pervasive computing, computational science, and algorithms. The research being done in these areas involves both undergraduates and graduates and supports the department's crosscutting areas of excellence: big data, critical infrastructure protection, cyber physical systems, and smart computing. Faculty are not only actively doing research in these areas; they integrate their research experiences into the classroom.

Computer science graduates from Missouri S&T work in a variety of environments. Some work for large companies, others prefer smaller companies. Many of our graduates have started their own companies. Regardless of their choice of employment, Missouri S&T computer science graduates are in high demand as evidenced by the number of companies that specifically recruit our graduates.

The computer science department at Missouri S&T makes use of both its own computer learning center (CLC) as well as university CLCs. The department CLC contains a mix of Linux and Windows computing platforms.

Research laboratories provide support for both undergraduate and graduate students. These laboratories include:

- Computer Vision and Biomedical Imaging Laboratory
- CRWMan Laboratory
- Critical Infrastructure Protection Laboratory
- McDonnell Douglas Software Engineering Laboratory
- Natural Computation Laboratory
- Network Research Laboratory
- Pervasive Computing Laboratory
- Social Computing Research Laboratory
- Web and Wireless Computing (W2C) Laboratory and NSF Industry-University Research Center on Net Centric Software Systems

Wired and wireless network access is available to all students, faculty and staff.

For further information, visit the department's web page at <http://cs.mst.edu> or contact us at 573-341-4491 or at [csdept@mst.edu](mailto:csdept@mst.edu).

## Bachelor of Science Computer Science

A minimum of 128 credit hours is required for a Bachelor of Science degree in computer science and an average of at least two grade points per credit hour must be obtained. These requirements for the B.S. degree are in addition to credit received for algebra, trigonometry, and basic ROTC.

The computer science curriculum requires twelve semester hours in humanities, exclusive of foreign language, and must include ENGLISH 1160 or ENGLISH 3560. A minimum of nine semester hours is required in social sciences, including either HISTORY 1300, HISTORY 1310, HISTORY 1200, or POL SCI 1200. Specific requirements for the bachelor degree are outlined in the sample program listed below.

All computer science majors must earn a "C" or better grade in all COMP SCI courses used to fulfill B.S. in computer science degree requirements as well as in COMP ENG 2210, COMP ENG 3150, and the required ethics elective.

## Sample Course of Study

Freshman Year			
First Semester	Credits	Second Semester	Credits
COMP SCI 1010 <sup>14</sup>	1	COMP SCI 1200	3
COMP SCI 1570	3	COMP SCI 1575	3
COMP SCI 1580	1	COMP SCI 1585	1
MATH 1214	4	MATH 1215	4
ENGLISH 1120	3	ENGLISH 1160 <sup>13</sup>	3
Humanities Elective <sup>5</sup>	3	SP&M S 1185 <sup>4</sup>	3
	15		17
Sophomore Year			
First Semester	Credits	Second Semester	Credits
COMP SCI 2200	3	COMP SCI 2300	3
COMP SCI 2500	3	COMP ENG 2210 <sup>12</sup>	3
PHYSICS 1135 <sup>3</sup>	4	PHYSICS 2135 <sup>3</sup>	4
Statistics Elective <sup>6</sup>	3	MATH 3108 <sup>7</sup>	3
Social Science Elective <sup>2</sup>	3	Literature Elective <sup>5</sup>	3
	16		16
Junior Year			
First Semester	Credits	Second Semester	Credits
COMP SCI 3100	3	COMP SCI 3600	3
COMP SCI 3500	3	COMP SCI 3800	3
COMP ENG 3150	3	Laboratory Science <sup>1</sup>	5
History Elective <sup>2</sup>	3	Sci/Eng Elective <sup>10</sup>	3
Ethics Elective <sup>11</sup>	3	Social Science Elective <sup>2</sup>	3
	15		17
Senior Year			
First Semester	Credits	Second Semester	Credits
COMP SCI 4096	3	Cmp Sc Electives <sup>9</sup>	9
Cmp Sc Electives <sup>9</sup>	6	Sci/Eng Elective <sup>10</sup>	3
Sci/Eng Elective <sup>10</sup>	3	Free Elective <sup>8</sup>	5
Free Elective <sup>8</sup>	3		
	15		17

Total Credits: 128

<sup>1</sup> Any science lecture-laboratory course or course pair totaling at least four hours credit. The laboratory is mandatory in all cases. These course(s) may be selected from: CHEM 1310 and CHEM 1319; CHEM 1351; BIO SCI 1113 and BIO SCI 1219; PHYSICS 1505 and PHYSICS 1509; GEOLOGY 1110 and GEOLOGY 1119; GEOLOGY 1120 and GEOLOGY 1129; BIO SCI 1223 and BIO SCI 1229; BIO SCI 2353 and BIO SCI 2359.

- <sup>2</sup> Any nine credit hours of social science courses approved on the list maintained on the computer science website. One course must satisfy the Missouri and U.S. Constitution requirement. COMP SCI 4700 may be counted as a Social Science elective.
- <sup>3</sup> Either PHYSICS 1135 or PHYSICS 1111-PHYSICS 1119; either PHYSICS 2135 or PHYSICS 2111-PHYSICS 2119.
- <sup>4</sup> SP&M S 1185 or SP&M S 3283.
- <sup>5</sup> One literature and one humanities course approved on the list maintained on the computer science website.
- <sup>6</sup> One of STAT 3113, STAT 3115, STAT 3117, or STAT 5643.
- <sup>7</sup> MATH 3103 or MATH 3108.
- <sup>8</sup> Courses chosen from any field so that 128 hours are completed. These and only these courses may be taken pass/fail and only one course may be taken pass/fail each semester. Some courses such as algebra, trigonometry, MATH 1214, MATH 1215, MATH 1221, PHYSICS 1111, PHYSICS 1119, PHYSICS 1135, PHYSICS 2135, PHYSICS 2111, PHYSICS 2119, PHYSICS 1145, PHYSICS 2145 and the first two years of ROTC do not count toward the free electives.
- <sup>9</sup> Fifteen hours of elective COMP SCI courses excluding COMP SCI 2002, COMP SCI 4700, COMP SCI 2001 - Domain Exploration and Innovation Methods, COMP SCI 3001 - Skill Development for Entrepreneurs and Innovators, COMP SCI 4001 - Advanced Domain Exploration and Innovation Methods, COMP SCI 4001 - Interpersonal Dynamics for Entrepreneurs and Innovators, and all COMP SCI x9xx courses. At least nine hours must be 5000-level or higher. At least nine hours must be lecture courses.
- <sup>10</sup> Any nine hours chosen from departments that offer a degree associated with either the Discipline Specific Curricula Committee for Sciences or the Discipline Specific Curricula Committee for Engineering, excluding computer science. These may not be MATH 1208, MATH 1214, MATH 1215, MATH 1221, PHYSICS 1111, PHYSICS 1119, PHYSICS 1135, PHYSICS 2135, PHYSICS 2111, PHYSICS 2119, PHYSICS 1145, or PHYSICS 2145.
- <sup>11</sup> One of PHILOS 3225, PHILOS 3235, PHILOS 4340, or PHILOS 4368.
- <sup>12</sup> Laboratory not required.
- <sup>13</sup> ENGLISH 1160 or ENGLISH 3560.
- <sup>14</sup> One of COMP SCI 1010, BIO SCI 1201, CHEM 1110, PHYSICS 1101, MATH 1101, or FR ENG 1100.

## Computer Science Minor Curriculum

A student with a minor in computer science must meet the following requirements:

1. A "C" or better grade in at least 18 credit hours of COMP SCI courses, excluding x9xx courses.
2. A "C" or better grade in at least 9 credit hours of COMP SCI courses at the 2000 or higher level.
3. A "C" or better grade in two of the following courses: COMP SCI 3100, COMP SCI 2200, COMP SCI 3200, COMP SCI 2300, COMP SCI 2500, COMP SCI 3500 and COMP SCI 3800.
4. At most 6 of the 18 credit hours can be transfer credits and transfer classes must show a "C" or better grade.

**Bushra Anjum**, Associate Teaching Professor  
PHD North Carolina University

**Randy Lawrence Canis**, Adjunct Professor  
JD University of Missouri-Columbia

**Sriram Chellappan**, Associate Professor  
PHD Ohio State University

**Maggie Xiaoyan Cheng**, Associate Professor  
PHD University of Minnesota

**Sajal K Das**, Professor  
PHD University of Central Florida

**Fikret Ercal**, Professor  
PHD Ohio State University

**Alireza Hurson**, Professor  
PHD University of Central Florida

**Wei Jiang**, Associate Professor  
PHD Purdue University

**Jennifer Leopold**, Associate Professor  
PHD University of Kansas

**Dan Lin**, Assistant Professor  
PHD National University of Singapore

**Xiaoqing Frank Liu**, Professor  
PHD Texas A&M University

**Sanjay Kumar Madria**, Professor  
PHD Indian Institute of Technology, India

**Bruce M McMillin**, Professor  
PHD Michigan State University

**David M Mentis**, Teaching Associate  
MASTER Missouri Science and Technology

**Angel Ricardo Morales**, Assistant Teaching Professor  
PHD Texas Tech University

**Clayton E Price**, Associate Teaching Professor; Freshman/Transfer  
Advisor  
MASTER University of Missouri - Rolla

**Chaman L Sabharwal**, Professor  
PHD University of Illinois-Urbana

**Abu Sayeed Saifullah**, Assistant Professor  
PHD Washington University

**Sahra Sedighsarvestani**, Associate Professor  
PHD Purdue University-W. Lafayette

**Simone Silvestri**, Assistant Professor  
PHD University of Rome

**Daniel R. Tauritz**, Associate Professor  
PHD Leiden University

**Donald C Wunsch II**, Professor<sup>1</sup>  
PHD University of Washington

**Zhaozheng Yin**, Assistant Professor  
PHD Pennsylvania State University

**COMP SCI 1001 Special Topics** (LAB 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP SCI 1010 Introduction To Computer Science** (LEC 1.0)

This course is devoted to an introduction of various areas of Computer Science, the faculty members, and lab equipment. Computer ethics will be discussed in several lectures.

**COMP SCI 1200 Discrete Mathematics For Computer Science** (LEC 3.0)

A rigorous treatment of topics from discrete mathematics which are essential to computer science. Principal topics include: formal logic (propositional & predicate), proof techniques, mathematical induction, program correctness, sets, combinatorics, probability, relations, functions, matrices, graph theory and graph algorithms. Prerequisite: A "C" or better grade in Comp Sci 1570.

**COMP SCI 1570 Introduction To Programming** (LEC 3.0)

Programming design and development using C++. Emphasis placed on problem solving methods using good programming practices and algorithm design and development. Topics included are syntax/ semantics, logical, relational and arithmetic operators, decision branching, loops, functions, file I/O, arrays, output formatting, C-strings, and an introduction to Object-Oriented Programming including the development and use of classes. Prerequisite: Accompanied by Comp Sci 1580.

**COMP SCI 1575 Data Structures** (LEC 3.0)

A continuation of Object-Oriented Programming, with emphasis on the efficient organization of data through Abstract Data Types and Data Structures. Topics include Linked Lists, Vectors, Stacks, Queues, Trees, Hash Tables, Graphs and their use in a variety of algorithms. Recursive programming techniques are also covered. This course is programming intensive. Prerequisite: Grade of "C" or better in Comp Sci 1570.

**COMP SCI 1580 Introduction To Programming Laboratory** (LAB 1.0)

Practical applications of concepts learned in Computer Science 1570. Hands-on instruction in C++ developing, debugging, and testing programming projects. Prerequisite: Accompanied by Comp Sci 1570.

**COMP SCI 1585 Data Structures Laboratory** (LAB 1.0)

Hands-on instruction in programming development tools such as version control systems, integrated development environments, debuggers, profilers, and event-based programming environments. Exercises will complement the concepts presented in Comp Sci 1575. Prerequisite: Preceded or accompanied by Comp Sci 1575.

**COMP SCI 1970 Basic Scientific Programming** (LEC 2.0)

Introduction to the structure of programs and programming techniques in Fortran to solve science and engineering problems. Topics include data representation, basic solutions of numerical problems and the debugging and verification of programs. Prerequisite: Entrance requirements.

**COMP SCI 1971 Introduction To Programming Methodology** (LEC 2.0)

Basic structured programming and problem solving techniques using C++. Development, debugging, and testing of programs, data representation. Topics to include syntax/semantics, operators, loops, decision branching, arrays, file I/O. This course is a terminal course for non-majors and is not sufficient for entry into Computer Science 1510.



**COMP SCI 1972 Introduction to MATLAB Programming** (LEC 2.0)

Programming design and development using MATLAB for non-CS majors. Strong emphasis placed on algorithmic problem solving methods using good programming practices. Introduction to built-in functions including plotting, as well as logical/relational/arithmetic operators, decision branching, loops, functions, file I/O, datastructures, and output formatting. Prerequisite: Accompanied by Comp Sci 1982 and a "C" or better grade in either Math 1208 or Math 1214.

**COMP SCI 1980 Computer Programming Laboratory** (LAB 1.0)

A laboratory to accompany Comp Sci 1970 which emphasizes the designing, writing and debugging of programs in Fortran. Prerequisite: Accompanied by Comp Sci 1970.

**COMP SCI 1981 Programming Methodology Laboratory** (LAB 1.0)

A hands-on introduction to structured programming in C++. Development, coding, debugging, and execution of programming concepts discussed in Computer Science 1971. Prerequisite: Accompanied by Computer Science 1971.

**COMP SCI 1982 MATLAB Programming Laboratory** (LAB 1.0)

Practical application of concepts learned in Comp Sci 1972. Hands-on instruction in MATLAB developing, debugging and testing programming projects. Prerequisite: Accompanied by Comp Sci 1972.

**COMP SCI 2001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP SCI 2002 Cooperative Work Training** (IND 1.0-5.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation. Not more than 9 hours may be applied to the B.S. degree.

**COMP SCI 2200 Theory of Computer Science** (LEC 3.0)

This course will cover the theoretical underpinnings of computer science. In particular, this course will cover the following topics: basic computability and formal language concepts, regular languages, context free languages, recursively-enumerable languages, and classes P, NP, and NP-completeness. Prerequisite: A "C" or better grade in both Comp Sci 1200 and Comp Sci 1510.

**COMP SCI 2300 File Structures And Introduction To Database Systems** (LEC 3.0)

Course covers major topics in file structures and database systems including techniques for disk access and organization, record and file structures, index structures, sequential file, dense/sparse and secondary indexes, B-trees, range queries, insertion/deletion, hash tables, fundamentals of database systems, the ER model, relational model, algebra and SQL. Prerequisite: A "C" or better grade in Comp Sci 1510.

**COMP SCI 2500 Algorithms** (LEC 3.0)

Students will solve recurrence relations, analyze algorithms for correctness and time/space complexity, apply these analysis techniques to fundamental dynamic programming, greedy, shortest-path, minimal spanning trees, and maximum flow algorithms and validate these analyses through programming. Prerequisite: A "C" or better grade in both Comp Sci 1200 and Comp Sci 1510; preceded by "C" or better grade in either Math 1208 or Math 1214, or accompanied by either Math 1208 or Math 1214.

**COMP SCI 2501 Java and Object Oriented Design** (LEC 3.0)

This course will cover Basic Java, Applets, Application, Classes, interfaces, Strings, Arrays, Generics, inheritance, Polymorphism, Algorithm and Object Oriented Design, Software Testing, Exception Handling, File I/O. The use of Graphical User Interfaces in program design and introduction to Software Life Cycle. Project included. Prerequisite: A "C" or better grade in Comp Sci 1570.

**COMP SCI 2889 Introduction To Computer Organization And Assembly** (LEC 3.0)

A detailed study designed to teach the building blocks of a computer system, assembly language programming and the basic computer organization concepts. Subjects include digital logic, performance issues, machine & assembly language, binary arithmetic, and the structure of an ALU. Prerequisites: Comp Sci 1510 and Comp Sci 1200.

**COMP SCI 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP SCI 3010 Seminar** (IND 0.0-6.0)

Discussion of current topics.

**COMP SCI 3100 Software Engineering I** (LEC 3.0)

Development of methodologies useful in the software engineering classical life cycle. This includes: requirements, design, implementation, and testing phases. These methodologies are reinforced through utilization of a CASE tool and a group project. Prerequisite: A "C" or better grade in Comp Sci 2500 and at least Junior standing.

**COMP SCI 3200 Introduction To Numerical Methods** (LEC 3.0)

Finite difference interpolation, numerical differentiation and integration, linear systems of equations, solution of nonlinear equations, numerical solution of ordinary differential equations, computational techniques and the programming of a large number of problems on digital computers. Prerequisites: Program competency and a "C" or better grade in either Math 1215 or Math 1221.

**COMP SCI 3500 Programming Languages And Translators** (LEC 3.0)

Covers basic design of programming languages, compilers and interpreters. The concepts of syntax, variables, expressions, types, scope, functions, procedures, statements, I/O, exception handling and concurrency are introduced. The manner in which various programming languages handle these concepts is discussed. Prerequisite: A "C" or better grade in Comp Sci 2200.

**COMP SCI 3600 Introduction to Computer Security** (LEC 3.0)

This course encompasses threats and vulnerabilities, trust and security policies, and enforcement. Specific topics include access control, risk management, systems and applications life cycle, physical security, key management, transmission security, and cryptography. Prerequisite: A "C" or better grade in Comp Sci 2500.

**COMP SCI 3601 Digital Forensics** (LEC 3.0)

Planning/managing incidents and response related to digital forensics; identifying, collecting, and preserving digital evidence; live/dead approaches covering systems as a whole emphasizing file system forensics; analysis and interpretation of artifacts culminating in a final project consisting of a collection, analysis, and report; legal and ethical issues. Prerequisites: A "C" or better grade in both COMP SCI 3600 and COMP SCI 3800.

**COMP SCI 3800 Introduction To Operating Systems** (LEC 3.0)

This course teaches the concepts, structure, and mechanisms of Operating Systems. Topics include process management, concurrency, synchronization, deadlock, multithreading, memory management, scheduling, and internetworking. Special emphasis is given to Unix and its modern-day derivatives. Prerequisites: A "C" or better grade in all of Comp Sci 1510, Comp Sci 1200, and Comp Eng 3150.

**COMP SCI 3803 Computer Organization** (LEC 3.0)

A detailed study of computer organization concepts and the components of a computer system including control unit, microprogramming, pipelining, memory hierarchy, cache design, virtual memory, I/O devices, and a brief introduction to parallel processors. Prerequisites: A "C" or better in both Comp Eng 2210 and Comp Sci 1510.

**COMP SCI 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**COMP SCI 4001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP SCI 4010 Seminar** (IND 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

**COMP SCI 4096 Software Systems Development I** (LEC 3.0)

Class members will work in small teams to develop a complete software system beginning with end-user interviews and concluding with end-user training. Prerequisites: 100 credit hours completed and a grade of "C" or better in both Comp Sci 3100 and one of Phil 3225, Phil 3235, Phil 4340, or Phil 4368.

**COMP SCI 4097 Software Systems Development II** (LEC 3.0)

This course is an optional continuation of Comp Sci 397. Those interested in project management should take this course since participants become officers or group leaders in the class "corporation." This course is especially important for those going straight into industry upon graduation. Students with coop experience may find this course redundant. Prerequisite: A "C" or better grade in Comp Sci 4096.

**COMP SCI 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Does not lead to the preparation of a thesis. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the faculty supervisor.

**COMP SCI 4489 Multimedia Systems** (LEC 3.0)

This course introduces the concepts and components of Multimedia information systems. Topics include: Introduction to Multimedia Data, Multimedia Data Compression, Techniques and Standards, Indexing and Retrieval, Data Storage Organization, Communication and Synchronization, Applications-Media-OnDemand Systems, Video Conferencing, Digital Libraries. Prerequisite: A "C" or better grade in Comp Sci 1510.

**COMP SCI 4600 Computer Communications And Networks** (LEC 3.0)

Network architecture model including physical protocols for data transmission and error detection/correction, data link concepts, LAN protocols, internetworking, reliable end to end service, security, and application services. Students will implement course concepts on an actual computer network. Prerequisite: A "C" or better grade in Comp Sci 3800.

**COMP SCI 4601 Computer Network Concepts And Technology** (LEC 3.0)

This course will introduce computer network concepts and will survey the current and evolving technology for the construction, operation, and management of those networks. Both hardware and software issues will be addressed with a focus on local area networks. Prerequisite: A "C" or better grade in Comp Sci 3800.

**COMP SCI 4700 Intellectual Property For Computer Scientists** (LEC 3.0)

A presentation of the relationship between the law of intellectual property and computer science. Topics include the application of copyright principles to computer programs, protection of computer programs through patents and trade secret law, and the effect of various agreements which are frequently encountered by the computer scientist. Prerequisite: Senior or graduate standing.

**COMP SCI 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**COMP SCI 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP SCI 5099 Research** (IND 0.0-16)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**COMP SCI 5100 Agile Software Development** (LEC 3.0)

Understand principles of agile software development and contrast them with prescriptive processes. Specifically: Eliciting, organizing, and prioritizing requirements; Design processes; Understand how a particular process promotes quality; Estimate costs and measure project progress and productivity. Prerequisite: A "C" or better grade in Comp Sci 3100.

**COMP SCI 5101 Software Testing And Quality Assurance** (LEC 3.0)

It covers unit testing, subsystem testing, system testing, object-oriented testing, testing specification, test case management, software quality factors and criteria, software quality requirement analysis and specification, software process improvement, and software total quality management. Prerequisite: A "C" or better grade in Comp Sci 2500.

**COMP SCI 5102 Object-Oriented Analysis And Design** (LEC 3.0)

This course will explore principles, mechanisms, and methodologies in object-oriented analysis and design. An object-oriented programming language will be used as the vehicle for the exploration. Prerequisite: A "C" or better grade in Comp Sci 2500.

**COMP SCI 5200 Analysis Of Algorithms** (LEC 3.0)

The purpose of this course is to teach the techniques needed to analyze algorithms. The focus of the presentation is on the practical application of these techniques to such as sorting, backtracking, and graph algorithms. Prerequisite: A "C" or better grade in Comp Sci 2500.

**COMP SCI 5201 Object-Oriented Numerical Modeling I** (LEC 3.0)

A study of object-oriented modeling of the scientific domain. Techniques and methodologies will be developed enabling the student to build a class library of reusable software appropriate for scientific application. Applications will be drawn from mechanics, finance, and engineering. Prerequisites: A "C" or better grade in both Comp Sci 3200 and Comp Sci 1510; a "C" or better grade in one of Math 3108, 3103, 3329.

**COMP SCI 5202 Object-Oriented Numerical Modeling II** (LEC 3.0)

A continued study of object-oriented modeling of the scientific domain. Advanced applications include models posed as balance laws, integral equations, and stochastic simulations. Prerequisite: A "C" or better grade in Comp Sci 5201.

**COMP SCI 5203 Mathematical Logic I** (LEC 3.0)

A mathematical introduction to logic with some applications. Functional and relational languages, satisfaction, soundness and completeness theorems, compactness theorems. Examples from Mathematics, Philosophy, Computer Science, and/or Computer Engineering. Prerequisite: Philos 3254 or Math 5105 or Comp Sci 2500 or Comp Eng 2210. (Co-listed with Math 5154, Philos 4354 and Comp Eng 5803.).

**COMP SCI 5204 Regression Analysis** (LEC 3.0)

Simple linear regression, multiple regression, regression diagnostics, multicollinearity, measures of influence and leverage, model selection techniques, polynomial models, regression with autocorrelated errors, introduction to non-linear regression. Prerequisites: Math 2222 and one of Stat 3111, 3113, 3115, 3117, or 5643. (Co-listed with Stat 5346).

**COMP SCI 5300 Database Systems** (LEC 3.0)

This course introduces the advanced database concepts of normalization and functional dependencies, transaction models, concurrency and locking, timestamping, serializability, recovery techniques, and query planning and optimization. Students will participate in programming projects. Prerequisite: A "C" or better grade in both Comp Sci 1200 and Comp Sci 2300.

**COMP SCI 5400 Introduction To Artificial Intelligence** (LEC 3.0)

A modern introduction to AI, covering important topics of current interest such as search algorithms, heuristics, game trees, knowledge representation, reasoning, computational intelligence, and machine learning. Students will implement course concepts covering selected AI topics. Prerequisite: A "C" or better grade in Comp Sci 2500.

**COMP SCI 5401 Evolutionary Computing** (LEC 3.0)

Introduces evolutionary algorithms, a class of stochastic, population-based algorithms inspired by natural evolution theory (e.g., genetic algorithms), capable of solving complex problems for which other techniques fail. Students will implement course concepts, tackling science, engineering and/or business problems. Prerequisite: A "C" or better grade in both Comp Sci 2500 and in a Statistics course.

**COMP SCI 5402 Data Mining & Machine Learning** (LEC 3.0)

Classical and modern data mining and machine learning algorithms; data preprocessing/warehousing, mining association rules, classification/prediction methods, clustering techniques, Bayesian networks; unsupervised/supervised/reinforcement learning, learning decision trees, artificial neural networks, support vector machines, and ensemble learning. Prerequisites: A "C" or better in both Comp Sci 2300 and one of Stat 3111, Stat 3113, Stat 3115, Stat 3117.

**COMP SCI 5403 Introduction to Robotics** (LEC 3.0)

This course provides an introduction to robotics, covering robot hardware, fundamental kinematics, trajectories, differential motion, robotic decision making, and an overview of current topics in robotics. Prerequisite: A "C" or better in both Math 3108 and Comp Sci 1510. (Co-listed with Comp Eng 5880 and Elec Eng 5880).

**COMP SCI 5404 Introduction to Computer Vision** (LEC 3.0)

This course introduces foundational theories and analysis methods in computer vision. Topics will include camera model and geometry, description of visual features, shape analysis, stereo reconstruction, motion and video processing, and visual object recognition. Prerequisite: A "C" or better grade in both Math 3108 and Comp Sci 2500.

**COMP SCI 5405 Java Gui & Visualization** (LEC 3.0)

Fundamentals of Java Swing Foundation Classes, Java System Language Specifics, Graphical User Interfaces, Images, Audio, Animation, Networking, and Threading. Visualization of Algorithms. GUI Elements include Event Driven Programming, Interaction with Mouse and KeyBoard, Window Managers, Frames, Panels, Dialog Boxes, Borders. Prerequisite: A "C" or better grade in Comp Sci 2500 or equivalent.

**COMP SCI 5406 Interactive Computer Graphics** (LEC 3.0)

Applications and functional capabilities of current computer graphics systems. Interactive graphics programming including windowing, clipping, segmentation, mathematical modeling, two and three dimensional transformations, data structures, perspective views, antialiasing and software design. Prerequisite: A "C" or better grade in both Comp Sci 3200 and Comp Sci 2500.

**COMP SCI 5500 The Structure of a Compiler** (LEC 3.0)

Review of Backus normal form language descriptors and basic parsing concepts. Polish and matrix notation as intermediate forms, and target code representation. Introduction to the basic building blocks of a compiler: syntax scanning, expression translation, symbol table manipulation, code generation, local optimization, and storage allocation. Prerequisite: A "C" or better grade in both Comp Sci 3500 and Comp Sci 2500.

**COMP SCI 5600 Computer Networks** (LEC 3.0)

This course focuses on the Internet and the general principles of computer networking. It covers the TCP/IP model from the application layer to the link layer in a top-down approach. It also exposes students to multimedia networking, network security, wireless and mobile networks. It is a networking class targeted for entry-level graduate students. This course has additional requirements beyond CS4600 on network performance modeling and analysis, development and implementation of complex communication protocols. Credit will not be given if previously have taken CS4600 or CpE 4410/5410. Prerequisite: A "C" or better grade in Comp Sci 3800.

**COMP SCI 5601 Security Operations & Program Management** (LEC 3.0)

An overview of information security operations, access control, risk management, systems and application life cycle management, physical security, business continuity planning, telecommunications security, disaster recovery, software piracy, investigations, ethics and more. There will be extensive reporting, planning and policy writing. Prerequisite: A "C" or better grade in all of: operating systems, computer networking, and a writing emphasized course.

**COMP SCI 5700 Bioinformatics** (LEC 3.0)

The course will familiarize students with the application of computational methods to biology, as viewed from both perspectives. It will introduce problems in molecular, structural, morphological, and biodiversity informatics, and will discuss principles, algorithms, and software to address them. Prerequisites: A grade of "C" or better in both one of Bio Sci 1113 or Bio Sci 1213 and one of Comp Sci 1570 and Comp Sci 1580 or Comp Sci 1971 and Comp Sci 1981. (Co-listed with Bio Sci 5323).

**COMP SCI 5800 Distributed Computing** (LEC 3.0)

This is an introduction to the fundamentals of distributed computing. Topics include a review of communication between distributed processes, causality, distributed state maintenance, failure detection, reconfiguration and recovery, distributed mutual exclusion, clock synchronization, and leader election. Students will implement select course concepts. Prerequisites: A grade of "C" or better in both Comp Sci 3800 and Comp Sci 2500.

**COMP SCI 5801 The Structure Of Operating Systems** (LEC 3.0)

The hardware and software requirements for operating systems for uniprogramming, multiprogramming, multiprocessing, time sharing, real time and virtual systems. The concepts of supervisors, interrupt handlers, input/output control systems, and memory mapping are discussed in detail. Prerequisite: A "C" or better grade in Comp Sci 3800.

**COMP SCI 5802 Introduction to Parallel Programming and Algorithms** (LEC 3.0)

Parallel and pipelined algorithms, architectures, network topologies, message passing, process scheduling and synchronization. Parallel programming on clusters. Cost, speedup and efficiency analysis. Prerequisite: A "C" or better grade in both Comp Sci 3800 and Comp Sci 2500.

**COMP SCI 5803 Introduction to High Performance Computer Architecture** (LEC 3.0)

Overviews high performance architecture of computing systems and covers various architectural/hardware and software/algorithmic means that enhance performance. Uniprocessor and concurrent systems are investigated. Various computational models are studied and linked to commercial systems. Prerequisite: A "C" or better grade in both Comp Eng 3150 and Comp Sci 2500.

## Economics

Economics has been called the "science of scarcity." It is the study of how individuals allocate scarce resources for production in order to satisfy their human needs and wants. This focus on the human condition places economics firmly into the social sciences area. However the application of economic principles to problems of choice in markets and in financial decision-making also gives economics a central role in the theory of business administration and management.

The Missouri S&T economics department offers a relevant business-oriented educational experience while maintaining the social science flavor of the traditional economics degree. The curriculum is based on a broad foundational core, business and information and technology. Students majoring in economics also take up to 33 hours of economics, finance, and management courses.

The economics courses are taught rigorously and are technically-oriented. They also provide a solid social science education with studies of the social problems of market failure, monopoly, inflation, and the effectiveness of government economic and social policy. Graduated students have an excellent education with job opportunities across the spectrum including business, finance, study of the law, government and public policy.

The economics program allows for the flexibility of selecting either the bachelor of arts or bachelor of science programs, depending on which best fits your goals and skills. Either degree will provide you with the necessary skills to compete effectively in the job market or succeed in graduate school.

Students wishing to minor in economics may select from a variety of courses tailored to their own needs. Specific tracks are available in energy/technology and international economics.

Students majoring in an academic area at Missouri S&T other than economics can pursue a secondary B.A. or B.S. in economics to accompany their primary major. See the department chair of economics for more details on this academic option.

The Missouri S&T economics department has in place a cooperative bachelor of science/master of science in accounting with the College of Business and Public Administration at the University of Missouri-Columbia. A student can take at Missouri S&T up to 90 hours of the 150 hours required for the BS/MS in accounting. The remaining 60 hours must be taken at Columbia. After completing the 90 hours at Missouri S&T, the student must take the GRE exam and be admitted into the MU graduate program.

## Bachelor of Arts Economics

In addition to the general university requirements for a bachelor of arts degree, a student must complete:

1. ECON 1100, ECON 1200, ECON 2100 and ECON 2200 with a minimum grade of "C" in each.
2. At least 18 additional hours of economics electives, at or above the 2000 level, with a minimum grade of "C" in each.
3. BUS 1210; and STAT 1115 or ECON 1300; and ECON 2300.

## Bachelor of Arts Economics (Secondary Education Emphasis Area)

You may earn a B.A. degree in economics from Missouri S&T and certification to teach at the secondary level in the schools of Missouri with the emphasis area program. This program can be completed in four academic years and student teaching is arranged with public schools within 30 miles of the Rolla campus.

Students interested in this emphasis area should consult with the minor advisor in the economics department.

In order to successfully complete this emphasis area, students must have at least a 22 ACT, maintain a cumulative GPA of at least 2.5, and attain at least a 2.5 GPA in all economics courses. Current Missouri S&T or transfer students who wish to pursue this emphasis area must meet both these GPA requirements to be accepted into the program. Students must also meet all requirements listed under the teacher education program of this catalog. Students who do not meet all the teacher certification requirements will not be eligible for the secondary education emphasis area, even if they have completed all course work.

A degree in this emphasis area requires 129 credit hours. The required courses are provided below. A minimum grade of "C" is required by the department in all mathematics and statistics courses counted toward this degree.

**Communications Skills: 9 semester hours**

ENGLISH 1120	Exposition And Argumentation	3
ENGLISH 1160	Writing And Research	3
or ENGLISH 3560	Technical Writing	
SP&M S 1185	Principles Of Speech	3

**Humanities: 6 semester hours**

Must include 6 hours from 2 of the following 3 areas: Art, Music or Theatre, Philosophy, Literature		6
---	--	---

**Social Sciences: 12 semester hours**

HISTORY 1300	American History To 1877	3
or HISTORY 1310	American History Since 1877	
POL SCI 1200	American Government	3
PSYCH 1101	General Psychology	3



HISTORY 2110	World Regional Geography	3
Natural Sciences: 7 semester hours (including 1 lab)		
Physics or Geology w/Lab		4
BIO SCI 1113	General Biology	3
Mathematics: 3 semester hours		
MATH 1120	College Algebra	3-5
or MATH 1140	College Algebra	
or higher		
Professional Requirements: 26 semester hours		
EDUC 1040	Perspectives In Education	2
EDUC 1174	School Organization & Adm For Elementary & Secondary Teachers	2
EDUC 2251	Historical Foundation Of American Education	3
EDUC 3216	Teaching Reading in Content Area	3
EDUC 3280	Teaching Methods And Skills In The Content Areas	6
EDUC 4298	Student Teaching Seminar	1
PSYCH 2300	Educational Psychology	3
PSYCH 3311	Psychological & Educational Development Of The Adolescent	3
PSYCH 4310	Psychology Of The Exceptional Child	3
Clinical Experience: 16 semester hours		
EDUC 1104	Teacher Field Experience	2
EDUC 1164	Aiding Elementary, Middle And Secondary Schools	2
EDUC 4299	Student Teaching	12
Economics: 30 semester hours		
ECON 1100	Principles Of Microeconomics	3
ECON 1200	Principles Of Macroeconomics	3
ECON 2100	Intermediate Microeconomic Theory	3
ECON 2200	Intermediate Macroeconomic Theory	3
HISTORY 4435	History of the American West (Delete Econ 1300 as a requirement, History 3430 is now 4435, Educ )	3
ECON 2300	Economic and Business Applications	3
Econ Electives (3000 or 4000 level)		9
BUS 1210	Financial Accounting	3
Certification: 20 semester hours		
HISTORY 1100	Early Western Civilization	3
or HISTORY 1200	Modern Western Civilization	
HISTORY 2220	Making Of Modern Britain	3
or HISTORY 2222	The Making Of Modern France	
or HISTORY 2224	Making Of Modern Russia	
or HISTORY 2210	European Diplomatic History 1814 - Present	
or HISTORY 3120	Ancient Greece	
or HISTORY 3130	Medieval History I	
or HISTORY 3135	Medieval History II	
or HISTORY 3140	History Of Renaissance Thought	
or HISTORY 3230	Europe In The Age Of The French Revolution And Napoleon	
or HISTORY 3235	Foundations Of Contemporary Europe 1815-1914	
or HISTORY 3240	Contemporary Europe	
HISTORY 3320	Colonial America	3
or HISTORY 3325	Revolutionary America, 1754-1789	
or HISTORY 3340	Age Of Jefferson And Jackson	
or HISTORY 3345	Civil War And Reconstruction	
or HISTORY 3360	Recent United States History	
or HISTORY 3450	American Intellectual History II	
or HISTORY 3425	History Of The Old South	
or HISTORY 3426	History Of The Modern South	
or HISTORY 3430		
or HISTORY 3480	History Of Baseball	
or HISTORY 3440	20th Century Americans In Combat	
or HISTORY 3441	The United States In World War II	
or HISTORY 3442	The United States in Vietnam	
or HISTORY 3761	U.S. Diplomatic History to World War II	
or HISTORY 3762	American Foreign Policy Since 1945	

POL SCI 3760	The American Presidency	3
--------------	-------------------------	---

## Areas of Concentration

Students are encouraged to use their electives, both in economics and in general, to develop areas of concentration beyond the core requirements. Among the possibilities are business, finance, and international affairs. Faculty advisors will assist students in establishing these curricular tracks.

## Bachelor of Science Economics

In Economics, the Bachelor of Science degrees consist of 120 credit hours. First, all undergraduate students in Economics are required to complete a prescribed General Education Requirements Core that corresponds to the recommendations of the Missouri State Coordinating Board for Higher Education and consists of 42 credit hours in the areas of Individual Expression, Natural Systems, and Human Institutions. In addition, all undergraduate students are required to complete a 39 credit hour core consisting of courses in Information Technology, Management, Quantitative Skills, and Communication Skills. A minimum grade of "C" is required for courses in both the Information Technology and the Management areas. Finally, each degree includes 19 credit hours of free electives.

The remaining 27 credit hours of the required 120 credit hours for the Economics degree are divided into a prescribed 18 credit hour degree core and 9 credit hours of specific degree electives. A minimum grade of "C" is required in these courses. The Economics degree requires courses in advanced Micro, Macro and Statistics. The electives for this degree consist of courses from areas such as Law and Economics, Money and Banking, Energy Economics and E-Commerce.

### Freshman Year

First Semester	Credits	Second Semester	Credits
ENGLISH 1120 <sup>1</sup>	3	PSYCH 1101	3
MATH 1140	3	MATH 1212	4
Free Electives	3	History	3
BIO SCI 1113, or 2223, or 2233, or 2263	3	IS&T 1750	3
Lab w/Living or Physical Science Course	1	ECON 1100 or 1200 <sup>4</sup>	3
13		16	

### Sophomore Year

First Semester	Credits	Second Semester	Credits
BUS 1110	3	BUS 1210	3
SP&M S 1185	3	ECON 1100 or 1200 <sup>4</sup>	3
STAT 3111	3	Chemistry, Geol, Ge Eng, or Physics	3
IS&T 1551	3	ART 1180, or 1185, or MUSIC 1150, or THEATRE 1190	3
ENGLISH 1211, or 1212, or 1231, or 1221, or 1222, or 2230, or 1223	3	Free Electives	3
15		15	

### Junior Year

First Semester	Credits	Second Semester	Credits
ENGLISH 1600	3	SP&M S 2181	3
FINANCE 2150	3	ECON 2200 <sup>4</sup>	3
ECON 2100 <sup>4</sup>	3	Emphasis Area Electives <sup>2</sup>	9

POL SCI 1200	3		
ECON 2300	3		
	15		15
<b>Senior Year</b>			
<b>First Semester</b>	<b>Credits</b>	<b>Second Semester</b>	<b>Credits</b>
ENGLISH 2560	3	Free Electives	13
Culture, Sociology, Religion <sup>3</sup>	3	ECON 4860	3
Emphasis Area Electives <sup>2</sup>	9		
	15		16
Total Credits: 120			

<sup>1</sup> In-Major Writing Intensive

<sup>2</sup> Economics Emphasis Electives 18 hours of which 12 hours must be Economics to be selected from ECON 2114, ECON 3810, ECON 3880 or at or above 3000 level Econ Lecture course and accumulate 6 hours from the following PSYCH 4700, PSYCH 4601, PSYCH 4602 or any 3000 or 4000 level Business Lecture courses.

<sup>3</sup> ECON 3830, ENGLISH 2242, ENGLISH 2245, ENGLISH 2410, ENGLISH 3215, ENGLISH 4290, Foreign Language Beyond Second Semester, HISTORY 3321, PHILOS 3225, PHILOS 3235, PHILOS 1175, PHILOS 4340, Any Political Science, PSYCH 4600, PSYCH 4992, Any Sociology, SP&M S 3235.

<sup>4</sup> A Grade of "C" or better is required for ECON 1100, ECON 1200, ECON 2100, ECON 2200, and ECON 2300.

## Economics Minor

Students majoring in other disciplines are encouraged to develop a minor in economics. The formal minor in economics is designed to provide students with a solid understanding of economic principles and concepts and the ability to apply this knowledge to a host of economic, public policy and business problems. This program will be of particular benefit to those students whose major field of study may lead them to pursue a management position or later graduate studies in business.

The minor in economics requires the completion of a minimum of 15 hours of economics course work with a grade of "C" or better. Required courses in the minor program include both ECON 1100 and ECON 1200 and at least one of the intermediate theory courses, ECON 2100 and/or ECON 2200. The choice of which intermediate theory course depends on which 300 level economic electives the student, in consultation with the department's minor advisor, selects for their program.

## Energy/Technology Minor

(15 hours)

### Required courses:

ECON 1100	Principles Of Microeconomics	3
ECON 1200	Principles Of Macroeconomics	3
ECON 2100	Intermediate Microeconomic Theory	3
<b>And 6 hours from:</b>		
ECON 4330		3
ECON 4430	Cost-Benefit Analysis	3
ECON 4440	Environmental And Natural Resource Economics	3

## Global Sustainable Economics Minor

(15 hours)

### Required courses:

ECON 1100 & ECON 2100 or ECON 1200 & ECON 2200	Principles Of Microeconomics and Intermediate Microeconomic Theory Principles Of Macroeconomics and Intermediate Macroeconomic Theory	6
ECON 4641	Foundations of Sustainability	3
<b>And 6 hours from:</b>		
ECON 3512/ MIN ENG 3512	Mining Industry Economics	3
ECON 4440	Environmental And Natural Resource Economics	3
ECON 4642	Introduction to Global Eco- and Social-preneurship and Innovation	3
ECON 4643	Ethical Problems in a Global Environment	3
ECON 4730	Economic Development	3
ECON 4540	Energy Economics	3
ENV ENG 5640	Environmental Law And Regulations	3
ENV ENG 5642	Sustainability, Population, Energy, Water, and Materials	3
PSYCH 4730	Environmental Psychology	3
HISTORY 4470	American Environmental History	3

## International Economics Minor

(15 hours)

### Required courses:

ECON 1100	Principles Of Microeconomics	3
ECON 1200	Principles Of Macroeconomics	3
ECON 2200	Intermediate Macroeconomic Theory	3
<b>And 6 hours from:</b>		
ECON 4710	International Trade	3
ECON 4730	Economic Development	3
ECON 4350	Statistical Models in Actuarial Science	3

**Bonnie J Bachman**, Professor  
PHD Rutgers University

**Michael C Davis**, Associate Professor  
PHD University of California-San Diego

**Mahelet Fikru**, Assistant Professor  
PHD Southern Illinois University-Carbondale

**Gregory Gelles**, Professor  
PHD West Virginia University

**Ana-Maria Ichim**, Assistant Professor  
PHD Louisiana State University

**Eun Soo Park**, Associate Professor  
PHD Northwestern University

**Sarah Steelman**, Assistant Teaching Professor  
MA University of Missouri-Columbia

**ECON 1000 Special Problems** (IND 1.0-6.0)  
Problems or readings on specific subjects or projects in the department.  
Prerequisite: Consent of instructor required.

**ECON 1001 Special Topics** (IND 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**ECON 1100 Principles Of Microeconomics** (LEC 3.0)  
An examination of how resources and products are priced and how income is distributed within various types of market structures.

**ECON 1200 Principles Of Macroeconomics** (LEC 3.0)

A study of alternative strategies for managing the U.S. economy within a global environment, to attain the goals of full employment, stability and growth.

**ECON 1300 Business And Economic Statistics I** (LEC 3.0)

This is an introductory course in business and economic statistics. Our main objective is to familiarize the student with elementary statistical concepts within the context of numerous applications in Business and Economics. We will highlight the primary use of statistics, that is, to glean information from an available sample regarding the underlying population. Prerequisite: Math 1120 or Math 1140 with a grade of "C" or better. (Co-listed with Stat 1111).

**ECON 2000 Special Problems** (IND 1.0-6.0)

Problems or readings on specific subjects or projects in the department. Prerequisite: Consent of instructor required.

**ECON 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ECON 2100 Intermediate Microeconomic Theory** (LEC 3.0)

Analysis of demand and supply in various market environments using the theories of production, resource pricing, and distribution of income. Emphasis on efficiency attainment and the rationale for market intervention. Prerequisites: Econ 1100 and 1200.

**ECON 2114 Managerial Economics** (LEC 3.0)

Focuses on micro- and macroeconomic contributions to managerial decision-making, business analysis and strategy. The roles of information, economic incentives, efficient markets, profits and decision-making under risk and uncertainty will be explored in both domestic and global settings. Prerequisites: Econ 1100 & 1200.

**ECON 2200 Intermediate Macroeconomic Theory** (LEC 3.0)

Examines the theoretical framework of national income and product generation, and the use of this theory to construct approaches such as, monetary and fiscal policy to attain economic, political and social goals. Prerequisites: Econ 1100 and 1200.

**ECON 2300 Economic and Business Applications** (LAB 1.0 and LEC 2.0)

Introduction and application of basic econometric and statistical techniques to solve real business and economics problems. Practical, hands-on use of Excel and SPSS will be introduced in the course. Prerequisites: Econ 1100 or 1200; Math 1140 or higher; Stat 1115 or 3111 or 3113 or 3115 or 3117 or 5643.

**ECON 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ECON 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ECON 3512 Mining Industry Economics** (LEC 3.0)

Importance of the mineral industry to national economy, uses, distribution, and trade of economic minerals, time value of money, mineral taxation, economic evaluation utilizing depreciation, depletion, and discounted cashflow concepts, social and economical significance of mineral resources. Prerequisite: Econ 1100 or 1200. (Co-listed with Min Eng 3512).

**ECON 3810 Law And Economics** (LEC 3.0)

Study of application of economics analysis to legal concepts, issues and reasoning. Emphasizes the use of microeconomic theory to examine questions of efficacy and efficiency of decisions emanating from three major areas of common law -property rights, contracts and torts. Prerequisite: Econ 1100 or equivalent.

**ECON 3830 History Of Economic Thought** (LEC 3.0)

Contributions of the classical and modern economists to the development of economic thought. Course aims at establishing a synthesis of evolving doctrines which have become the basis of currently accepted economic theory. Prerequisites: Econ 1100 and 1200.

**ECON 3880 Introduction to Sports Economics** (LEC 3.0)

The course uses economics to analyze the business of sports. The course is designed for students with both an introductory or broader economics background, but who have not studied the economics of sports. Topics include labor relations, stadium financing, league structure, competitive balance, amateurism, sports gambling and in-game strategy. Prerequisite: Econ 1100 or Econ 1200.

**ECON 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ECON 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ECON 4010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

**ECON 4085 Internship** (IND 0.0-6.0)

Internship will involve students applying critical thinking skills and discipline-specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisite: Senior status; must have completed 24 hours in major.

**ECON 4120 Micro and Macro Economics Essentials** (LEC 1.5)

This course is an introduction to the essentials of micro and macro economics for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Senior or Junior standing and 3.0 GPA required.

**ECON 4130 Network Economy** (LEC 3.0)

Emerging Network/Internet economy, using traditional economic tools. Topics: production and reproduction cost of information, information as an "experience good," versions of products, switching cost, lock-in effects, market adoption dynamics, first-mover advantage, intellectual property rights. Prerequisite: Econ 1100 or Econ 1200. (Co-listed with IS&T 4257).

**ECON 4230 Money And Banking** (LEC 3.0)

Study of the origin, principles, and functions of money, emphasizing the role of banks in the effectuation of monetary policies geared to achieve various economic and political goals. Prerequisite: Econ 2200.

**ECON 4310 Mathematical Economics** (LEC 3.0)

Marginal analysis, calculus, and linear algebraic systems are applied in selected advanced topics in economics such as price theory, general equilibrium theory, input-output analysis, activity analysis, and game theory. Prerequisite: Econ 2100, 2200, and Math 1208.

**ECON 4350 Statistical Models in Actuarial Science** (LEC 3.0)

This course covers the statistical foundation of actuarial models and their applications. Topics include survival and severity models, Kaplan-Meier and Nelson-Aalen estimators, aggregate and credibility models for insurance losses, discrete time Markov chains, ruin theory, and simulation. Prerequisite: Stat 5643 and either Stat 5644 or a 3000-level Stat course. (Co-listed with Stat 5755).

**ECON 4410 Public Finance** (LEC 3.0)

Study of government expenditures and sources of revenue. Particular emphasis is given to governmental decision making—how these decisions affect the economy and the behavior of individuals, firms, and families within the economy; and how these decisions may be evaluated. Prerequisite: Econ 2100.

**ECON 4430 Cost-Benefit Analysis** (LEC 3.0)

Investigates the rationale for cost-benefit analysis within a free enterprise setting. Discussion of market efficiency and failure; determination of social costs and benefits; applications of cost-benefit analysis; and, problems remaining in theory and practice. Prerequisite: Econ 2100.

**ECON 4440 Environmental And Natural Resource Economics** (LEC 3.0)

Optimum use of replenishable and non-replenishable resources, public goods and common resources, externalities, private vs. public costs, and quality of the environment; emphasis on public policy related to environmental and natural resource economics. Prerequisite: Econ 2100. (Co-listed with Min Eng 4523).

**ECON 4512 Mine Management** (LEC 3.0)

Theory and practice of mine management, including basic managerial functions, management theories, communication skills, motivation, leadership, organization, maintenance management, managerial decision making, cost control, labor relations, government relations, ethics and risks management with emphasis in presentation skills. Prerequisite: Completion of 50 credits toward Mining Engineering degree. (Co-listed with MIN ENG 4512).

**ECON 4540 Energy Economics** (LEC 3.0)

Market structure. World resource development. Supply and demand analysis on energy production and consumption within domestic and global settings. Prerequisite: Econ 2100. (Co-listed with Min Eng 4524).

**ECON 4641 Foundations of Sustainability** (LEC 3.0)

This interdisciplinary course is designed as an introduction to sustainability in commerce. It examines the concept of environmental, social, and economic issues in an organizational context. Principles, processes, and practices of sustainability will be explored.

**ECON 4642 Introduction to Global Eco- and Social-preneurship and Innovation** (LEC 3.0)

This interdisciplinary course applies an entrepreneurial mindset to the environmental and social opportunities and challenges facing the global community. Topics are examined from multiple perspectives: nonprofit, hybrid, and for-profit organizations.

**ECON 4643 Ethical Problems in a Global Environment** (LEC 3.0)

Focuses on the international dimension of ethics including corporate responsibility from economic, social, and environmental perspectives. It addresses the ethical challenges of decision making, stakeholder engagement, and governance at micro- (personal), meso- (org), and macro- (system) levels.

**ECON 4710 International Trade** (LEC 3.0)

Analysis of gains from trade; the effects of factor mobility; effects of trade restrictions on trade flow and income distribution; arguments for restricting trade; and effects of trade on economic development, employment and human capital development. Prerequisite: Econ 2100.

**ECON 4720 International Finance** (LEC 3.0)

Examination of the international monetary system, the Balance of Payments, the foreign exchange market, futures and options markets; foreign exchange and other risk management for firms, financing from a global perspective and direct foreign investment. Prerequisite: Econ 2200.

**ECON 4730 Economic Development** (LEC 3.0)

Theoretical analysis of the problem of economic development of the "poor" countries, where two-thirds of the world's population lives. Treatment of basic problem areas leading to a synthesis of theoretical approaches for the achievement of development. Prerequisite: Econ 2100 or 2200.

**ECON 4820 Labor Economics** (LEC 3.0)

Labor as a factor of production, collective bargaining, trade unionism, labor legislation, from the viewpoint of public policy. Prerequisite: Econ 2100 or Econ 2200.

**ECON 4860 Problems In Economic Policy** (LEC 3.0)

Advanced course designed for students majoring within the department. Appraisal and analysis of major problems of economic policy. Research and reports. Topics covered vary from year to year. Offered jointly by members of the department. Prerequisite: Seniors with 24 or more hours in Econ.

**ECON 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ECON 5001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course.

**ECON 5010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

**ECON 5120 Advanced Micro and Macro Economics Essentials** (LEC 1.5)

An introduction to the essentials of micro and macro economics for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Additional case or report required. Prerequisite: Bachelor Degree.

**ECON 5310 Advanced Mathematical Economics** (LEC 3.0)

Marginal analysis, calculus, and linear algebraic systems are applied in selected advanced topics in economics such as price theory, general equilibrium theory, input-output analysis, activity analysis, and game theory. This course is an advanced version of Econ 4310, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4310 and Econ 5310. Prerequisites: Econ 2100, 2200 and Math 1208, Math 3103.

**ECON 5330 Econometric Methods** (LEC 2.0 and LAB 1.0)

A survey of econometric topics and methods illustrated through real world applications. Includes least squares estimation, generalized least squares, two-stage least squares, simultaneous equations models, panel data and qualitative choice models. Students will use modern statistical software packages (STATA, R) to perform hands-on quantitative analysis. Prerequisites: Econ 2100 and Econ 2200, Stat 3111 or Stat 3113 or Stat 3115 or Stat 3117 or Stat 5643.



**ECON 5337 Financial Mathematics** (LEC 3.0)

The course objective is to provide an understanding of the fundamental concepts of financial mathematics. Topics include pricing, assets-liability management, capital budgeting, valuing cash flow, bonds, futures, swaps, options. Preparation for the financial mathematics actuarial exam will be provided. Prerequisites: Math 1215 or Math 1221, Econ 2100 or Econ 2200 or Finance 2150 or Econ 5160, Stat 3111 or Stat 3113 or Stat 3115 or Stat 3117 or Stat 5643. (Co-listed with Math 5737).

**ECON 5342 Advanced Finance** (LEC 3.0)

This course provides a rigorous and consistent presentation of the theory of financial decisions. Capital markets are analyzed under assumptions of risk aversion and uncertainty. Models of modern portfolio theory are discussed including the CAPM and the Modigliani-Miller analysis. This course is an advanced version of Econ 321, and will include additional research and project assignments. Credit cannot be obtained for both Econ 5160 and Econ 5342. Prerequisite: Econ 2100 or Econ 2200.

**ECON 5430 Advanced Cost-Benefit Analysis** (LEC 3.0)

Investigates the rationale for cost-benefit analysis within a free enterprise setting. Discussion of market efficiency and failure; determination of social costs and benefits; applications of cost-benefit analysis; and, problems remaining in theory and practice. This course is an advanced version of Econ 4430, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4430 and Econ 5430. Prerequisite: Econ 2100.

**ECON 5440 Advanced Environmental And Natural Resource Economics** (LEC 3.0)

Optimum use of replenishable and non-replenishable resources, public goods and common resources, externalities, private vs. public costs, and quality of the environment; emphasis on public policy related to environmental and natural resource economics. This course is an advanced version of Econ 4440, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4440 and Econ 5440. Prerequisite: Econ 2100.

**ECON 5532 Advanced Mining Economics** (LEC 3.0)

Mining industry & national economics. Social & economics significance of mined commodities. Marketing of mined commodities. Innovation approaches to mine financing, project loans, and leasing. Mining feasibility studies, government influence & policy, mining industry foreign investment, investment strategies, mining taxation, cost predictions. Case Studies. (Co-listed with MIN ENG 5532).

**ECON 5540 Advanced Energy Economics** (LEC 3.0)

Market structures. World resource development. Supply and demand analysis on energy production and consumption within domestic and global settings. This course is an advanced version of Econ 4540, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4540 and Econ 5540. Prerequisite: Econ 2100.

**ECON 5644 Creativity, Innovation, and Sustainability** (LEC 3.0)

This interdisciplinary course examines the use of innovation as a competitive technological strategy with a sustainability perspective. It explores ways in which individuals, groups, and organizations can become more creative and how leadership and a culture of change can be implemented.

**ECON 5710 Advanced International Trade** (LEC 3.0)

Analysis of gains from trade; the effects of factor mobility; effects of trade restrictions on trade flow and income distribution; arguments for restricting trade; and effects of trade on economic development, employment and human capital development. This course is an advanced version of Econ 4710+D1194, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4710 and Econ 5710. Prerequisite: Econ 2100.

**ECON 5720 Advanced International Finance** (LEC 3.0)

Examination of the international monetary system, the Balance of Payments, the foreign exchange market, futures and options markets; foreign exchange and other risk management for firms, financing from a global perspective and direct foreign investment. This course is an advanced version of Econ 4720, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4720 and Econ 5720. Prerequisite: Econ 2200.

**ECON 5820 Advanced Labor Economics** (LEC 3.0)

Labor as a factor of production, collective bargaining, trade unionism, labor legislation, from the viewpoint of public policy. This course is an advanced version of Econ 4820, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4820 and Econ 5820. Prerequisite: Econ 2100 or Econ 2200.

## Education

The purpose of the teacher education program is to prepare collaborative, technologically adept, effective educators for a diverse and global society.

You may earn a B.A. or B.S. degree in your chosen field from Missouri S&T and a certificate to teach in the schools of Missouri. The program may be completed in four academic years, although you may wish to carry lighter course loads during the regular academic semesters.

Secondary certification (grades 9-12) may be earned in the following majors: chemistry, physics or biological sciences in the science area; history, economics, or psychology in the social studies area; English in the language arts area; and mathematics in the mathematics area.

For updated information contact the director of the Missouri S&T teacher education program and look on the homepage: <http://teachereducation.mst.edu/>.

## Elementary Teacher Education Program

The elementary education program is endorsed by the Missouri Department of Elementary and Secondary Education (DESE) and is fully accredited. Students will earn a bachelor of arts degree in multidisciplinary studies with a teaching certificate for elementary education. Graduates of this program will have the knowledge of science, technology, engineering, art and mathematics (STEAM) to share with 1st through 6th grade students.

## Secondary Teacher Education Program

Missouri University of Science and Technology is approved by the Missouri State Board of Education to offer professional education programs for purposes of professional certification. **Admission to the university does not automatically qualify a student to participate in the professional component of the teacher education program.** That participation is granted upon demonstration of a high level of academic and professional competence.

## General Education Requirements

General education requirements are intended to provide you with the intellectual knowledge and skills for basic education. This body of knowledge and skills is arranged according to two broad categories: systems of symbolic thought and communication represented by linguistic and mathematical studies and systems of intellectual inquiry represented by basic academic disciplines. In addition, you must complete one course or unit in cultural diversity and the general education requirements can be fulfilled at the same time.

The following are generic requirements for all education students. However, any degree requirement not included in these general education requirements must be included in the professional requirements or subject matter requirements for each degree program.

- English 9-12
- Mathematics 9-12
- Social Science 9-12
- Biology, Chemistry, Physics 9-12

Note: If changes occur at the state level, then the state's education requirements will supersede those in the catalog and DO NOT fall under the grandfather clause.

**Kelly Carter**, Lecturer  
MA Tennessee Technological University

**Monica Davis**, Lecturer  
EdD Lindenwood University

**Christy Ann Green**, Lecturer  
MASTER University of MO-Columbia

**Olivia Horton**, Lecturer  
MS Webster University

**Merilee Krueger Wilsdorf**, Associate Teaching Professor  
MA University of Nebraska Omaha

**Dennis I Wilson**, Lecturer  
MED Kent State University Main

**Gary D Young**, Lecturer  
BACHELOR Northwest Missouri State University

**Aaron R Zalis**, Lecturer  
EdD Saint Louis University

**EDUC 1000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**EDUC 1001 Special Topics** (IND 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**EDUC 1040 Perspectives In Education** (LEC 2.0)  
This course is an introduction course which will assist students planning to enter the teacher-education program in assessing their personal and professional characteristics required for the teaching profession. It is an overview of the teacher education profession for elementary, middle and secondary.

**EDUC 1104 Teacher Field Experience** (LAB 2.0)  
Observation and analysis of instructional techniques and duties in the classroom and school environment by discipline. Student will spend at least 30 contact hours per credit hours in classroom. In addition, library and field experience reports will be made. In addition, Action Research and Seminars will be required. Prerequisite: Educ 1040.

**EDUC 1164 Aiding Elementary, Middle And Secondary Schools** (LAB 2.0)  
Instructionally-related clinical/administrative and monitorial duties in the classroom during semesters and summer. Student works 30 hours for each credit, with instructor supervising. Also, Action Research and Seminars are required. Prerequisites: Educ 1040 and Educ 1104.

## Symbolic Thought and Communications

1. **Linguistic Studies** (9 semester hours) You are required to take two courses in written communication and one course in oral communication. You must have a grade of "C" or better in each course.
2. **Mathematical Studies** (3 semester hours) The course must be college algebra or above and you must earn a grade of "C" or better.

## Systems of Intellectual Inquiry

1. **Humanities** At least one course each from two of the following areas required: art, music, philosophy, literature and theater.
2. **Natural Science** One course in biological sciences and one in physical science is required. One of these two courses must include a laboratory.
3. **Social and Behavioral Science** One course in each of the following areas is required: (1) American History, (2) American Government, and (3) General Psychology.

## Secondary Education Certification

In addition to the prescribed general educational courses, if you are preparing to become a secondary school teacher you must complete the following secondary professional education courses and the required courses of at least one teaching major.

You may major in English with English certification (9-12); economics, history or psychology with social sciences certification (9-12); mathematics with mathematics certification (9-12); biological sciences, chemistry or physics with certification (9-12).

You must meet Missouri S&T degree requirements and, in addition, course requirements for certification. The necessary course requirements and arrangements will be coordinated through the education office. Please pick up a sheet from the education office for your discipline area or print from [www.teachereducation.mst.edu](http://www.teachereducation.mst.edu) (<http://teachereducation.mst.edu>).

## Missouri State Board of Education Approved Programs

The following professional education programs have been approved by the Missouri State Board of Education for the purpose of teacher preparation and certification.

- Elementary Education
- Secondary Education:

**EDUC 1174 School Organization & Adm For Elementary & Secondary Teachers** (LEC 2.0)

Required for certification of elementary and secondary teachers. Course content relates to methods of organization and management in the elementary and secondary schools. Prerequisites: Educ 1040 and Educ 1104.

**EDUC 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**EDUC 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**EDUC 2002 Problems Of Teaching Social Studies** (LEC 2.0)

A study of current methodologies for teaching in area of specialization.

**EDUC 2102 Educational Psychology** (LEC 3.0)

Principles of psychology relevant to the field of education. Course covers theoretical and applied information on such topics as human growth and development, and cognitive and behavioral views of learning and intelligence. The course also covers motivation, creation of learning environments, measurement and evaluation of learning. Prerequisite: Psych 1101. (Co-listed with Psych 2300).

**EDUC 2203 Problems Of Teaching Mathematics** (LEC 3.0)

A study of current methodologies for teaching in area of specialization.

**EDUC 2205 Problems Of Teaching Science/Chemistry** (LEC 2.0)

A study of current methodologies for teaching in area of specialization.

**EDUC 2206 Problems Of Teaching Science/Physics** (LEC 2.0)

A study of current methodologies for teaching in area of specialization.

**EDUC 2207 Problems Of Teaching English** (LEC 2.0)

A study of current methodologies for teaching in area of specialization.

**EDUC 2219 Art For Elementary Teachers** (LEC 3.0)

Considers the vital role of art activities and creative experiences in the growth and development of children at their level. Prerequisite: Educ 1040. (Co-listed with Art 3219).

**EDUC 2230 Methods In Physical Education K-4** (LEC 3.0)

The course will provide the opportunity to learn how to promote student fitness and skill development while building the foundation for a physically active life through specific activities aimed at the younger child. (Co-listed with Phy Ed 2300).

**EDUC 2231 Methods In Physical Education 5-9** (LEC 3.0)

The course will provide the opportunity to learn how to promote student fitness and skill development while building the foundation for a physically active life through specific activities aimed at the student in transition from childhood to young adulthood (5-9). (Co-listed with Phy Ed 2310).

**EDUC 2251 Historical Foundation Of American Education** (LEC 3.0)

Development of American educational institutions and ideas, and of social forces that have influenced them. Prerequisites: Educ 1040 and History 1300 or 1310.

**EDUC 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**EDUC 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**EDUC 3211 Child Psychology** (LEC 3.0)

The psychological, intellectual, social, and physical development of children with emphasis on the cognitive and affective processes. The theory, research and application will be studied. Prerequisite: Educ 1040 or Psych 1101.

**EDUC 3215 Teaching of Reading in Elementary and Middle School** (LEC 3.0)

Current materials, methods and teaching techniques in teaching reading in elementary and middle school grades. Emphasis on assessing elementary and middle students needs, individualizing programs based on needs, reading in the content areas, study skills and recreational reading as a lifetime habit. Prerequisite: Educ 1040.

**EDUC 3216 Teaching Reading in Content Area** (LEC 3.0)

For elementary, middle and secondary school teachers. Specific ways teachers can help students improve reading skills in content areas and ways reading can be taught in reading classes.

**EDUC 3217 Analysis and Correction of Reading Difficulties** (LEC 3.0)

Procedures for diagnosing and correcting reading problems within the classroom. Acquaint preservice teachers preparing for elementary education with commercially prepared informal diagnostic instruments, attitude and interest inventories, prescriptive measures, anecdotal records and strategies for corrective reading instruction within the regular classroom. Prerequisite: Educ 3215.

**EDUC 3218 Language Arts for Elementary Teachers** (LEC 3.0)

Procedures used in teaching integrated language arts in elementary grades. The strategies would be the development of written and oral communication for use in elementary grades. Prerequisite: Educ 1040.

**EDUC 3221 Teaching Math in Elementary and Middle Schools** (LEC 3.0)

The course presents an overview of how children learn mathematics, various techniques in teaching mathematics, and examples of applying these techniques to specific mathematical concepts (such as geometry, measurement, basic operations, statistics and probability, etc.). Prerequisite: Math 1120 or Math 1140. (Co-listed with Math 3921).

**EDUC 3222 Geometric Concepts for Elementary Teachers** (LEC 3.0)

The course covers methods of teaching the study of points, lines, polygons, similarity, congruence, constructions, and proof in Euclidean Plane Geometry. Transformational geometry and trigonometry are introduced to elementary teachers. Prerequisites: Math 1120 or Math 1140. (Co-listed with Math 3922).

**EDUC 3280 Teaching Methods And Skills In The Content Areas** (LEC 6.0)

Series of weekly experiences, demonstrations, observations, micro teaching, small group discussions to develop concepts of and skills in a variety of basic teaching tasks. Also, demonstration and lecture exercises in the preparation and use of audio visual materials for teaching. Prerequisites: Educ 1040 and 1104.

**EDUC 3305 Philosophy And Administration Of The Middle School** (LEC 3.0)

This course will acquaint students with aspects of education that are unique to the middle school. Attention will be given to the philosophy underlying the middle school. Finally, leadership theories most appropriate to the middle school will be studied.

**EDUC 3311 Psychological & Educational Development Of The Adolescent** (LEC 3.0)

A theoretical and empirical examination of the psychological and educational development of the adolescent.

**EDUC 3320 Professional Development** (LEC 1.0)

This online course focuses on the responsibilities of the professional development committee, state requirements, and components of effective programs that positively impact student performance. Students will examine the relationships among the district's Comprehensive School Improvement Plan, MSIP and the PD Plan. Prerequisite: Graduate standing.

**EDUC 3325 Novell Netware 4.1 / 4.11** (LEC 3.0)

A practical, hands-on course for Novell network administration including NDS planning, mapping and documentation; system power up/down; security, resource service management; user management from creation to user and workstation maintenance; application software installation and management, and Novell Server installation.

**EDUC 3335 Curriculum And Instruction Of The Middle School** (LEC 3.0)

This course advances teachers' understanding of middle school curriculum and instruction. It utilizes knowledge about the nature and needs of young adolescents in developing interdisciplinary learning units, and fosters applications appropriate to experienced teachers' professional assignments. Prerequisite: Graduate standing.

**EDUC 3339 Current Issues In Educ: Performance Based Assessment, Beginning** (LAB 2.0 and LEC 1.0)

This course is intended to provide an understanding of the principles of sound classroom assessment, the five different types of learning outcomes that need to be assessed and the choice of an assessment that best evaluates the achievement targets. Prerequisite: Practicing educator.

**EDUC 3340 Current Issues In Educ: Performance Based Assessment, Intermediate** (LEC 3.0)

This course will provide participants with an understanding of performance-based assessments, how to construct performance tasks and how to construct scoring guides.

**EDUC 3341 Current Issues In Educ: Performance Based Assessment, Advanced** (LEC 1.0 and LAB 2.0)

This course is intended to provide an understanding of balanced classroom assessment. Students will learn to create multiple types of assessment measures for the purpose of evaluating a wide variety of achievement targets. Prerequisite: Practicing educator.

**EDUC 3345 Introducing Educators To Computers** (LEC 1.0)

A basic introduction to computers for K-12 educators. Includes identification and use of hardware components, as well as the fundamentals of using the operating system and basic computer software. Actual software taught will reflect current usage. Prerequisite: Post Bac/practicing teacher.

**EDUC 3350 Social Studies In The Elementary School** (LEC 3.0)

Problems in preparation, teaching of social studies units with suitable materials, techniques for elementary teachers. Prerequisite: Instructor's approval.

**EDUC 4298 Student Teaching Seminar** (LEC 1.0)

Weekly seminars will be required for all students enrolled in student teaching. Contemporary educational topics, trends, reflective decision making and other pertinent topics will be covered. Reflection of topics and experiences will be exhibited in papers, portfolios and journal writings. Prerequisites: Meet all requirements for student teaching and concurrently be enrolled in student teaching.

**EDUC 4299 Student Teaching** (LEC 12)

Student teaching will be supervised participation, on the level of certification in an assigned Public School. Student teaching is based on 16 weeks (8 weeks in two schools and requires the student teacher to demonstrate his/her ability to be effective decision making teacher and an inquiry learner. Prerequisites: Professional standing and arrangements made previous semester.

**EDUC 4310 Psychology Of The Exceptional Child** (LEC 3.0)

Study of the psychology of children on both ends of the educational spectrum. The course presents the fundamentals of providing services as well as understanding the abilities and disabilities of children classified as exceptional. Includes coverage of various disabilities, and the implications of dealing with personal, family and classroom issues. Prerequisite: Psych 1101. (Co-listed with Psych 4310).

**EDUC 4315 Advanced Adolescent Development** (LEC 3.0)

This course is an advanced examination of the intellectual and social development of the adolescent. Theories of adolescent development and their implications for the educative process are covered and debated.

**EDUC 4370 Teachers Academy: Effective Instructional Strategies** (LEC 3.0)

Participants will develop an understanding of research-based instruction and the ability to implement the instructional strategies in their classrooms. In addition to effective instructional practices, the teachers' academy will focus on leadership, empowerment, collaboration and renewal. Prerequisite: Graduate standing.

## Electrical Engineering

**Emphasis areas at all levels in circuits and electronics, power and energy, communications and signal processing, controls and systems, electromagnetics, optics and devices, and computer engineering.**

Electrical engineers are involved in channeling natural resources into uses for society such as heating, lighting, home appliances, consumer products, computing, sensing, control, and communication. They contribute to systems and devices for power, instrumentation, measurement, communication, management, manufacturing, transportation, etc. They are primarily concerned with the processes of generation, transmission, transformation, control, and utilization of energy or information.

Students who are interested in electrical engineering begin in the Freshman Engineering Program, thus obtaining fundamental skills and an overview of the various degree programs at Missouri S&T, before entering the main program. They commit to a given degree program after exposure to the different career options. Once in the program, students gain knowledge in the main areas of electrical engineering, learn to use hardware and software tools in numerous laboratories, and apply engineering concepts in both freshman and capstone design experiences. Educational options include dual major programs (such as electrical and computer engineering degrees), minor programs, emphasis areas, and honors activities (such as the Honors Scholar Program in electrical engineering). They may supplement their education with participation in design competitions, professional societies, work internships, research experiences, etc.

The curriculum exposes students to the breadth of electrical engineering and allows them to pursue electives in several areas or to emphasize a specialty. The areas are defined as circuits and electronics, power and energy, communications and signal processing, controls and systems, electromagnetics, optic and devices, and computer engineering.



In circuits and electronics, courses provide study of basic electrical devices – energy sources, resistors, inductors, capacitors, diodes, and transistors – and their interconnection in operational networks. Circuits design and analysis techniques are covered with both analog and digital applications.

In power and energy, courses emphasize the design and applications of motors, generators, transformers, distribution systems, high-voltage devices, and power electronics.

In communications and signal processing, courses include concepts required for the characterization and manipulation of information-bearing signals, modulation systems, wireless networks, image processing, and detection hardware.

In controls and systems, courses emphasize the design and application of circuits and systems to automatically monitor and regulate devices, machines, and processes. Advanced technologies using digital control, intelligent processing, neural networks, and programmable logic controllers are included.

In electromagnetics, courses provide instruction in the interaction, propagation, and transmission of high-frequency waves and signals through space and in conductors. Topics include grounding and shielding, antennas, microwaves, and systems.

In optic and devices, courses provide study of solid-state materials, electronic devices, and optoelectronics. Applications are microfabrication, telecommunications, computing, instrumentation, lasers and fiber optics, nanotechnologies, sensing, and smart technologies.

In computer engineering, courses are offered in computers and architecture, integrated circuits and logic design, embedded computer systems, computational intelligence, networks and software engineering, and software security and reliability.

The electrical engineering program and the related computer engineering program are administered in the same department. Degree programs for B.S., M.S., and Ph.D. are offered. The classrooms and laboratories are located in Emerson Electric Company Hall. Additional research activities are being conducted in various research centers on campus. The department supports chapters for the following student groups: the Institute for Electrical and Electronics Engineers; IEEE-Eta Kappa Nu, the Electrical and Computer Engineering Honor Society; and the Amateur Radio Club. Various faculty and students participate in other campus organizations and are active in professional societies, design competitions, and technical conferences.

## Educational Mission

The electrical and computer engineering department strives to contribute to the state, nation, and world through the education of outstanding professionals and leaders in engineering. Our educational focus is on a broad, rigorous education in all areas of electrical and computer engineering with significant hands-on experiences. The program will provide students with an understanding of engineering problem solving at all levels and an appreciation for engineering as a profession.

## Objectives

The electrical and computer engineering degree programs will provide students the foundation to:

- Succeed in professional career placement and practice as engineers, scholars and entrepreneurs
- Grow their career through technical and professional activities and leadership roles
- Contribute to society and the economy through technical products, services, and knowledge
- Adapt to an ever-changing world through continued education, graduate study, professional development activities, independent learning, or pursuit of follow-on degrees

The hallmarks of students capable of obtaining these objective are:

- **Technical Competency.** Graduates will have a sound knowledge of the fundamentals in electrical or computer engineering that allows them to analyze and solve technical problems, to apply hardware and software tools, to create and evaluate technical products, to learn independently, and to succeed in the workplace and in graduate school.
- **An Engineering Perspective.** Graduates will be capable of understanding complex projects and the creative process required to find innovative problem solutions, including their evolution and abstraction and the optimization of associated decisions and risk, both locally and globally.
- **Professional Skills and Knowledge.** Graduates will have the ability to communicate well in both oral and written form, to interact in teams, to manage and lead technical projects, to manage their career, and to conduct themselves with an understanding of ethics, economics, and intellectual property.

Approved by the faculty February 25, 2015.

## Bachelor of Science Electrical Engineering<sup>1</sup>

Entering freshmen desiring to study Electrical Engineering will be admitted to the Freshman Engineering Program. They will be permitted to state a Electrical Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering Program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major.

For the Bachelor of Science degree in Electrical Engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in Electrical Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1. All students are required to take one American history course, one economics course, one humanities or social sciences course, and ENGLISH 1120. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200. The humanities or social sciences course must be selected from the approved lists for art, English, foreign languages, music, philosophy, speech and media studies, or theater.

2. Depth requirement. Three credit hours must be taken in humanities or social sciences at the 2000-level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 1180 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 4000-level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.
3. The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to ENGLISH 1120.
4. Any specific departmental requirements in the general studies area must be satisfied.
5. Special topics and special problems and honors seminars are allowed only by petition to and approval by the student's department chairman.

The Electrical Engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

## Free Electives Footnote:

Students are required to take five hours of free electives in consultation with their academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of engineering and science must be at least three credit hours.

Freshman Year			
First Semester	Credits	Second Semester	Credits
FR ENG 1100 <sup>2</sup>	1	MECH ENG 1720	3
CHEM 1310	4	MATH 1215 <sup>3</sup>	4
CHEM 1319	1	PHYSICS 1135 <sup>3,4</sup>	4
MATH 1214 <sup>3</sup>	4	ECON 1100 or 1200	3
HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3	Elective-Hum or Soc Sci (any level) <sup>5</sup>	3
ENGLISH 1120	3		
	16		17
Sophomore Year			
First Semester	Credits	Second Semester	Credits
ELEC ENG 2100 <sup>3,6,7</sup>	3	ELEC ENG 2200 <sup>3,6,7,10</sup>	3
ELEC ENG 2101 <sup>3,6</sup>	1	ELEC ENG 2201 <sup>3,6,7</sup>	1
MATH 2222 <sup>3</sup>	4	ELEC ENG 2120 <sup>3,7,9</sup>	3
COMP ENG 2210 <sup>3,6,8</sup>	3	MATH 3304 <sup>3</sup>	3
COMP ENG 2211 <sup>3,6</sup>	1	Engineering Science Elective <sup>11</sup>	3
PHYSICS 2135 <sup>3,4</sup>	4	COMP SCI 1570	3
		COMP SCI 1580 <sup>12</sup>	1
	16		17

Junior Year			
First Semester	Credits	Second Semester	Credits
ELEC ENG 3100 <sup>3,6,9,10</sup>	3	ELEC ENG 3600 <sup>3,9</sup>	4
ELEC ENG 3101 <sup>3,6,9,10</sup>	1	El Eng Elective A <sup>10,14,19</sup>	3
ELEC ENG 3320	3	ELEC ENG 3430	3
ELEC ENG 3321	1	ELEC ENG 3431	1
SP&M S 1185 <sup>13</sup>	3	STAT 3117 <sup>12</sup>	3
MATH 3108	3	Communication Elective <sup>13</sup>	3
	14		17
Senior Year			
First Semester	Credits	Second Semester	Credits
El Eng Power Elective <sup>3,6,9,15</sup>	3	El Eng Elective C <sup>10,14</sup>	3
El Eng Power Elective Lab <sup>3,6,9,15</sup>	1	El Eng Elective E <sup>17,19</sup>	3
El Eng Elective B <sup>10,14</sup>	3	ELEC ENG 4097	3
El Eng Elective D <sup>10,16,19</sup>	3	Elective-Hum or Soc Sci (upper level) <sup>5</sup>	3
ELEC ENG 4096 <sup>3</sup>	1	Free Elective <sup>18</sup>	3
Free Elective <sup>18</sup>	2		
Elective-Hum or Soc Sci (any level) <sup>5</sup>	3		
	16		15

Total Credits: 128

**Note:** Student must satisfy the common engineering freshman year requirements and be admitted into the department. See Freshman Engineering.

- <sup>1</sup> The minimum number of hours required for a degree in Electrical Engineering is 128.
- <sup>2</sup> Students that transfer after their freshman year are not required to enroll in FR ENG 1100.
- <sup>3</sup> A minimum grade of "C" must be attained in MATH 1214, MATH 1215, MATH 2222, and MATH 3304, PHYSICS 1135 and PHYSICS 2135 (or their equivalents), ELEC ENG 2100, ELEC ENG 2101, ELEC ENG 2120, ELEC ENG 2200, ELEC ENG 2201, ELEC ENG 3320, ELEC ENG 3321, ELEC ENG 3430, ELEC ENG 3431, ELEC ENG 3100, ELEC ENG 3101, and ELEC ENG 3600, the ELEC ENG power elective (ELEC ENG 3500 and ELEC ENG 3501 or ELEC ENG 3540 and ELEC ENG 3541), ELEC ENG 4096 and COMP ENG 2210 and COMP ENG 2211. Also, students may not enroll in other courses that use these courses as prerequisites until the minimum grade of "C" is attained.
- <sup>4</sup> Students may take PHYSICS 1111 and PHYSICS 1119 in place of PHYSICS 1135. Students may take PHYSICS 2111 and PHYSICS 2119 in place of PHYSICS 2135.
- <sup>5</sup> All electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog.
- <sup>6</sup> Students who drop a lecture course prior to the last week to drop a class must also drop the corequisite lab.
- <sup>7</sup> Students must earn a passing grade on the ELEC ENG Advancement Exam I (associated with ELEC ENG 2100) before they enroll in ELEC ENG 2120 or ELEC ENG 2200 and ELEC ENG 2201.
- <sup>8</sup> Students must earn a passing grade on the COMP ENG Advancement Exam (associated with COMP ENG 2210) before they enroll in any course with COMP ENG 2210 and/or COMP ENG 2211 as prerequisites.

- <sup>9</sup> Students must earn a passing grade on the ELEC ENG Advancement Exam II (associated with ELEC ENG 2120) before they enroll in ELEC ENG 3500, ELEC ENG 3540, ELEC ENG 3501, ELEC ENG 3541, ELEC ENG 3320, ELEC ENG 3321, ELEC ENG 3430, ELEC ENG 3431, ELEC ENG 3100, ELEC ENG 3101, or ELEC ENG 3600, or other courses with ELEC ENG 2120 as a prerequisite.
- <sup>10</sup> Students must earn a passing grade on the ELEC ENG Advancement Exam III (associated with ELEC ENG 2200) before they enroll in ELEC ENG 3100 and ELEC ENG 3101 or other courses with ELEC ENG 2200 as a prerequisite.
- <sup>11</sup> Students must take MECH ENG 2340, MECH ENG 2519, MECH ENG 2527, PHYSICS 2305, PHYSICS 2311, PHYSICS 2401, NUC ENG 3103, CHEM 2210, BIO SCI 2213, or BIO SCI 2223. The following pairs of course are substitutions: CIV ENG 2200 and MECH ENG 2350 or ENG MGT 2110 and ENG MGT 3310.
- <sup>12</sup> Students may replace STAT 3117 with STAT 3115 or STAT 5643. Students may replace COMP SCI 1580 with ELEC ENG 3001 Circuits and Systems Laboratory.
- <sup>13</sup> Students must take English 3560 or English 1160. Students may replace SpMS 1185 with the ROTC sequence of Mil Army 4250 and 4500 or Mil Air 4110 and 4120.
- <sup>14</sup> ELEC ENG Electives A, B, and C must be chosen from ELEC ENG 56XX, ELEC ENG 3500, ELEC ENG 3540, ELEC ENG 3410, ELEC ENG 3250, ELEC ENG 3340, ELEC ENG 3440, ELEC ENG 3120, and COMP ENG 3150. Only one ELEC ENG 56XX course may be used.
- <sup>15</sup> The ELEC ENG Power Elective may be satisfied with ELEC ENG 3500 and ELEC ENG 3501 or ELEC ENG 3540 and ELEC ENG 3541.
- <sup>16</sup> ELEC ENG Elective D must be a 4XXX-level or above ELEC ENG or COMP ENG course with at least a 3-hour lecture component. ELEC ENG 4000, ELEC ENG 5000, COMP ENG 4000, COMP ENG 5000, ELEC ENG 4099, COMP ENG 4099, ELEC ENG 4096, COMP ENG 4096, ELEC ENG 4097, COMP ENG 4097, ELEC ENG 5070, COMP ENG 5070, ELEC ENG 58XX, and COMP ENG 58XX may not be used for Elective D.
- <sup>17</sup> ELEC ENG Elective E may be any 3XXX-level or above ELEC ENG or COMP ENG course except ELEC ENG 3002, ELEC ENG 38XX, ELEC ENG 4096, ELEC ENG 4097, and ELEC ENG 5070 and COMP ENG 3002, COMP ENG 38XX, COMP ENG 4000, COMP ENG 4096, COMP ENG 4097, and COMP ENG 5070.
- <sup>18</sup> Students are required to take five hours of free elective in consultation with their academic advisors. Credits that do not count toward this requirement are deficiency courses (such as algebra and trigonometry) and extra credits from courses meeting other requirements. Any courses outside of engineering and science must be at least three credit hours. ELEC ENG 28XX, ELEC ENG 38XX, ELEC ENG 4096, ELEC ENG 4097, COMP ENG 28XX, COMP ENG 38XX, COMP ENG 4096 and COMP ENG 4097 may not be used for free electives. No more than one credit hour of ELEC ENG 3002 or COMP ENG 3002 may be applied to the BS degree for free electives.
- <sup>19</sup> Students that pursue an optional degree emphasis area have restricted options for El Eng Electives A, D, and E.

All Electrical Engineering students are encouraged to take the fundamentals of Engineering Examination prior to graduation. It is the first step toward becoming a registered professional engineer.

# Emphasis Areas for Electrical Engineering

**Circuits and Electronics, Communications and Signal Processing, Computer Engineering, Controls and Systems, Electromagnetics, Optics and Devices, Power and Energy**

A declared emphasis area is not required. A student may choose to obtain an Electrical Engineering degree without a formal emphasis or may choose to obtain an Electrical Engineering degree with a declared emphasis in one or more of the emphasis areas of electrical engineering. A major change request is required to add the emphasis area option to the degree program.

For students who seek an Electrical Engineering degree without a formal emphasis, these emphasis areas may guide the choice of their ELEC ENG Electives A, B, C, D, and E as well as their free electives. Students should consult with their advisors on such course selections.

For students who seek an Electrical Engineering degree with a declared emphasis, courses in the declared emphasis area will be applied to ELEC ENG Electives A, D, and E in the degree requirements. For students who choose to have multiple emphasis areas, the additional courses will apply to ELEC ENG Elective B or C and free elective requirements. Students should seek guidance from their advisors on emphasis areas and on courses that are relevant to more than one emphasis area. Students may have an emphasis area or emphasis areas listed on their transcript by completing three three-credit-hour courses in electrical and computer engineering from the designated lists with at least one of the courses being at the 4XXX-level or above. This requirement will be satisfied by completing the relevant ABC Elective course, a 4XXX-level or above course for Elective D, and another 3XXX-level or above course for Elective E from the designated listing. The required ELEC ENG courses ELEC ENG 3320, ELEC ENG 3430, ELEC ENG 3100, and ELEC ENG 3600 and the course used to satisfy the power requirement (ELEC ENG 3500 or ELEC ENG 3540) may not be used to meet the three course requirement. Transfer courses do not apply to emphasis areas. A co-listed course may count toward both areas. Experimental courses ELEC ENG 3001, ELEC ENG 4001, ELEC ENG 5001, COMP ENG 3001, COMP ENG 4001, or COMP ENG 5001 require departmental approval to apply toward an emphasis area.

Circuits and Electronics		
ELEC ENG 3120	Electronics II	3
ELEC ENG 41XX and ELEC ENG 51XX Courses		
Communications and Signal Processing		
ELEC ENG 3410	Digital Signal Processing	3
ELEC ENG 3440	Digital Communications II	3
ELEC ENG 44XX and ELEC ENG 54XX Courses		
Computer Engineering		
ELEC ENG 3410, COMP ENG 3XXX-level or above Courses (Excluding COMP ENG 3000, COMP ENG 4000, COMP ENG 5000, COMP ENG 3002, COMP ENG 4096, COMP ENG 4097, and COMP ENG 5070) See the COMP ENG degree program for details on COMP ENG areas.		
Controls and Systems		
ELEC ENG 3340	Basic Programmable Logic Controllers	3
ELEC ENG 43XX and ELEC ENG 53XX Courses		
Electromagnetics		
ELEC ENG 46XX and ELEC ENG 56XX Courses		
Optics and Devices		
ELEC ENG 3250	Electronic And Photonic Devices	3
ELEC ENG 42XX and ELEC ENG 52XX Courses		
Power and Energy		
ELEC ENG 3500	Electromechanics	3

ELEC ENG 3540	Power System Design And Analysis	3
ELEC ENG 5150	Photovoltaic Systems Engineering	3
ELEC ENG 5520	Power Electronics	3
ELEC ENG 5521	Power Electronics Laboratory	2
ELEC ENG 45XX and ELEC ENG 55XX Courses		

## Minor in Electrical Engineering

A minor in electrical engineering will require the following:

Pass the ELEC ENG Advancement Exam I (ELEC ENG 2100 final) with a "C" grade or better. \*

Pass ELEC ENG 2120 and ELEC ENG Advancement Exam II with a "C" grade or better.

Pass 12 additional hours of ELEC ENG coursework excluding ELEC ENG 28XX, 38XX, ELEC ENG 4096, ELEC ENG 4097, and ELEC ENG 4099. At least 3 lecture hours at the 4XXX-level or above are required. A "C" grade or better is required for all 12 hours. No transfer courses and no more than 3 hours of ELEC ENG 3000, ELEC ENG 4000, or ELEC ENG 5000 may be used to meet the requirements. The course choice for the 12 additional hours are subject to the approval of the minor advisor.

\*One opportunity will be given to pass the ELEC ENG Advancement Exam I if a student has prior circuit coursework or experience. Otherwise, the student must pass ELEC ENG 2100.

## Minor in Automation Engineering

A minor in automation engineering will require the following:

- Pass ELEC ENG 3340 Basic Programmable Logic Controllers with a "C" or better
- Pass one of the following courses with a "C" or better:
  - ELEC ENG 3320 Control Systems
  - MECH ENG 4479 Automatic Control Of Dynamic Systems
  - CHEM ENG 4110 Chemical Engineering Process Dynamics And Control
- Pass 9 additional hours of coursework from the following list. A "C" or better is required for all 9 hours.
  - CHEM ENG 5370 Intermediate Process Dynamics And Control
  - CHEM ENG 5190/ELEC ENG 5350 Plantwide Process Control
  - CHEM ENG 4310/MECH ENG 5644 Interdisciplinary Problems In Manufacturing Automation
  - ELEC ENG 4380 Practicum in Automation Engineering (no more than one can be applied to the Automation Engineering Minor)
  - ELEC ENG 5340 Advanced PLC
  - ELEC ENG 5870/MECH ENG 5478 Mechatronics
  - MECH ENG 5449 Robotic Manipulators and Mechanisms
  - MECH ENG 5655 Manufacturing Equipment Automation

**Levent Acar**, Associate Professor  
PHD Ohio State University

**Daryl G Beetner**, Professor<sup>1</sup>  
DSC Washington University

**Egemen K Cetinkaya**, Assistant Professor  
PHD University of Kansas

**Minsu Choi**, Associate Professor  
PHD Oklahoma State University

**Mariesa L Crow**, Professor<sup>1</sup>  
PHD University of Illinois-Urbana

**Mihail Cutitaru**, Assistant Teaching Professor  
PHD Old Dominion University

**Kristen Marie Donnell Hilgedick**, Assistant Professor  
PHD Missouri Univeristy of Science & Technology

**James L Drewniak**, Curators Professor  
PHD University of Illinois-Urbana

**Rohit Dua**, Assistant Teaching Professor  
PHD University of Missouri-Rolla

**Kelvin Todd Erickson**, Professor<sup>1</sup>  
PHD Iowa State University

**Jun Fan**, Associate Professor  
PHD University of Missouri-Rolla

**Mehdi Ferdowsi**, Associate Professor  
PHD Illinois Institute of Technology

**Steven Leslie Grant**, Associate Professor  
PHD Rutgers State University-College of Engineering

**Amardeep Kaur**, Assistant Teaching Professor  
PHD Missouri University of Science & Technology

**Victor Khilkevich**, Assistant Professor  
PHD Moscow Power Engineering Institute

**Chang-Soo Kim**, Associate Professor  
PHD Kyungpook National University

**Jonathan William Kimball**, Associate Professor<sup>1</sup>  
PHD University of Illinois-Urbana

**Kurt Louis Kosbar**, Associate Professor  
PHD University of Southern California

**Randy Hays Moss**, Professor<sup>1</sup>  
PHD University of Illinois-Urbana

**Theresa Avosuahi Odun-Ayo**, Assistant Teaching Professor  
PHD Missouri University of Science & Technology

**David Pommerenke**, Professor  
PHD Technical University Berlin

**Jagannathan Sarangapani**, Professor  
PHD University of Texas-Arlington

**Sahra Sedighsarvestani**, Associate Professor  
PHD Purdue University-W. Lafayette

**Pourya Shamsi**, Assistant Professor  
PHD University of Texas-Dallas

**Yiyu Shi**, Assistant Professor  
PHD University of California-LA

**Bijaya Shrestha**, Associate Teaching Professor  
PHD University of Missouri-Rolla



**Ronald Joe Stanley**, Associate Professor  
PHD University of Missouri-Columbia

**Theresa Mae Swift**, Assistant Teaching Professor  
PHD University of Missouri-Rolla

**Steve E Watkins**, Professor  
PHD University of Texas at Austin

**Cheng Hsiao Wu**, Professor  
PHD University of Rochester

**Donald C Wunsch II**, Professor<sup>1</sup>  
PHD University of Washington

**Chengshan Xiao**, Professor  
PHD University of Sydney-Australia

**Maciej J Zawodniok**, Associate Professor  
PHD University of Missouri-Rolla

**Yahong Rosa Zheng**, Associate Professor  
PHD Carleton University

**Reza Zoughi**, Professor  
PHD University of Kansas

**ELEC ENG 1010 Transfer Student Seminar** (LEC 0.50)  
Discussion of current topics. Prerequisite: First semester transfer student.

**ELEC ENG 2001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**ELEC ENG 2100 Circuits I** (LEC 3.0)  
Circuit elements, signals, Kirchhoff's laws, network theorems, mesh and nodal analysis, transient and complete response of RL, RC, and RLC circuits. Prerequisites: Math 1215 (or 1221) with a grade of "C" or better. Students should enroll in Elec Eng 2100 and Elec Eng 2101 simultaneously.

**ELEC ENG 2101 Circuit Analysis Laboratory I** (LAB 1.0)  
Safety, basic measurements and meters, oscilloscopes, resistor networks, measurement of capacitors and inductors, RLC circuit response. Prerequisite: Preceded or accompanied by Elec Eng 2100. A student who drops Elec Eng 2100 must also drop Elec Eng 2101.

**ELEC ENG 2120 Circuits II** (LEC 3.0)  
Analysis of steady state AC circuits, phasor notation, polyphase circuits, complex frequency and frequency response, magnetically coupled circuits. Prerequisites: Elec Eng 2100 and Math 2222 each with grade of "C" or better; passing the Elec Eng Advancement Exam I.

**ELEC ENG 2200 Introduction to Electronic Devices** (LEC 3.0)  
Materials and device structures for applications in analog and digital electronics. Topics include characteristics and basic circuits for diodes, field-effect transistors, bipolar junction transistors, and operational amplifiers. Prerequisites: Elec Eng 2100, Elec Eng 2101, and Physics 2135 each with grade of "C" or better; passing the Elec Eng Advancement Exam I. Students should enroll in Elec Eng 2200 and Elec Eng 2201 simultaneously.

**ELEC ENG 2201 Electronic Devices Laboratory** (LAB 1.0)  
Laboratory tools and measurement techniques for basic electronic circuits using diodes, field-effect transistors, bipolar junction transistors, and operational amplifiers. Topics include DC biasing and applications in analog and digital electronics. Prerequisites: Elec Eng 2100, Elec Eng 2101, and Physics 2135 each with grade of "C" or better; passing the Elec Eng Advancement Exam I. Preceded or accompanied by Elec Eng 2200.

**ELEC ENG 2800 Electrical Circuits** (LEC 3.0)  
Taught primarily as an alternating current (AC) circuits course with direct current (DC) circuits as a special case. Current, voltage, and power relations; complex algebra; voltage and power relations in polyphase circuits with an emphasis on Transformers and Induction Machines. Not for electrical engineering majors. Prerequisites: Math 3304 or 3329; Physics 2135.

**ELEC ENG 3000 Special Problems** (IND 1.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ELEC ENG 3001 Special Topics** (LAB 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**ELEC ENG 3002 Cooperative Engineering Training** (IND 1.0)  
On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation. Pass-fail grading option only. Prerequisite: Consent of the Electrical and Computer Engineering Department required.

**ELEC ENG 3100 Electronics I** (LEC 3.0)  
Diode and transistor circuits, small signal analysis, amplifier design, differential and operational amplifiers, flipflop circuits and waveshaping. Prerequisites: Elec Eng 2120, Elec Eng 2200, Elec Eng 2201, and Comp Eng 2210 each with a grade of "C" or better. Passing grade on Elec Eng Advancement Exam II and III. Elec Eng 3101 is a corequisite.

**ELEC ENG 3101 Electronics I Laboratory** (LAB 1.0)  
Experiments in design with diodes, transistors, differential and operational amplifiers, and logic components. Prerequisites: Elec Eng 2120, Elec Eng 2200, Elec Eng 2201, and Comp Eng 2210 each with a grade of "C" or better. Passing grade on Elec Eng Advancement Exam II and III. Elec Eng 3100 is a corequisite.

**ELEC ENG 3120 Electronics II** (LEC 3.0)  
Continuation of Elec Eng 3100. Diode and transistor circuits, small signal analysis, amplifier design, differential and operational amplifiers, flipflop circuits and waveshaping. Prerequisites: Elec Eng 3100 and Elec Eng 3101 each with a grade of "C" or better. Elec Eng 3121 is optional, but recommended.

**ELEC ENG 3121 Electronics II Laboratory** (LAB 1.0)  
Experiments in design with diodes, power transistors, integrated circuits, advanced bipolar and FET logic gates, flipflops and registers. Prerequisites: Elec Eng 3100 and Elec Eng 3101 each with a grade of "C" or better. Elec Eng 3120 is a corequisite.

**ELEC ENG 3250 Electronic And Photonic Devices** (LEC 3.0)  
Semiconductor materials and devices for electronic and photonic applications. Topics include crystal physics, electron and photon behavior, pn junctions, heterojunctions, junction diodes, optoelectronic devices, and ohmic and rectifying contacts. Prerequisite: Elec Eng 2200 and Elec Eng 2120 each with grade of "C" or better; passing the Elec Eng Advancement Exams II and III.

**ELEC ENG 3320 Control Systems** (LEC 3.0)

Laplace transforms, formulation of the control problem, system equations and models, time and frequency domain analysis, stability, and design of linear control systems. Prerequisites: ELEC ENG 2120 and MATH 3304 each with a grade of "C" or better; passing the ELEC ENG Advancement Exam II; accompanied by ELEC ENG 3321.

**ELEC ENG 3321 Control Systems Laboratory** (LAB 1.0)

Software tools for control systems analysis. Prerequisites: ELEC ENG 2120 and MATH 3304 with a grade of "C" or better; passing the ELEC ENG Advancement Exam II; preceded or accompanied by ELEC ENG 3320.

**ELEC ENG 3340 Controllers For Factory Automation** (LEC 2.0 and LAB 1.0)

Introduction to programmable automation, programmable logic controller (PLC) hardware, programming languages and techniques, closed-loop strategies using PLC's, sensors, transducers. Case studies. Laboratory experiments. Prerequisites: Elec Eng 2120 and Comp Eng 2210 each with a grade of "C" or better.

**ELEC ENG 3410 Digital Signal Processing** (LEC 3.0)

Analysis methods for discrete-time signals and systems in the time and frequency-domains including signal models and Fourier techniques. Continuous-time concepts are included as introductory material. Prerequisites: ELEC ENG 2120 with a grade of "C" or better; passing the ELEC ENG Advancement Exam II.

**ELEC ENG 3411 Discrete Linear Systems Laboratory** (LAB 1.0)

Software tools for signal and system representation and for time and frequency-domain systems analysis. Prerequisites: Elec Eng 2120 with a grade of "C" or better; passing the Elec Eng Advancement Exam II. Preceded or accompanied by Elec Eng 3410.

**ELEC ENG 3430 Digital Communications I** (LEC 3.0)

Signals and systems for digital communications. Topics include signals and their spectra, source formatting and source coding, digital baseband data communication, and digital pass-band modulation and demodulation. Prerequisites: ELEC ENG 2120 with a grade of "C" or better; passing the ELEC ENG Advancement Exam II; accompanied by ELEC ENG 3431.

**ELEC ENG 3431 Digital Communication Laboratory** (LAB 1.0)

Laboratory and software tools for the analysis of communications and for linear and non-linear signals and systems. Topics include spectral analysis, transforms, and applications. Prerequisites: ELEC ENG 2120 and ELEC ENG 2101 with a grade of "C" or better; passing the ELEC ENG Advancement Exam II; preceded or accompanied by ELEC ENG 3430.

**ELEC ENG 3440 Digital Communications II** (LEC 3.0)

Continuation of Elec Eng 3430. Signals and their spectra with application to digital communication systems. Prerequisites: ELEC ENG 3430 with a grade of "C" or better.

**ELEC ENG 3500 Electromechanics** (LEC 3.0)

Magnetics and magnetically coupled circuits, electromechanical energy conversion, rotating magnetic fields, stepper motors, DC machines, induction machines, synchronous machines, and brushless DC machines. Prerequisites: Physics 2135 with a grade of "C" or better; Elec Eng 2120 with a grade of "C" or better; passing grade on the Elec Eng Advancement Exam II.

**ELEC ENG 3501 Electromechanics Laboratory** (LAB 1.0)

Experiments with power measurement, transformers, magnetically coupled circuits, rotating magnetic fields, stepper motors, DC machines, induction machines, synchronous machines, and brushless DC machines. Credit will only be given for one of Elec Eng 3501 or Elec Eng 3541. Prerequisites: Elec Eng 2120 with a grade of "C" or better; passing grade on the Elec Eng Advancement Exam II. Preceded or accompanied by Elec Eng 3500.

**ELEC ENG 3540 Power System Design And Analysis** (LEC 3.0)

Power system components and transmission lines, three phase balanced power system theory, analysis and design including economic and reliability considerations, and fault analysis. A power system design project using a graphical power flow program is included. Prerequisites: Elec Eng 2120 with a grade of "C" or better; passing grade on the Elec Eng Advancement Exam II.

**ELEC ENG 3541 Power System Design And Analysis Laboratory** (LAB 1.0)

Computer-aided analysis of voltage regulation, power flow, compensation, and economic analysis. Individual projects are required. Credit will only be given for one of Elec Eng 3501 or Elec Eng 3541. Prerequisites: Elec Eng 2120 with a grade of "C" or better; passing grade on the Elec Eng Advancement Exam II. Preceded or accompanied by Elec Eng 3540.

**ELEC ENG 3600 Electromagnetics** (LEC 4.0)

Static electric and magnetic fields using vector analysis and time-varying electromagnetic fields using Maxwell's equations. Topics include Coulomb's law, Gauss's law, Ampere's law, dielectric and magnetic materials, plane waves, and transmission lines. Prerequisites: Elec Eng 2120, Elec Eng 2101, Physics 2135, and Math 3304 each with a grade of "C" or better. Passing grade on Elec Eng Advancement Exam II.

**ELEC ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ELEC ENG 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ELEC ENG 4010 Senior Seminar** (RSD 0.50)

Discussion of current topics. Prerequisite: Next to last semester senior.

**ELEC ENG 4096 Electrical Engineering Senior Project I** (LAB 0.50 and RSD 0.50)

A complete design cycle. Working in small teams, students will design, document, analyze, implement and test a product. Topics include: Iteration in design, prototyping, group dynamics, design reviews, making effective presentations, concurrent design, designing for test, ethics and standards, testing and evaluation. Prerequisites: Comp Eng 2210, Econ 1100 or 1200, English 3560, at least 3 of the following: Elec Eng 3500, Elec Eng 3540, Elec Eng 3320, Elec Eng 3420, Elec Eng 3600, Elec Eng 3100.

**ELEC ENG 4097 Electrical Engineering Senior Project II** (LAB 3.0)

A continuation of EI Eng 4096. Prerequisite: Elec Eng 4096 with a grade of "C" or better, Stat 3117, Sp&M S 1185.

**ELEC ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**ELEC ENG 4380 Practicum in Automation Engineering** (LAB 3.0)

Students on an approved internship or cooperative education assignment with industry will complete a project designed by the advisor and employer. The project selected must be related to topics in one or more of the other courses in the Automation Engineering Minor program. The same work period cannot receive credit for both Elec Eng 3002 and Elec Eng 4380. Prerequisites: Elec Eng 3340.

**ELEC ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ELEC ENG 5001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ELEC ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**ELEC ENG 5070 Teaching Engineering** (LEC 3.0)

Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mgt 5070, Env Eng 5070, Comp Eng 5070, Civ Eng 5070).

**ELEC ENG 5099 Special Research And Thesis** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**ELEC ENG 5100 Advanced Electronic Circuits** (LEC 3.0)

Application of feedback theory, oscillators and frequency standards, precision analog techniques, low-power circuit design, interfacing sensors, designing for high reliability, electronics for harsh environments. Prerequisite: Elec Eng 3120.

**ELEC ENG 5120 Communication Circuits** (LEC 3.0)

Analysis and design of circuits used in communication systems. Topics include RF semiconductor devices, low-noise amplifiers, mixers, modulators, crystal oscillators, AGC circuits, highpower RF amplifiers, phase-locked loops, impedance matching, and frequency-selective networks and transformers. Prerequisites: Elec Eng 3120, preceded or accompanied by Elec Eng 3420.

**ELEC ENG 5140 High-Frequency Amplifiers** (LEC 3.0)

Analysis and design of high frequency amplifiers. Topics include parameter conversions, activity and passivity, stability criteria, device operating conditions, Smith chart usage, matching networks, microstrip, scattering parameters, and practical applications. Prerequisites: Elec Eng 3120, 3600.

**ELEC ENG 5150 Photovoltaic Systems Engineering** (LEC 3.0)

Physics and characteristics of photovoltaic (solar) cell technologies, electronic control of alternative energy sources, site selection, array design, energy storage methods, electrical code compliance, stand-alone systems, grid-intertie systems, legal and economic considerations. Prerequisite: Senior or graduate standing in Science or Engineering.

**ELEC ENG 5160 Computer-Aided Network Design** (LEC 3.0)

Analysis and design of active and passive electric networks. Theory and computer application, including methods for automatic formulation of network state equations, network tolerance, network optimization, and device modeling. Prerequisites: Elec Eng 3100.

**ELEC ENG 5170 Introduction To Circuit Synthesis** (LEC 3.0)

Fundamentals of linear circuit theory. Matrix formulation, and topological methods as applied to circuit analysis. Properties of network functions and introductory network synthesis. Prerequisites: Elec Eng 3400.

**ELEC ENG 5200 Classical Optics** (LEC 3.0)

Physical optics and advanced topics in geometrical optics. Topics include ray propagation, electromagnetic propagation, mirrors, lenses, interference, diffraction, polarization, imaging systems, and guided waves. Prerequisites: Math 2222 and Physics 2135 or 2111. (Co-listed with Physics 4503).

**ELEC ENG 5210 Fourier Optics** (LEC 3.0)

Applications of Fourier analysis and linear systems theory to optics. Topics include scalar diffraction theory, Fourier transforming properties of lenses, optical information processing, and imaging systems. Prerequisites: Both ELEC ENG 3400 and 3600 or both PHYSICS 2401 and 4211. (Co-listed with PHYSICS 5503).

**ELEC ENG 5220 Fiber And Integrated Optics** (LEC 3.0)

Introduction to optical waveguides and their applications to communication and sensing. Topics include dielectric waveguide theory, optical fiber characteristics, integrated optic circuits, coupled-mode theory, optical communication systems, and photonic sensors. Prerequisite: Elec Eng 3600 or Physics 4211. (Co-listed with Physics 5513).

**ELEC ENG 5250 Optical Computing** (LEC 3.0)

Introduction to the principles, subsystems, and architectures of optical computing. Topics include characteristics of optical devices; optical implementations of memory, logic elements, and processors; and computational structures. Prerequisite: Comp Eng 2210 or equivalent. (Co-listed with Comp Eng 5230).

**ELEC ENG 5270 Smart Materials And Sensors** (LEC 2.0 and LAB 1.0)

Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multidisciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior standing and Math 3304. (Co-listed with Aero Eng 5529, Mech Eng 5229 and Civ Eng 5118).

**ELEC ENG 5300 Digital Control** (LEC 3.0)

Analysis and design of digital control systems. Review of ztransforms; root locus and frequency response methods; state space analysis and design techniques; controllability, observability and estimation. Examination of digital control algorithms. Prerequisite: Elec Eng 3320.

**ELEC ENG 5310 Computational Intelligence** (LEC 3.0)

Introduction to Computational Intelligence (CI), Biological and Artificial Neuron, Neural Networks, Evolutionary Computing, Swarm Intelligence, Artificial Immune Systems, Fuzzy Systems, and Hybrid Systems. CI application case studies covered include digital systems, control, power systems, forecasting, and time-series predictions. Prerequisite: Graduate Standing. (Co-listed with Comp Eng 5310 and Sys Eng 5211).

**ELEC ENG 5320 Neural Networks Control and Applications** (LEC 3.0)

Introduction to artificial neural networks and various supervised and unsupervised learning techniques. Detailed analysis of some of the neural networks that are used in control and identification of dynamical systems. Applications of neural networks in the area of Control. Case studies and a term project. Prerequisites: Elec Eng 3320.

**ELEC ENG 5330 Fuzzy Logic Control** (LEC 3.0)

A mathematical introduction to the analysis, synthesis, and design of control systems using fuzzy sets and fuzzy logic. A study of the fundamentals of fuzzy sets, operations on these sets, and their geometrical interpretations. Methodologies to design fuzzy models and feedback controllers for dynamical systems. Various applications and case studies. Prerequisite: Elec Eng 3320.

**ELEC ENG 5340 Advanced PLC** (LEC 2.0 and LAB 1.0)

Advanced programmable logic controller (PLC) programming, function block, structured text, function chart, sequencer. Factory communications, system simulation, human-machine interface (HMI) programming. Advanced PID control. Network security and reliability. Class-wide project. Prerequisite: Elec Eng 3340.

**ELEC ENG 5345 PLC Motion Control** (LAB 1.0 and LEC 2.0)

Factory automation motion control integrated with programmable logic controllers, servo control, variable-speed drive control, PackML state model, sizing motors and drives, machine safety, and experience with commercial hardware/software. Laboratory exercises on small-scale standard applications such as coordinated motion of multiple axes and camming. Prerequisite: Elec Eng 3340.

**ELEC ENG 5350 Plantwide Process Control** (LEC 3.0)

Synthesis of control schemes for continuous and batch chemical plants from concept to implementation. Multiloop control, RGA, SVD, constraint control, multivariable model predictive control, control sequence descriptions. Design project involving a moderately complicated multivariable control problem. Prerequisites: Chem Eng 4110 or Elec Eng 3320 or Elec Eng 3340 or graduate standing. (Co-listed with Chem Eng 5190).

**ELEC ENG 5360 System Simulation And Identification** (LEC 3.0)

Computationally efficient methods of digital simulation of linear systems. Non-parametric identification. Parametric identification with least squares and recursive least squares algorithms. Algorithms programmed using MATLAB. Prerequisite: Elec Eng 3320.

**ELEC ENG 5370 Introduction to Neural Networks and Applications** (LEC 3.0)

The course provides an introduction to basic neural network architectures and their applications. Students learn to construct neural networks and train them to solve engineering problems, specifically pattern recognition and function approximation. Mathematical analysis of network architectures, training algorithms and practical applications of neural nets. Prerequisites: Graduate Standing. (Co-listed with Sys Eng 5212).

**ELEC ENG 5380 Autonomous Mobile Robots** (LEC 3.0)

This course will provide an introduction to mobile robots and current approaches to robot autonomy. Topics include mobile robot systems, modeling and control, sensors and estimation, localization and mapping, and motion planning. Prerequisites: Elec Eng 3320 or equivalent and Stat 3117 or equivalent.

**ELEC ENG 5400 Digital Signal Processing II** (LEC 3.0)

Spectral representations, sampling, quantization, z-transforms, digital filters and discrete transforms including the Fast Fourier transform. Prerequisites: Elec Eng 3410 or Elec Eng 3420.

**ELEC ENG 5420 Communications Systems II** (LEC 3.0)

Random signals and their characterization; noise performance of amplitude, angle and pulse modulation systems; digital data transmission; use of coding for error control. Prerequisite: Elec Eng 3420.

**ELEC ENG 5430 Wireless Networks** (LAB 1.0 and LEC 2.0)

Introduction to wireless communications and networking. Topics include transmission fundamentals, wireless channel, coding techniques and error control, satellite and cellular networks, cordless systems, mobile IP and management, multiple access techniques and wireless protocols, wireless LAN, IEEE 802.11, and adhoc and sensor networks. Prerequisites: Hardware competency, Elec Eng 3420 or Comp Eng 3150 and graduate standing. (Co-listed with Comp Eng 5430 and Sys Eng 5323).

**ELEC ENG 5440 Stochastic Signal Analysis I** (LEC 3.0)

Introduction to the application of probabilistic models to typical electrical engineering problems. Topics include: methods for describing random voltages, random digital signals, correlation, linear mean-square estimation, linear transformation of random digital signals, and bit-error rate calculation for communication systems. Prerequisites: Math 3304 and Elec Eng 2120.

**ELEC ENG 5450 Digital Image Processing** (LEC 3.0)

Fundamentals of human perception, sampling and quantization, image transforms, enhancement, restoration, channel and source coding. Prerequisites: At least one of the following: Elec Eng 3400, Elec Eng 3410, Elec Eng 3420, or prior exposure to Fourier Transforms and consent of the instructor. (Co-listed with Comp Eng 5450).

**ELEC ENG 5460 Machine Vision** (LEC 3.0)

Image information, image filtering, template matching, histogram transformations, edge detection, boundary detection, region growing and pattern recognition. Complementary laboratory exercises are required. Prerequisites: At least one of the following: Elec Eng 3400, Elec Eng 3410, Elec Eng 3420, or prior exposure to Fourier Transforms and consent of the instructor. (Co-listed with Comp Eng 5460).

**ELEC ENG 5500 Electric Drive Systems** (LEC 3.0)

Course content is roughly 1/3 power electronics, 1/3 applied control and 1/3 electric machinery and focuses on analysis, simulation, and control design of electric drive based speed, torque, and position control systems. Prerequisites: Elec Eng 3500 and Elec Eng 3320.

**ELEC ENG 5510 Electric-Drive Vehicles** (LEC 3.0)

Course covers introductory topics related to understanding/analysis of electric, hybrid/plug-in hybrid power trains. Classification of hybrid drivetrains, driving cycles, energy storage systems, mechanical coupling devices, automotive applications of fuel cells and introduction to power converters. Prerequisite: Senior standing and Physics 2135.

**ELEC ENG 5520 Power Electronics** (LEC 3.0)

Analysis, design, modeling, and control of switching mode power converter circuits for ac-dc, dc-dc, dc-ac, and ac-ac conversion. Power semiconductor devices, passive components, and non-ideal sources and loads. Applications to industry, consumer goods, electric vehicles, and alternative energy. Prerequisite: Elec Eng 3100.

**ELEC ENG 5521 Power Electronics Laboratory** (LAB 2.0)

An introduction to power electronic circuits is presented. Students will construct several dc/dc, dc/ac and ac/dc converters. Various switching algorithms, including pulse width modulation, delta modulation, and hysteresis control will be developed to regulate and control the respective circuits. Prerequisite: Co-requisite Elec Eng 5520.



**ELEC ENG 5540 Power Systems Engineering** (LEC 3.0)

Network analysis applied to power systems; the load flow concept; economic operation of power systems; synchronous machine reactances and transient stability; symmetrical components and asymmetrical faults; protective relaying. Prerequisite: Elec Eng 3540.

**ELEC ENG 5550 Electric Power Quality** (LEC 3.0)

Definitions of power quality, types of power quality problems; sources of sags, transient overvoltages and harmonics; distribution overcurrent protection methods and their effect on power quality and reliability; harmonic analysis, principles of controlling harmonics, devices for filtering harmonics; power quality improvement methods. Prerequisite: Elec Eng 3500 or Elec Eng 3540.

**ELEC ENG 5570 Extra High Voltage Engineering** (LEC 2.0 and LAB 1.0)

The physical phenomena associated with high voltage dielectric breakdown are presented. Methods of generating and measuring high voltages and currents are explained. Demonstration of design and performance. Field trips to companies for laboratory testing of high voltage according to industry standards will serve as the lab part of the course. Prerequisite: Senior standing.

**ELEC ENG 5600 Interference Control in Electronic Systems** (LEC 3.0)

Principles of high frequency effects in PCBs and components, generation of unwanted radio-frequency (RF) signals by ICs, RF radiation mechanisms, shielding, and immunity against electrostatic discharge and RF signals. Prerequisites: Elec Eng 3400 and 3600.

**ELEC ENG 5620 Signal Integrity in High-Speed Digital & Mixed Signal Design** (LEC 3.0)

Signal integrity ensures signals transmitted over a propagation path maintain sufficient fidelity for proper receiver operation. Compromised signal integrity is often associated with parasitics (e.g. unintentional inductance, capacitance). Theory and CAD tools used for signal integrity analysis of functioning designs. Prerequisites: Elec Eng 3600 or Comp Eng 3150, and Senior standing. (Co-listed with Comp Eng 5620).

**ELEC ENG 5630 Wave Propagation and Transmission Lines** (LEC 3.0)

The materials in this course are intended to provide a) follow up electromagnetics related courses, b) electromagnetics related career including RF design and c) a graduate degree in electromagnetic related fields an in-depth understanding of the basics of wave propagation and transmission lines. Prerequisite: Elec Eng 3600.

**ELEC ENG 5640 Antennas and Propagation** (LEC 3.0)

Propagated fields of elemental dipole, directivity and gain, radiation resistance, the half-wave dipole, wire antennas, arrays, broadband antennas, aperture antennas, horn antennas, and antenna temperature. Prerequisite: Elec Eng 3600.

**ELEC ENG 5650 Microwave and Millimeter Wave Engineering and Design** (LEC 3.0)

Introduce senior and graduate students to the concept of microwave and millimeter wave engineering and passive component design such as waveguide, cavities, couplers, detectors, mixers, etc., including network theory and scattering matrix. Finally, their specific application in the design of various microwave circuits will be discussed. Prerequisites: Elec Eng 3600.

**ELEC ENG 5660 Microwave Principles For Mixed-Signal Design** (LEC 3.0)

Transmission lines; coupled transmission lines; microwave network analysis; impedance matching and tuning; design of microwave amplifiers and oscillators. Prerequisite: Elec Eng 3600.

**ELEC ENG 5670 Nondestructive Testing** (LEC 3.0)

Principles and applications of various means of non-destructive testing of metallic materials. Radiological inspection methods, ultrasonic testing, magnetic methods, electrical and eddy current methods and others. Prerequisite: Physics 2135 or 2111. (Co-listed with Met Eng 5510).

**ELEC ENG 5870 Mechatronics** (LAB 1.0 and LEC 2.0)

This course will introduce students to the basics of mechatronics (i.e., the integration of mechanical, electrical, computer, and control systems). Students will learn the fundamentals of sensors and actuators for mechanical systems, computer interfacing, microcontrollers, real-time software, and control. Prerequisite: Mech Eng 4479 or equivalent. (Co-listed with Mech Eng 5478, Aero Eng 5478 and Comp Eng 5820).

**ELEC ENG 5880 Introduction to Robotics** (LEC 3.0)

This course provides an introduction to robotics, covering robot hardware, fundamental kinematics, trajectories, differential motion, robotic decision making, and an overview of current topics in robotics. Prerequisite: A "C" or better in both Math 3108 and Comp Sci 1510. (Co-listed with Comp Sci 5403 and Comp Eng 5880).

## Engineering Management

The engineering management degree programs prepare students for leadership roles in today's complex environment as engineers, managers and educators. Graduates are capable of designing, implementing, operating and optimizing sophisticated high technology enterprises in manufacturing, government or service sectors of our global economy.

In today's economy there is a need to see the business unit as a complete, technology driven enterprise and to integrate system components thus ensuring that the company thrives in global competition. In such an environment engineers need both excellent technical and managerial skills to cope effectively with the continuous change that will take place during their careers.

The engineering management discipline prepares individuals to successfully integrate engineering and management knowledge while optimizing the use of people, equipment, money and information. The discipline also seeks to develop students into individuals with leadership potential who achieve results in an ethical and sustainable manner.

Missouri S&T's engineering management program has served the needs of students at the B.S., M.S., and Ph.D. level, enabling graduates to pursue career opportunities in the private sector, government, and academia. Furthermore, many alumni now occupy top executive positions in a variety of enterprises.

## Mission, Educational Objectives and Student Outcomes

### Mission

The mission of the engineering management and systems engineering department is to equip individuals with engineering, management and systems expertise to prepare them to be leaders in the identification and solution of technical and organizational problems that are complex and evolving.

### Educational Objectives:

Graduates of the engineering management program will exhibit proficiency and excellence in the areas of technology, finance, human relations, communications, and professional behavior. Within these areas

of proficiency, graduates will exhibit the explicit skills and knowledge as described below:

**Technical Knowledge and Analytical Problem Solving:** Graduates of the engineering management program are able to analyze and solve complex problems utilizing the following:

- a mastery of engineering management tools and techniques including those utilized in operations management, project management, management of technology and supply chain management
- in-depth knowledge in at least one emphasis area within engineering management
- an understanding of the fundamental principles and concepts of engineering
- sound business judgment
- relevant analytical and model tool such as statistics

**Finance:** Graduates of the engineering management program are responsible and financially aware managers and leaders who utilize basic finance, accounting, engineering economy and risk analysis methods to manage and identify the financial impact of business opportunities.

**Human Relations:** Graduates of the engineering management program are competent leaders who can develop and utilize the skills and abilities of teams and individuals within the organization as evidenced by proficiency in:

- team building
- conflict resolution
- efficient and effective management of constituents with diverse skills
- empowering teams and individuals through coaching and mentoring
- conducting effective and efficient meetings.

**Communication:** Graduates of the engineering management program engage others through effective oral, technical and written communication evidenced by:

- active listening
- clarity and conciseness in presentation
- an ability to adjust content and presentation style to audience
- confidence and discernment in asking appropriate questions to obtain information vital to the project or task at hand.

**Professional Behavior:** Graduates of the engineering management program will continually grow in their awareness and understanding of the societal, ethical, cultural, legal and political issues prevalent in an increasingly global society.

**Integration:** Drawing on proficiencies in the areas described above, graduates of the engineering management program are able to integrate their skills and knowledge to:

- effectively manage people, talent, time and financial resources
- develop successful marketing strategies
- develop plans for projects and programs
- analyze problems, consider alternatives, and implement solutions

## Student Outcomes

Engineering management graduates will:

- have an ability to apply knowledge of mathematics, science, and engineering in the solution of engineering management problems
- have an ability to design and conduct experiments related to operation, marketing, management and finance, as well as to analyze and interpret data
- have an ability to carry out the design of an operational system and its various components and processes for engineering management applications and within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- understand the importance of teams, know how to develop effective teams and have an ability to function on multidisciplinary teams
- have an ability to identify, formulate, and solve engineering management problems
- have an understanding of professional ethical responsibility
- have an ability to communicate effectively individually and in teams
- have the broad education necessary to understand the impact of engineering and enterprise solutions in a global, economic, environmental, and societal context
- recognize the need for and have an ability to engage in life-long learning
- have knowledge of contemporary issues related to engineering management
- have an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

## Bachelor's Degree Components

The bachelor's program includes the basic chemistry, physics, mathematics and engineering science courses required by all engineering disciplines at Missouri S&T. These courses are followed by required core engineering management courses and students then specialize in focused emphasis areas with 18 hours of course work.

## Engineering Management Core

- Economic Analysis of Engineering Projects
- Managing Engineering & Technology
- Engineering Accounting and Finance
- Introduction to System Engineering
- Marketing Management
- Operations and Production Management
- Introduction to Project Management
- Quality
- General Management Design & Integration
- Engineering Management Senior Design

As a senior you will take a capstone design course that integrates the technical and managerial skills acquired. Students complete their bachelor of science degree requirements by taking the fundamental in engineering exam.

## Emphasis Areas in Engineering Management

**Management of Technology** focuses on the management aspects of system design, logistics, scheduling, budgeting, information development, legal aspects of technology management, managing people, and decision making for positions in supply chain logistics,

project engineering/scheduling, operations management, cost control/estimating, technical marketing/procurement, sales engineering, engineering administration, information systems, and finance economic analysis.

**Industrial Engineering** focuses on productivity analysis and system optimization for manufacturing and service organizations. Industrial engineering includes a variety of quantitative and qualitative techniques to identify potential improvements in productivity, quality, safety, and other areas. This emphasis area prepares students for positions such as process engineer, project manager, quality engineer, safety engineer, supply chain manager, operations manager and consulting.

**General Emphasis Area** focus on the convergence of engineering, management, and innovation in high technology environments. A general engineering emphasis allows students to customize their degree program and create a unique engineering emphasis area that focuses on a traditional engineering field or even a unique combination of engineering courses.

## Bachelor of Science Engineering Management

Entering freshmen intending to study engineering management are admitted to the Freshman Engineering Program. They may, however, state an engineering management preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major.

The bachelor of science degree in engineering management requires a minimum of 128 credit hours. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in engineering management.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1. All students are required to take one American history course, one economics course, and ENGLISH 1120. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200. All students must choose one additional humanities or social science course from "The Approved List of Humanities and Social Sciences Courses for Engineering Degrees" maintained by the Office of Undergraduate Studies.
2. Depth requirement. Three credit hours must be taken in humanities or social sciences at the 2000-level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 1180 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 4000-level or above. All courses taken to satisfy the depth requirement must be taken after graduating from high school.

3. The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to ENGLISH 1120.
4. Any specific departmental requirements in the general studies area must be satisfied.
5. Special topics, special problems and honors seminars are allowed only by petition to and approval by the student's department chair.

The engineering management program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

### Free Electives Footnote:

Free electives. Each student is required to take three hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of engineering and science must be at least three credit hours.

Freshman Year			
First Semester	Credits	Second Semester	Credits
FR ENG 1100	1	MECH ENG 1720	3
CHEM 1310 <sup>1</sup>	4	MATH 1215 <sup>1</sup>	4
CHEM 1319	1	PHYSICS 1135 <sup>1</sup>	4
CHEM 1100	1	ECON 1100 or 1200	3
MATH 1214 <sup>1</sup>	4	COMP SCI 1972 <sup>1</sup>	2
ENGLISH 1120	3	COMP SCI 1982	1
HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3		
	17		17
Sophomore Year			
First Semester	Credits	Second Semester	Credits
MATH 2222 <sup>1</sup>	4	MATH 3304 <sup>1</sup>	3
PHYSICS 2135 <sup>1</sup>	4	STAT 3115 or 3117 <sup>1</sup>	3
CIV ENG 2200 <sup>1</sup>	3	ENG MGT 2110 <sup>1</sup>	3
ENG MGT 1210 <sup>1</sup>	2	ENG MGT 2211 <sup>1</sup>	3
ENG MGT 2310 <sup>1</sup>	3	MECH ENG 2350	2
		PSYCH 1101	3
	16		17
Junior Year			
First Semester	Credits	Second Semester	Credits
ENG MGT 3310 <sup>1</sup>	3	ENG MGT 4710 <sup>1</sup>	3
CIV ENG 2210	3	MECH ENG 2527	3
CIV ENG 2211	1	ELEC ENG 2800	3
ENG MGT 3510 <sup>1</sup>	3	ENGLISH 3560	3
SP&M S 1185 or 2181	3	ENG MGT 3320 <sup>1</sup>	3
Humanities and Social Sciences <sup>2</sup>	3		
	16		15

**Senior Year**

First Semester	Credits	Second Semester	Credits
Emphasis Area Required Course	3	ENG MGT Technical Elective	3
Emphasis Area Required Course	3	ENG MGT Technical Elective	3
Emphasis Area Required Course	3	ENG MGT 4907 <sup>1</sup>	3
ENG MGT 4110 <sup>1</sup>	3	Upper Level Hum/SS <sup>2</sup>	3
ENG MGT Technical Elective	3	Free Elective <sup>3</sup>	3
			15
			15

Total Credits: 128

## Example Emphasis Area Programs for Engineering Management Students

One unique aspect of the engineering management degree is the student's ability to select an established emphasis area or create a specialized emphasis. Two examples of established emphasis areas are shown below.

### Management of Technology

ENG MGT 5511	Technical Entrepreneurship	3
ENG MGT 5512	Legal Environment	3
ENG MGT 5410	Industrial System Simulation	3
ENG MGT 5614	Supply Chain Management Systems	3
ENG MGT Technical Electives (in consultation with your advisor)		6

### Industrial Engineering

ENG MGT 4310	Materials Handling and Plant Layout	3
ENG MGT 4330	Human Factors	3
ENG MGT 5410	Industrial System Simulation	3
ENG MGT 5414	Introduction To Operations Research	3
ENG MGT Technical Electives (in consultation with your advisor)		6

### General

Engineering Area Courses (Engineering Discipline)	15
ENG MGT-Technical Elective (in consultation with your advisor)	3

**Note:** All electives must be chosen in consultation with the student's advisor. Students must satisfy the common engineering freshman year course requirements in addition to the sophomore, junior, and senior year requirements listed above with a minimum of 128 hours.

<sup>1</sup> Must have a grade of "C" or better in these courses for graduation. MATH 1208 and MATH 1221 may be substituted for MATH 1214 and MATH 1215, respectively.

<sup>2</sup> Humanities and social science electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog.

<sup>3</sup> Each student is required to take three hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of engineering and science must be at least three credit hours.

<sup>4</sup> Students are required to select an emphasis area and maintain a minimum 2.0 GPA for these courses.

<sup>5</sup> All engineering management students must take the fundamentals of engineering (FE) exam prior to graduation. A passing grade on this examination is not required to earn a B.S. degree. This requirement is part of the Missouri S&T assessment process as described in assessment requirements found elsewhere in this catalog.

## Minor in Engineering Management

A student who receives a bachelor of science degree in an accredited engineering program from Missouri S&T may receive a minor in engineering management by completing 15 hours of the courses listed below.

ENG MGT 2110	Managing Engineering And Technology	3
ENG MGT 2211	Engineering Accounting and Finance	3
ENG MGT 3310	Operations and Production Management	3
Eng Mgt 3000, 4000, or 5000-level course work chosen in consultation with minor advisor.		6
Total Credits		15

**Randy Lawrence Canis**, Adjunct Professor  
JD University of Missouri-Columbia

**Steven M. Corns**, Associate Professor  
PHD Iowa State University

**Elizabeth Anne Fargher Cudney**, Associate Professor  
PHD Missouri S&T

**Cihan H Dagli**, Professor  
PHD University of Birmingham, UK

**David Enke**, Professor  
PHD University of Missouri-Rolla

**Abhijit Gosavi**, Associate Professor  
PHD University of South Florida

**Katie Grantham**, Associate Professor  
PHD University of Missouri-Rolla

**Kellie Sue Grasman**, Lecturer  
MBA University of Michigan Ann Arbor

**Stanley W Grzyb Jr**, Adjunct Associate Professor  
PHD University of Missouri-Columbia

**Ivan Guardiola**, Associate Professor  
PHD Texas Tech University

**Glenn L Haley**, Lecturer  
MASTER Keller Graduate School

**Sheryl Hodges**, Assistant Teaching Professor  
DEng Louisiana Tech Univeristy

**Dincer Konur**, Assistant Professor  
PHD University of Florida

**Hongy Lin**, Adjunct Professor  
PHD University of Missouri-Rolla

**Suzanna K. Long**, Professor  
PHD University of Missouri-Rolla



**Susan L Murray**, Professor<sup>1</sup>  
PHD Texas A&M University

**Ruwen Qin**, Associate Professor  
PHD Pennsylvania State University

**Stephen A Raper**, Associate Professor  
PHD University of Missouri-Rolla

**Michael Stephen Schmidt**, Adjunct Professor  
MS University of Missouri-Rolla

**Joan Barker Schuman**, Assistant Teaching Professor  
PHD University of Southern Mississippi

**David G Spurlock**, Lecturer  
PHD University of Illinois Urbana

**Zeyi Sun**, Assistant Professor  
PHD University of Illinois at Chicago

**ENG MGT 1001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENG MGT 1100 Practical Concepts for Technical Managers** (LEC 1.0)

This course introduces topics relevant to the technical manager in the 21st Century. Topics covered include management practices, leadership, communications, project management, working in the global environment, risk management, systems engineering, product development, and quality management.

**ENG MGT 1210 Economic Analysis of Engineering Projects** (LEC 2.0)

Engineering project analysis from an engineering economics perspective. Topics include: interest, equivalent worth, comparing alternatives, rate of return methods, depreciation and taxes, inflation and price changes, benefit-cost analysis and risk analysis. Prerequisites: Math 1214.

**ENG MGT 2001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENG MGT 2002 Cooperative Engineering Training** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation.

**ENG MGT 2011 Competition Team Leadership** (LEC 1.0)

Students will participate in open lecture on team based management and leadership as it pertains to ongoing project activities. Project activity reports will be generated using real project data and assessed at the end of the semester through a project master plan and oral presentation. Prerequisite: Sophomore (or greater) standing and leadership role in an experiential learning design team or nomination by an experiential learning team advisor.

**ENG MGT 2012 Competition Team Communication** (LEC 0.50 and LAB 0.50)

Communication skills, both technical and promotional, will be covered. Students will practice both communication skills in written, oral and media-based modes. Specific activities will include writing a proposal for funding, developing a promotional media piece and speaking to external groups about a SDELC team. Assessment will be made on each of the deliverables. Prerequisite: Sophomore (or greater) standing and membership in an experiential learning design team.

**ENG MGT 2013 Competition Team Design** (LAB 1.0)

Students will participate in a significant design activity as part of one of the experiential learning design team projects. Design activity will be reported and assessed at the end of the semester through a design report and oral presentation. Prerequisite: Sophomore (or greater) standing and membership in an experiential learning design team.

**ENG MGT 2110 Managing Engineering And Technology** (LEC 3.0)

Introduces the management functions of planning, organizing, motivating, and controlling. Analyzes the application of these functions in research, design, production, technical marketing, and project management. Studies evolution of the engineering career and the transition to engineering management. Prerequisite: A grade of "C" or better is required in this course to meet Engineering Management degree requirements.

**ENG MGT 2211 Engineering Accounting and Finance** (LEC 3.0)

This course is designed to introduce the fundamentals of accounting and finance and provide the student with tools used in making financial decisions within a technically based enterprise. Prerequisite: Eng Mgt 1210, or understanding of engineering economic principles.

**ENG MGT 2310 Introduction to System Engineering** (LEC 3.0)

Provide an understanding of systems engineering and tools to manage system design, construction, and operation. Topics include systems thinking, modeling and simulation of systems, uncertainty in engineering, risk, and decision making in certain and uncertain environments. Prerequisites: Math 1208 or Math 1214.

**ENG MGT 3310 Operations and Production Management** (LEC 3.0)

Concepts of operations and production management are presented at an introductory level. Qualitative and quantitative tools and techniques used for the optimization of the operations component of the total enterprise are explored in the context of improved productivity and strategic competitiveness. Prerequisites: Eng Mgt 2110.

**ENG MGT 3320 Introduction to Project Management** (LEC 3.0)

This course covers the fundamentals of project management including project definition, project selection, project planning, estimating, scheduling, resource allocation and project control. Prerequisites: Junior or above standing.

**ENG MGT 3510 Marketing Management** (LEC 3.0)

Study of basic functions of marketing in the technological enterprise, including product selection and development, market research, market development, selection of distribution channels and advertising, marketing strategy. Prerequisites: Preceded or accompanied by Eng Mgt 2110.

**ENG MGT 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ENG MGT 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENG MGT 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Consent of instructor required.

**ENG MGT 4110 General Management-Design and Integration** (LEC 3.0)

Integrating and executing marketing, production, finance, and engineering policies and strategies for the benefit of an enterprise. Analysis, forecasting, and design methods using case studies and management simulation. Prerequisites: Eng Mgt 2210, 2211; preceded or accompanied by Eng Mgt 3310, 3320, 4710, and senior standing.

**ENG MGT 4310 Materials Handling and Plant Layout** (LAB 1.0 and LEC 2.0)

The design and objectives of materials handling equipment including diversity of application in industry from the viewpoint of efficient movement of materials and products from the receiving areas to the shipping areas. The layout of a plant to include materials handling equipment is considered throughout. Cost comparison of various systems will be made. Prerequisites: Junior standing.

**ENG MGT 4312 Risk Assessment and Reduction** (LEC 3.0)

Safe, secure manufacturing facilities protect the health of employees and the public, preserve the environment, and increase profitability. Methods for systematically identifying hazards and estimating risk improve the safety performance and security of manufacturing facilities. Prerequisite: Senior or Graduate Standing. (Co-listed with Chem Eng 5130).

**ENG MGT 4330 Human Factors** (LEC 3.0)

An examination of human-machine systems and the characteristics of people that affect system performance. Topics include applied research methods, systems analysis, and the perceptual, cognitive, physical and social strengths and limitations of human beings. The focus is on user-centered design technology, particularly in manufacturing environments. Prerequisite: Psych 1101. (Co-listed with Psych 4710).

**ENG MGT 4710 Quality** (LEC 3.0)

This course will provide an overview of quality tools and methodologies and how they apply to engineering management. Quality management methodologies will be explored as well as current and relevant tools and techniques used in the successful application of quality into various environments. Prerequisites: Stat 3115 or Stat 3117.

**ENG MGT 4907 Engineering Management Senior Design** (LEC 3.0)

Open-ended design projects will be addressed with small teams. The emphasis will be on solving industry-based projects that are broad in nature and which will require the students to incorporate the knowledge and skills acquired in earlier course work in the solution of the problems. Prerequisites: Preceded or accompanied by Eng Mgt 4110.

**ENG MGT 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ENG MGT 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENG MGT 5070 Teaching Engineering** (LEC 3.0)

Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Env Eng 5070, Comp Eng 5070, Elec Eng 5070, Civ Eng 5070).

**ENG MGT 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**ENG MGT 5110 Managerial Decision Making** (LEC 3.0)

Individual and group decision making processes and principles for engineers and technical managers with emphasis on the limitations of human rationality and the roles of social influence and organizational contexts; principles and skills of negotiation. Prerequisite: Senior or graduate standing.

**ENG MGT 5111 Management for Engineers and Scientists** (LEC 3.0)

The transition of the engineer or scientist to manager; study of management roles and theory, organizational systems and behavior, managing and motivating technical personnel, leadership, communication, processes, and customer focus. Prerequisite: Graduate standing.

**ENG MGT 5210 Economic Decision Analysis** (LEC 3.0)

Comprehensive treatment of engineering economy including effects of taxation and inflation; sensitivity analysis; decisions with risk and uncertainty; decision trees and expected value, normally includes solutions on personal computer and student problem report. Prerequisite: Graduate students without previous course in engineering economy because of partial overlap.

**ENG MGT 5212 Intelligent Investing** (LEC 3.0)

An overview of the essential elements of intelligent investing. Coverage includes stocks, bonds, exchange traded funds, mutual funds, stock screening, fundamental and technical analysis, valuation, market and industry analysis, macroeconomic indicators, investing strategies, and portfolio construction. Prerequisites: Senior or Graduate Standing.

**ENG MGT 5312 Advanced Risk Assessment and Reduction** (LEC 3.0)

Safe, secure manufacturing facilities protect the health of employees and the public, preserve the environment, and increase profitability. Methods for systematically identifying hazards and estimating risk improve the safety performance and security of manufacturing facilities. Prerequisite: Senior or Graduate Standing.

**ENG MGT 5313 Packaging Management** (LEC 3.0)

Provides a comprehensive background in the field of packaging and its place in productive systems. Emphasizes the design or economics of the system. Analyzes the management of the packaging function and interrelationship with other functions of an enterprise.

**ENG MGT 5314 Computer Integrated Manufacturing Systems** (LEC 2.0 and LAB 1.0)

Study of the design and use of computer-based integrated manufacturing management systems in the allocation and control of plant, equipment, manpower, and materials. Prerequisite: Eng Mgt 3310.

**ENG MGT 5315 Interdisciplinary Problems In Manufacturing Automation** (LEC 1.0 and LAB 2.0)

Introduction to basic techniques and skills for concurrent engineering, manufacturing strategies, product design, process planning, manufacturing data management and communication are the topics covered. Students experiment the design process through team projects and structured manufacturing laboratory work. (Co-listed with Mech Eng 5644, Chem Eng 4310).

**ENG MGT 5316 Safety Engineering Management** (LEC 3.0)

This course is an introduction to the principles of safety engineering applied to industrial situations. Job safety analysis, reduction of accident rates, protective equipment, safety rules and regulations, environmental hazards, health hazards, and ergonomic hazards are covered. Prerequisite: Senior or graduate standing.

**ENG MGT 5320 Project Management** (LEC 3.0)

Organization structure and staffing; motivation, authority and influence; conflict management; project planning; network systems; pricing, estimating, and cost control; proposal preparation; project information systems; international project management. Prerequisite: Graduate Standing.

**ENG MGT 5330 Advanced Human Factors** (LEC 3.0)

An in-depth review of the foundations of human factors, focusing on the interaction of people with various forms of technology in a variety of environments. Topics include research and evaluation methods, displays (e.g., visual, auditory), attention and information processing, decision making, motor skills, anthropometry, and biomechanics. (Co-listed with PSYCH 5710).

**ENG MGT 5410 Industrial System Simulation** (LEC 3.0)

Simulation modeling of manufacturing and service operations through the use of computer software for operational analysis and decision making. Prerequisite: Stat 3115 or Stat 3117.

**ENG MGT 5411 Engineering Design Optimization** (LEC 3.0)

This course is an introduction to the theory and practice of optimal design as an element of the engineering design process. The use of optimization as a tool in the various stages of product realization and management of engineering and manufacturing activities is stressed. The course stresses the application of nonlinear programming methods. Prerequisite: Math 3304 or 3329.

**ENG MGT 5412 Operations Management Science** (LEC 3.0)

Application of management science with an emphasis on supporting managerial decision-making. Design and operations of systems are modeled and analyzed using quantitative and qualitative techniques implemented using modern technology. Specific approaches include mathematical modeling and optimization, probabilistic/statistical analysis, and simulation. Prerequisites: Graduate standing.

**ENG MGT 5413 Introduction To Intelligent Systems** (LEC 3.0)

Introduction to the design of intelligent systems. Topics include: definitions of intelligence, rule-based expert systems, uncertainty management, fuzzy logic, fuzzy expert systems, artificial neural networks, genetic algorithms and evolutionary computation, hybrid systems, and data mining. Prerequisite: Graduate or senior standing.

**ENG MGT 5414 Introduction To Operations Research** (LEC 3.0)

Mathematical methods for modeling and analyzing industrial systems, topics including linear programming, transportation models, and network models. Prerequisite: Stat 3115 or Stat 3117.

**ENG MGT 5510 Industrial Marketing Systems Analysis** (LEC 3.0)

An analysis of the factors of engineered products, customers, communication, promotion, personal selling, persuasion and management within a dynamic industrial sales environment. Prerequisites: Senior or graduate standing.

**ENG MGT 5511 Technical Entrepreneurship** (LEC 3.0)

Student teams develop a complete business plan for a company to develop, manufacture and distribute real technical/product service. Lectures & business fundamentals, patents, market/ technical forecasting, legal and tax aspects, venture capital, etc., by instructor and successful technical entrepreneurs. Prerequisite: Senior or graduate standing.

**ENG MGT 5512 Legal Environment** (LEC 3.0)

Study of the effect of the legal environment on the decisions which the engineering manager must make. The course investigates the social forces that produced this environment and the responsibilities incumbent upon the engineer. Prerequisites: Senior or graduate standing.

**ENG MGT 5513 Energy and Sustainability Management Engineering** (LEC 3.0)

This course explores strategic processes and partnership required for the management of sustainable energy infrastructures and innovation in energy systems. Topics relate to renewable energy, energy efficiencies, energy conversion, energy technology, and economic efficiency of energy sources. Prerequisite: Senior or Graduate Standing.

**ENG MGT 5514 Patent Law** (LEC 3.0)

A presentation of the relationship between patent law and technology for students involved with developing and protecting new technology or pursuing a career in patent law. Course includes an intense study of patentability and preparation and prosecution of patent applications. Prerequisite: Senior or graduate standing. (Co-listed with Chem Eng 4300).

**ENG MGT 5515 Integrated Product And Process Design** (LEC 3.0)

Emphasize design policies of concurrent engineering and teamwork, and documenting of design process knowledge. Integration of product realization activities covering important aspects of a product life cycle such as "customer" needs analysis, concept generation, concept selection, product modeling, process development, and end of product life options. Prerequisites: Junior or above standing. (Co-listed with MECH ENG 5757).

**ENG MGT 5516 Integrated Product Development** (LAB 2.0 and LEC 1.0)

Students in design teams will simulate the industrial concurrent engineering development process. Areas covered will be design, manufacturing, assembly, process quality, cost, supply chain management, and product support. Students will produce a final engineering product at the end of the project. Prerequisite: Eng Mgt 5515 or Mech Eng 5757 or Mech Eng 3653 or Mech Eng 5708. (Co-listed with Mech Eng 5758).

**ENG MGT 5610 Advanced Facilities Planning & Design** (LAB 1.0 and LEC 2.0)

An integrated approach to the planning and design of facilities; examination of advanced techniques and tools for facility location, space allocation, facility layout materials handling system design, work place design; e.g. mathematical programming and simulation modeling. Prerequisites: Graduate standing.

**ENG MGT 5613 Value Analysis** (LEC 3.0)

An organized effort at analyzing the function of goods or services for the purpose of achieving the basic functions at the lowest overall cost, consistent with achieving the essential characteristics. Covers the basic philosophy, function analysis, FAST diagramming, creativity techniques, evaluation of alternatives, criteria analysis, and value stream mapping. Prerequisite: Senior or graduate standing.

**ENG MGT 5614 Supply Chain Management Systems** (LEC 3.0)

This course focuses on the development of logistics management skills related to global supply chains. Particular attention will be given to supply chain systems management as part of the firm's strategic positioning, cultural interactions and transportation sourcing decisions. Prerequisite: Stat 3115 or Stat 3117.

**ENG MGT 5615 Production Planning And Scheduling** (LEC 3.0)

Introduction to basic techniques of scheduling, manufacturing planning and control, just-in-time systems, capacity management, master production scheduling, single machine processing, constructive Algorithms for flow-shops, scheduling heuristics, intelligent scheduling systems are the topics covered. Prerequisite: Eng Mgt 3310.

**ENG MGT 5710 Six Sigma** (LEC 3.0)

This course is an introduction to the principles of implementing the Six Sigma philosophy and methodology. Topics include tools and methods including process flow diagrams, cause and effect diagrams, failure mode and effects analysis, gage R&R, capability studies, design of experiments and strategy for organizing six sigma techniques in industry. Prerequisite: Graduate standing.

**ENG MGT 5711 Total Quality Management** (LEC 3.0)

Examination of various quality assurance concepts and their integration into a comprehensive quality management system: statistical techniques, FMEA's, design reviews, reliability, vendor qualification, quality audits, customer relations, information systems, organizational relationships, motivation. Prerequisite: Senior or graduate standing.

**ENG MGT 5712 Introduction To Quality Engineering** (LEC 3.0)

This course is an introduction to the theory and practice of quality engineering with particular emphasis on the work of Genichi Taguchi. The application of the quality loss function, signal to noise ratio and orthogonal arrays is considered in-depth for generic technology development; system, product and tolerance design; and manufacturing process design. The emphasis of the course is off-line quality control. Other contributions in the field are also considered. Prerequisite: Eng Mgt 5711.

**ENG MGT 5713 Management And Methods In Reliability** (LEC 3.0)

Study of basic concepts in reliability as they apply to the efficient operation of industrial systems. Prerequisite: Stat 3115, 3117, or 5643.

**ENG MGT 5714 Statistical Process Control** (LEC 3.0)

The theoretical basis of statistical process control procedures is studied. Quantitative aspects of SPC implementation are introduced in context along with a review of Deming's principles of quality improvement and a brief introduction to sampling inspection. Prerequisite: Stat 3115, or Stat 3117.

## English

The English program is offered in the department of English and technical communication.

The English curriculum involves the study of language, literature, and culture. Topics include literary history, criticism, literary forms, and detailed examinations of individual authors. Additional genre and theme courses are available, including world literature, literature and film, and science fiction. Linguistics and writing courses include the history and structure of the English language, advanced composition, and creative writing.

If you plan to become a secondary school teacher of English/language arts, the department offers an emphasis area in secondary education.

Six minors in English also are available. These minors consist of approved course work in American studies, creative writing, literature, writing, technical communication, and literature and film. You can major in any other academic field and minor in these areas.

In addition to taking the courses in the English curriculum, English majors and minors will have the opportunity to join the writing staffs of campus publications to contribute work to a creative magazine (*Southwinds*), to participate in Sigma Tau Delta and to attend lectures given by visiting scholars and writers.

## Bachelor of Arts English

The requirements for the English major are as follows:

1. Prerequisites for the English major are ENGLISH 1211, ENGLISH 1212, ENGLISH 1221, and ENGLISH 1222. Six of these hours will satisfy the general education humanities requirements for the bachelor of arts degree.
2. ENGLISH 2002 Critical Approaches to Literature.
3. Capstone course for major: ENGLISH 4290 Texts and Contexts.
4. In addition to the requirements above, fifteen hours of course work at the 2000-level or above in departmental courses, twelve of which must be at the 3000 level or above.

Students are strongly recommended to work closely with their advisors in planning their major curriculum.

## Bachelor of Arts (Emphasis Area in Secondary Education)

The student will fulfill the general requirements for the bachelor of arts degree, *except for foreign language and a minor*; the requirements for the English major (*emphasis in secondary education*); and the requirements for Missouri certification in the teaching of English. See Education. Contact the Missouri S&T English department for advising. Students who do not complete certification requirements must complete regular requirements (foreign language and a minor) in order to receive a B.A. Students preparing for teacher certification should note that the requirements for the English major are as follows:

1. ENGLISH 1211, ENGLISH 1212, ENGLISH 1221, ENGLISH 1222.
2. ENGLISH 2002 Critical Approaches to Literature.
3. Capstone course for major: ENGLISH 4290 Texts and Contexts.
4. Fifteen hours of course work at the 2000 or 3000 level in English and American literature, including two courses in English Literature; and two American Literature courses, including literature for adolescents.
5. Six hours of linguistics.
6. Twelve hours of writing, including a course in the teaching of writing. Six of these hours will also be satisfied by the general education composition requirement for the B.A. degree; three of these hours will also be satisfied by the capstone course.
7. A minimum of fifteen hours must be at the 3000 level or above.

## English Minor Curriculum

All students who minor in English and technical communication must have a minor advisor in the English department, must complete a minor form, and must file it with the English department. (ENGLISH 1120 Exposition And Argumentation cannot be counted toward an English minor.)

English offers six minors:

### Literature

To complete this minor, students must take 12 hours of Literature courses offered by the English department; at least 9 hours of these must be at the 2000 or 3000-level.



## Writing

To complete this minor, students must take ENGLISH 2410 Theory Of Written Communication, plus 9 hours selected from the following courses: ENGLISH 1160, ENGLISH 1600, ENGLISH 1170, ENGLISH 3560, ENGLISH 2560, ENGLISH 3101, ENGLISH 3302, OR ENGLISH 3301.

## Literature and Film

The minor requires 12 hours, including the core course, ENGLISH 2230 Literature And Film. In addition, students will take 9 hours of electives in the field of literature and film studies. These electives can include but are not limited to ENGLISH 2248 Thematic Studies in Literature and Film (3 hours), ART 3250 Thematic Studies In Film & Literature (3 hours), and other film courses at the Art 2000-level or above.

## American Studies

The minor requires 15 hours, including ENGLISH 1223 Introduction To American Studies and ENGLISH 3228 The American Experience. In addition, the student, in consultation with the minor advisor, will select three courses, one of which must be at the 300 level, from the areas of American art, history, literature, music, or philosophy.

## Minor in Technical Communication

To complete this minor students must take TCH COM 1600, TCH COM 2540 (or ENGLISH 2540), and TCH COM 2560 (or ENGLISH 2560) plus six additional hours elected from the 4000-level or above technical communication courses.

## Creative Writing

The minor requires 12 hours including ENGLISH 1170 Creative Writing. Students are required to take an advanced writing workshop either ENGLISH 2171 Fiction Writing or ENGLISH 2172 Creative Nonfiction Writing. In consultation with the minor advisor, students will select two additional courses, one of which must be at the 3000-level or higher that emphasize literary craft. Suggested Electives: ENGLISH 2171, ENGLISH 2172, ENGLISH 2247, ENGLISH 3219, ENGLISH 3223, ENGLISH 3226, ENGLISH 3232, ENGLISH 3233.

**Randall Lee Arthur**, Lecturer  
MASTER Ball State University

**Trent Alan Brown**, Associate Professor  
PHD University of Chicago

**Eric Shane Bryan**, Associate Professor  
PHD Saint Louis University

**Anne Lucile Cotterill**, Associate Professor  
PHD Washington University

**Melissa Ann Green Dereberry**, Lecturer  
MASTER Missouri State University

**Kathryn C Dolan**, Assistant Professor  
PHD University of California-Santa Barbara

**Kathleen M Drowne**, Professor  
PHD University of North Carolina at Chapel Hill

**Mathew R Goldberg**, Associate Teaching Professor  
MFA University of Arkansas Fayetteville

**Sarah Hercula**, Assistant Professor  
PHD Illinois State University

**Jossalyn Gale Larson**, Assistant Teaching Professor  
MA Saint Louis University

**Ed A. Malone**, Professor  
PHD Southern Illinois University Carbondale

**Kathryn Michele Northcut**, Professor  
PHD Texas Tech University

**Daniel Charles Reardon**, Assistant Professor  
PHD SUNY College at Albany

**Elizabeth Roberson**, Assistant Teaching Professor  
MS Missouri University of Science and Technology

**Rachel Schneider**, Assistant Teaching Professor  
PHD University of Texas at Austin

**Kristine Swenson**, Professor  
PHD University of Iowa

**Kelly Jeanne Tate**, Assistant Teaching Professor  
MFA University of Arkansas Fayetteville

**Michael David Wright**, Associate Professor  
PHD Oklahoma State University Main

**ENGLISH 1000 Special Problems And Readings** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department.  
Consent of instructor required.

**ENGLISH 1001 Special Topics** (IND 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**ENGLISH 1110 English As A Second Language-I** (IND 0.0-6.0)  
Elementary English for non-English speakers. Conversation and reading.  
A study of English recommended for international students during their first semester in the United States.

**ENGLISH 1120 Exposition And Argumentation** (LEC 3.0)  
Practice in college level essay writing.

**ENGLISH 1160 Writing And Research** (LEC 3.0)  
Practice in techniques of analytical writing and in methods of research.  
Prerequisite: English 1120.

**ENGLISH 1170 Creative Writing** (LEC 3.0)  
Practice in forms and techniques of poetry and prose fiction, with special attention to narrative development. Prerequisite: English 1120.

**ENGLISH 1211 British Literature I: The Beginnings To 1800** (LEC 3.0)  
A survey of works and authors that explores the way these works represent the chronological period and express the individual concerns and techniques of those authors.

**ENGLISH 1212 British Literature II 1800 To Present** (LEC 3.0)  
A survey of works and authors that explores the way these works represent the chronological period and express the individual concerns and techniques of those authors.

**ENGLISH 1221 American Literature: 1600 To 1865** (LEC 3.0)  
A chronological survey that explores the ways the literature represents the concerns of individual authors as well as the history of literature.

**ENGLISH 1222 American Literature: 1865 To Present** (LEC 3.0)

A chronological survey that explores the ways the literature represents the concerns of individual authors as well as the history of literature.

**ENGLISH 1223 Introduction To American Studies** (LEC 3.0)

Introduces the core subjects as well as the methods and theories that constitute the field of American Studies.

**ENGLISH 1231 World Literature I: From The Beginnings To The Renaissance** (LEC 3.0)

A survey of representative works and authors from the world's cultures. (Excludes British and American works).

**ENGLISH 1600 Introduction to Technical Communication** (LEC 3.0)

Introduction to the role of the professional technical communicator in business and industry and practice in methods of developing technical documents. Prerequisite: English 1120. (Co-listed with TCH COM 1600).

**ENGLISH 2000 Special Problems And Readings** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ENGLISH 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENGLISH 2002 Critical Approaches To Literature** (LEC 3.0)

Study and application of the terminology and critical approaches used in understanding literary forms and genres.

**ENGLISH 2010 Seminar** (IND 0.0-6.0)

Discussion of current topics. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2171 Fiction Writing** (LEC 3.0)

This course introduces students to concepts of craft in fiction writing and the critical tools writers bring to revision. Students will write and present their own fully-developed stories and examine the stories of others in a workshop format. Prerequisite: English 1120 or equivalent.

**ENGLISH 2172 Creative Nonfiction Writing** (LEC 3.0)

Students will write creative nonfiction essays about their experiences and the experiences of others. The course will emphasize the revision process, focusing on both sentence-level and global issues. Additionally, this course will introduce students to published writers rhetorical choices. Prerequisite: English 1120 or equivalent.

**ENGLISH 2230 Literature And Film** (LEC 3.0)

This course will examine intertextual connections between literature and film, in terms of such things as adaptations, narrative technique and theory, genre, theme, and ideological movements. Prerequisite: English 1120.

**ENGLISH 2240 Children's Literature** (LEC 3.0)

Introduction to the study of children's literature. Emphasis on historical developments, multicultural issues and works. Prerequisites: English 1120.

**ENGLISH 2241 Literature For Adolescents** (LEC 3.0)

Primarily intended for teacher certification students. Selection and organization of materials for teaching literature to adolescents. Emphasizes literature written for adolescents and includes a unit of literature of American ethnic groups. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2242 Literature By Women** (LEC 3.0)

A study of writings by women, emphasizing major writers and the development of a female literary tradition. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2243 Science Fiction And Fantasy Literature** (LEC 3.0)

A study of short stories, poems, or novels which represent the development and the techniques of the science fiction-fantasy genre. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2244 Fantasy Literature** (LEC 3.0)

A study of the development of fantasy literature in the nineteenth and twentieth centuries. The primary focus will be on novels, especially the work of J.R.R. Tolkien. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2245 African American Literature** (LEC 3.0)

The history and development of African American literature, with special emphasis upon contemporary achievements. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2246 The Bible As Literature** (LEC 3.0)

Deals with the Old Testament, the Apocryphal/Deuterocanonical books, and the New Testament. Class lectures and discussions focus on literary forms and patterns, use of symbolism, narrative methods, and characterization. The basic approach is literary rather than theological or historical. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2247 American Crime And Detective Fiction** (LEC 3.0)

An introduction survey of American crime literature emphasizing the works of Hammett, Chandler, and James M. Cain to the more recent "true crime" tradition beginning with Capote's *In Cold Blood*. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2248 Thematic Studies in Literature and Film** (LEC 3.0)

Topics examine different thematic relationships between literature and film (e.g. Poe and Hitchcock, Shakespeare on film, etc.) announced at time of registration. Prerequisites: English 1120 and semester of college literature.

**ENGLISH 2250 American Short Story** (LEC 3.0)

This course follows the development of the short story genre from its early nineteenth-century beginnings up to and including stories written by contemporary American authors. Prerequisite: English 1120.

**ENGLISH 2410 Theory Of Written Communication** (LEC 3.0)

Major critical and conceptual approaches to written communication theory; includes semantics, history of print media, visible language, grammars, discourse theory, socio-linguistics reception theory, stylistics. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2540 Layout And Design** (LEC 3.0)

Theory and practice of layout and design for print and electronic media. Prerequisite: English 1600 or TCH COM 1600. (Co-listed with TCH COM 2540).

**ENGLISH 2560 Technical Marketing Communication** (LEC 3.0)

An introduction to technical marketing communication with an emphasis on relevant genres such as (but not limited to) the data sheet, white paper, and technical demonstration. Prerequisites: English 1600 or Tch Com 1600 or English 1160. (Co-listed with TCH COM 2560).

**ENGLISH 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ENGLISH 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENGLISH 3010 Seminar** (RSD 3.0)

Discussion of current topics. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3085 Internship** (IND 0.0-6.0)

Internship will involve students applying critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisite: Senior status; must have completed 24 hours in the major.

**ENGLISH 3101 Advanced Composition** (LEC 3.0)

Instruction and practice in writing expository essays of substantial content and skill, with particular emphasis on the rhetorical applications of recent findings in language research. Papers required will include critical analyses of literary works, and library research. Prerequisite: English 1160 or 3560.

**ENGLISH 3170 Teaching And Supervising Reading and Writing** (LEC 3.0)

Students will study contemporary and traditional approaches to reading and writing instruction. The course will give students practice in applying literacy and composition theory and research to development of teaching methods, including course syllabi and assignments. Prerequisite: 6 hours of college level writing courses.

**ENGLISH 3210 Survey Of Old And Middle English Literature** (LEC 3.0)

Survey of Old English poetry in translation and Middle English literature (excluding Chaucer) through Malory. Special emphasis on culture and language with some attention given to modern reinterpretation of medieval works. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3211 Chaucer** (LEC 3.0)

A study of Chaucer as a narrative poet by an intensive examination of The Canterbury Tales and Troilus and Criseyde. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3212 Sixteenth Century English Literature** (LEC 3.0)

A survey of the poetry and prose of England from 1500 to 1600. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3213 Seventeenth Century English Literature** (LEC 3.0)

A study of major authors (excluding Milton) of prose and poetry in England from 1600 to 1660. Special attention will be paid to John Donne and the metaphysical poets, to Ben Jonson and the Cavalier poets, and to major prose writers such as Francis Bacon, Sir Thomas Browne, and others. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3214 The Plays Of William Shakespeare** (LEC 3.0)

Selected comedies, tragedies, histories, and romances from early middle, and late periods of William Shakespeare's life. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3215 The Restoration & Eighteenth Century** (LEC 3.0)

The history, development, and cultural contexts of British literature from 1660 to 1798. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3216 British Romantic Literature** (LEC 3.0)

A study of the prose and poetry of the British Romantic period, 1775 to 1832. Prerequisite: English 1120 and a semester of college literature.

**ENGLISH 3217 Victorian Literature** (LEC 3.0)

A study of British prose and poetry from 1832 to 1900. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3218 The British Novel I** (LEC 3.0)

The history, development, and cultural contexts of the British novel from the late seventeenth to the early nineteenth century. Prerequisite: English 1120 and a semester college literature.

**ENGLISH 3219 The British Novel II** (LEC 3.0)

A study of the development of the novel with major attention given to the Victorian and 20th century novelists. Prerequisites: ENGLISH 1120 and a semester of college literature.

**ENGLISH 3220 Early American Literature** (LEC 3.0)

This course will follow the development of American literature from its Colonial beginnings (1614) to the rise of Romanticism (1836). The course will pay particular attention to how American writers used literature in defining and even creating the New World. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3221 American Poetry I** (LEC 3.0)

A study of significant selected poets of, primarily, the 19th century, with special attention to theme, diction, and form, and to poetry as a compressed image of the human condition. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3222 The American Renaissance** (LEC 3.0)

A study of American literature from Poe to Whitman. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3223 American Poetry II** (LEC 3.0)

A study of significant selected poets of the 20th century, with special attention to theme, diction, and form, and poetry as a compressed image of the human condition. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3224 Southern Culture** (LEC 3.0)

Introduction to major issues in the history and culture of the recent American South. Non-fiction, fiction, memoir, autobiography, journalism and film explore the social, economic, and political transformations of the region in the last half-century. Prerequisite: English 1120 and one semester of literature.

**ENGLISH 3225 The American Novel I** (LEC 3.0)

A study of selected, representative novels in chronological sequence from the beginning to the major realists. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3226 The American Novel II** (LEC 3.0)

A study of selected, representative novels in chronological sequence from the major realists to the present. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3227 American Gothic** (LEC 3.0)

This course follows the development of gothic/horror literature in the United States for its earliest expression in Phillip Freneau's 18th century works through Brockden Brown's late 18c. Gothic novels, to Hawthorne, Melville, and Poe's dark fiction, and finally to modern and contemporary works by Faulkner, O'Connor, Stephen King and others. Prerequisite: English 1120 and a previous literature course.

**ENGLISH 3228 The American Experience** (LEC 3.0)

Examines one or more of the subjects of the American experience such as race, gender, class, ethnicity, region, technology, religion, as it is expressed in the culture. Prerequisite: English 1223.

**ENGLISH 3232 Contemporary American Literature** (LEC 3.0)

Studies in American prose (fiction and non-fiction), drama, poetry, and screen plays published within the last fifteen years. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3233 Contemporary British Literature** (LEC 3.0)

Studies in British prose (fiction and non-fiction), drama, poetry, and screen plays published within the last fifteen years. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3234 Myth & Folklore** (LEC 3.0)

This course traces the development of myth and folklore from Ancient Mesopotamia through nineteenth century Europe. Students will be challenged with three questions along the way: What do myth and folklore do? Why were they important to earlier societies? Is myth alive today? Prerequisites: English 1120 and one semester of college literature.

**ENGLISH 3301 A Linguistic Study Of Modern English** (LEC 3.0)

A descriptive analysis of Modern English—its phonology, grammar, and vocabulary. Prerequisite: English 1120.

**ENGLISH 3302 History And Structure Of The English Language** (LEC 3.0)

An introduction to the study of the English language and its history through Old English, Middle English, and Modern English. Prerequisite: English 1120.

**ENGLISH 3560 Technical Writing** (LEC 3.0)

The theory and practice of writing technical papers and reports in the professions. Prerequisites: English 1120 and second-semester junior standing.

**ENGLISH 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Consent of instructor required.

**ENGLISH 4290 Texts And Contexts** (LEC 3.0)

Examines the relationships between selected texts written or published in a given year and the context of events of that time. Also explores current critical approaches to such texts and contexts. Writing intensive and Computer intensive. Prerequisites: English 1120 and a semester of college literature; junior standing.

**ENGLISH 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ENGLISH 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENGLISH 5100 Readings In Rhetoric And Composition** (LEC 3.0)

Directed readings and writing on selected topics and areas in Rhetoric and Composition. Credit will only be given for one of English 5210, 5220, 5230, or 5100 toward the Coop MA with UMSL. Prerequisites: Graduate standing and consent of instructor.

**ENGLISH 5210 Readings In British Literature** (LEC 3.0)

Directed readings and writing on selected topics and areas in British literature. Credit will only be given for one of English 5210, 5220, 5230, or 5100 toward the Coop MA with UMSL. Prerequisites: Graduate standing and consent of instructor.

**ENGLISH 5220 Readings In American Literature** (LEC 3.0)

Directed readings and writing on selected topics and areas in American literature. Credit will only be given for one of English 402, 403, 404, or 405 toward the Coop MA with UMSL. Prerequisites: Graduate standing and consent of instructor.

**ENGLISH 5230 Readings In Literature And Theory** (LEC 3.0)

Directed readings and writing on selected topics and areas in Literature and Theory. Credit will only be given for one of English 5210, 5220, 5230, or 5100 toward the Coop MA with UMSL. Prerequisites: Graduate standing and consent of instructor.

**ENGLISH 5571 Advanced Writing For Science & Engineering** (LEC 3.0)

Focus on writing applications specifically for students in scientific or engineering fields. Primary emphases will be on producing effective and readable professional writing. Prerequisites: English 3560 and 2560, or graduate standing.

**ENGLISH 5572 Advanced Writing For Science And Engineering II** (LEC 2.0)

This course – second in a series – focuses on writing for publication, from the initial proposal and query to the final product. Students will work on the materials they have underway with their advisers and/or research colleagues. Prerequisites: English 3560 and 2560, or graduate standing.

## Enterprise Resource Planning

**Yu Hsien Chiu**, Associate Teaching Professor

MASTER University of Wisconsin-Milwaukee

**Craig C Claybaugh**, Associate Professor

PHD University of Wisconsin-Milwaukee

**Bih-Ru Lea**, Associate Professor

PHD Clemson University

**Wen-Bin Yu**, Associate Professor

PHD University of Louisville

**ERP 2110 Introduction to Enterprise Resource Planning** (LEC 3.0)

Fundamentals of enterprise resource planning (ERP) systems concepts, and the importance of integrated information systems in an organization. The focus of this course is on illustrating procurement, production, and sales business processes using ERP software. Use of SAP as an example ERP system. Prerequisite: IS&T 1750.

**ERP 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ERP 4220 Introduction to Enterprise Decision Dashboard Prototyping** (LEC 3.0)

Study design and implementation principles for enterprise decision dashboards utilizing data warehouse and databases to support visual analytics. SAP HANA & BW, Business Objects Dashboards, IBM Watson Analytics, SAS Visual Analytics, or similar tools are used for practical assignments. Prerequisites: (ERP 2110 or ERP 5110) and one of ERP 5410, ERP 6444, or IS&T 6444.

**ERP 4610 Customer Relationship Management in ERP Environment** (LEC 3.0)

The course emphasizes identification (targeting), acquisition, retention, and development (expansion) of (profitable) customers, as well as effective and efficient management of customers, using information technology. SAP CRM, SAS BI tools, and Sybase mobile application development are used. Prerequisite: ERP 2110 or preceded or accompanied by ERP 5110.

**ERP 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ERP 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.



**ERP 5110 Enterprise Resource Planning Systems Design and Implementation** (LEC 3.0)

This course provides a technical overview of Enterprise Resource Planning Systems and their impact on organizations. SAP is introduced to illustrate the concepts, fundamentals, framework, general information technology context, technological infrastructure, and integration of business enterprise-wide applications. Prerequisites: Preceded or accompanied by ERP 2110; or Graduate Standing and computer programming knowledge.

**ERP 5130 ERP in Small & Mid-Size Enterprises** (LEC 3.0)

Provides an overview of enterprise applications for small and midsize companies. A leading platform such as Microsoft Dynamics AX or SAP Business One is introduced to illustrate theories and practical enterprise-wide applications for entrepreneurs, who manage business functions across sales, operation, and financials, all in a single integrated system. Prerequisites: ERP 5110 or ERP 2110.

**ERP 5210 Performance Dashboard, Scorecard and Data Visualization** (LEC 3.0)

This course will study different performance management systems including dashboards, management cockpit, scorecards, and strategy maps in an organization. SAP's BW, Business Objects Xcelsius, Crystal Reports, Sybase Unwired Platform will be used to develop the applications.. Prerequisite: ERP 2110 or preceded or accompanied by ERP 5110.

**ERP 5240 Enterprise Application Development and Software Security** (LEC 3.0)

This course provides a conceptual foundation and hands on experience in web and mobile based (HTML5) applications development deployed through an enterprise platform. Enterprise development tools, such as SAP HANA Cloud Platform, will be used to build these apps. The course also covers software cybersecurity from a web and mobile perspective. Prerequisites: Programming knowledge and either ERP 2110 or preceded or accompanied by ERP 5110.

**ERP 5310 Supply Chain Management Systems in an ERP Environment** (LEC 3.0)

The course studies the need for supply chain integration and the challenges of managing complex interfaces using the systems approach for the planning, analysis, design, development, and evaluation of supply chain. SAP's ERP ECC, SCM, BW, and Sybase Unwired Platform are used to deploy SCM apps. Prerequisite: ERP 2110 or preceded or accompanied by ERP 5110.

**ERP 5410 Use of Business Intelligence** (LEC 3.0)

This course introduces data-oriented techniques for business intelligence. Topics include Business Intelligence architecture, Business Analytics, and Enterprise Reporting. SAP Business Information Warehouse, Business Objects, or similar tools will be used to access and present data, generate reports, and perform analysis. Prerequisites: IS&T 3423 or equivalent; ERP 2110 or preceded or accompanied by ERP 5110.

**ERP 5510 ERP System Administration** (LEC 3.0)

System administration and performance monitoring practices for an Enterprise Resource Planning (ERP) system will be studied. Students will install an instance of an ERP system and establish user management attributes and system security. Prerequisite: ERP 5110.

must have a strong background in the earth sciences to understand complex environmental problems and then pose and design appropriate engineering solutions. As problem solvers for something as diverse as "the environment," environmental engineers also need to understand the most current technologies used in practice and have a desire to maintain a high level of learning in this rapidly evolving field.

Drinking water and wastewater treatment are cornerstones of the environmental engineering field, and students' education in these areas is thorough. Turning river, lake, or even sea water into drinking water requires a unique expertise because each water source offers distinctive challenges. Air pollution is a growing concern on scales ranging from the global atmosphere to the indoor environment. From a fundamental understanding of the chemistry and dynamics of air pollution, students learn how human activities degrade air quality and also how to evaluate and design control technology to reduce emissions from industry and other sources. The geology of a location greatly impacts its water resources, and comprehension of hydrogeology is important to an environmental engineer. The amount and quality of water a geologic formation can produce can influence and limit development of a region. Subsurface hydrology can be the most critical aspect in remediation of contaminated groundwater. Sustainable infrastructure, in terms of energy and environment, is yet another challenge that environmental engineers will have the opportunity to address in their careers.

The environmental engineering work place is diverse. Consulting firms represent a large portion of the work force and many specialize in areas of drinking water and wastewater treatment. The U.S. Environmental Protection Agency, state departments of natural resources, departments of health, and the U.S. Departments of Energy and Defense all have positions that require a wide array of skills and expertise.

The courses and skills learned as an undergraduate student also provide preparation for graduate studies and advanced leadership roles. Many specialized positions require a graduate education. Within the Missouri S&T environmental engineering program, elective courses include topics such as water and wastewater; geo-environmental; air pollution and control; environmental chemistry and processes; and environmental microbiology and processes. Some courses are required in each of these areas to provide breadth, which allows graduates to interact with the wide range of professionals in this particularly interdisciplinary field. Project teams may include health care professionals, city planners, developers, and all types of engineers. Additionally, the ever-developing field of environmental engineering is saturated with legal issues, many of which are yet to have precedents or legal statutes established.

Many courses include laboratory exercises in the environmental engineering program laboratories in the Civil Engineering Building. In addition to teaching laboratories, the laboratory facilities include a pilot-scale unit-operations laboratory, temperature control facilities, a roof-top greenhouse, and state of the art analytical facilities. Undergraduate-level research is encouraged and promotes participation in environmental research carried out, largely in the Environmental Research Center. In summary, the diverse curricula, interdisciplinary faculty, and superb facilities afford students an excellent opportunity for an unparalleled education and prepare them for a bright future of solving tomorrow's problems in environmental engineering.

## Mission Statement

The environmental engineering program will prepare students for a career in the global, interdisciplinary field of environmental engineering and for life-long development in the profession. The program's fundamental base

## Environmental Engineering

Environmental engineers uphold the dual goals of minimizing our impact on the local, regional, and global environment and concurrently improving our standard of living. In this role of preserving environmental and public well-being, environmental engineers face unique issues and

in biological and earth sciences and development of specific engineering application skills prepares graduates to approach unique, atypical problems with a true problem-solving approach, develop solutions to benefit society and the environment, and promote these solutions.

## Environmental Engineering Program Educational Objectives

Consistent with the mission statement, graduates of the Missouri S&T environmental engineering program will demonstrate, within a few years of graduation:

1. professional development,
2. technical competency,
3. responsibility and knowledge of leadership,
4. an ability to communicate effectively,
5. an ability to work in teams, and
6. a holistic view of problems within their field.

## Program Outcomes

Consistent with the program educational objectives listed above, the Missouri S&T environmental engineering program graduates will have:

1. ability to apply knowledge of mathematics including differential equations, probability and statistics, sciences including physics, chemistry, biology, and geology, and engineering fundamentals including fluid mechanics
2. ability to outline and conduct experiments in sciences and in at least two environmental engineering areas
3. ability to carry out the design of an integrated system and its various components and processes for an environmental engineering project
4. effective communication in multi-disciplinary environments
5. ability to identify, evaluate, and solve environmental engineering problems
6. understanding of the responsibility of environmental engineers to practice in a professional and ethical manner at all times
7. ability to communicate effectively using oral, written, and graphic forms
8. ability to provide leadership when working in multi-disciplinary teams
9. understanding of the potential impacts of engineering solutions on society and the environment
10. understanding of the need for up-to-date engineering tools acquired through life-long learning
11. knowledge of contemporary issues related to environmental engineering
12. environmental engineering project management skills and design techniques
13. proficiency as demonstrated by problem solving in at least four environmental engineering areas
14. ability to explain environmental issues associated with air, land, and water systems and associated environmental health impacts

## Environmental Engineering Bachelor of Science

Entering freshmen desiring to study environmental engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a environmental engineering preference, which will be used as a consideration for available freshman

departmental scholarships. The focus of the Freshman Engineering program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major.

For the bachelor of science degree in environmental engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in environmental engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1. All students are required to take one American history course, one economics course, one humanities course, and ENGLISH 1120. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200. The humanities course must be selected from the approved lists for art, English, foreign languages, music, philosophy, speech and media studies, or theater.
2. HISTORY 2510 or HISTORY 3530 is required.
3. The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to ENGLISH 1120 .
4. Special topics and special problems and honors seminars are allowed only by petition to and approval by the student's department chair.

The environmental engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

### Freshman Year

First Semester	Credits	Second Semester	Credits
FR ENG 1100 <sup>2</sup>	1	MECH ENG 1720	3
CHEM 1310 & CHEM 1319	5	MATH 1215	4
MATH 1214	4	PHYSICS 1135	4
ENGLISH 1120	3	General Education Elective <sup>1</sup>	6
General Education Elective <sup>1</sup>	3		
	16		17

### Sophomore Year

First Semester	Credits	Second Semester	Credits
CIV ENG 2200	3	CIV ENG 2210	3
MATH 2222	4	CIV ENG 2211	1
ENV ENG 2601 <sup>3</sup>	3	MECH ENG 2350	2
CHEM 1320 or GEOLOGY 3410	3	CHEM ENG 2100	3
BIO SCI 1113	3	ENV ENG 2602	3
		PHYSICS 2135	4
	16		16

Junior Year			
First Semester	Credits	Second Semester	Credits
ENV ENG 3615 <sup>3</sup>	3	ENV ENG 5619	3
ENV ENG 3603	3	STAT 3113	3
CIV ENG 3330 <sup>2</sup>	3	CHEM ENG 2110	3
MATH 3304	3	ENV ENG Technical Elective <sup>5,6</sup>	3
GEO ENG 1150	3	Communications Elective <sup>7</sup>	3
		15	15
Senior Year			
First Semester	Credits	Second Semester	Credits
CIV ENG 4448	3	ENV ENG 4097 <sup>3</sup>	3
ENV ENG 4010 <sup>3</sup>	1	ENV ENG Depth Elective <sup>4,5</sup>	3
CIV ENG 3334	4	ENV ENG Depth Elective <sup>4,5</sup>	3
ENV ENG Air Pollution Elective <sup>4,6</sup>	3	ENV ENG Technical Elective <sup>5,6</sup>	3
HISTORY 2510 or 3530	3	ENV ENG 4609	1
ENV ENG Depth Elective <sup>4,5</sup>	3	General Education Elective <sup>1</sup>	3
		17	16
Total Credits: 128			

- <sup>1</sup> All general education electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog.
- <sup>2</sup> A grade of 'C' or better required to satisfy graduation requirements
- <sup>3</sup> Existing CIV ENG course that is cross-listed as ENV ENG course.
- <sup>4</sup> Choose 3 of the following: ENV ENG 5640, ENV ENG 5630, ENV ENG 5650, ENV ENG 5670, ENV ENG 5605, ENV ENG 5660, ENV ENG 5662 or GEO ENG 5331. One class may not be used to fulfill both the air pollution requirement and a depth elective.
- <sup>5</sup> A grade of 'C' or better may be required in ENV ENG technical and depth elective prerequisite courses. Refer to the Missouri S&T undergraduate catalog for this prerequisite information.
- <sup>6</sup> Select technical electives from approved list. A maximum total of 6 credit hours of independent study (ENV ENG 5000 or ENV ENG 4099) can be used as depth or technical electives in the B.S. environmental engineering curriculum.
- <sup>7</sup> Choose 1 of the following: CIV ENG 2003, ENGLISH 1160, ENGLISH 3560, or SP&M S 1185

**Note:** All environmental engineering students must take the Fundamentals of Engineering examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree, however, it is the first step toward becoming a registered professional engineer. This requirement is part of the Missouri S&T assessment process as described in assessment requirements found elsewhere in this catalog. Students must sign a release form giving the university access to their Fundamentals of Engineering Examination score.

## Environmental Engineering Depth Electives

The following classes may be used to fulfill the three depth elective courses required for the B.S. in environmental engineering:

ENV ENG 5640	Environmental Law And Regulations	3
ENV ENG 5630	Remediation of Contaminated Groundwater And Soil	3
ENV ENG 5650	Public Health Engineering	3

ENV ENG 5670	Solid Waste Management	3
ENV ENG 5605	Environmental Systems Modeling	3
ENV ENG 5642	Sustainability, Population, Energy, Water, and Materials	3
ENV ENG 5665	Indoor Air Pollution	3
ENV ENG 5660	Introduction To Air Pollution	3
ENV ENG 5662	Air Pollution Control Methods	3
GEO ENG 5331	Subsurface Hydrology	3

One class may not be used to fulfill both the air pollution requirement and depth elective.

## Environmental Engineering Technical Electives

The following classes may be used to fulfill the two technical elective courses required for the B.S. in environmental engineering:

CIV ENG 5331	Hydraulics Of Open Channels	3
CIV ENG 5335	Water Infrastructure Engineering	3
CIV ENG 5446	Management Of Construction Costs	3
CIV ENG 5360	Water Resources And Wastewater Engineering	3
CIV ENG 5744	Geosynthetics in Engineering	3
CIV ENG 386		
CHEM ENG 5340	Principles Of Environmental Monitoring	3
GEO ENG 3148	Fundamentals Of Geographic Information Systems	3
GEO ENG 3175	Geomorphology And Terrain Analysis	3
GEO ENG 5233	Risk Assessment In Environmental Studies	3
GEO ENG 5235	Environmental Geological Engineering	3
GEO ENG 5239	Groundwater Remediation	3
GEO ENG 4276	Environmental Aspects Of Mining	3
PET ENG 3210		3
GEOLOGY 3410	Introduction To Geochemistry	3
GEOLOGY 4451	Aqueous Geochemistry	3
GEOLOGY 382		
CIV ENG 5662/ ENV ENG 5662	Air Pollution Control Methods	3
CHEM 3410	Chemical Thermodynamics I	3
CHEM 373		
PHYSICS 337		
CHEM ENG 3120	Chemical Engineering Thermodynamics II	3
CHEM ENG 3100	Chemical Engineering Fluid Flow	3
CHEM ENG 3110	Chemical Engineering Heat Transfer	2
CHEM ENG 374		
CHEM 1550	Elementary Quantitative Chemical Analysis	2
CHEM 2210	Organic Chemistry I	4
BIO SCI 2223	General Genetics	3
BIO SCI 2263	Ecology	3
BIO SCI 5313	Pathogenic Microbiology	3
BIO SCI 322		
BIO SCI 325		3
BIO SCI 4323	Molecular Genetics	3
BIO SCI 4329	Molecular Genetics Laboratory	
BIO SCI 4383	Toxicology	3

**Joel G Burken**, Curators Distinguished Professor<sup>1,5</sup>  
PHD University of Iowa

**Mark W Fitch**, Associate Professor  
PHD University of Texas-Austin

**Felix Wilfredo Flechas**, Lecturer  
MS University of Colorado Boulder

**Melanie R Mormile**, Professor  
PHD University of Oklahoma, Norman

**Glenn Morrison**, Professor<sup>1</sup>  
PHD University of California-Berkeley

**Daniel B Oerther**, Professor<sup>1,5</sup>  
PHD University of Illinois-Urbana

**Jianmin Wang**, Associate Professor<sup>1</sup>  
PHD University of Delaware

**David J Wronkiewicz**, Associate Professor  
PHD New Mexico Institute of Mining & Technology

**ENV ENG 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENV ENG 2601 Fundamentals Of Environmental Engineering and Science** (LEC 2.0 and LAB 1.0)

Course discusses fundamental chemical, physical, and biological principles in environmental engineering and science. Topics include environmental phenomena, aquatic pollution and control, solid waste management, air pollution and control, water and wastewater treatment systems, sustainability and life cycle analyses. Prerequisites: Chem 1310, Chem 1301, or Chem 1351; Math 1214, Math 1212, or Math 1208. (Co-listed with Civ Eng 2601).

**ENV ENG 2602 Biological Fundamentals Of Environmental Engineering** (LEC 3.0)

Introduction to the function of organisms related to environmental engineering. The course focuses on both the application of organisms to removing contaminants and the effects of contaminants on organisms. Prerequisites: Bio Sci 1113 and preceded or accompanied by Civ/Env Eng 2601. (Co-listed with Civ Eng 2602).

**ENV ENG 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENV ENG 3603 Chemical Fundamentals Of Environmental Engineering** (LEC 2.0 and LAB 1.0)

Introduction to the key chemical and physical concepts integral to environmental systems and processes. This course provides a fundamental background in those chemical and environmental engineering principles that are common to all environmental engineering disciplines. Prerequisites: Chem 1320 or Geology 3410; Physics 1135, Math 2222.

**ENV ENG 3615 Water And Wastewater Engineering** (LEC 3.0)

A study of the engineering design principles dealing with the quantity, quality and treatment of water, and the quantity, characteristics, treatment and disposal of wastewater. Prerequisites: Civ Eng 2601 and at least junior standing. (Co-listed with Civ Eng 3615).

**ENV ENG 4010 Senior Seminar: Engineering In A Global Society** (RSD 1.0)

Discussion of contemporary issues: public safety, health, and welfare; the principles of sustainable development; lifelong learning; impact of engineering solutions in a global and societal and political context; relationships with owners, contractors, and the public; public service; the Code of Ethics; and the Missouri licensing Statutes and Board Rules. Prerequisite: Senior standing. (Co-listed with Civ Eng and Arch Eng 4010).

**ENV ENG 4097 Senior Design Project** (LEC 3.0)

Open-ended design projects involving one or more areas of engineering. Planning design projects, philosophy of design, and application of engineering principles to design problems. Prerequisite: Civ Eng 4448 or Arch Eng 4448. (Co-listed with Arch Eng 4097 and Civ Eng 4097).

**ENV ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**ENV ENG 4609 Research in Environmental Engineering** (LEC 1.0)

Students will investigate cutting edge research in the environmental engineering field including experimental studies, current environmental policy changes, and international environmental issues. Investigation to include live research seminars, reading current literature, and/or laboratory experimentation. Prerequisite: Senior standing.

**ENV ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department.

**ENV ENG 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENV ENG 5070 Teaching Engineering** (LEC 3.0)

Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mgt 5070, Comp Eng 5070, Elec Eng 5070, Civ Eng 5070).

**ENV ENG 5360 Water Resources And Wastewater Engineering** (LEC 3.0)

Application of engineering principles to the planning and design of multipurpose projects involving water resources development and wastewater collection/treatment/disposal systems. Latest concepts in engineering analysis are applied to evaluation of alternative solutions. Prerequisites: Civ Eng 3333, 3335, 3615. (Co-listed with Civ Eng 5360).

**ENV ENG 5605 Environmental Systems Modeling** (LEC 3.0)

Introductory course in modeling environmental systems. Course will focus on contaminant fate and transport in the environment. Models will be developed that will include physical, chemical and biological reactions and processes that impact this fate. Prerequisites: Env Eng/Civ Eng 2601, Env Eng/Civ Eng 2602 and Env Eng/ Civ Eng 3603; or Graduate standing. (Co-listed with Civ Eng 5605).

**ENV ENG 5619 Environmental Engineering Design** (LEC 2.0 and LAB 1.0)

Functional design of water and wastewater facilities and other environmental cleanup systems. Prerequisite: Civ Eng 3615 or Env Eng 3615. (Co-listed with Civ Eng 5619).

**ENV ENG 5630 Remediation of Contaminated Groundwater And Soil** (LEC 2.0 and LAB 1.0)

Course covers current in-situ and ex-situ remediation technologies. Current literature and case studies are utilized to provide the focus for class discussions and projects. Prerequisites: Civ Eng 3615, Geo Eng 5237 or Graduate Standing. (Co-listed with Civ Eng 5630).



**ENV ENG 5635 Phytoremediation and Natural Treatment Systems: Science and Design** (LEC 3.0)

Students learn the scientific basics of chemical transport in soil and groundwater and learn fundamental plant physiology and processes. Students then learn how these processes are utilized in design of phytoremediation and natural treatment systems, including the most up to date literature and design guidance available. Prerequisite: Env Eng 3615 or Civ Eng 3615 or graduate standing.

**ENV ENG 5640 Environmental Law And Regulations** (LEC 3.0)

This course provides comprehensive coverage of environmental laws and regulations dealing with air, water, wastewater, and other media. The primary focus is permitting, reporting, and compliance protocols. The course topics include U.S. and international legal systems and judicial processes, liability, enforcement, Clean Air Act, Clean Water Act (NPDES permitting), Safe Drinking Water Act, OSGA, TSCA, RCRA, and CERCLA. Case studies will be emphasized. (Co-listed with Civ Eng 5640).

**ENV ENG 5642 Sustainability, Population, Energy, Water, and Materials** (LEC 3.0)

This course will examine the concepts regarding the continued advancement of humankind while maintaining our ecological niche on earth. Key topics include: population growth, poverty, and impacts of development; energy consumption, sources, storage, conservation and policy; water quality and quantity; materials and building; and policy implications. Prerequisite: Senior or graduate standing. (Co-listed with Civ Eng 5642 and Arch Eng 5642).

**ENV ENG 5650 Public Health Engineering** (LEC 3.0)

A comprehensive course dealing with the environmental aspects of public health. Prerequisite: Civ Eng 2601 with grade of "C" or better. (Co-listed with Civ Eng 5650).

**ENV ENG 5660 Introduction To Air Pollution** (LEC 3.0)

Introduction to the field of air pollution dealing with sources, effects, federal legislation, transport and dispersion and principles of engineering control. Prerequisite: Civ Eng 3330 or equivalent; or graduate standing. (Co-listed with Civ Eng 5660).

**ENV ENG 5662 Air Pollution Control Methods** (LEC 3.0)

Study of the design principles and application of the state-of-the-art control techniques to gaseous and particulate emissions from fossil fuel combustion, industrial and transportation sources. Prerequisite: Civ Eng 3330 or equivalent; or graduate standing. (Co-listed with Civ Eng 5662).

**ENV ENG 5665 Indoor Air Pollution** (LEC 3.0)

By developing a practical understanding of indoor air pollution sources, physics, chemistry and consequences, students will learn how radon, cigarette smoke, VOCs from furnishings, and so forth affect indoor air quality and apply engineering analyses to specify ventilation rates, choose furnishings and minimize occupant exposure to pollutants. Prerequisite: Civ Eng 2601 or Mech Eng 5571 or Graduate Status. (Co-listed with Civ Eng 5665 and Arch Eng 5665).

**ENV ENG 5670 Solid Waste Management** (LEC 3.0)

A systematic study of the sources, amounts and characteristics of solid wastes and methods used for their collection, reclamation, and ultimate disposal. Prerequisite: Civ Eng 2601 with grade of "C" or better; or graduate standing. (Co-listed with Civ Eng 5670).

## Etymology

Gerald Leonard Cohen, Professor  
PHD Columbia University

**ETYM 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Prerequisite: Consent of instructor.

**ETYM 4306 Introduction To Etymology** (LEC 3.0)

Introduction to etymology in its broadest sense: origin of words, idioms, writing systems, etc. Prerequisite: Any foreign language course or English 1120.

## Explosives Engineering

### Minor in Explosives Engineering

The department of mining and nuclear engineering, mining engineering program, realizing the attractiveness of explosives engineering to students, the potential for jobs in the area (post 9-11), and the use of over 6 billion pounds of explosives in mining, tunneling, construction, and other areas, is offering a minor in explosives engineering so that students interested in explosives engineering have a chance to attain in-depth knowledge of the sub-discipline.

A student who received a bachelor of science degree in an accredited engineering program from Missouri S&T may receive the minor in explosives engineering by completing 15 credit hours from the courses listed below. Non-engineering students who have a strong background in mathematics and the physical sciences may also qualify for the minor in explosives engineering, with the approval of the department and based on an individually designed program of study. Students need to consult with the chair of the explosives engineering program to determine pre-requisite requirements for each course. The program granting the bachelor of science degree shall determine whether or not courses taken for the explosives engineering minor may also be used to fulfill the requirements of the B.S. degree from that program.

The following courses are required for the minor in explosives engineering:

EXP ENG 5612/ MIN ENG 5612	Principles of Explosives Engineering	3
EXP ENG 5622/ MIN ENG 5622	Blasting Design And Technology	3

Three other explosives related courses as approved by program coordinator.

The minor in explosives engineering is not accredited by the Accreditation Board of Engineering and Technology (ABET).

## Explosives Engineering Certificate

This certificate program is designed to provide formalized education in the area of explosives engineering.

Students will be exposed to the theoretical and practical approaches of explosives engineering. Students will be exposed to the analysis and design of explosive-related systems and both natural and built structure effects.

The explosives engineering certificate program is open to all persons holding a high school diploma who have a minimum of 12-months of post-high school professional employment or college experience.

Once admitted to the program, the student must take four designated courses as given below. In order to receive an undergraduate certificate, the student must have an average cumulative grade of 2.0 or better in the certificate courses.

Students admitted to the certificate program will have non-matriculated status; however, if they complete the four course sequence with a grade of B or better in each of the courses taken, they may apply to the B.S. mining engineering program if they so choose. The certificate credits taken by students admitted to the B.S. program may be eligible to count toward their bachelors degrees depending on the degree requirements. Prerequisite courses outside of those in this certificate program may be waived at the discretion of the administrative co-coordinators for persons that are not regular Missouri S&T students.

Once admitted to the program, a student will be given three years to complete the program so long as he/she maintains a 2.0 GPA in the courses taken.

The following courses constitute the undergraduate certificate in explosives engineering:

Required courses:

EXP ENG 5612	Principles of Explosives Engineering
EXP ENG 5622	Blasting Design And Technology
Choose any two courses from the list below:	
EXP ENG 5001	Special Topics (Pyrotechnic Show Design)
EXP ENG 5112	Explosives Handling and Safety
EXP ENG 5512	Commercial Pyrotechnics Operations
EXP ENG 5513	Stage Pyrotechnics and Special Effects
EXP ENG 5514	Display Fireworks Manufacturing
EXP ENG 5713	Demolition of Buildings and Structures
MIN ENG 4922/ MIN ENG 5922	Tunneling & Underground Construction Techniques
Any 6000 level explosives course or other explosive-related course with the approval of the student's advisor and instructor permission.	

Other courses approved by the explosives engineering faculty may be substituted for any of the above listed courses on a case-by-case basis.

Students with a GPA of 3.0 in the certificate program may take postgraduate explosives classes as electives.

## Explosives Technology Certificate

Once admitted to the program, the student must take four designated 3 credit hour explosives courses for a total of 12 credit hours as given below. In order to receive an undergraduate certificate, the student must have an average cumulative grade of 2.0 or better in the certificate courses. Students admitted to the certificate program will have non-matriculated status; however, if they complete the four-course sequence with a grade of B or better in each of the courses taken, they will be eligible to apply to the S&T mining engineering B.S. program. The certificate credits taken by students admitted to the B.S. program may be eligible to count toward their bachelor's degrees depending on the degree requirements. Prerequisite courses outside of those in this certificate program may be waived at the discretion of the administrative co-coordinators for persons that are not regular Missouri S&T mining engineering students. Once admitted to the certificate a student will be given three years to complete the certificate so long as he/she maintains a 2.0 GPA in the courses taken.

The following courses constitute the undergraduate certificate in explosives technology:

Required-One of the following four courses:

EXP ENG 5612	Principles of Explosives Engineering
EXP ENG 5711	Explosives in Industry
EXP ENG 5721	Specialty Uses of Energetic Materials

EXP ENG 5914	Explosives Manufacturing
Choose an additional three courses from those listed above or the list below:	
EXP ENG 5112	Explosives Handling and Safety
EXP ENG 5512	Commercial Pyrotechnics Operations
EXP ENG 5513	Stage Pyrotechnics and Special Effects
EXP ENG 5514	Display Fireworks Manufacturing
EXP ENG 5555	Computer Fired Pyrotechnic Show Design and Firing System Operation
EXP ENG 5622	Blasting Design And Technology
EXP ENG 5713	Demolition of Buildings and Structures
EXP ENG 5922	Advanced Tunneling & Underground Construction Techniques
EXP ENG 6112	Explosives Regulations

Other courses approved by the explosives engineering faculty may be substituted for any of the above listed courses on a case-by-case basis. Students with a GPA of 3.0 in the certificate program may take graduate level explosives classes as electives.

**Stephen W Hall**, Lecturer

MASTER Missouri University of Science and Technology

**Catherine Johnson**, Assistant Professor

PHD University of Kentucky

**Braden Lusk**, Professor<sup>1</sup>

PHD University of Missouri-Rolla

**Kyle Perry**, Assistant Professor<sup>1</sup>

PHD University of Kentucky

**Matt Sutcliffe**, Lecturer

**Paul Nicholas Worsey**, Professor<sup>1</sup>

PHD University of Newcastle-upon-Tyne, United Kingdom

**Gillian M Worsey**, Assistant Adjunct Professor

PHD Univeristy of Missouri-Rolla

**EXP ENG 5000 Special Problems** (IND 1.0-3.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**EXP ENG 5001 Special Topics** (LEC 1.0 and LAB 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**EXP ENG 5112 Explosives Handling and Safety** (LEC 3.0)

Basic handling & safety for explosives, explosive devices and ordnance related to laboratory handling, testing, manufacturing & storage, for both civil and defense applications. Classroom instruction only. Prerequisite: Junior Standing or above.

**EXP ENG 5512 Commercial Pyrotechnics Operations** (LAB 1.0 and LEC 2.0)

Provide participants with training preparing for Missouri Licensed Display Operator (Outdoor) License and advanced lead pyrotechnic operator training. Class work will be complemented by practical training in laboratory sessions, culminating in a full pyrotechnic show, from start to finish. Prerequisites: Both Chem 1310 and Chem 1319 or their equivalent; US Citizen or permanent resident, Successful background check, resident enrollment at Missouri S&T.

**EXP ENG 5513 Stage Pyrotechnics and Special Effects** (LAB 2.0 and LEC 1.0)

Use of energetic materials in close proximity to audiences. Provide participants with training preparing for Missouri Pyrotechnics Display Operators License. Covers: close proximity indoor and outdoor pyrotechnics and special effects. Working with stage crews and talent, safety and permitting. Prerequisites: Both Chem 1310 and Chem 1319 or their equivalent; US Citizen or permanent resident, Successful background check, resident enrollment at Missouri S&T.

**EXP ENG 5514 Display Fireworks Manufacturing** (LAB 2.0 and LEC 1.0)

Theory and practice of manufacturing display fireworks. Focusing on safety, chemical interaction, color development, basic theory, state and federal law. The lab will include hands on building of ball and canister shells and other pyrotechnic effects. Prerequisites: Chem 1310, Chem 1319, Chem 1100; one of Econ 1100, Econ 1200, Eng Mgt 1210; Successful background check.

**EXP ENG 5555 Computer Fired Pyrotechnic Show Design and Firing System Operation** (LAB 2.0 and LEC 1.0)

Students will learn to use music editing, electronic firing system operation and Fire One pyrotechnic choreography and simulation software to design their own pyromusical show programs. Creation of a musical sound track, selecting the fireworks and choreographing to the musical score. Create, setup, diagnose and fire a pyrotechnic show. Prerequisites: Exp Eng 5512 or Exp Eng 5513 and successful background check.

**EXP ENG 5612 Principles of Explosives Engineering** (LAB 1.0 and LEC 2.0)

Theory and application of explosives in the mining industry; explosives, initiating systems, characteristics of explosive reactions and rock breakage, fundamentals of blast design, drilling and blasting, regulatory and safety considerations. Prerequisites: Min Eng 2126; successful background check. (Co-listed with Min Eng 5612).

**EXP ENG 5622 Blasting Design And Technology** (LAB 1.0 and LEC 2.0)

Advanced theory and application of explosives in excavation; detailed underground blast design; specialized blasting including blast casting, construction and pre-splitting. Introduction to blasting research. Examination of field applications. Prerequisites: Min Eng 5612. Student must be at least 21 years of age. Successful background check. (Co-listed with Min Eng 5622).

**EXP ENG 5711 Explosives in Industry** (LEC 3.0)

Overview of how explosives are applied in various industrial settings. Focus is placed on the general application, identification, and necessity of explosives in industry. Topics include explosive use in surface and underground mining, road development, construction, utility placement, demolition, oil, gas, and underwater.

**EXP ENG 5713 Demolition of Buildings and Structures** (LAB 1.0 and LEC 2.0)

Provide participants with basics and solid grounding in the equipment, techniques and processes required for the demolition and remediation of mine plant and processing equipment sites and non-mining structures such as buildings, factories, bridges, etc. Field trip required. Prerequisites: Preceded or accompanied by Civ Eng 2200 or Mech Eng 2340; US citizen or permanent resident; Successful background check.

**EXP ENG 5721 Specialty Uses of Energetic Materials** (LEC 3.0)

Overview of special, less common uses of energetic materials and how they can be applied as a functional tool. Topics include the use of energetics in aerospace, explosive ordnance, oil field development, welding, pyrotechnics, theatrics, and cinematic special effects.

**EXP ENG 5914 Explosives Manufacturing** (LEC 3.0)

History of industrial explosives from discovery to what is used today. Manufacturing processes for packaged and bulk explosives are explored along with specialty explosives such as detonating cord, cast boosters, detonators, shaped charges, and commercial fireworks. Field manufacturing of explosives by mixing or gassing is also covered.

**EXP ENG 5922 Advanced Tunneling & Underground Construction Techniques** (LAB 1.0 and LEC 2.0)

Advanced topics in mechanical and conventional excavation techniques in underground tunneling and construction. Topics include tunneling layouts design, equipment and performance modeling, ground control systems including support, drainage, and structural integrity. Construction specifications, advance rate and contractual and cost estimation. Prerequisite: Consent of Instructor (Co-listed with Min Eng 5922).

## Finance

**Hongxian Zhang**, Assistant Professor  
PHD University of Texas at San Antonio

**FINANCE 2000 Special Problems** (IND 0.0-6.0)

(Variable) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**FINANCE 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**FINANCE 2150 Corporate Finance I** (LEC 3.0)

This course studies the need for funds in business and the techniques of analysis used to determine how effectively these funds are invested within the firm. Topics include the institutions, instruments, and markets concerned with raising funds. Prerequisites: Bus 1210 or Eng Mgt 2211.

**FINANCE 3000 Special Problems** (IND 0.0-6.0)

(Variable) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**FINANCE 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**FINANCE 3205 Finance Essentials** (LEC 1.5)

This course is an introduction to the essentials of corporate finance for running a business. This course is designed for students planning to enter the MBA program. Credit in this course cannot be applied to any major or minor in Business, Information Sciences and Technology. Prerequisites: Senior or Junior Standing; 3.0 GPA required.

**FINANCE 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed towards graduation credit. Subject and credit to be arranged with the instructor.

**FINANCE 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in finance. Prerequisite: Admission to the MBA program and permission of the instructor.

**FINANCE 5001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title. Prerequisite: Admission to the MBA program.

**FINANCE 5099 Research** (IND 0.0-9.0)

Research investigation of an advanced nature leading to a major report suitable for publication in a journal or in a conference proceedings.

Prerequisite: Permission of the instructor.

**FINANCE 5160 Corporate Finance II** (LEC 3.0)

This course provides a rigorous and consistent presentation of the theory of financial decisions. Capital markets are analyzed under assumptions of risk aversion and uncertainty. Models of modern portfolio theory are discussed including the CAPM and the Modigliani-Miller analysis.

Prerequisite: Finance 2150.

**FINANCE 5205 Graduate Finance Essentials** (LEC 1.5)

This course is an introduction to the essentials of corporate finance for running a business. This course is designed for students planning to enter the MBA program. Credit in this course cannot be applied to any major or minor in Business, Information Sciences and Technology. Additional case or report required. Prerequisite: Bachelor Degree.

**FINANCE 5260 Investments I** (LEC 3.0)

Introduction to fundamental elements of investment analysis. Students learn financial tools and gain necessary knowledge to select among alternative financial assets. Real world experience includes stock analysis, portfolio simulations and interactions with professionals in the securities industry. Prerequisites: Finance 2150.

## Foreign Languages

### French, German, Russian, and Spanish

Missouri S&T offers courses in French, German, Russian, and Spanish. Previous training is not required for language study at Missouri S&T.

After two semesters of foreign language study on campus, you should be able to converse on an elementary level. You will be introduced to foreign literature in the second or third semester.

A minor in French, German, Russian or Spanish is available. You may fulfill your B.A. language requirement from any of the four foreign languages offered.

### French Minor

A French minor will consist of nine hours beyond the 12 hours B.A. foreign language requirement selected in consultation with a faculty advisor. The additional nine hours must be at the 2000-level or higher, with at least two of the courses at the 4000-level.

### German Minor

A German minor will consist of nine hours beyond the 12 hours B.A. foreign language requirement selected in consultation with a faculty advisor. The additional nine hours must be at the 2000-level or higher, with at least two of the courses at the 4000-level.

### Russian Minor

A Russian minor will consist of nine hours beyond the 12 hours B.A. foreign language requirement selected in consultation with a faculty advisor. The additional nine hours must be at the 2000-level or higher, with at least two of the courses at the 4000-level.

### Spanish Minor

A Spanish minor will consist of nine hours beyond the 12 hours B.A. foreign language requirement selected in consultation with a faculty

advisor. The additional nine hours must be at the 2000-level or higher, with at least two of the courses at the 4000-level.

## French

**Audra Lynn Merfeld-Langston**, Associate Professor  
PHD Pennsylvania State University

**FRENCH 1101 Elementary French I** (LEC 4.0)

Introduction to reading, conversation, and grammar. Prerequisite: Entrance requirements.

**FRENCH 1102 Elementary French II** (LEC 4.0)

A continuation of French 1101. Prerequisite: French 1101.

**FRENCH 1180 Intermediate French** (LEC 4.0)

Focuses on intermediate reading, writing, speaking, & listening skills in French. Prerequisite: French 1102.

**FRENCH 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**FRENCH 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**FRENCH 2110 Basic French Conversation** (LEC 3.0)

French conversation and oral practice. Prerequisite: French 1102.

**FRENCH 2170 Masterpieces Of French Literature** (LEC 3.0)

Selected major works and movements in French literature. Prerequisite: French 1180.

**FRENCH 2180 Basic French Composition** (LEC 3.0)

Composition and translations from English. Prerequisite: French 1102.

**FRENCH 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**FRENCH 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**FRENCH 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**FRENCH 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**FRENCH 4010 Seminar** (IND 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

**FRENCH 4311 Advanced French Conversation** (LEC 3.0)

Advanced conversation and oral practice. Prerequisite: French 2170.

**FRENCH 4320 French and Francophone Cinema** (LEC 3.0)

A survey of French and Francophone cinema. Prerequisite: French 2170.

**FRENCH 4330 Business French** (LEC 3.0)

This course addresses practical reading, speaking, listening, and writing strategies for conducting business in French-speaking countries. Students will also improve their knowledge of the contemporary Francophone world. Readings, lectures, and discussions are in French. Prerequisite: French 2170.



**FRENCH 4360 French Culture And Civilization** (LEC 3.0)  
A survey of French culture and civilization of the past 2,000 years, including art, architecture, music, literature, geography and politics. Prerequisite: French 2170.

**FRENCH 4370 Survey Of French Literature I (Early Period)** (LEC 3.0)  
The history and development of French literature from Les Chansons De Geste through the important philosophers of the 18th century to Beaumarchais. Assigned readings are in French, and lectures are largely in French. Prerequisite: French 2170.

**FRENCH 4375 Survey Of French Literature II (Modern Period)** (LEC 3.0)  
19th and 20th century French literature. Prerequisite: French 2170.

## Freshman Engineering Program

Entering freshmen desiring to study engineering are admitted to the Freshman Engineering Program. They may state a preference for a major in a particular engineering field if they wish. In the event a preference is stated, it will be used in the consideration for freshmen scholarships, if available, in the preferred department.

The goals of the Freshman Engineering Program are:

1. to provide high quality advising in order to enhance the likelihood of student academic success, and
2. to provide information about careers in the various engineering fields so that students can make an informed decision regarding an engineering major.

Students will complete a set of required courses common to all engineering fields and then may apply for admission as degree candidates to the program of their choice.

## Common Engineering Freshman Year

The following courses are common to all the engineering programs offered at Missouri S&T and are normally taken while the student is in the Freshman Engineering Program:

MATH 1214 & MATH 1215	Calculus For Engineers I and Calculus For Engineers II	8
CHEM 1310 & CHEM 1319 & CHEM 1100	General Chemistry I and General Chemistry Laboratory and Introduction To Laboratory Safety & Hazardous Materials	6
ENGLISH 1120	Exposition And Argumentation	3
Humanities/Social Sciences courses <sup>1</sup>		
FR ENG 1100	Study And Careers In Engineering	1
MECH ENG 1720	Introduction to Engineering Design	3
PHYSICS 1135	Engineering Physics I	4

Courses required in the remainder of each specific engineering program are listed under that program's description in the catalog.

<sup>1</sup> Students must receive credit prior to graduation for a course that fulfills the Williams law requirement (HISTORY 1200, HISTORY 1300, HISTORY 1310 or POL SCI 1200). Students planning to major in architectural engineering should take HISTORY 1200.

Students planning to major in ceramic engineering, chemical engineering, environmental engineering, geological engineering, metallurgical engineering or petroleum engineering will require additional chemistry or chemistry/geochemistry electives. It is recommended that, during the freshman year, these students should plan on taking CHEM 1320,

MET ENG 1210, GEOLOGY 3410, or other suggested courses as outlined in the curriculum of those specific majors.

Students planning to major in mining engineering should take GEO ENG 1150, MIN ENG 1912, and MIN ENG 2126 during their freshman year. Students planning to major in nuclear engineering should take NUC ENG 1105 during their freshman year.

Students may transfer from the Freshman Engineering Program to their selected degree program after having satisfied all of the above requirements except two courses, provided the degree programs will accept them. Students are advised to check special program requirements as listed with the program curricula in the catalog.

**FR ENG 1100 Study And Careers In Engineering** (LEC 1.0)  
Examination of engineering degree programs available at Missouri S&T and career opportunities in engineering. Introduction to non-engineering majors and minors at Missouri S&T. Academic, professional and ethical expectations of the student and engineering professional. Introduction to campus facilities and resources for assisting in student success.

## Geological Engineering

**Emphasis areas at the bachelor of science level in environmental protection and hazardous waste management, groundwater hydrology and contaminant transport, engineering geology and geotechnics, petroleum, energy and natural resources, and quarry engineering.**

The geological engineering program is offered under the department of geosciences and geological and petroleum engineering.

Geological engineering - we care about the earth! We care for the earth, its resources and its inhabitants.

Geological engineers apply their engineering skills to projects which protect and preserve the earth and the environment in which we live. Do you like working outdoors? Do you enjoy solving problems using your skills and creativity? Do you like helping people and the environment? Then you may be a good candidate for geological engineering!

Geological engineers work on a variety of projects that involve the earth and its resources. For example, a geological engineer may be involved in the design of a project to protect wetlands. A geological engineer may be involved in the cleanup of lead contaminated soil which threatens peoples' homes. Geological engineers may develop safe drinking water supplies in parts of the world where infant mortality is many times higher than it is in the United States. Geological engineers work on protecting infrastructure like bridges, buildings and utilities from earthquake damage. Geological engineers evaluate the use of naturally-occurring materials like clay to prevent the spread of subsurface contamination. Geological engineers are interested in the development of renewable energy resources to conserve traditional sources of energy. Geological engineers work with the environment to improve conditions for everyone and the world around us.

The curriculum for geological engineers includes the familiar engineering subjects like math, chemistry, physics and mechanics. However, geological engineers also take courses that are focused on the earth - its soil, rock and fluids; these courses frequently include field work! Of course, geological engineers also are well-trained in engineering design and such design courses typical focus on projects that help people and society through careful consideration of where, when, and how the earth's resources are utilized.

Because the use and conservation of the earth's resources is an ever-growing concern and responsibility, there is an increasing need for geological engineers in a wide variety of areas including industry, government agencies, and research applications. Scholarships are available as are summer internships and, ultimately, challenging and rewarding permanent employment.

## Mission Statement

It is the mission of the geological engineering program to teach integrated concepts of geology and engineering in such a manner that graduates will graduate as competent, ethical, professional geological engineers. The program is designed to provide background in geological and engineering sciences courses in the lower division which support the applied analysis and design concepts courses taught in the upper division. It is expected that the students will have gained the ability to identify and, through analysis and design, solve problems resulting from the interaction of man's activities with the geologic environment. The curriculum is intended to blend theoretical concepts with practical application, so as to offer the student a well-rounded education, and to include sufficient discussion and project oriented work with real-world issues to provide the student with a thorough awareness of the graduate's responsibility to society. Since geological engineering students are oriented toward careers in environmental protection, social awareness and the engineer's responsibility to both client and society is strongly emphasized throughout the curriculum, particularly in the senior seminar and design courses.

## Program Objectives and Outcomes

**Objectives:** Graduates will be prepared to serve public and private interests as future professional geological engineers practicing in the state of Missouri, the nation, and international situations; they will be prepared to ultimately achieve the status of licensed engineers.

**Outcome Group 1: General engineering and science competence.** Graduates will be well trained in the fundamentals of general engineering, mathematics, and the sciences; with particular focus on geology and engineering applications.

**Outcomes:**

1. Students will have a fundamental knowledge of basic mathematical principles particular to geological engineering, and to prepare them to write the Fundamentals of Engineering Exams.
2. Students will have a fundamental knowledge of basic science principles particular to geological engineering, and to prepare them to write the Fundamentals of Engineering Exams.
3. Students will have a fundamental knowledge of general engineering mechanics particular to geological engineering (including design, statics, mechanics of materials), and to prepare them to write the Fundamentals of Engineering Exam.
4. Students will have a fundamental knowledge of basic geology topics particular to geological engineering (geological processes, identification of rocks and minerals, visualize and solve problems in 3 and 4 D, and to apply principles of geology and geophysics).
5. Students will have the ability to apply mathematics including differential equations, calculus based physics and chemistry to geological engineering.

**Outcome Group 2: Geological engineering competence.** Graduates will acquire a broad knowledge of geological engineering principles and practices and understand what practicing geological engineers do.

1. Students will have a fundamental knowledge of principles associated with geological engineering and closely related disciplines, and to design solutions to geological engineering and geomechanics problems.
2. Students will have an applied specific knowledge of aspects of geological engineering and closely related disciplines, including specialization in one or more emphasis area of geological engineering.
3. Students will learn the importance of professional licensure and the appropriate path to professional licensure.
4. Students will learn practical professional skills required of practicing engineers.
5. Students will learn what some practicing professionals in our field do as a part of their job.
6. Students will gain exposure to international engineering situations.

**Outcome Group 3: Problem solving skills.** Graduates will have the ability to use mathematics and scientific principles and analytical and other problem-solving skills necessary to systematically solve problems within the environmental, economic, social, political, and professional constraints of society and the geological engineering community, by themselves and in teams.

**Outcomes:**

1. Students will be able to conduct experiments, design projects, and analyze and interpret data.
2. Students will be able to design components and integrated systems to solve a typical geological problem associated with subsurface conditions or the environment.
3. Students will be able to successfully work in design teams.
4. Students will have the ability to function on multidisciplinary teams.
5. Students will have an appreciation for the inherent uncertainty and variability of naturally occurring materials and the risks and difficulties of decision making and engineering design within such a framework, especially with respect to the economic and optimum use of resources.
6. Students will have the ability to understand how to use non-invasive imaging technologies for geotechnical, environmental, hydrologic, and structural investigations.
7. Students will have the ability to use state-of-the-practice computer software.
8. Students will have the ability to use state-of-the-practice accepted field methods and equipment.
9. Students will have the confidence to provide leadership and communicate effectively in a multidisciplinary team in order to analyze and interpret data, transmit results, make proposals, and prepare reports.

**Outcome Group 4: Social skills.** Graduates will possess the highest level of personal and professional ethics, have a broad based knowledgeable of humanities and social sciences, and have the communication and personal skills necessary to be leaders and effective members of multidisciplinary teams.

**Outcomes:**

1. Students will have knowledge of, and appreciation for, historical and contemporary issues and the impact of such issues, by taking non-technical classes as part of an engineering education.
2. Students will have broad knowledge of environmental, economic, social, political and professional issues relevant to the practice of engineering in today's world.
3. Students will be able to communicate effectively.
4. Students will understand how to development personal and professional ethics and professional responsibility.
5. Students will be encouraged to join a professional society.
6. Students will be encouraged to participate in extra-curricular activities.
7. Students will be encouraged to become leaders.

Outcome Group 5: Life-long learning skills. Graduates will have the skills and motivation to continue learning throughout their careers.

Outcome:

1. Students will understand the need for and attain the skills to develop life-long learning.

## Bachelor of Science Geological Engineering

Entering freshmen desiring to study geological engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a geological engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major.

For the bachelor of science degree in geological engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. A student must maintain at least two grade points per credit hour for all courses taken in the student's major department, and an average of at least two grade points per credit hour must be maintained in geological engineering.

The geological engineering curriculum contains a required number of hours in humanities and social sciences as specified by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. Each student's program of study must contain a minimum of 18 credit hours of course work from the humanities and the social sciences areas and should be chosen according to the following rules:

1. All students are required to take one American history course and one economics course. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200. Some disciplines require one humanities course to be selected from the approved lists for art, English, foreign languages, music, philosophy, speech and media studies, or theater.
2. Of the remaining hours, six credit hours must be taken in humanities or social sciences at the 100 level or above and must be selected from the approved lists. Each of these courses must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 70 to 80 can be considered to be one of these courses. (Students may receive

humanities credit for foreign language courses in their native tongue only if the course is at the 300 level.)

3. Some departments list specific requirements; e.g. a psychology course, a literature course, and /or a second semester of economics. Selections should be made to ensure that these requirements are met.
4. Skill courses are not allowed to meet humanities and social sciences requirements except in foreign languages. Students who select the foreign language option are urged to take more than one course.
5. Special topics, special problems courses and honors seminars are allowed only by petition to and approval by the student's program head.

The geological engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

### Freshman Year

First Semester	Credits	Second Semester	Credits
MATH 1214	4	MATH 1215	4
CHEM 1310	4	Chemistry/Geochemistry Elective <sup>b</sup>	3
CHEM 1100	1	MECH ENG 1720	3
CHEM 1319	1	PHYSICS 1135	4
ENGLISH 1120	3	H/SS Elective <sup>a</sup>	3
FR ENG 1100	1		
H/SS Elective <sup>a</sup>	3		
	17		17

### Sophomore Year

First Semester	Credits	Second Semester	Credits
MATH 2222	4	MATH 3304	3
PHYSICS 2135	4	CIV ENG 2200	3
GEO ENG 3148	3	GEO ENG 2110	1
GEO ENG 1150	3	GEOLOGY 2611	3
GEO ENG 1120	1	GEO ENG 3175	3
		Humanities/Soc Sci Elective <sup>a</sup>	3
	15		16

### Junior Year

First Semester	Credits	Second Semester	Credits
MECH ENG 2350	2	CIV ENG 3330	3
CIV ENG 2210	3	GEO ENG 4115	3
GEOLOGY 3310	3	GEO ENG 5443	3
Economics Elective <sup>j</sup>	3	Technical Communications Elective <sup>d</sup>	3
Hum/Soc Sc Elective <sup>a</sup>	3	Humanities/Soc. Sci Elective <sup>a</sup>	3
Earth Energy Elective <sup>c</sup>	3		
	17		15

### Senior Year

First Semester	Credits	Second Semester	Credits
Geophysics Elective <sup>i</sup>	3	GEO ENG 5174	3
GEO ENG 4010	0.5	GEO ENG 4010	0.5

GEO ENG 5331	3	Earth Mechanics Elective <sup>e</sup>	3
GEO ENG 5441	3	Eng Econ Elective <sup>f</sup>	3
GEO ENG 5090 or 5092 <sup>h</sup>	3	Technical Electives <sup>g</sup>	6
CIV ENG 3715 or MIN ENG 4823	3		
	15.5		15.5

Total Credits: 128

- The sequence of course selection must provide both breadth and depth of content and must be selected from the list of approved humanities/social science electives available from your advisor. A total of 18 hours of humanities and social science credit is required.
- The chemistry/geochemistry elective must be selected from chemistry, geochemistry or biology courses as approved by your advisor.
- Students should select GEO ENG 5556, or other earth energy electives such as PET ENG 3330, PET ENG 2510, or GEOLOGY 5513.
- The Technical Communications elective can be selected from ENGLISH 1160, ENGLISH 3560, SP&M S 1185, or the complete four-course sequence in Advanced ROTC (MIL ARMY 3250, MIL ARMY 3500, MIL ARMY 4250, and MIL ARMY 4500 or AERO ENG 5758, AERO ENG 351, AERO ENG 4790, and AERO ENG 5481).
- To be selected from GEO ENG 5471, GEO ENG 5381, MIN ENG 4823, PET ENG 2510, PET ENG 3520, CIV ENG 3715, CIV ENG 4729, or CIV ENG 5715.
- To be selected from ENG MGT 5210, MIN ENG 3512, or PET ENG 4590 or both ENG MGT 1100 and ENG MGT 1210.
- To be selected from advanced courses in geological, mining, petroleum or civil engineering, geology or other courses with approval of your advisor. Must contain design content and must be approved by your advisor.
- Students may take GEO ENG 5090 or GEO ENG 5092 for senior design credit.
- The Geophysics elective can be selected from GEO ENG 5736, GEO ENG 5761, or GEO ENG 5782.
- The Economics Elective must be selected from Econ 1100 or Econ 1200.

All GE students must take the Fundamentals of Engineering Examination prior to graduation. A passing grade is not required; however, it is the first step toward becoming a registered professional engineer. This requirement is part of the Missouri S&T assessment process. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.

Geological engineering students must earn the grade of “C” or better in all geological engineering courses to receive credit toward graduation. The total number of credit hours required for a degree in Geological Engineering is 128. The assumption is made that a student admitted to the Department has completed 34 hours toward graduation to fulfill the requirements of the Freshman Engineering program.

## Geological Engineering Emphasis Areas

Electives are selected by the student with advisor approval. Some appropriate electives are listed for each emphasis area.

### Environmental Protection and Hazardous Waste Management

GEO ENG 5235      Environmental Geological Engineering

3

GEO ENG 5237	Geological Aspects Of Hazardous Waste Management	3
GEO ENG 5381	Intermediate Subsurface Hydrology And Contaminant Transport Mechs	3
GEO ENG 5331	Subsurface Hydrology	3
GEO ENG 4115	Statistical Methods in Geology and Engineering	3
GEO ENG 4276	Environmental Aspects Of Mining	3
GEO ENG 5233	Risk Assessment In Environmental Studies	3
CIV ENG 3715	Fundamentals of Geotechnical Engineering	3

### Groundwater Hydrology and Contaminant Transport

GEO ENG 5381	Intermediate Subsurface Hydrology And Contaminant Transport Mechs	3
GEO ENG 5233	Risk Assessment In Environmental Studies	3
GEO ENG 5174	Geological Engineering Field Methods	3
GEO ENG 5331	Subsurface Hydrology	3
GEO ENG 4115	Statistical Methods in Geology and Engineering	3
GEO ENG 5441	Engineering Geology And Geotechnics	3
CIV ENG 3715	Fundamentals of Geotechnical Engineering	3
PET ENG 3330	Well Logging	3

### Engineering Geology and Geotechnics

GEO ENG 5471	Rock Engineering	3
CIV ENG 3715	Fundamentals of Geotechnical Engineering	3
MIN ENG 4823	Rock Mechanics	3
CIV ENG 4729	Foundation Engineering	3
MIN ENG 308		
GEO ENG 5146	Applications Of Geographic Information Systems	3
GEO ENG 5441	Engineering Geology And Geotechnics	3
GEO ENG 4115	Statistical Methods in Geology and Engineering	3

### Petroleum, Energy and Natural Resources

PET ENG 3520	Petroleum Reservoir Engineering	3
MIN ENG 4823	Rock Mechanics	3
GEO ENG 5146	Applications Of Geographic Information Systems	3
GEO ENG 5381	Intermediate Subsurface Hydrology And Contaminant Transport Mechs	3
GEOLOGY 5511	Applied Petroleum Geology	3
PET ENG 2510	Properties Of Hydrocarbon Fluids	3
PET ENG 1110	Introduction to Petroleum Engineering	1
PET ENG 3330	Well Logging	3
PET ENG 4520	Well Test Analysis	3

### Quarry Engineering

MIN ENG 4823	Rock Mechanics	3
GEO ENG 5575	Aggregates And Quarrying	3
CIV ENG 3116	Construction Materials, Properties And Testing	3
GEO ENG 5471	Rock Engineering	3
GEO ENG 4276	Environmental Aspects Of Mining	3
MIN ENG 3913	Mineral Identification and Exploration	3
MIN ENG 5612	Principles of Explosives Engineering	3
MIN ENG 308		3
MIN ENG 5822	Strata Control	3

## Minor in Geological Engineering

Geological engineering offers employment opportunities for a broad spectrum of disciplines including civil, mining, nuclear, and petroleum engineering as well as for geologists and geophysicists. A minor in geological engineering or engineering geology, therefore, enhances the academic credentials of a student and broadens employment choices. A minor in geological engineering requires 15 hours of Missouri S&T credit to include the following:



GEO ENG 1150	Physical and Environmental Geology <sup>1</sup>	3
GEO ENG 3175	Geomorphology And Terrain Analysis	3
GEO ENG 5331	Subsurface Hydrology	3
GEO ENG 5441	Engineering Geology And Geotechnics	3
GEO ENG Elective <sup>2</sup>		3
Total Credits		15

<sup>1</sup> GEOLOGY 1110 may be substituted for geology and geophysics majors.

<sup>2</sup> To be selected with geological engineering advisor approval.

## Minor in Humanitarian Engineering and Science

Humanitarian engineering may be described as a multi-disciplinary approach to improve the well-being of underserved or developing communities and/or populations. The purpose of the minor is to provide the opportunity to all Missouri S&T students to:

- Potentially participate in activities designed to improve the well-being of underserved or developing communities/populations
- Address quality of life issues, local leadership partnerships, resource allocation, the natural world, and climate and risk
- Obtain a degree that explicitly requires experiential service learning

The Humanitarian Engineering and Science Minor requires the completion of a minimum of 15 hours of courses as described below:

A minimum of three semesters (for a minimum total of 1.5 SCH):

GEO ENG 1810	Humanitarian Engineering and Science Colloquium
--------------	---

A minimum of three semesters (for a minimum total of 1.5 SCH):

GEO ENG 1880	Civic Engagement
--------------	------------------

Three hours of ethics-related coursework to be selected from:

PHILOS 3223	Bioethics
PHILOS 3225	Engineering Ethics
PHILOS 3235	Business Ethics

Nine hours of electives to be selected from:

ARCH ENG 5642	Sustainability, Population, Energy, Water, and Materials (co-listed with CIV ENG 5642 and ENV ENG 5642)
BIO SCI 2372	Issues in Public Health
BUS 3115	Introduction to Teambuilding and Leadership
ECON 4440	Environmental And Natural Resource Economics
ECON 4641	Foundations of Sustainability
ECON 4642	Introduction to Global Eco- and Social-preneurship and Innovation
ECON 4730	Economic Development
ENG MGT 4330	Human Factors
ENGLISH 3228	The American Experience
GEO ENG 5331	Subsurface Hydrology
GEO ENG 5211	Introduction to International Engineering and Design Lab
GEO ENG 5247	Introduction to International Engineering and Design
GEO ENG 5092	International Engineering and Design
HISTORY 3510	Twentieth Century Technology And Society
MKT 3210	Consumer Behavior
MKT 4150	Customer Focus and Satisfaction
POL SCI 2500	International Relations
POL SCI 3510	
PSYCH 4600	Social Psychology
PSYCH 4710	Human Factors
PSYCH 4730	Environmental Psychology
PSYCH 4992	Cross-Cultural Psychology
SP&M S 3235	Intercultural Communication

SP&M S 3250	Interpersonal Communication
Foreign language - a maximum of 4 SCH may be applied to the Humanitarian Engineering and Science Minor electives requirement.	

**Neil L Anderson, Professor**<sup>1,2</sup>  
PHD University of Calgary

**Kwame Awuah-Offei**, Associate Professor  
PHD University of Missouri-Rolla

**James L Bunch**, Lecturer  
MASTER Missouri University of Science

**Jeffrey D Cawfield**, Professor<sup>1,2</sup>  
PHD University of California-Berkeley

**Leslie Sour Gertsch**, Associate Professor  
PHD Colorado School of Mines

**Katherine R Grote**, Associate Professor  
PHD University of California, Berkeley

**Joe D Guggenberger**, Assistant Professor  
PHD Missouri University of Science and Technology

**James E Kaufmann**, Lecturer  
MASTER University of Missouri-Rolla

**Norbert H Maerz**, Associate Professor<sup>1,2</sup>  
PHD University of Waterloo

**J David Rogers**, Associate Professor<sup>1,2</sup>  
PHD University of California-Berkeley

**James E Vandike**, Lecturer  
MASTER South Dakota School of Mines & Technology

**Emitt Cleveland Witt**, Adjunct Assistant Professor  
PHD Missouri University of Science & Technology

### ***GEO ENG 1001 Special Topics*** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

### ***GEO ENG 1119 Physical and Environmental Geology Laboratory*** (LAB 1.0)

Geology 1119 is designed to accompany Geology 1110 and consists of laboratory explorations of the study of common rocks and minerals, air photographs, maps, and case studies of geological problems related to management of Earth resources, hazards, and environmental challenges. Prerequisite: Preceded or accompanied by Geology 1110. (Co-listed with Geology 1119).

### ***GEO ENG 1150 Physical and Environmental Geology*** (LEC 3.0)

Materials, structure, and surface features of the Earth and planets are studied in the context of the processes that continuously transform the Earth and affect management of Earth resources, hazards, engineering problems, and environmental challenges. Prerequisite: Entrance requirements. (Co-listed with Geology 1110).

### ***GEO ENG 1175 Geological Engineering in Popular Media*** (LAB 2.0 and LEC 1.0)

Examination of the issues and topics related to geological engineering as presented in movies, television programs, and other communications media.

**GEO ENG 1605 Mathematical Concepts for Military Engineers** (LEC 2.0)

Review of fundamental concepts in Algebra, Trigonometry and Calculus for students in Geological Engineering. Designed as a bridging course for Military Reserve officers enrolled in the On-Line Certificate in Military Geological Engineering. Prerequisite: Permission of instructor. This course was designed for military officers registered in either the GE DL MS Degree Program or the GE FLW MS Degree Program.

**GEO ENG 1810 Humanitarian Engineering and Science Colloquium** (RSD 0.50)

Course introduces Humanitarian Engineering & Science Minor students to topics such as impact of Western interventions on developing cultures, ethics and engineering, frugal engineering, the role of civic engagement in corporate culture, responsible behavior in outreach programs, and others. Cannot be used for credit towards Geological Engineering B.S. Prerequisites: Open to undergraduate students pursuing the Humanitarian Engineering and Science Minor.

**GEO ENG 1880 Civic Engagement** (IND 0.50)

Course provides a formal independent study framework so that Humanitarian Engineering & Science Minor students and other students have the opportunity to achieve formal recognition of experiential service learning that may occur during participation in extracurricular programs. Cannot be used for credit towards Geological Engineering B.S. Prerequisites: Open to undergraduate students pursuing the Humanitarian Engineering and Science Minor.

**GEO ENG 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GEO ENG 2001 Special Topics** (LEC 1.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEO ENG 2002 Cooperative Work Training** (IND 1.0-3.0)

On the job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation.

**GEO ENG 2110 Principles Of Geological Engineering** (LEC 1.0)

Introduce GE students to the GE program. Topics include career paths, professional development, licensure, life long learning, engineering ethics, societal issues, engineering law, international engineering, and GE program outcomes and objectives. Discussion of the teaching and research of the faculty. Prerequisite: Sophomore standing in the GE program.

**GEO ENG 2407 Geology and Engineering of Ancient and Modern Peru** (LEC 1.0)

A study of the geological engineering of the Cuzco-Machu Picchu corridor, including the interrelations of geology, climate, archeology, and history. A technical report and a week-long field trip to Peru during Spring Break are required.

**GEO ENG 2536 Basic Weather** (LAB 1.0 and LEC 2.0)

A course to study basic concepts of atmospheric science such as air masses, frontal weather patterns and weather forecasting. The course also will include topics on climate and severe weather. Prerequisites: Physics 1135, Geo Eng 1150.

**GEO ENG 2605 Statics and Mechanics of Geologic Materials** (LEC 3.0)

Fundamental statics of rigid bodies and mechanics of deformable bodies for entering graduate students, focusing on behavior of rock and soil in engineering situations. Not for students intending to register as professional engineers. Designed for military officers registered in GE DL MS Degree Program or GE FLW MS Degree Program. Prerequisite: Permission of instructor.

**GEO ENG 3148 Fundamentals Of Geographic Information Systems** (LAB 1.0 and LEC 2.0)

Introduction to the fundamental concepts and components of Geographic Information Systems. Techniques for acquiring, manipulating and analyzing digital terrain data for geological and geotechnical applications. (Co-listed with Geology 3811).

**GEO ENG 3175 Geomorphology And Terrain Analysis** (LAB 1.0 and LEC 2.0)

Study of geomorphic processes, landform development, and surficial materials. Stresses evaluation of the engineering properties of terrain for site selection and design of engineered structures. Prerequisite: Geo Eng 1150.

**GEO ENG 3249 Fundamentals Of Computer Applications In Geological Engineering** (LAB 1.0 and LEC 2.0)

Applications of existing and available software packages utilizing a variety of hardware systems for geological engineering purposes. Emphasis on practical utilization of personal computers and network operations for graphical analysis of geologic data, mapping of surface and subsurface configurations and modeling of geologic processes. Prerequisites: Geo Eng 1150, Comp Sci 1970, 1980.

**GEO ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GEO ENG 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEO ENG 4010 Current Topics and Professionalism** (RSD 0.50)

Discussion of current topics, professionalism, and ethics. Required for two semesters during senior year. (Course cannot be used for graduate credit). Prerequisite: Senior standing.

**GEO ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**GEO ENG 4115 Statistical Methods in Geology and Engineering** (LEC 3.0)

Statistical methods in engineering and geological applications including site investigations and environmental data analyses. Introduction to spatial correlation analysis and geostatistical techniques such as kriging for resource evaluation and estimation.

**GEO ENG 4276 Environmental Aspects Of Mining** (LEC 3.0)

Permitting: the legal environment of reclamation and environmental impact assessment; post-mining land-use selection and mine planning for optimum reclamation of all mines: metal, nonmetal, and coal; unit operations of reclamation; drainage, backfill, soil replacement, revegetation, maintenance, etc. Prerequisites: Co-requisites: MIN ENG 4933 or GEO ENG 5441 or ENV ENG 5619. (Co-listed with MIN ENG 4742).

**GEO ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor is required.

**GEO ENG 5001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEO ENG 5085 Internship** (IND 0.0-15)

Students working toward a doctor of engineering degree will select, with the advice of their committees, appropriate problems for preparation of a dissertation. The problem selected and internship plan must conform to the purpose of providing a high level engineering experience consistent with the intent of the doctor of engineering degree.

**GEO ENG 5090 Geological Engineering Design** (LEC 2.0 and LAB 1.0)

Geological engineering design is an open-ended project course requiring the collection of data, analysis and synthesis of that data and design of a socially acceptable, economical solution to the selected problem. Oral and written reports are required. Prerequisite: To be taken in the semester before graduation.

**GEO ENG 5092 International Engineering and Design** (LEC 3.0)

A multi-disciplinary engineering course focused on sustainable design and technology transfer to developing countries. Course includes elements of traditional capstone design classes. Experiential learning through competitions and/or field work is a major component of the class. Prerequisites: Senior standing, instructor approval, Geo Eng 5211, Geo Eng 5247. (Co-listed with Met Eng 4510 and Cer Eng 4510).

**GEO ENG 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**GEO ENG 5144 Remote Sensing Technology** (LEC 2.0 and LAB 1.0)

Principles of digital image processing including image enhancement and multispectral classification. Emphasis upon design and implementation of remote sensing systems and analysis of remotely sensed data for geotechnical and environmental investigations. Prerequisite: Geo Eng 3148. (Co-listed with Geology 4310).

**GEO ENG 5146 Applications Of Geographic Information Systems** (LEC 2.0 and LAB 1.0)

Applications of Geographical Information Systems and remote sensing to environmental monitoring, mineral resource exploration, and geotechnical site evaluation. Prerequisite: Geo Eng 3175 or consent of instructor. (Co-listed with Geology 4821).

**GEO ENG 5153 Regional Geological Engineering Problems In North America** (LEC 3.0)

A physiographic approach to engineering materials and problems. Course emphasizes the distribution and engineering characteristics of soil and rock to construction and site problems and includes aggregates, foundations, excavations, surface and ground water, slope stability and arctic conditions.

**GEO ENG 5172 Soil Science In Engineering Practice** (LEC 3.0)

A study of the ways in which soils and geologic conditions influence engineered projects. Soil formation, soil chemistry and properties to include composition, organic component, ion exchange and water relationships as well as erosion control and revegetation will be covered. Prerequisite: Geo Eng 3175.

**GEO ENG 5173 Geologic Field Methods** (LAB 3.0)

Field practice in geologic mapping and interpretation in the Western United States using topographic base maps and aerial photos. Emphasizes the description and interpretation of stratigraphic sections, sedimentary and tectonic structures. Prerequisite: Two courses in either Geology or Geological Engineering.

**GEO ENG 5174 Geological Engineering Field Methods** (LAB 3.0)

Instruction in methods of field investigation required for geological engineering studies. Course will include procedures for qualitative and quantitative data collection for characterizing surficial geologic conditions, groundwater and surface water investigations, and other engineering activities. Written reports and field trip required.

**GEO ENG 5211 Introduction to International Engineering and Design Lab** (LAB 1.0)

The lab for multi-disciplinary design will be as follows: Students will develop a work plan to address design objectives and other considerations including scheduling, budgeting, environmental impacts, and life cycle design. Prerequisites: Senior standing, instructor approval, accompanied by GEO ENG 5247.

**GEO ENG 5233 Risk Assessment In Environmental Studies** (LEC 3.0)

This course will present the concepts required to assess the human health and environmental risks resulting from contaminants in soil and groundwater. Course topics include evaluation of data sets, exposure calculation, chemical fate and transport, and development of conceptual site models.

**GEO ENG 5235 Environmental Geological Engineering** (LEC 3.0)

Introduction to engineering geologic mapping for site selection for solid waste disposal facilities; landfill site selection, design, permitting, construction, operation, and closeout/reclamation. Prerequisites: Geo Eng 3175, accompanied or preceded by Civ Eng 3715.

**GEO ENG 5237 Geological Aspects Of Hazardous Waste Management** (LEC 3.0)

Nature and classification of hazardous wastes; federal and state regulation for treatment and disposal; geological characterization of facility sites; design of impoundments, storage and containment facilities; ground water monitoring and protection; site permitting and licensing planning. Prerequisite: Geo Eng 3175.

**GEO ENG 5239 Groundwater Remediation** (LEC 3.0)

A survey of conventional and innovative techniques for remediation of contaminated groundwater. Topics include groundwater cleanup standards, physico-chemical properties of groundwater and contaminants, fate and transport of contaminants in the subsurface, hydrogeologic site characterization, and selection process of a remedial technology. Various computer programs developed to assist in preliminary selection and design of remediation technologies will be used. Prerequisite: Geo Eng 5331.

**GEO ENG 5247 Introduction to International Engineering and Design** (LEC 2.0)

A multi-disciplinary design course focused on sustainable design and technology transfer to developing countries. Students will develop a work plan to address design objectives and other considerations including scheduling, budgeting, environmental impacts, and life cycle design. Prerequisites: Senior standing, instructor approval, accompanied by Geo Eng 5211.

**GEO ENG 5276 Advanced Environmental Aspects Of Mining** (LEC 3.0)

Applied and fundamental research issues pertaining to: permitting -- the legal environment of reclamation and environmental impact assessment; post-mining land-use selection and mine planning for optimum reclamation of all mines: metal, nonmetal, and coal; unit operations of reclamation: drainage, backfill, soil replacement, revegetation, maintenance, etc. Course project.

**GEO ENG 5315 Advanced Statistical Methods in Geology and Engineering** (LEC 3.0)

Application of statistical methods to study of geologic materials and practices, with emphasis on reliable interpretation of laboratory and field data for water, hydrocarbon, and mineral exploration, research, and engineering as well as other aspects of geological engineering. Prerequisites: Geo Eng 4115 or Stat 3111 or Stat 3113 or Stat 3115 or Stat 3117.

**GEO ENG 5320 Groundwater Modeling** (LEC 3.0)

This course is an introduction to advanced modeling techniques for understanding flow and transport in porous media under different hydrologic conditions. Emphasis is placed on both theoretical and practical modeling considerations. Computer demonstrations are incorporated. Practical applications are emphasized. Prerequisite: Civ Eng 3330 or Geo Eng 5331.

**GEO ENG 5331 Subsurface Hydrology** (LEC 3.0)

Introduction to the theory and engineering concepts of the movement of subsurface fluids. Properties of water and other subsurface fluids. Hydraulic characteristics of earth materials. Engineering problems related to subsurface fluids. Prerequisites: Geo Eng 1150, Math 3304.

**GEO ENG 5332 Fundamentals of Groundwater Hydrology** (LEC 3.0)

Focus on fundamental analysis and survey of groundwater hydrology with emphasis on practical geo-environmental and subsurface hydrology issues of interest to working professionals. Topics will include general hydrology, surface and subsurface interconnection, basic groundwater flow and well test analysis, and a brief intro to contaminant transport.

**GEO ENG 5381 Intermediate Subsurface Hydrology And Contaminant Transport Mechs** (LEC 3.0)

A study of the physical/chemical properties of rocks and sediments in the subsurface environment. Emphasis is put on waterrock properties such as permeability, capillarity, and mechanical dispersion. Both microscopic and macroscopic approaches are used. Prerequisites: Civ Eng 3330 & Geo Eng 5331.

**GEO ENG 5415 Soil Mechanics for Geoprosessionals** (LEC 3.0)

The basic principles of soil mechanics necessary for professionals to practice in the field of geoconstruction. Topics related to the practical aspects of engineering include: soil classification, index properties, water flow through soils, compaction, compressibility, and shear strength. These basic principles will be applied to real world problems.

**GEO ENG 5441 Engineering Geology And Geotechnics** (LEC 3.0)

Study of procedures and techniques used to evaluate geologic factors for site selection and the design of engineered structures. Prerequisite: Geo Eng 3175.

**GEO ENG 5443 Subsurface Exploration** (LAB 1.0 and LEC 2.0)

Lectures and field and laboratory exercises in the use of geologic and geophysical techniques for evaluation of subsurface geology and resources. Prerequisite: Geo Eng 1150.

**GEO ENG 5471 Rock Engineering** (LEC 3.0)

Data requirements for design; engineering properties of rock; characterization of fractures and rock masses; stereonet analysis of discontinuities; graphic analysis of failure; ground stress distribution; tunnel construction methods; ground support principles; selection of tunneling equipment; and specifications for underground construction. Prerequisite: Geo Eng 3175.

**GEO ENG 5556 Renewable Energy Systems** (LEC 3.0)

Introduction to the theory and performance prediction of typical renewable energy systems such as, but not limited to, those based on energy from the sun, wind and water, and geothermal. The use of environmental data, including stochastic modeling, for renewable energy system (including wind turbine, photovoltaic, and geothermal) design is addressed. Prerequisites: Math 3304, Physics 2135, and preceded or accompanied by Geo Eng 4115 or any Probability and Statistics class. Junior or senior standing is required.

**GEO ENG 5575 Aggregates And Quarrying** (LEC 3.0)

Properties and uses of aggregates. Finding aggregate deposits and methods of extraction. Aggregate processing. Aggregate testing. Economics and politics of aggregates. Special topics in aggregates and quarrying. Prerequisites: Geo Eng 1150, Geo Eng 3175.

**GEO ENG 5642 Military Geology** (LEC 3.0)

This course will familiarize geologists, geophysicists, civil and geological engineers with the fundamental principles of physical geology, geohydrology and geomorphology as applied to military problems, such as development of fortifications, core infrastructure, water resources and combat engineering requirements. Prerequisite: Geo Eng 3175 or graduate standing.

**GEO ENG 5736 Geophysical Field Methods** (LEC 2.0 and LAB 1.0)

Imaging of selected subsurface features and engineering structures using various geophysical tools. Special emphasis is placed on ground penetrating radar and surface wave techniques. One field trip at student expense required. Prerequisite: Junior level standing or higher. (Co-listed with Geophys 5736).

**GEO ENG 5761 Transportation Applications of Geophysics** (LAB 1.0 and LEC 2.0)

Overview of geophysical and non-destructive test methods that are commonly used to investigate transportation structures and their foundations. Emphasis is placed on bridge system substructure, bridge system superstructure, pavement, roadway subsidence, subsurface characterization and vibration measurements. Prerequisite: Junior level standing or higher. (Co-listed with Geophys 5761 and Civ Eng 5750).

**GEO ENG 5782 Environmental and Engineering Geophysics** (LEC 2.0 and LAB 1.0)

An introduction to the theory and application of the gravity, magnetic, resistivity, self-potential, induced polarization and electromagnetic methods as applied to the solution of engineering and environmental problems. Prerequisite: Math 2222. (Co-listed with Geophys 5782).

## Geology and Geophysics

**Emphasis areas at the bachelor of science level in geochemistry, geology, geophysics, groundwater and environmental geochemistry, and petroleum geology.**

The geology and geophysics program is offered under the department of geosciences and geological and petroleum engineering.

Geology, geochemistry and geophysics study the history, composition, and structure of Earth and other planetary bodies. The expertise and activities in the geology and geophysics program help make the Missouri University of Science and Technology one of the leading U.S. research universities. Faculty and students are investigating areas such as the study of nuclear waste disposal, ground water pollution, palynostratigraphy (microfossils), geophysical characterization of geological hazards (e.g., earthquakes, collapsed caverns) reflection and theoretical seismology, computational geophysics, 3D seismic



applications to petroleum exploration, evolution of petroleum reservoirs, genesis of ore deposits, magmatism and tectonics. We provide the only program in Missouri in geophysics and geochemistry with an emphasis on exploration and environmental applications.

Students are drawn to geology and geophysics by a desire to explore a topic that is for many a personal passion. As a student in the geology and geophysics program, you may become involved in a wide range of studies. We have students investigating their world and beyond in areas as diverse as planetary geology, fossils and evolution, volcanology, structure and dynamics of Earth's deep interior, development of cave systems, exploration for oil and gas, adsorption of pollutants by soils, ore mineralization, and the creation of mountain systems to name but a few. Many courses involve work outdoors and in the laboratory. You may even find yourself hiking in the Grand Canyon, snorkeling over a coral reef in the Caribbean Sea, working in the rifted valleys in Africa or examining the evolution of the desert lakes in the Outback of Australia.

In the first two years of study, students develop a strong foundation in geology through the core curriculum. This foundation is strengthened by course work in chemistry, physics, mathematics, computer science, and the humanities and social sciences. Students begin to take more specialized courses pertaining to their particular area of geological interest in their junior and senior years. The numerous elective courses offered by the geology and geophysics program, as well as courses outside the department, provide our majors with the flexibility to custom design an emphasis area of their choice, focusing in on aspects of Earth Science that are of most interest to them. In this way, our majors develop a broad understanding of the fundamentals of the geosciences while preserving the opportunity to develop their own passion within a broad field of science and engineering disciplines.

The Earth sciences have been an integral part of Missouri S&T since its founding in 1870. Our student organizations in geology and geophysics are among the oldest in the nation and include the Dake Society, American Association of Petroleum Geologists, Society of Exploration Geophysicists, and the Sigma Gamma Epsilon (Eta Chapter) honor society. These organizations provide numerous opportunities for social and scientific interaction among students, professionals, and faculty.

The geology and geophysics program is located in McNutt Hall and it is especially well endowed with modern, state-of-the-art equipment for teaching and research in most areas of the Earth sciences. The availability of such equipment provides our students with an excellent laboratory and field educational experience. In addition, cooperative studies with the Missouri Geological Survey and the U.S. Geological Survey provide students with opportunities for part time employment and on-the-job experience while they pursue their degree.

Geological scientists enjoy their work. As a professional geologist or geophysicist you may explore for oil, gas, and coal to provide for our nation's energy needs. You may search for minerals critical to industry. You may become involved in minimizing environmental pollutants and geologic hazards. In all cases, you will have the opportunity to work outdoors, in the lab, and with cutting edge technology.

## Mission Statement

1. Provide the highest quality education to students leading to the B.S., M.S., and Ph.D. degrees in geology and geophysics. Prepare students for professional careers in five emphasis areas: geology, geochemistry, geophysics, groundwater and environmental geochemistry, and petroleum geology. Provide service courses for students in related programs (including geological engineering,

- mining engineering, petroleum engineering, environmental engineering, ceramic engineering, civil engineering, physics, biology and chemistry) as well as many of the programs in the humanities and liberal arts.
2. The program has both the opportunity and the mission to engage in basic and applied research that contributes to the solution of problems related to mankind and the environment. To meet this goal, the program collaborates on projects that transcend the traditional boundaries between scientific and engineering disciplines. Faculty and students commonly conduct research with geologists in the Rolla offices of the United States Geological Survey and the Missouri Geological Survey, with scientists and engineers from various disciplines at Missouri S&T and other campuses of the University of Missouri system, as well as with other Earth scientists in universities within the United States and abroad (e.g., Ireland, Republic of South Africa).
  3. Provide graduates to the mining, petroleum, groundwater, and environmental industries; to the Missouri Geological Survey, the U.S. Geological Survey and other educational research institutions.
  4. Provide professional service in the fields of geology, geophysics, geochemistry, groundwater and environmental geology. Such service includes the identification of minerals, rocks, and fossils that are sent to the department, the assessment of geologic hazards, contributing to the development and operation of professional organizations, and when called upon, assisting local and state agencies with the evaluation of geological problems.
  5. Provide a strong foundation in fundamental principles of geology and geophysics for undergraduate students who desire to pursue opportunities for advanced research in the top graduate schools across the United States. Our graduates have continued their education in prestigious programs, including Arizona State, California-Berkeley, Colorado, Colorado School of Mines, Delaware, MIT, Michigan, Michigan State, Oklahoma, Stanford, Texas, Virginia Tech, Washington, University of Missouri-St. Louis and the Missouri University of Science and Technology.

## Bachelor of Science Geology and Geophysics

A minimum of 127 credit hours is required for a Bachelor of Science degree in Geology and Geophysics. Students must average at least two grade points per credit hour and must obtain a letter grade of "C" or better in all Geology and Geophysics courses.

The Geology and Geophysics curriculum must include ENGLISH 1120 and ENGLISH 1160 , ECON 1100 or ECON 1200 , either HISTORY 1200 , HISTORY 1300 , HISTORY 1310 or POL SCI 1200 , and nine elective hours in humanities/social sciences. Specific requirements for the bachelor degree program are outlined in the sample program below

### Freshman Year

First Semester	Credits	Second Semester	Credits
GEOLOGY 1110	3	GEOLOGY 1120 <sup>1</sup>	3
GEOLOGY 1119	1	GEOLOGY 1129 <sup>1</sup>	1
ENGLISH 1120	3	MATH 1208 <sup>2</sup>	5
CHEM 1310	4	Elective (Science & Eng) <sup>3</sup>	3
CHEM 1319	1	Humanities/ Social Science Elective	3

CHEM 1100	1		
	13	15	

**Sophomore Year**

First Semester	Credits	Second Semester	Credits	Summer Semester	Credits
GEOLOGY 2610	4	GEOLOGY 2620 <sup>1</sup>	4	GEOLOGY 2096	3
GEOPHYS 3210	3	GEOLOGY 3410	3		
MATH 1221 <sup>2</sup>	5	ENGLISH 1160 or 3560	3		
COMP SCI 1970 & COMP SCI 1980 (or COMP SCI 1971 & COMP SCI 1981)	3	ECON 1100 or 1200	3		
		HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3		
	15	16	3		

**Junior Year**

First Semester	Credits	Second Semester	Credits	Summer Semester	Credits
GEOLOGY 3310	3	GEOLOGY 3620	3	GEOLOGY 4097	3
GEOLOGY 3319	1	GEOLOGY 3629	1		
PHYSICS 1135 <sup>4</sup>	4	PHYSICS 2135 <sup>4</sup>	4		
STAT 3113, or 3115, or 3117, or GEO ENG 4115	3	Elective (Geo & Geop) <sup>5</sup>	6		
Elective (Geo & Geop) <sup>5</sup>	3	Humanities/ Social Sciences Elective	3		
	14	17	3		

**Senior Year**

First Semester	Credits	Second Semester	Credits
GEOLOGY 4010	1	GEOLOGY 4310	3
Humanities/ Social Sciences Elective	3	GEOPHYS 5096	3
Elective (Science & Eng) <sup>3</sup>	6	Elective (Science & Eng) <sup>3</sup>	6
Elective (Geo & Geop) <sup>5</sup>	6	Free Elective <sup>6</sup>	3
	16	15	

Total Credits: 127

<sup>1</sup> Communications Emphasized (CE) courses<sup>2</sup> Students may substitute MATH 1214 for MATH 1208; MATH 1215 for MATH 1221.<sup>3</sup> All Geology/Geophysics students must complete at least 15 hours of elective course work in science (which may include additional Geology/Geophysics courses), mathematics, and/or engineering, courses required for the basic program. 12 hours of this course work must be numbered 2000 or above.<sup>4</sup> Students may substitute PHYSICS 1111 and PHYSICS 1119 for PHYSICS 1135; PHYSICS 2111 and PHYSICS 2119 for PHYSICS 2135.<sup>5</sup> All Geology and Geophysics students must complete at least 15 hours of elective course work numbered 2000 or above in the Department of Geology and Geophysics, in addition to the required core curriculum.<sup>6</sup> Free elective hours may be taken in any combination of credit hours (1, 2, 3, etc.) and can include any course offerings at the University.

## Core Curriculum

Taken by all students in Geology &amp; Geophysics.

GEOLOGY 1110	Physical And Environmental Geology	3
GEOLOGY 1119	Physical and Environmental Geology Laboratory	1
GEOLOGY 1120	Evolution Of The Earth	3
GEOLOGY 1129	Evolution of the Earth Laboratory <sup>5</sup>	1
GEOLOGY 2610	Mineralogy And Crystallography	4
GEOLOGY 2620	Igneous And Metamorphic Petrology	4
GEOLOGY 3310	Structural Geology	3
GEOLOGY 3319	Structural Geology Lab	1
GEOLOGY 3410	Introduction To Geochemistry	3
GEOLOGY 3620	Stratigraphy And Sedimentation	3
GEOLOGY 3629	Stratigraphy Lab	1
GEOLOGY 4010	Seminar	1
GEOLOGY 4310	Remote Sensing Technology	3
GEOLOGY 2096	Field Geology	3
GEOLOGY 4097	Advanced Field Geology	3
GEOPHYS 3210	Introduction to Geophysics	3
GEOPHYS 5096	Global Tectonics	3
Total Credits		43

## Geology and Geophysics Focus Areas Geochemistry

Students should complete at least 5 courses (15 hours minimum) from the list.

Students may also choose additional courses to be selected from an approval list and with guidance from student's advisor.

GEOLOGY 3511	Introduction to Mineral Deposits	3
GEOLOGY 4451	Aqueous Geochemistry	3
GEOLOGY 4461	Isotope Geochemistry	3
GEOLOGY 4631	Advanced Igneous and Metamorphic Petrology	4
GEOLOGY 4841	Geological Field Studies	3
GEOLOGY 5611	Granites And Rhyolites	4
GEOLOGY 5671	Clay Mineralogy	3
CER ENG 2110	Atomic Structure Of Crystalline Ceramics	3
CER ENG 3220	Phase Equilibria	3

## General Geology

Students should complete at least 5 courses (15 hours minimum) from the list.

Students may also choose additional courses to be selected from an approval list and with guidance from student's advisor.

GEOLOGY 3511	Introduction to Mineral Deposits	3
GEOLOGY 3631	Systematic Paleontology	3
GEOLOGY 3811	Fundamentals Of Geographic Information Systems	3
GEOLOGY 4631	Advanced Igneous and Metamorphic Petrology	4
GEOLOGY 4711	Paleoclimatology and Paleoeology	3
GEOLOGY 4841	Geological Field Studies	3
GEOLOGY 5513	Petroleum Geology	3
GEOLOGY 5611	Granites And Rhyolites	4
GEOLOGY 5741	Micropaleontology	3
GEOLOGY 6311	Advanced Structural Geology	3
GEO ENG 3175	Geomorphology And Terrain Analysis	3

## Geophysics

Students must choose 1 math and 3 geophysics courses from the list. Students should also choose at least one additional course to be selected from an approved list and with guidance from student's advisor.

MATH 2222	Calculus with Analytic Geometry III	4
-----------	-------------------------------------	---

MATH 3304	Elementary Differential Equations	3
MATH 3108	Linear Algebra I	3
MATH 5325	Partial Differential Equations	3
GEOPHYS 4231	Seismic Interpretation	3
GEOPHYS 5202	Exploration and Development Seismology	3
GEOPHYS 5231	Seismic Data Processing	3
GEOPHYS 5261	Computational Geophysics	3
GEOPHYS 5736	Geophysical Field Methods	3

## Groundwater and Environmental Geochemistry

Students should complete at least 5 courses (15 hours minimum) from the list. Students may also choose additional courses to be selected from an approval list and with guidance from student's advisor.

GEOLOGY 4411	Hydrogeology	3
GEOLOGY 4431	Methods Of Karst Hydrogeology	3
GEOLOGY 4451	Aqueous Geochemistry	3
GEOLOGY 4711	Paleoclimatology and Paleoecology	3
GEOPHYS 5782	Environmental and Engineering Geophysics	3
BIO SCI 1173	Introduction to Environmental Sciences	3
ENV ENG 2601	Fundamentals Of Environmental Engineering and Science	3
ENV ENG 5640	Environmental Law And Regulations	3
GEO ENG 5237	Geological Aspects Of Hazardous Waste Management	3
GEO ENG 5331	Subsurface Hydrology	3

## Petroleum Geology

Students should complete at least 5 courses (15 hours minimum) from the list. Students may also choose additional courses to be selected from an approval list and with guidance from student's advisor.

GEOLOGY 3631	Systematic Paleontology	3
GEOLOGY 5311	Depositional Systems	3
GEOLOGY 5513	Petroleum Geology	3
GEOLOGY 5661	Advanced Stratigraphy and Basin Evolution	3
GEOLOGY 5741	Micropaleontology	3
GEOPHYS 5202	Exploration and Development Seismology	3
PET ENG 3330	Well Logging	3

## Minor in Geology

The minor will consist of 18 hours of geology related course work and must include GEOLOGY 2611 and one of GEOLOGY 1110 or GEO ENG 1150 or GEOLOGY 1120. Six additional hours of course work must come from any combination of 1000, 2000, 3000 geology courses. The remaining 6 hours of course work can be from any combination of geology related courses approved by the geology and geophysics program. Approved geology related course work:

BIO SCI 1113	General Biology
BIO SCI 1213	Principles of Biology
BIO SCI 2233	Evolution
BIO SCI 2263	Ecology
ENV ENG 3603	Chemical Fundamentals Of Environmental Engineering
ENV ENG 5630	Remediation of Contaminated Groundwater And Soil
ENV ENG 5605	Environmental Systems Modeling
GEO ENG 3175	Geomorphology And Terrain Analysis
GEO ENG 4115	Statistical Methods in Geology and Engineering
MIN ENG 3913	Mineral Identification and Exploration
MIN ENG 3812	Statics And Mechanics Of Rock Materials
MIN ENG 4522	Ore Reserve Analysis And Geostatistics
MIN ENG 4823	Rock Mechanics
PET ENG 3330	Well Logging
PET ENG 4311	Reservoir Characterization

PET ENG 4720	Mechanical Earth Modeling
--------------	---------------------------

**Neil L Anderson**, Professor<sup>1,2</sup>  
PHD University of Calgary

**David L Bridges**, Adjunct Professor  
PHD University of Missouri-Rolla

**Stephen Shangxing Gao**, Professor  
PHD University of California-Los Angeles

**John Patrick Hogan**, Associate Professor  
PHD Virginia Polytechnic Institute

**Kelly Hong Liu**, Professor  
PHD University of California-Los Angeles

**Marek Locmelis**, Assistant Professor  
PHD Marquarie University, Sydney

**Francisca Oboh Ikuenobe**, Professor<sup>2</sup>  
PHD Cambridge University

**Jonathan Obrist Farner**, Assistant Professor  
PHD Missouri University of Science and Technology

**Cheryl M Seeger**, Lecturer<sup>2</sup>  
PHD University of Missouri-Rolla

**James E Vandike**, Lecturer  
MASTER South Dakota School of Mines & Technology

**Emitt Cleveland Witt**, Adjunct Assistant Professor  
PHD Missouri University of Science & Technology

**David J Wronkiewicz**, Associate Professor  
PHD New Mexico Institute of Mining & Technology

**Wan Yang**, Associate Professor  
PHD University of Texas at Austin

### ***GEOLOGY 1110 Physical And Environmental Geology*** (LEC 3.0)

Materials, structure, and surface features of the Earth and planets are studied in the context of the processes that continuously transform the Earth and affect management of Earth resources, hazards, engineering problems, and environmental challenges. Prerequisite: Entrance requirements. (Co-listed with Geo Eng 1150).

### ***GEOLOGY 1111 Introduction to Physical Geology*** (LAB 1.0 and LEC 2.0)

A study of Earth materials, surface features, internal structures and processes. Particular attention is paid to Earth resources, geological hazards, engineering and environmental problems. Prerequisite: Entrance requirements.

### ***GEOLOGY 1119 Physical and Environmental Geology Laboratory*** (LAB 1.0)

Geology 1119 is designed to accompany Geology 1110 and consists of laboratory explorations of the study of common rocks and minerals, air photographs, maps, and case studies of geological problems related to management of Earth resources, hazards, and environmental challenges. (Co-listed with Geo Eng 1119). Prerequisite: Preceded or accompanied by Geology 1110.

**GEOLOGY 1120 Evolution Of The Earth** (LEC 3.0)

A survey of the Earth history from the coalescence of the solar system to the present and the events that have profoundly transformed the planet in the context of the dynamic feedback between physical and biological systems. A one day field trip is required. Prerequisites: Recommend Geo Eng 1150 or Geology 1110 or Bio Sci 1113 but not required.

**GEOLOGY 1129 Evolution of the Earth Laboratory** (LAB 1.0)

Geology 1129 is designed to accompany Geology 1120 and consists of laboratory explorations of fundamental concepts in geology and the diversity of the fossil record. Prerequisite: Preceded or accompanied by Geology 1120.

**GEOLOGY 1141 Physical Oceanography** (LEC 3.0)

An introduction to the study of the physical and geological processes in the world's oceans including the importance of the oceans to the environment and to life on Earth. Prerequisites: GEOLOGY 1110 or GEOLOGY 1120 or equivalent.

**GEOLOGY 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEOLOGY 2096 Field Geology** (LEC 3.0)

Theory and practice in the qualitative and quantitative description of spatial relationships of major rock types, contacts, and structures through construction of geologic maps. Emphasis on developing fundamental field skills, including logistical planning, navigation, data collection and documentation, and professional protocol during site visits. Students will be charged a fee to cover the cost of field trip expenses. Prerequisites: GEOLOGY 1111, 1110, 1119, & 1129.

**GEOLOGY 2610 Mineralogy And Crystallography** (LEC 3.0 and LAB 1.0)

An introduction to the study of minerals, including their systematic classification, crystallography, morphology, chemistry, societal use, geologic occurrence, environmental application and impact, and identification by means of their physical and chemical properties. Prerequisites: Chem 1310 and Chem 1319.

**GEOLOGY 2611 Physical Mineralogy And Petrology** (LEC 2.0 and LAB 1.0)

An introduction to the study of physical mineralogy and petrology, overviewing systematic determination of minerals and rocks by means of their physical properties. Includes the recognition of crystal forms and field relationships of rocks. Course designed for non-geology majors, credit will not count towards a geology-geophysics degree. Prerequisites: Chem 1310 and Chem 1319 or Chem 1351; Geo Eng 1150 or Geology 1110.

**GEOLOGY 2620 Igneous And Metamorphic Petrology** (LEC 3.0 and LAB 1.0)

A comprehensive study of megascopic and microscopic characteristics of igneous and metamorphic rocks. Fundamental theories for their origin are presented. The class includes a trip to examine these rock types in the field. Prerequisite: Geology 2610.

**GEOLOGY 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GEOLOGY 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEOLOGY 3310 Structural Geology** (LEC 3.0)

Students will develop of an appreciation for the geometrical beauty of geologic structures through an understanding of crustal deformation at scales from mineral lattices to tectonic plates. Field trip fee required. Prerequisites: GEOLOGY 1110 or GEO ENG 1111.

**GEOLOGY 3319 Structural Geology Lab** (LAB 1.0)

This course reinforces the principles of Structural Geology through detailed analysis of rock deformation. Techniques will include using a geologic compass, preparing rock descriptions, stereographic analysis, interpretation of geologic maps, construction of cross-sections, and orthographic projections to solve scientific and engineering problems. Prerequisites: Preceded or accompanied by GEOLOGY 3310.

**GEOLOGY 3410 Introduction To Geochemistry** (LEC 3.0)

Application of basic chemical principals towards investigations of element distributions in geologic systems. Emphasis on origin of elements in our Solar System, element distribution during planetary formation, phase equilibria, rock-water interactions, thermodynamic principles, environmental and isotope geochemistry. Prerequisite: Chem 1310.

**GEOLOGY 3511 Introduction to Mineral Deposits** (LEC 3.0)

Basic processes involved in the formation of metallic and industrial mineral deposits illustrated by typical examples of deposits from throughout the world. Exploration and economic factors in mineral exploration and development are reviewed. Prerequisites: Geology 1110 and Geology 2610.

**GEOLOGY 3620 Stratigraphy And Sedimentation** (LEC 3.0)

Principles of physical stratigraphy, bio-stratigraphy and introductory sedimentation. Introduction to depositional systems, facies, unconformities, stratigraphic nomenclature and correlation. One field trip at student expense is required. Prerequisite: Geology 2620 or Geology 2611.

**GEOLOGY 3629 Stratigraphy Lab** (LAB 1.0)

This course re-enforces the principles of stratigraphy and sedimentation through the use of "hands-on" laboratory procedures such as sieve and pipette analyses, correlation problems, fence diagrams and stratigraphic maps. One field trip at student expense is required. Prerequisite: Concurrent with Geology 3620.

**GEOLOGY 3631 Systematic Paleontology** (LAB 1.0 and LEC 2.0)

Introduction to paleontological principles, biostratigraphy, paleoenvironments, and the study of fossil invertebrates, microfossils, plants and palynology. Emphasis of the course is on fossil morphology, classification, and environmental relationships. Prerequisite: Geology 1110 or Geology 1120 or Bio Sci 1113.

**GEOLOGY 3811 Fundamentals Of Geographic Information Systems** (LEC 2.0 and LAB 1.0)

Introduction to the fundamental concepts and components of Geographic Information Systems. Techniques for acquiring, manipulating and analyzing digital terrain data for geological and geotechnical applications. (Co-listed with Geo Eng 3148).

**GEOLOGY 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GEOLOGY 4001 Special Topics** (LAB 1.0 and LEC 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEOLOGY 4010 Seminar** (RSD 0.0-6.0)

Discussion of current topics. Required for two semesters during senior year. (Course cannot be used for graduate credit). Prerequisite: Senior standing.



**GEOLOGY 4085 Internship** (IND 3.0)

Students will select, with the advice of their advisor, appropriate problems for investigation through practical application of fundamental geoscience principles. The problems selected must provide higher level experiential learning. Assessment is based upon the quality of written and oral presentations and supervisor's evaluation. Prerequisite: Advisor's approval.

**GEOLOGY 4097 Advanced Field Geology** (LEC 3.0)

Advanced instruction in theory and practice of qualitative and quantitative description of spatial relationships of rock types in areas exhibiting complex deformation. Emphasis on experiential learning where students plan, implement, and reflect on outcomes for several scientific field campaigns in a manner consistent with professional scientific practices. Students will be charged a fee to cover the cost of field trip expenses. Prerequisites: GEOLOGY 2610, 2620, 3310, 3620, 3629, and 2096.

**GEOLOGY 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**GEOLOGY 4211 Electrical Methods In Geophysics** (LEC 3.0)

The theory and instrumentation for measurements of the electrical properties of the earth. Includes passive and active techniques, the advantages and disadvantages of the various techniques, and geologic interpretations of electrical soundings. Several weekends are spent making a variety of electrical surveys of local features. Prerequisites: Math 5325 and Geophysics 3221.

**GEOLOGY 4310 Remote Sensing Technology** (LAB 1.0 and LEC 2.0)

Principles of digital image processing including image enhancement and multispectral classification. Emphasis upon design and implementation of remote sensing systems and analysis of remotely sensed data for geotechnical and environmental investigations. Prerequisite: Geo Eng 3148. (Co-listed with Geo Eng 5144).

**GEOLOGY 4411 Hydrogeology** (LEC 3.0)

This course discusses geologic aspects of major surface and subsurface hydrologic systems of North America. Chemical and physical relationships between groundwater and fractures, faults, karst, subsurface pressures, mineral deposits plus both contaminant and hydrocarbon migration are discussed. Prerequisites: Geo Eng 1150 or Geology 1110, Geology 3620 recommended.

**GEOLOGY 4421 Radioactive Waste Management And Remediation** (LEC 3.0)

Sources and classes of radioactive waste, long-term decay, spent fuel storage, transport, disposal options, regulatory control, materials issues, site selection and geologic characterization, containment, design and monitoring requirements, domestic and foreign waste disposal programs, economic and environmental issues; history of disposal actions, and conduct of remedial actions and cleanup. Prerequisite: Math 3304. (Co-listed with Nuc Eng 4367).

**GEOLOGY 4431 Methods Of Karst Hydrogeology** (LEC 3.0)

Familiarize geoscientists with the origin and identification of karst features, discuss groundwater movement, engineering problems, water quality and supply in karst areas, and teach investigative techniques including fluorescent dye tracing. Several field trips at student expense will be required. Prerequisite: Geology 1110 or Geo Eng 1150; Geology 3620.

**GEOLOGY 4441 Applied Geochemistry** (LEC 2.0 and LAB 1.0)

Application of the principles of geochemistry and techniques of geochemical analysis in a student research project investigating geochemical processes (mineral deposits, environmental geochemistry, trace element migration, or water-rock interaction). Field trip fee required. Prerequisites: Geology 2610 and Geology 3410.

**GEOLOGY 4451 Aqueous Geochemistry** (LEC 3.0)

Studies of the interaction of water with minerals and organic materials at low temperatures; including processes affecting the migration of elements (alteration, precipitation, and adsorption), the influence of geochemical processes on water composition, weathering, soil formation, and pollution. Field trip fee required. Prerequisite: Geology 3410.

**GEOLOGY 4461 Isotope Geochemistry** (LEC 2.0 and LAB 1.0)

Introduction to the fundamentals of radiogenic and stable isotopes as used to understand geologic processes. The use of selected isotopic systems in petrology, ore petrogenesis, paleontology, and the global climate systems will be discussed. Prerequisites: Geology 2620, 3620, 3410.

**GEOLOGY 4521 Ore Microscopy** (LAB 2.0 and LEC 1.0)

A study of polished sections of minerals and ores under reflected light. Includes the preparation of polished sections, the identification of ore minerals, and the study of the textures, associations, and alterations of ore minerals. Prerequisite: Geology 2610.

**GEOLOGY 4631 Advanced Igneous and Metamorphic Petrology** (LAB 1.0 and LEC 3.0)

Processes governing the formation of igneous and metamorphic rocks as constrained by geochemical, isotopic, and thermodynamic data, with particular reference to the relationship between rock suites and tectonic setting. The laboratory will emphasize the description of rock suites in hand sample and thin section. A field trip at the student's expense is required. Prerequisite: Geology 2620.

**GEOLOGY 4711 Paleoclimatology and Paleocology** (LEC 3.0)

This course will introduce students to the elements of climate, evidence of climate changes, proxy measurements and paleoclimate models. There is a review of Holocene climates and Archean to Pleistocene paleoclimates. Prerequisite: Geology 1110 or Geology 1120 or Geo Eng 1150.

**GEOLOGY 4721 Meteorology and Climatology** (LEC 3.0)

An introduction to the atmospheric and climatic systems of the Earth including weather, paleoclimatology, and global climate change. Prerequisites: GEOLOGY 1110 or GEOLOGY 1120 or equivalent.

**GEOLOGY 4731 Astronomy and Planetary Science** (LEC 3.0)

Basic principles of astronomy, the origin and evolution of the universe, stellar evolution, and the origin, composition, and processes operating on the planetary bodies in the solar system (besides the Earth). Prerequisite: Entrance requirements for the MST program in Earth Science.

**GEOLOGY 4821 Applications Of Geographic Information Systems** (LAB 1.0 and LEC 2.0)

Applications of Geographical Information Systems and remote sensing to environmental monitoring, mineral resource exploration, and geotechnical site evaluation. Prerequisite: Geo Eng 31+D151275 or consent of instructor. (Co-listed with Geo Eng 5146).

**GEOLOGY 4831 Computational Geology** (LEC 2.0 and LAB 1.0)

This course introduces the technology used for both surface and subsurface geologic mapping. It utilizes common systems and programs such as UNIX, Windows and industry-standard mapping applications. The goal of the course is to fully prepare students for their first professional assignment. Prerequisites: Geology 1110 or Geology 1120 or Geo Eng 1150.

**GEOLOGY 4841 Geological Field Studies** (LEC 3.0)

Intensive review of the scientific literature corresponding to a selected geographical region of geologic interest; followed by a 7 to 10 day long field trip to be held over spring break or after the end of the semester. Students will be expected to bear a portion of the field trip expenses. Repeatable for credit. Prerequisites: Geology 1110 or Geo Eng 1150.

**GEOLOGY 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GEOLOGY 5001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEOLOGY 5010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

**GEOLOGY 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**GEOLOGY 5085 Internship** (IND 3.0)

Students will select, with their committee's advice, problems for investigation and preparation of a graduate research proposal. Problems must provide higher level experiential learning consistent with a graduate degree in geology. Assessment is based upon the quality of written and oral presentations and supervisor's evaluation. Repeatable for credit. Prerequisite: Graduate Standing.

**GEOLOGY 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation.

**GEOLOGY 5111 Advanced Physical Geology** (LEC 3.0)

Examination of topics concerned with the physical properties of earth materials, processes affecting change of the surface and interior of the earth, and the driving forces causing these changes. Weekly critical assessment of literature, and an oral presentation and term paper required. Prerequisite: Consent of instructor.

**GEOLOGY 5121 Advanced Historical Geology** (LEC 2.0 and LAB 1.0)

Study of the physical and biological history of the Earth beginning with the origin of the solar system up to the present. Emphasis will be placed on processes that shaped the Earth and its ecosystems. Prerequisite: Entrance requirements for the MST program in Earth Science.

**GEOLOGY 5311 Depositional Systems** (LEC 3.0)

Development of three dimensional depositional models using Walther's Law, Walther's Warning and seismic stratigraphy. Emphasis on overall geometries and internal porosity and permeability characteristics of aquifers and hydrocarbon reservoirs. Includes 3-D models for clastic, carbonate and evaporate sequences. Prerequisites: Geology 1110 or Geo Eng 1150; accompanied or preceded by both Geology 3310 and Geology 3620.

**GEOLOGY 5411 Advanced Geochemistry** (LEC 3.0)

A study of the absolute and relative abundance of elements and isotopes in the Earth, principles of element transport, formation of the Earth's crust, mineral deposits, and soils. Field trip fee required. Prerequisite: Geology 3410.

**GEOLOGY 5511 Applied Petroleum Geology** (LEC 1.0 and LAB 2.0)

The principles of petroleum geology are applied in solving hydrocarbon exploration and developmental problems. Geological and economical techniques for evaluating hydrocarbonbearing reservoirs are presented, with methods for decisionmaking under conditions of extreme uncertainty. Prerequisite: Geology 5411.

**GEOLOGY 5513 Petroleum Geology** (LEC 2.0 and LAB 1.0)

Principles of origin, migration, and accumulation of oil and gas. The laboratory introduces the procedures used for exploration, and development of hydrocarbon resources. Prerequisites: Geology 1110 or Geo Eng 1150; accompanied or preceded by both Geology 3310 and Geology 3620.

**GEOLOGY 5521 Coal Petrology** (LEC 3.0)

Formation, composition, and properties of coals. Discussion of the geology of selected coal deposits, the analysis of coal, and the optical identification of coal minerals. Prerequisite: Permission of instructor.

**GEOLOGY 5611 Granites And Rhyolites** (LAB 1.0 and LEC 3.0)

Processes governing the generation and crystallization of felsic magma will be covered, with specific reference to: 1) crust vs mantle sources, 2) melt migration and emplacement, 3) magma chamber dynamics, 4) the volcanic-plutonic connection, and 5) the relationship to tectonic setting. A field trip at the student's expense is required. Prerequisite: Geology 2620.

**GEOLOGY 5631 Carbonate Petrology** (LEC 2.0 and LAB 1.0)

Petrology, chemistry and sedimentology of carbonates and other associated chemical sedimentary rocks. Prerequisites: GEOLOGY 2620, 3620 and CHEM 1320 or equivalent; GEOLOGY 3410 recommended.

**GEOLOGY 5641 Advanced Igneous Petrology** (LEC 2.0 and LAB 1.0)

The genesis of eruptive rocks as evidenced by the physico-chemical conditions of formation of their constituent minerals. A critical examination of various magmatic processes. Use of advanced petrographic techniques. Prerequisites: GEOLOGY 4631.

**GEOLOGY 5661 Advanced Stratigraphy and Basin Evolution** (LEC 3.0)

Advanced topics in sedimentary geology including: tectonic controls on sedimentary basin development, global sequence stratigraphy, regional facies and diagenetic patterns, basin hydrogeology, thermal evolution of basins and distribution of economic resources. This course should be preceded or accompanied by Geology 3410. Prerequisites: Geology 3620 and Geology 3310.

**GEOLOGY 5671 Clay Mineralogy** (LEC 2.0 and LAB 1.0)

Mineral structure, geochemical properties, occurrence, environment, and uses of clays. Determination of physical properties, optics, x-ray diffraction, and thermal features of clays. Field trip fee required. Prerequisites: Geology 2610 and 3410, or Chem 2310, or Civ Eng 5715, or Geo Eng 5172.

**GEOLOGY 5679 Field and Laboratory Studies in Earth Science** (LAB 3.0)

Hands-on laboratory and field experiences in the Earth Sciences. This course is designed to be taught in an intensive three week session during the summer on the S&T campus. Prerequisites: GEOLOGY 2096 or 5121 or equivalents.

**GEOLOGY 5681 Lidar Principles and Application** (LEC 3.0)

Provides a comprehensive understanding of light detection and ranging (lidar) technology as it has been developed for commercial use; various methods of deploying technology for collection of data for mapping, engineering and science, and application of the data using specialized software for editing and processing point cloud data. Assumes GIS experience. Prerequisite: Senior or graduate standing.

**GEOLOGY 5741 Micropaleontology** (LEC 2.0 and LAB 1.0)

This course studies the fossil and soft-body characteristics of bacteria, protists, microinvertebrates and organic-walled microfossils (palynomorphs). Focused discussions on systematics, evolutionary histories, paleoecology, and geologic applications of the microfossil groups. Extraction of foraminifera and palynomorphs from rocks in lab. Prerequisite: Geology 3631.

**GEOPHYS 2211 Geophysical Imaging** (LEC 2.0 and LAB 1.0)

A study of the major geophysical methods applicable to shallow engineering and environmental geoscience. Topics include the background theory and practical application of gravity, magnetics, radiometrics, resistivity, induced polarization, spontaneous potential, reflection and refraction seismics, ground penetrating radar, electromagnetics, and borehole logging methods. Prerequisites: Physics 2135; Geo Eng 1150 or Geology 1110.

**GEOPHYS 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course.

**GEOPHYS 3210 Introduction to Geophysics** (LEC 3.0)

An introduction to a broad area of solid earth geophysics and exploration geophysics. Topics include plate tectonics, earthquake study, structure and dynamics of the Earth's deep interior, gravity, magnetism, heat flow, and geophysical exploration for natural resources. Prerequisites: Math 1208 and Geology 1110.

**GEOPHYS 3211 Introduction To Geophysical Data Analysis** (LEC 3.0)

The application of time series and spatial series analysis techniques to geophysical data. Topics covered include digitization and aliasing of geophysical signals, frequency and wavenumber spectra, digital filtering and linear systems theory. Prerequisites: Math 2222 and Comp Sci 1570, 1970 & 1980, or 1971 & 1981.

**GEOPHYS 3221 Potential Field Theory** (LEC 3.0)

The mathematics and physics of gravitational, magnetic, and electrical fields of the earth as derived from potential functions, with applications to practical problems. The theorems of Laplace, Poisson, Gauss, and Green and their applications to geophysics are presented. Prerequisite: Accompanied or preceded by Math 5325.

**GEOPHYS 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GEOPHYS 4001 Special Topics** (LEC 2.0 and LAB 1.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEOPHYS 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**GEOPHYS 4231 Seismic Interpretation** (LEC 2.0 and LAB 1.0)

An introduction to 2-D/3-D seismic structural interpretation, stratigraphic interpretation, reservoir identification and evaluation, and horizon and formation attributes. The students are expected to master interactive 2-D/3-D seismic interpretation software packages that are routinely used in the petroleum industry. Prerequisites: Math 1208 or Math 1214; Geology 1110 or Geo Eng 1150.

**GEOPHYS 4241 Electrical Methods In Geophysics** (LEC 2.0 and LAB 1.0)

The theory and instrumentation for measurements of the electrical properties of the earth. Includes passive and active techniques, the advantages and disadvantages of the various techniques, and geologic interpretations of electrical soundings. Several weekends are spent making a variety of electrical surveys of local features. Prerequisites: Math 5325 and Geophys 2211 or Geophys 3251.

**GEOPHYS 4261 Geophysical Instrumentation** (LAB 1.0)

Field and laboratory practice in the use of geophysical instrumentation. Techniques of geophysical data reduction and interpretation are also covered. May be taken more than once for credit with Geophys 4241 and Geophys 384. Prerequisite: Concurrent registration in Geophys 3251, 283 or 384.

**GEOPHYS 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GEOPHYS 5001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEOPHYS 5010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

**GEOPHYS 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**GEOPHYS 5096 Global Tectonics** (LEC 3.0)

An integrated view of the Earth's structure and dynamics with an emphasis on information gained through geophysical methods. Topics include seismology, heat flow, gravity, rheological and compositional structure, plate motions and intermotions, and mantle driving mechanisms for plate tectonics. Prerequisite: Geology 3310.

**GEOPHYS 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**GEOPHYS 5202 Exploration and Development Seismology** (LAB 1.0 and LEC 2.0)

Principles of reflection seismology as applied to the delineation of geologic structures and the determination of stratigraphy and lithology. Emphasis on both the capabilities and limitations of the seismic method. The laboratory utilizes both modeled and actual seismic data. Prerequisites: Math 1208 or Math 1214; Geology 1110 or Geo Eng 1150.

**GEOPHYS 5211 Seismic Stratigraphy** (LEC 2.0 and LAB 1.0)

A study of the seismic expression of depositional models. Reflection patterns and reflection amplitudes are interpreted to determine bed thicknesses, fluid content, depositional environment, and lithology. Special data acquisition and processing techniques are examined. Prerequisites: Geophys 4521, Geology 3310, 3620.

**GEOPHYS 5221 Wave Propagation** (LEC 3.0)

A study of Hamilton's principle and energy theorems, fundamentals of plane wave theory, waves in stratified fluids, elastic waves in solids, electromagnetic and hydromagnetic radiation, and Allen's functions and point sources. Prerequisites: Geophys 281, 3221.

**GEOPHYS 5231 Seismic Data Processing** (LAB 1.0 and LEC 2.0)

Introduction to seismic data processing. Topics to be covered include statics corrections, filtering, velocity analysis, deconvolution, stacking and migration. The course has a field component to record seismic data. If this is offered in the summer, an off-campus trip may be needed. Extra fee may be charged to cover the field expenses. Prerequisites: Geophys 3210 or Geophys 5202.

**GEOPHYS 5241 Advanced Electrical And Electromagnetic Methods In Geophysical Exp** (LAB 1.0 and LEC 2.0)

Theory of the electrical geophysical methods as applied to subsurface investigations addressing geologic, engineering, groundwater and contaminant transport problems. Course content includes both passive and active methods and recent advances in the application of these methods. Course will include a field component illustrating application of techniques to local problems. Prerequisites: Geophys 3251, Math 2222.

**GEOPHYS 5261 Computational Geophysics** (LEC 1.0 and LAB 2.0)

Scientific programming in a UNIX/Linux environment, with emphasis on solving geophysical problems such as linear and nonlinear inversion, spectral analysis, seismicity, seismic wave attenuation, shear-wave splitting, and seismic tomography. Prerequisite: Geophys 3210.

**GEOPHYS 5736 Geophysical Field Methods** (LAB 1.0 and LEC 2.0)

Imaging of selected subsurface features and engineering structures using various geophysical tools. Special emphasis is placed on ground penetrating radar and surface wave techniques. One field trip at student expense required. Prerequisite: Junior level standing or higher. (Co-listed with Geo Eng 5736).

**GEOPHYS 5761 Transportation Applications of Geophysics** (LAB 1.0 and LEC 2.0)

Overview of geophysical and non-destructive test methods that are commonly used to investigate transportation structures and their foundations. Emphasis is placed on bridge system substructure, bridge system superstructure, pavement, roadway subsidence, subsurface characterization and vibration measurements. Prerequisite: Junior level standing or higher. (Co-listed with Geo Eng 5761 and Civ Eng 5750).

**GEOPHYS 5782 Environmental and Engineering Geophysics** (LEC 2.0 and LAB 1.0)

An introduction to the theory and application of the gravity, magnetic, resistivity, self-potential, induced polarization and electromagnetic methods as applied to the solution of engineering and environmental problems. Prerequisite: Math 2222. (Co-listed with Geo Eng 5782).

## German

Gerald Leonard Cohen, Professor  
PHD Columbia University

**GERMAN 1101 Elementary German I** (LEC 4.0)

Introduction to grammar, reading, and conversation. Prerequisites: Entrance requirements.

**GERMAN 1102 Elementary German II** (LEC 4.0)

A continuation of German 1101. Prerequisite: German 1101.

**GERMAN 1180 Classical And Modern German Readings** (LEC 4.0)

Readings in German narrative literature. Prerequisite: German 1102.

**GERMAN 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GERMAN 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GERMAN 2110 Basic German Conversation** (LEC 2.0)

Conversation and oral practice. Prerequisite: German 1102.

**GERMAN 2170 Masterpieces Of German Literature** (LEC 3.0)

A study of selected major works and movements in German literature. Prerequisite: German 1180.

**GERMAN 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GERMAN 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GERMAN 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GERMAN 4001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GERMAN 4010 Seminar** (RSD 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

## Global Studies

### Global Studies Minor

Global studies is a multi-disciplinary undergraduate minor program designed to aid in the preparation of Missouri S&T students to be successful in an increasingly global workforce. Students who complete the global studies minor will have an increased awareness of the society, culture, technical issues, and/or language of at least one country other than the United States prior to the completion of their Missouri S&T undergraduate experience. Any Missouri S&T student enrolled in an undergraduate degree program is eligible for the Global Studies minor program, which consists of 12 credit hours from an approved list of classes and at least 2 weeks (14 days) of experience in a foreign country acquired during an approved Missouri S&T class or research project, Missouri S&T extracurricular activity, and/or Missouri S&T study abroad activity.

Courses must be selected from the list of approved courses maintained by the Global Studies Advisory Committee. At least one three hour course must focus on the society, culture, and/or language of a foreign country. Approved courses that meet this criterion are from the arts, languages, humanities, or social sciences. The other nine hours comes from approved courses that include at least 25 percent international studies content. "International studies content" is defined as course



content addressing countries or regions outside of the United States. "International studies content" does not include content that is universal but rather that which addresses specific countries or regions outside of the United States. To satisfy the multi-disciplinary aspect of the minor, no more than six hours may be taken from a single Missouri S&T degree program.

The minor requires personal experience in a foreign country. Students will participate in one or more approved Missouri S&T-sponsored trips to a foreign country for no less than 14 days total. Examples of approved trips include, but are not limited to, those that may be a part of Missouri S&T classes and/or an OURE project-related trip, an extracurricular activity including Missouri S&T's Engineers Without Borders field trips, and/or Missouri S&T sanctioned study abroad. The list of approved activities is maintained by the Global Studies Advisory Committee.

The curricula criteria, including course lists and the list of approved activities for foreign country experience, are maintained by the Global Studies Advisory Committee and are available on the quick links section of the Missouri S&T undergraduate studies website at <http://ugs.mst.edu>.

## History

History is a response to the eternal desire of human beings to know more about themselves. For this reason, history students experience a variety of courses, which emphasize the importance of people, their individual choices, their values and their ways of seeing themselves and their world. History majors study humans' accumulated heritage from the fossil past to the nuclear present.

This varied course of study includes fundamental survey classes, specific chronological or topical investigations, and special topic seminars. At Missouri S&T individuals who hold Ph.D. degrees and are publishing scholars teach virtually all of your history and political science courses. The hallmark of the program is individual attention. In upper-level courses, efforts are made to keep class sizes small enough to enable discussion, which in turn provides for a greater breadth of knowledge and depth of understanding, and for personal student-professor associations.

As a history major you learn to analyze information, communicate effectively, and engage in research. Such skills are useful for careers in government service, business, industry, and social service institutions, as well as being the fundamental requisites for graduate and professional studies beyond the undergraduate degree.

If you plan to become a secondary school history teacher, you can fulfill the general requirements for the bachelor of arts degree, the requirements for the history major, and the requirements for Missouri certification in the teaching of history. See education for further information. Contact the Missouri S&T history department for advising.

A minor in history is an option for non-majors who wish to complement their major field of study. This five-course option allows you to gain a broader perspective on human events and to develop your abilities in historical analysis.

In short, when you study history you not only learn important information and skills but you also are challenged to think, to communicate, and to cope with complexity.

## Bachelor of Arts History

(In addition to general requirements for bachelor of arts degree.)

HISTORY 1790	Introduction to History	1
HISTORY 1300	American History To 1877	3
HISTORY 1310	American History Since 1877	3
HISTORY 2790	Historiography	3
2 American History Electives		6
2 European History Electives		6
3 History Electives		9
Total Credits		31

Note: History majors are also required to complete HISTORY 1100 and HISTORY 1200 as part of the general education requirements for the B.A. In addition, 9 hours of the 31 major hours must be taken at the 3000 or 4000 level.

Note: History majors interested in graduate or professional school should take HISTORY 4097 as independent research under the guidance of a faculty member in a short period (one semester).

Note: History majors must complete an experiential learning requirement. They can meet this requirement by taking HISTORY 4085 or HISTORY 4097 or study abroad, among other options, in consultation with their advisor.

Note: Entering students will normally take ENGLISH 1120 either semester of the first year.

## Secondary Education Emphasis Area

You may earn a B.A. degree in history from Missouri S&T and certification to teach in the schools of Missouri. This program may be completed in four academic years and student teaching is arranged with public schools within 30 miles of the Rolla campus.

Students interested in the certification program should consult with the advisor for history/education majors in the department of history and political science for requirements particular to those interested in this degree. Students should process a change of major form to designate history with an emphasis area of secondary education.

History students must complete 128 credit hours, including the requirements of the teacher education program listed in this catalog. A minimum grade of "C" is required by the department in all history and political science courses counted towards this degree. Students must take the following courses:

<b>Communication Skills: 9 hours</b>		
ENGLISH 1120	Exposition And Argumentation	3
ENGLISH 1160	Writing And Research	3
SP&M S 1185	Principles Of Speech	3
<b>Humanities: 12 hours with at least one course from the first three areas</b>		
Art or Music or Theater Appreciation		
Philosophy		
Literature		
Foreign Language		
ETYM 4306	Introduction To Etymology	3
<b>Social Sciences: 18 hours</b>		
POL SCI 1200	American Government	3
POL SCI 3763	Contemporary Political Thought	3
or POL SCI 3211	American Political Parties	

ECON 1100	Principles Of Microeconomics	3
or ECON 1200	Principles Of Macroeconomics	
PSYCH 1101	General Psychology	3
PSYCH 4600	Social Psychology	3
HISTORY 2110	World Regional Geography	3
<b>Natural Sciences: 7 hours = 2 courses and 1 lab</b>		
One course in Physics or Chemistry or Geology and one course in Biology		
One laboratory in any of the above science courses		
<b>Mathematics: 3 hours</b>		
MATH 1120	College Algebra (or higher)	3-5
or MATH 1103	Fundamentals Of Algebra	
or MATH 1140	College Algebra	
<b>Clinical Experience: 16 hours</b>		
EDUC 1104	Teacher Field Experience	2
EDUC 1164	Aiding Elementary, Middle And Secondary Schools	2
EDUC 4299	Student Teaching	12
<b>Professional Requirements: 26 hours</b>		
EDUC 1040	Perspectives In Education	2
EDUC 1174	School Organization & Adm For Elementary & Secondary Teachers	2
ENGLISH 3170	Teaching And Supervising Reading and Writing	3
EDUC 3216	Teaching Reading in Content Area	3
EDUC 3280	Teaching Methods And Skills In The Content Areas	6
EDUC 4298	Student Teaching Seminar	1
PSYCH 2300/ EDUC 2102	Educational Psychology	3
PSYCH 4310/ EDUC 4310	Psychology Of The Exceptional Child	3
PSYCH 3310	Developmental Psychology	3
<b>History Requirements: 37 hours</b>		
HISTORY 1790	Introduction to History	1
HISTORY 1100	Early Western Civilization	3
HISTORY 1200	Modern Western Civilization	3
HISTORY 1300	American History To 1877	3
HISTORY 1310	American History Since 1877	3
HISTORY 2790	Historiography	3
American History Electives		6
European History Electives		6
History Electives		9

## Bachelor of Science History

Students must take a minimum of 120 hours for a Bachelor of Science degree in history, and obtain a grade point average of 2.0. These requirements for the B.S. are in addition to credit received for basic ROTC.

The B.S. in history requires the following:

1. ENGLISH 1120 (entering students will normally take ENGLISH 1120 within their first year of study) and one other writing intensive course outside their major, which may include ENGLISH 1160, ENGLISH 1170, or ENGLISH 3560. (6 hours)

2. Math and Sciences. The general requirements for a B.S. call for at least 18 hours in biological, physical (chemistry, geology, physics), and mathematical (mathematics, statistics, computer science, and information science and technology) sciences. The B.S. in history requires at least one course from each of the biological and physical sciences, one lab, and at least one math course at the level of college algebra or higher. In addition to these requirements, students may count STAT 1115, up to 3 hours from psychology classes (PSYCH 2200 preferred), and up to 3 hours from history of science and technology

classes (HISTORY 2510, HISTORY 3510, or HISTORY 2530), but may not use them to satisfy another requirement. (18 hours)

3. Humanities. Students must take 12 hours in humanities other than history with at least one course from literature, philosophy, and fine arts (Art, Music, or Theater Appreciation). Students may take courses in language and humanities other than history to meet the 12 hours requirement. (12 hours)

4. Social Sciences. Students must take 12 hours in social sciences. Students must take POL SCI 1200 and at least one course in two from the three areas: economics, political science, and psychology. At the discretion of the major adviser, students may transfer up to 3 hours of Sociology to meet the 12 hours requirement. (12 hours)

5. History. Students must take 37 hours in required history courses, including HISTORY 1790, HISTORY 1100, HISTORY 1200, HISTORY 1300, HISTORY 1310, and HISTORY 2790 (16 hours) and at least 21 hours in history electives, including at least 6 hours in American history and at least 6 hours in European history. Nine of these 21 hours of history electives must be at or above the 3000 level. The student must earn a grade of C or better in these required courses. (37 hours)

6. Electives Credit. Each student will elect sufficient additional courses to complete a minimum of 120 credit hours, which may include up to 12 hours in engineering courses at the discretion of the major adviser. At least 9 hours of these electives must be at the 3000 or above level, although substitutions may be permitted at the discretion of the major adviser. All electives must accumulate to at least a 2.0 grade point average.

## History Minor Curriculum

The history/political science department offers a minor in history. To qualify, all students must take 15 hours of course work in history to include:

HISTORY 1100	Early Western Civilization	3
or HISTORY 1200	Modern Western Civilization	
HISTORY 1300	American History To 1877	3
or HISTORY 1310	American History Since 1877	

An additional 9 hours of an approved sequence of 2000 or higher level courses.

9

## Science, Technology and Humanity Minor

The science, technology and humanity (STH) minor is designed for students who want to explore the relationship between history, political science, and science and technology. The minor is particularly useful for technologically oriented students, because it provides insight into humanities and social science disciplines. It also shows how these disciplines interact with science and technology, thereby broadening their horizon of thought and action and preparing them for an increasingly technologically oriented future. To minor in STH the student must complete one of the following history survey courses: HISTORY 1100 or HISTORY 1200 or HISTORY 1300 or HISTORY 1310; and POL SCI 1200. The student then must take either HISTORY 2510 or HISTORY 3530. After completing the required six hours, the student will select nine additional hours from the list below.

### 15 credit hours total.

Students must take one of the following:

HISTORY 1100	Early Western Civilization	3
HISTORY 1200	Modern Western Civilization	3
HISTORY 1300	American History To 1877	3

HISTORY 1310	American History Since 1877	3
POL SCI 1200	American Government	3
<b>Students must take one of the following:</b>		3
HISTORY 2510	History of Technology	3
HISTORY 3530	History of Science	3
<b>Student must take three of the following as approved by minor advisor:</b>		9
BIO SCI 1163	Biotechnology in Film	3
BIO SCI 2263	Ecology	3
ECON 4540	Energy Economics	3
ECON 4820	Labor Economics	3
ENG MGT 4330/ PSYCH 4710	Human Factors	3
ENGLISH 2243	Science Fiction And Fantasy Literature	3
ENV ENG 5640	Environmental Law And Regulations	3
GEO ENG 1175	Geological Engineering in Popular Media	3
HISTORY 2510	History of Technology	3
HISTORY 3510	Twentieth Century Technology And Society	3
HISTORY 3530	History of Science	3
HISTORY 3443	The American Military Experience	3
HISTORY 4470	American Environmental History	3
HISTORY 4550	Architecture, Technology and Society; 1750 to Present	3
IS&T 5251	Technological Innovation Management and Leadership	3
IS&T 5885	Human-Computer Interaction	3
PHILOS 3223	Bioethics	3
PHILOS 3225	Engineering Ethics	3
PHILOS 4320	Minds And Machines	3
PHILOS 4345	Philosophy Of Science	3
PHILOS 4350	Environmental Ethics	3
POL SCI 3300	Principles Of Public Policy	3
PSYCH 4700	Industrial Psychology	3
PSYCH 4710	Human Factors	3
PSYCH 4720	Human-Computer Interaction	3
TCH COM 5610	History of Technical Communication	3

**Diana L Ahmad**, Curators Distinguished Teaching Professor  
PHD University of Missouri-Columbia

**Mike W Beattie**, Lecturer  
MA Missouri State University

**Michael W. Bruening**, Associate Professor  
PHD University of Arizona

**David E Croft**, Lecturer  
MA Lincoln University

**Petra DeWitt**, Assistant Professor  
PHD University of Missouri-Columbia

**Shannon L Fogg**, Professor  
PHD University of Iowa

**Larry Dale Gragg**, Curators Distinguished Teaching Professor  
PHD University of Missouri-Columbia

**Patrick J Huber**, Professor  
PHD University of North Carolina

**John C McManus**, Curators Distinguished Professor  
PHD University of Tennessee

**Jennifer L Rivera**, Lecturer  
MA Webster University

**Jeffrey W. Schramm**, Associate Professor  
PHD Lehigh University

**Kathleen Lynn Sheppard**, Assistant Professor  
PHD University of Oklahoma

**HISTORY 1100 Early Western Civilization** (LEC 3.0)  
Growth and development of ideas and institutions of western culture from prehistoric man to the voyages of discovery.

**HISTORY 1200 Modern Western Civilization** (LEC 3.0)  
A continuation of History 1100 to the present with special emphasis on the philosophical, political, social, and economic backgrounds of modern society.

**HISTORY 1300 American History To 1877** (LEC 3.0)  
Survey of the history of the American colonies and United States from colonial times through Reconstruction.

**HISTORY 1310 American History Since 1877** (LEC 3.0)  
Survey of the history of America since Reconstruction.

**HISTORY 1790 Introduction to History** (LEC 1.0)  
This required course for history majors will introduce them to the study of history, the various fields of history, and the current faculty. The course will also introduce students to the research methods of historians.

**HISTORY 2000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**HISTORY 2001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**HISTORY 2110 World Regional Geography** (LEC 3.0)  
An introduction to the distinguishing cultural and physical characteristics of the major regions of the world. Emphasis on the political problems within the regions and the contemporary issues involved.

**HISTORY 2210 European Diplomatic History 1814 - Present** (LEC 3.0)  
A survey of European Diplomatic History beginning with The Congress of Vienna to the present, including the Congress system, the Eastern Question, the shift to realpolitik, the diplomatic origins and concluding conferences of the World Wars and Cold War diplomacy. Prerequisite: History 1200.

**HISTORY 2220 Making Of Modern Britain** (LEC 3.0)  
A survey of modern Britain from the era of Restoration and Glorious Revolution (1660-1689) to the present. Major themes include the social, intellectual, cultural, political and economic aspects of modern and contemporary Britain. Prerequisite: History 1200.

**HISTORY 2221 Making of Modern Germany** (LEC 3.0)  
A survey of modern Germany from 1815 through the present. Major themes include social, intellectual, cultural, political, and economic aspects of modern and contemporary Germany, with emphasis on developments during the twentieth century. Prerequisite: History 1200 or History 1300 or History 1310.

**HISTORY 2222 The Making Of Modern France** (LEC 3.0)  
A survey of modern France from the era of Louis XIV (1660-1715) to the present. Major themes include the social, intellectual, cultural, political and economic aspects of modern and contemporary France. Prerequisite: History 1200.

**HISTORY 2224 Making Of Modern Russia** (LEC 3.0)

A survey of modern Russia from the era of "Westernization" and Peter the Great (1660-1725) to the present. Major themes include the social, intellectual, cultural, political and economic aspects of modern and contemporary Russia, with emphasis on the Soviet period. Prerequisite: History 1200.

**HISTORY 2430 History of the American Pacific** (LEC 3.0)

This course examines United States expansion into the Pacific as an extension of 19th century Manifest Destiny. Emphasizing American Pacific possessions, the course includes a historical, political, geographical, and cultural look at the islands from 1800 to the present. Prerequisite: History 1300 or History 1310 or History 1200.

**HISTORY 2510 History of Technology** (LEC 3.0)

Technological achievements from prehistoric times to present; topics include agriculture, building and construction, communications, transportation, power sources, the Industrial Revolution, relationships between science and technology, factors in invention and innovation and sociocultural effects. Prerequisite: History 1100 or 1200 or 1300 or 1310.

**HISTORY 2790 Historiography** (LEC 3.0)

Historical interpretation from Herodotus to the present. Emphasis will be placed on reading the works of prominent historians in analyzing the major developments in historical writing. Familiarization with historical source material will be another feature of this course. Serves as capstone course. Prerequisite: Sophomore standing.

**HISTORY 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**HISTORY 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**HISTORY 3010 Seminar** (IND 0.0-6.0)

Discussion of current topics.

**HISTORY 3120 Ancient Greece** (LEC 3.0)

Aegean and Greek Civilization from Homeric times to the Roman Conquest of the Hellenic World. Designed for the student who wishes to understand the fundamental conditions of classical life and to comprehend the ideas that inspired action. Emphasis will be on social, intellectual, political and religious aspects of the classical world. Prerequisite: History 1100.

**HISTORY 3125 Ancient Rome** (LEC 3.0)

Rome 509 B.C. to 337 A.D. The Roman world from the founding of the Republic through the reign of Constantine. Special emphasis is on the transformation of classical culture during the Republic and Imperial age. Prerequisite: History 1100.

**HISTORY 3130 Medieval History I** (LEC 3.0)

The Early Middle Ages, 284 A.D.-753 A.D., transition from ancient to Medieval civilization. The fundamental differences between Roman and Medieval ideas, institutions and life. The triumph of Christianity, the conditions which made this triumph possible and its role in the development of Western Europe. Prerequisite: History 1100.

**HISTORY 3135 Medieval History II** (LEC 3.0)

Medieval Civilization, 11th-13th centuries. The transition from Medieval to Modern world, developments in the political, social and economic institutions of the Medieval world and their enduring effect on Western European Civilization, conflict of faith and reason during this period. Prerequisite: History 1100.

**HISTORY 3140 History Of Renaissance Thought** (LEC 3.0)

Concentrates on the political, religious, and social thought of the Renaissance. Particular emphasis on the revival of the classics, the spread of humanistic values, and reform efforts during the period with relationship to the material basis of society. Prerequisite: History 1100 or 1200.

**HISTORY 3150 Tudor and Stuart England** (LEC 3.0)

A study of England 1485 - 1689 covering the social, political, religious, and cultural developments. Prerequisite: History 1100 or History 1200.

**HISTORY 3230 Europe In The Age Of The French Revolution And Napoleon** (LEC 3.0)

An in-depth examination of the causes, courses and results of the French Revolution and the Napoleonic Era (1789-1815). The impact of the age of the French Imperium upon European economic, diplomatic, intellectual, political and social development. Prerequisite: History 1200.

**HISTORY 3235 Foundations Of Contemporary Europe 1815-1914** (LEC 3.0)

Europe after Napoleon, development of democracy and nationalism, revolutionary movements and leaders, unification of Italy and Germany, national developments of the major powers and the road to the First World War are the bases of this course. Prerequisite: History 1200.

**HISTORY 3240 Contemporary Europe** (LEC 3.0)

First World War, the Versailles Peace Settlement and its aftermath, the Soviet, Fascist and Nazi revolutions and regimes, Western culture between the wars, the Second World War, the age of the atom and Cold War. Prerequisite: History 1200 or History 1310.

**HISTORY 3280 European Migrations and Nationalism Formation** (LEC 3.0)

Analyzes migration patterns into, out of, and within Europe in context of global population movements from Roman Empire through the present. Students will learn to analyze and synthesize factors involved in these movements and correlations to personal and national identity formations. Prerequisites: History 1200 or History 1300 or History 1310.

**HISTORY 3320 Colonial America** (LEC 3.0)

Political and social trends in America to 1754. Emphasis placed upon native American culture, Spain and France in America, population trends, family, religion, class structure, economic change, social conflict, and the development of individualism in early America. Prerequisite: History 1300.

**HISTORY 3321 Religion And Witchcraft In Early America** (LEC 3.0)

An examination of the role of occult ideas and practices in the religious life of early Americans. Emphasis placed upon Puritan beliefs which contributed to seventeenth century effort to eradicate witchcraft. Prerequisite: History 1300 or History 1200.

**HISTORY 3325 Revolutionary America, 1754-1789** (LEC 3.0)

An examination of the causes and consequences of the American Revolution. Emphasis placed upon the social conditions in America which contributed to both the Revolution and the writing of the 1787 Constitution. Prerequisite: History 1300.

**HISTORY 3340 Age Of Jefferson And Jackson** (LEC 3.0)

Economic, political, social and constitutional development of the early American republic; the Federalist and Jeffersonian periods, Jacksonian Democracy, rise of sectionalism. Emphasis placed on historical interpretation and historiography of the period. Prerequisite: History 1300.



**HISTORY 3345 Civil War And Reconstruction** (LEC 3.0)

Lecture, discussion and readings on the causes and consequences of the American Civil War. Focuses on the prewar North-South sectional rivalry: impact of the war on American society, government and politics. Reconstruction including the development of racial crisis in United States history. Prerequisite: History 1300.

**HISTORY 3360 Recent United States History** (LEC 3.0)

Examines America's modern age including the New Era, the New Deal, Internationalism, post-war affluence, the post-industrial era as well as the cultural, intellectual, social and technological features of American society from 1920 to the present. Prerequisite: History 1310.

**HISTORY 3420 History Of Missouri** (LEC 3.0)

Survey of Missouri's political, social, economic and cultural development from the beginning of settlement to the present. Prerequisite: History 1300 or 1310.

**HISTORY 3425 History Of The Old South** (LEC 3.0)

Analysis of the southern region of the United States between 1607-1861 with emphasis on economic, social, political, intellectual, and racial themes. Prerequisite: History 1300.

**HISTORY 3426 History Of The Modern South** (LEC 3.0)

Analysis of the southern region of the United States between 1877 and the present with emphasis on economic, social, political, intellectual, and racial themes. Prerequisite: History 1310.

**HISTORY 3440 20th Century Americans In Combat** (LEC 3.0)

Through lectures, films, readings, exams, film reviews and discussions, this course examines the American military and combat experience throughout much of the twentieth century. The ultimate goal of the course is for students to understand the realities of warfare and its effect on ordinary Americans as well as American society. Prerequisite: History 1300 or 1310 or 1200.

**HISTORY 3441 The United States In World War II** (LEC 3.0)

Through lectures, readings and film this course will explore the American experience in World War II. The course will particularly focus on the war's American major battles along with the war's effect on Americans in combat and on the home front. Prerequisite: History 1300 or 1310.

**HISTORY 3442 The United States in Vietnam** (LEC 3.0)

Through lecture, film and readings, this course examines the American experience in the Vietnam War. The course covers the causes and consequences of the war as well as its effect on those who fought and on American society as a whole. There is a special emphasis on the realities of combat and the war's impact on individual Americans. Prerequisite: History 1310.

**HISTORY 3443 The American Military Experience** (LEC 3.0)

A study of American military history, strategy, policy and institutions from the colonial period to the present. War will be viewed in the mainstream of history with emphasis on the American Revolution, the Civil War, and the 20th century conflicts. Prerequisite: History 1200 or History 1300 or History 1310 or Pol Sci 1200.

**HISTORY 3450 American Intellectual History II** (LEC 3.0)

The ideas of intellectuals and the thought of popular culture, and possible relationships between the two. Among the climates of opinion studied are the Gilded Age, Darwinism, Progressivism, the Twenties, the Great Depression, the Affluent Fifties, the Counter-Culture Sixties. Prerequisite: History 1310.

**HISTORY 3480 History Of Baseball** (LEC 3.0)

This course will survey and interpret the history of baseball from its earliest beginnings down to the present. Main focus will be on the evolution of the professional game in all of its facets. Prerequisite: History 1300 or 1310.

**HISTORY 3510 Twentieth Century Technology And Society** (LEC 3.0)

An investigation of technological achievements since 1900 and their effects on society. Topics include: education in a technological society, technology and the state, the individual and the environment, cybernation, agriculture, scientific and industrial research. Prerequisite: History 1200 or 1310.

**HISTORY 3530 History of Science** (LEC 3.0)

A study of the history of science focusing on the leading conceptual developments within science, the scientific revolution, and science's role in society. Prerequisite: History 1100 or History 1200 or History 1300 or History 1310.

**HISTORY 3660 Modern East Asia** (LEC 3.0)

An analysis of the history of East Asia in the nineteenth and twentieth centuries. Topics include: social, historical, and intellectual traditions; imperialism and its impact; and the effects of World War II on Modern East Asia. Prerequisite: History 1200 or History 1300 or History 1310.

**HISTORY 3665 History of Japan** (LEC 3.0)

This course covers the history of modern Japan from 1600 to the present and includes Japan's political, social, and cultural/intellectual history. Prerequisite: History 1200 or History 1300 or History 1310.

**HISTORY 3760 The American Presidency** (LEC 3.0)

Historical development of the presidency; emphasis on the constitutional powers and limits of the office and the political contextual variables that influence presidential behaviors. Prerequisite: Pol Sci 1200 or History 1310. (Co-listed with Pol Sci 3760).

**HISTORY 3761 U.S. Diplomatic History to World War II** (LEC 3.0)

This course is a history of American foreign relations, broadly conceived, from the War for Independence to WWII. Among other things, it deals with the diplomacy of survival, of expansion and of economic and political hegemony. Prerequisites: History 1300, 1310 or Pol Sci 1200. (Co-listed with Pol Sci 3761).

**HISTORY 3762 American Diplomatic History Since World War II** (LEC 3.0)

American Diplomatic History Since World War II will address the major issues in American foreign policy from WWII to the present. Its primary focus is on the Cold War and the post-Cold War problems the U.S. has faced. Prerequisite: History 1310 or Pol Sci 1200. (Co-listed with Pol Sci 3762).

**HISTORY 3763 Contemporary Political Thought** (LEC 3.0)

This course will explore the impact of ideas on American politics and history, including the relationship between technological change and public policy; this will be pursued through the study of American political history, social institutions, and intellectual history. Prerequisite: History 1300 or History 1310 or Pol Sci 1200. (Co-listed with Pol Sci 3763).

**HISTORY 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**HISTORY 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**HISTORY 4010 Seminar** (RSD 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

**HISTORY 4085 Internship** (IND 0.0-6.0)

Internship will involve students applying critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisites: Senior status; must have completed 24 hours in major.

**HISTORY 4097 Senior Project** (LEC 3.0)

History majors interested in graduate school or professional school, such as law school, should complete an extended research project, or thesis, under the supervision of a department faculty member. Prerequisites: History 2790 and senior standing.

**HISTORY 4145 The Reformation** (LEC 3.0)

An examination of the backgrounds, events, ideas, and impact of the Reformation in Europe. Emphasis on the competing ideas of the reformers as well as on the Reformation's long-term social, cultural, and political impact. Prerequisite: History 1100 or History 1200.

**HISTORY 4245 Nazi Germany and the Holocaust** (LEC 3.0)

This course focuses on the rise of Nazism and its consequences for politics, society, and culture in Europe. The period's history will be examined from the perspective of perpetrators, victims, and bystanders with emphasis on the Holocaust and its legacy. Prerequisite: History 1200.

**HISTORY 4246 War and Society in Twentieth-Century Europe** (LEC 3.0)

This course explores individuals' experiences in France and Germany between 1914 and 1945. Ideas about society changed in the twentieth century due to war; these changes were reflected in politics and changed relationships between men and women. Seminar-style course. Prerequisite: History 1200 or History 1310.

**HISTORY 4435 History of the American West** (LEC 3.0)

This class examines the American settlement of the Trans-Mississippi West. Areas to be considered include cattle, mining, exploring, women, and Native Americans. Traditional and contemporary views of the American West will be analyzed. Prerequisite: History 1300 or History 1310.

**HISTORY 4470 American Environmental History** (LEC 3.0)

This class discusses the impact of human interactions with the physical environment and the natural world's influence on human civilizations with emphasis on the 19th and 20th centuries. Prerequisite: History 1200 or History 1300 or History 1310.

**HISTORY 4550 Architecture, Technology and Society; 1750 to Present** (LEC 3.0)

This course investigates the relationships between architecture and technology and, as a consequence, architecture's impact on modern culture and society. Topics include; the industrial revolution, housing styles, new materials, Bauhaus and international style, and post-modern architecture. A field trip to Chicago is an integral part of the course. Prerequisites: History 1100 or History 1200 or History 1300 or History 1310 or Pol Sci 1200. Recommended: Junior or Senior Standing. Recommended for Arch Eng majors: Art 3203 taken prior to course.

**HISTORY 5003 Readings In American History Since 1865** (IND 3.0-5.0)

Directed readings and writing on selected topics and areas in American History since 1865. Prerequisites: Graduate standing and consent of instructor.

**HISTORY 5004 Readings In European History To 1715** (IND 3.0-5.0)

Directed readings and writing on selected topics and areas in European History to 1715. Prerequisites: Graduate standing and consent of instructor.

**HISTORY 5005 Readings In European History Since 1715** (IND 3.0-5.0)

Directed readings and writing on selected topics and areas in European History since 1715. Prerequisites: Graduate standing and consent of instructor.

## Information Science and Technology

Information science and technology offers a bachelors degree focused on today's cutting-edge information technology. Students in information science and technology study the latest technology in areas including business analytics & data science, networking, database management systems, telecommunications, enterprise resource planning, human-computer interaction, e-commerce, and integrated business systems. Professionals in this field administer, maintain, and support computer systems and networks.

Today's business environments have a critical need for professionals who have an understanding of information technologies based on a broad knowledge of management practices, economics, psychology, and the humanities. These individuals are needed to implement technology to support business processes, managerial decision-making, and organizational communication.

As an information science and technology major, you will take courses that are rigorous and oriented toward building the foundation necessary for lifetime learning. Studying at Missouri S&T, you will benefit from the world-class computer environment and your association with excellent students from around the country and the world. Students in the program are strongly encouraged to do summer internships or co-ops with companies before they graduate. There are many rich opportunities and students benefit greatly in terms of their education and the edge they have seeking full-time employment once they graduate.

## Bachelor of Science Information Science and Technology

In Information Science and Technology, the Bachelor of Science degree consists of 120 credit hours. All undergraduate students in Business and Management Systems are required to complete a General Education Requirements Core, including courses in Humanities, Social Sciences, Mathematics, Science, and Communication Skills.

A common departmental core of courses in Management and Information Technology helps provide students with skills to succeed in a fast-changing and globalized environment. Information Science and Technology (IST) Core courses and IST Electives provide students with comprehensive knowledge of information technology utilization in businesses. These courses include business analytics & data science, database management, systems analysis, introduction to data science and management, computing internals, networks and communications, and electronic and mobile commerce. The electives for this degree consist of advanced coursework in the areas introduced by the required courses.

A minimum grade of "C" is required in the IST Core, IST Electives, Management, and Information Technology courses. Students have 9 credit hours for free electives.

**Freshman Year**

First Semester	Credits	Second Semester	Credits
BUS 1810 <sup>1</sup>	1	PSYCH 1101	3
ENGLISH 1120	3	MATH 1212	4

MATH 1140 <sup>5</sup>	3	IS&T 1551	3
Science Elective <sup>2</sup>	3	BUS 1110	3
IS&T 1750	3	BUS 1210	3
Laboratory w/Science Elective	1		
	14		16
<b>Sophomore Year</b>			
<b>First Semester</b>	<b>Credits</b>	<b>Second Semester</b>	<b>Credits</b>
ECON 1200	3	IS&T 3131	3
SP&M S 1185	3	Science Elective <sup>2</sup>	3
IS&T 1552	3	IS&T Elective or Emphasis Area <sup>4</sup>	3
ENGLISH 1600 or TCH COM 1600	3	STAT 3111	3
ERP 2110	3	ECON 1100	3
	15		15
<b>Junior Year</b>			
<b>First Semester</b>	<b>Credits</b>	<b>Second Semester</b>	<b>Credits</b>
IS&T 4654	3	IS&T 3343	3
FINANCE 2150	3	MKT 3110	3
IS&T 3423	3	IS&T 3420	3
IS&T 3333	3	IS&T 4641	3
IS&T Elective or Emphasis Area <sup>4</sup>	3	ENGLISH 2560 or TCH COM 2560	3
	15		15
<b>Senior Year</b>			
<b>First Semester</b>	<b>Credits</b>	<b>Second Semester</b>	<b>Credits</b>
Free Elective	3	BUS 5980	3
Fine Art, Social Science, or Humanities Elective <sup>3</sup>	3	POL SCI 1200	3
IS&T Electives or Emphasis Area <sup>4</sup>	6	IS&T Elective or Emphasis Area <sup>4</sup>	3
History Elective	3	Free Electives	6
	15		15
Total Credits: 120			

A grade of "C" or better is required in the following courses for graduation; BUS 1110 , BUS 1210 , BUS 1810 , BUS 5980 , ECON 1100 , ECON 1200 , ERP 2110 , FINANCE 2150 , MKT 3110 , IS&T 1551 , IS&T 1552 , IS&T 1750 , IS&T 3131 , IS&T 3333 , IS&T 3343 , IS&T 3420 , IS&T 3423 , IS&T 4641 , IS&T 4654 , and all IST Electives.

<sup>1</sup> Writing intensive course

<sup>2</sup> Any course in the following areas: biology, chemistry, geology, geological engineering, physics.

<sup>3</sup> Any course in the following areas not used for other degree requirements: art, economics, English, foreign language, history, literature, music, philosophy, political science, psychology, sociology, theater.

<sup>4</sup> A grade of "C" or better is required in IS&T electives and emphasis area courses for graduation. Students choosing the human-computer interaction emphasis area must take IS&T 5885, IS&T 5886, and IS&T 5887 . Students choosing the enterprise resource planning emphasis area must take 9 hours of ERP-designated courses at the 4000-level or above. Students who choose no emphasis area must take three courses from: IS&T 4000-level or above, ERP 4000-level or above, COMP SCI 4700, COMP SCI 5601.

<sup>5</sup> MATH 1120 may be substituted for MATH 1140.

## Emphasis Areas

Two emphasis areas may be taken to specialize if the student wishes to do so. The first, human-computer interaction, consists of three courses:

IS&T 5885	Human-Computer Interaction	3
IS&T 5886	Prototyping Human-Computer Interactions	3
IS&T 5887	Human-Computer Interaction Evaluation	3

The second emphasis area, enterprise resource planning, consists of any 9 hours of ERP-designated courses at the 4000-level or above.

## Minors

You must see the department advisor and complete a minor application before beginning your minor. Requirements change over time. You will be held to the requirements in force at the time you apply for the minor. Postponing your application for the minor may result in you having to take additional courses to complete the minor. At least six (6) hours of the minor course work must be taken in residence at Missouri S&T.

### Minor in Business

The minor in business and management systems requires the following 15 hours of coursework:

FINANCE 2150	Corporate Finance I	3
ECON 1100	Principles Of Microeconomics	3
or ECON 1200	Principles Of Macroeconomics	
BUS 1110	Introduction to Management and Entrepreneurship	3
BUS 1210	Financial Accounting	3
MKT 3110	Marketing	3

### Minor in Business Analytics and Data Science

The minor in business analytics and data science requires the following 15 hours of coursework:

IS&T 1750	Introduction to Management Information Systems	3
IS&T 3423	Database Management	3
IS&T 3420	Introduction to Data Science and Management	3

And two of the following:

IS&T 4450 Introduction to Information Visualization  
IS&T 5420 Business Analytics and Data Science

IS&T 5001 Data Methodologies in Python

### Minor in Cybersecurity Management and Information Assurance

This minor requires the following 15 hours of coursework:

The following three courses are required:

BUS 5910	Privacy and Information Security Law	3
IS&T 4780	Human and Organizational Factors in Cybersecurity	3
IS&T 3333	Data Networks and Information Security	3

Two of the following three courses must also be taken:

ERP 5240	Enterprise Application Development and Software Security	3
IS&T 4335	Fundamentals of Mobile Technology for Business	3
IS&T 4641	Digital Commerce and the Internet of Things	3

## Minor in Digital Supply Chain Management

The minor in digital supply chain management requires the following 15 hours of coursework:

BUS 5360	Business Operations	3
or MECH ENG 3653	Manufacturing	
ERP 5310	Supply Chain Management Systems in an ERP Environment	3
ERP 4610	Customer Relationship Management in ERP Environment	3
or MECH ENG 5760/ Probabilistic Engineering Design AERO ENG 5760		
Two courses from the following list: *		6
ERP 5410	Use of Business Intelligence	
ERP 5110	Enterprise Resource Planning Systems Design and Implementation	
MECH ENG 5708	Rapid Product Design And Optimization	
MECH ENG 5656	Design For Manufacture	
MECH ENG 5757/ ENG MGT 5515	Integrated Product And Process Design	
MECH ENG 5763	Principles And Practice Of Computer Aided Design	

\* Non business and information technology students must select ERP 5110 as one of the two electives.

## Minor in Electronic and Social Commerce

The minor in electronic and social commerce requires the following 15 hours of coursework:

IS&T 4641	Digital Commerce and the Internet of Things	3
Four courses from the following list:		12
IS&T 4335	Fundamentals of Mobile Technology for Business	
IS&T 5251	Technological Innovation Management and Leadership	
IS&T 5652	Advanced Web Development	
IS&T 5168	Law and Ethics in E-Commerce	
IS&T 5885	Human-Computer Interaction	
IS&T 5886	Prototyping Human-Computer Interactions	
MKT 5310	Digital Marketing and Promotions	
MKT 4580	Marketing Strategy	

## Minor in Enterprise Resource Planning (ERP)

The minor in ERP requires the following 15 hours of coursework:

BUS 1210	Financial Accounting	3
ERP 2110	Introduction to Enterprise Resource Planning	3
ERP 5110	Enterprise Resource Planning Systems Design and Implementation	3
Six credit hours of electives from any other ERP-designated courses at the 4000-level or above		6
Total Credits		15

## Minor in Entrepreneurship

The minor in entrepreneurship requires the following 15 hours of coursework:

BUS 1110	Introduction to Management and Entrepreneurship	3
BUS 5980	Business Models for Entrepreneurship and Innovation	3
MKT 5310	Digital Marketing and Promotions	3
Two courses from the following list:		6
BUS 4150	Customer Focus and Satisfaction	
BUS 5580	Strategic Management	
IS&T 4641	Digital Commerce and the Internet of Things	
IS&T 4654	Web and Digital Media Development	
IS&T 4335	Fundamentals of Mobile Technology for Business	
IS&T 5251	Technological Innovation Management and Leadership	

IS&T 6654	Advanced Web and Digital Media Development	
IS&T 5886	Prototyping Human-Computer Interactions	
ENG MGT 5511	Technical Entrepreneurship	
ENG MGT 5411	Engineering Design Optimization	

## Minor in Finance

The minor in finance requires the following 15 hours of coursework:

ECON 1100	Principles Of Microeconomics	3
or ECON 1200	Principles Of Macroeconomics	
FINANCE 2150	Corporate Finance I	3
Three additional FINANCE electives at the 3000 level or above (Undergraduate Research is acceptable)		9
Total Credits		15

## Minor in Human-Computer Interaction and User Experience

The minor in human-computer interaction and user experience requires the following 15 hours of coursework:

IS&T 4654	Web and Digital Media Development	3
IS&T 4680	Introduction to Web and New Media Studies	3
IS&T 5885	Human-Computer Interaction	3
IS&T 5886	Prototyping Human-Computer Interactions	3
IS&T 5887	Human-Computer Interaction Evaluation	3

## Minor in Information Science and Technology

The minor in information science and technology requires the following 15 hours of coursework:

IS&T 1750	Introduction to Management Information Systems	3
IS&T 1551	Implementing Information Systems: User Perspective	3
IS&T 1552	Implementing Information Systems: Data Perspective	3
ERP 2110	Introduction to Enterprise Resource Planning	3
One other IS&T or ERP course at the 2000-level or above.		3
Total Credits		15

## Minor in Management

The minor in management requires the following 15 hours of coursework:

BUS 1110	Introduction to Management and Entrepreneurship	3
Four courses from the following list:		12
BUS 2910	Business Law	
BUS 3115	Introduction to Teambuilding and Leadership	
BUS 4111	Business Negotiations	
BUS 4150	Customer Focus and Satisfaction	
BUS 5360	Business Operations	
BUS 5470	Human Resource Management	
BUS 5580	Strategic Management	
IS&T 4261	Information Systems Project Management	
ENG MGT 3320	Introduction to Project Management	

## Minor in Marketing

The minor in marketing requires the following 15 hours of coursework:

ECON 1100	Principles Of Microeconomics	3
or ECON 1200	Principles Of Macroeconomics	
MKT 3110	Marketing	3
Three courses from the following list:		9
MKT 3210	Consumer Behavior	
MKT 5310	Digital Marketing and Promotions	
MKT 4150	Customer Focus and Satisfaction	



MKT 4580	Marketing Strategy
ERP 4610	Customer Relationship Management in ERP Environment
Other marketing electives approved by the department (MKT 3000 and above)	

## Minor in Mobile Business and Technology

The minor in mobile business and technology requires the following 15 hours of coursework:

IS&T 4641	Digital Commerce and the Internet of Things	3
IS&T 4335	Fundamentals of Mobile Technology for Business	3
ERP 5240	Enterprise Application Development and Software Security	3
Two courses from the following list:		6
IS&T 3333	Data Networks and Information Security	
IS&T 5652	Advanced Web Development	
IS&T 5886	Prototyping Human-Computer Interactions	
ERP 4610	Customer Relationship Management in ERP Environment	
ERP 5310	Supply Chain Management Systems in an ERP Environment	
ERP 5210	Performance Dashboard, Scorecard and Data Visualization	

**Carla Pauline Bates**, Assistant Teaching Professor  
MASTER Missouri S&T

**Darryl Lee Brinkmann**, Adjunct Instructor  
MASTER Sangamon State University

**Randy Lawrence Canis**, Adjunct Professor  
JD University of Missouri-Columbia

**Langtao Chen**, Assistant Professor  
PHD Georgia State University

**Yu Hsien Chiu**, Associate Teaching Professor  
MASTER University of Wisconsin-Milwaukee

**Craig C Claybaugh**, Associate Professor  
PHD University of Wisconsin-Milwaukee

**Arlan Dekock**, Professor Emeritus  
PHD University of South Dakota

**Cassandra Carlene Elrod**, Associate Professor  
PHD University of Missouri-Rolla

**Li-Li Eng**, Associate Professor  
PHD University of Michigan Ann Arbor

**Hanqing Fang**, Assistant Professor  
PHD Mississippi State University

**Barry B Flachsbarth**, Professor  
PHD Stanford University

**Nobuyuki Fukawa**, Associate Professor  
PHD Louisiana State University

**Richard H Hall**, Professor  
PHD Texas Christian University

**Michael Gene Hilgers**, Professor  
PHD Brown University

**Bih-Ru Lea**, Associate Professor  
PHD Clemson University

**Chris J Merz**, Adjunct Instructor  
PHD University of California-Irvine

**Fiona Fui-Hoon Nah**, Professor  
PHD University of British Columbia

**Nicholas Oswald**, Adjunct Instructor  
MASTER Missouri University of Science & Technology

**Keng Leng Siau**, Professor  
PHD University of British Columbia

**James K Tharp**, Adjunct Instructor  
MBA Webster University

**Nathan W Twyman**, Assistant Professor  
PHD University of Arizona

**Wen-Bin Yu**, Associate Professor  
PHD University of Louisville

**Hongxian Zhang**, Assistant Professor  
PHD University of Texas at San Antonio

### ***IS&T 1001 Special Topics*** (IND 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

***IS&T 1551 Implementing Information Systems: User Perspective*** (LEC 3.0)  
Introduction to object-oriented programming in the context of developing and implementing the various components of an information system with particular attention given to system interface such as window and web forms. Class will include numerous projects covering foundational programming.

***IS&T 1552 Implementing Information Systems: Data Perspective*** (LEC 3.0)  
Continuation of object-oriented programming in the context of developing and implementing the various components of an information system with particular attention given to database incorporation. Class will include numerous projects covering intermediate topics. Prerequisite: IS&T 1551.

***IS&T 1750 Introduction to Management Information Systems*** (LEC 2.0 and LAB 1.0)

This course familiarizes the students with the fundamental concepts and principles of management information systems. Topics covered include the strategic role of IT, decision support systems, database and datawarehouse, enterprise applications, mobile applications, and social and ethical issues related to information systems.

### ***IS&T 2000 Special Problems*** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### ***IS&T 2001 Special Topics*** (IND 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

***IS&T 2002 Cooperative Training in Information Science & Technology*** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry with credit arranged through departmental co-op advisor. Grade received depends on quality of reports submitted and work supervisors's evaluation. Prerequisite: Completed 30 hours toward degree.

### ***IS&T 3000 Special Problems*** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### ***IS&T 3001 Special Topics*** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**IS&T 3131 Computing Internals And Operating Systems** (LEC 3.0)

Design-oriented introduction to computer components and operation. Standard codes; number systems; base conversions; computer arithmetic; boolean algebra; operating system components including memory management, device management, and I/O management; and related issues are covered. Prerequisite: IS&T 1552 or Comp Sci 1510.

**IS&T 3321 Network Performance Design And Management** (LEC 3.0)

This course provides analytical capabilities needed to effectively design, deploy, and manage computer networks and protocols. Prerequisites: IS&T 3333.

**IS&T 3333 Data Networks and Information Security** (LEC 3.0)

The course provides an overview of current and evolving networking and information security principles. Concepts include network standards and protocols; operation and management; switching and routing; area networks; wireless network infrastructure; security frameworks, policies, and management. Prerequisites: IS&T 1750; IS&T 1552 or Comp Sci 1510.

**IS&T 3343 Systems Analysis** (LEC 3.0)

Introduction to the processes by which business information systems are analyzed, designed, and introduced into the business environment. Topics include investigation of existing systems, requirements analysis, logical and physical design, database design, forms design, and report analysis. Prerequisite: IS&T 3423.

**IS&T 3420 Introduction to Data Science and Management** (LEC 3.0)

Introduces students to increasing business success through analysis of large-scale data collections. Topics include: import/export of data, summary statistics, cross-tabulation, data transformations (sub setting, merging, sorting and aggregation), modeling methods, and visualization. Significant programming in R is expected. Prerequisites: IS&T 1552 or Comp Sci 1510.

**IS&T 3423 Database Management** (LEC 3.0)

The course introduces the concepts of database management systems. Issues in database architecture, design, administration, and implementation are covered. Prerequisites: IS&T 1750; IS&T 1552 or Comp Sci 1510.

**IS&T 3443 Database Applications in Business** (LEC 3.0)

Design, development and implementation of application software typical to the modern business environment utilizing popular commercial database management systems such as Oracle and Access. Focus given to business case modeling, requirement analysis, database design, and implementation challenges. Project oriented. Prerequisite: IS&T 3343.

**IS&T 3553 Modular Software Systems in Java** (LEC 3.0)

Introduction to Software Life Cycle and characteristics of large modular software systems. Exploration of software support for such systems, using Java, including use of GUI interfaces, advanced I/O and String handling, Interfaces, Threads, and other modularity features. Program project included. Prerequisites: IS&T 1552 and IS&T 3131.

**IS&T 4001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

**IS&T 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**IS&T 4257 Network Economy** (LEC 3.0)

Emerging Network/Internet economy, using traditional economic tools. Topics: production and reproduction cost of information, information as an "experience good," versions of products, switching cost, lock-in effects, market adoption dynamics, first-mover advantage, intellectual property rights. Prerequisite: Econ 1100 or Econ 1200. (Co-listed with Econ 4130).

**IS&T 4261 Information Systems Project Management** (LEC 3.0)

The course overviews general project management principles and then focuses on information system application development. Topics include requirements analysis, project scheduling, risk management, quality assurance, testing, and team coordination. Prerequisites: IST 1552 or Comp Sci 1510; Senior Standing.

**IS&T 4335 Fundamentals of Mobile Technology for Business** (LEC 3.0)

A broad overview of mobile technology use in business environments. Topics include the mobile industry; mobile network and wireless standards; mobile devices; mobile web design and app development; social and user experience issues; mobile marketing and commerce. Prerequisites: IS&T 3333.

**IS&T 4450 Introduction to Information Visualization** (LEC 3.0)

Topics include: the visualization development framework, traditional presentations of data, human perception and aesthetics, colorspace theory, visualization algorithms and software, modern visualizations of large data sets. Application of R packages will be emphasized throughout. Prerequisites: Statistics, Calculus, and Programming Knowledge.

**IS&T 4641 Electronic and Mobile Commerce** (LEC 3.0)

Introduction to fundamental concepts of management and application to IT and support of commerce. Examines the use of IT in business processes and the management issues of integrating IT into organization processes to gain a competitive advantage. Prerequisites: IS&T 1750 and at least Sophomore standing.

**IS&T 4642 E-Commerce Architecture** (LEC 3.0)

Course will cover the issues associated with computer architecture, as it relates specifically to e-commerce applications. Topics will include e-commerce systems and processes, specialized software, and databases. Prerequisite: IS&T 3333.

**IS&T 4654 Web and Digital Media Development** (LEC 3.0)

This course covers techniques and tools for design and development of web-based media, including text, graphics, animation, audio, and video.

**IS&T 4680 Introduction to Web and New Media Studies** (LEC 3.0)

The course covers web culture, including topics such as social media, citizen journalism, crowd intelligence, privacy, and copyright. Prerequisite: Junior or Senior standing.

**IS&T 4780 Human and Organizational Factors in Cybersecurity** (LEC 3.0)

In-depth examination of human and organizational factors in cybersecurity and information assurance. Study of how to protect information integrity, availability, and confidentiality, as well as tools, methods, principles, and analytics for fraud prevention, insider threat detection, and forensic investigations. Assumes prior exposure to cybersecurity or IA.

**IS&T 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**IS&T 5001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

**IS&T 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**IS&T 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**IS&T 5131 Foundations of Computer Architecture** (LEC 3.0)

Design-oriented foundations of computer components and operation. Standard codes; number systems; base conversions; computer arithmetic; boolean algebra; operating system components including memory management, device management; plus related computer architecture topics. Research paper required. Prerequisites: IS&T 1552 and graduate standing.

**IS&T 5168 Law and Ethics in E-Commerce** (LEC 3.0)

Provides the ethical framework to analyze the ethical, legal, and social issues that arise for citizens and computer professionals regarding the computerization of society. Topics include: free speech, privacy, intellectual property, product liability, and professional responsibility. (Co-listed with Philos 4368).

**IS&T 5251 Technological Innovation Management and Leadership** (LEC 3.0)

The course focuses on the knowledge and skills necessary for the development and implementation of effective strategies for the management of technology-based organizations. This involves: developing a general management perspective on technology and innovation, examining the problems of new product development, identifying distinctive technological competencies, licensing and marketing technologies, assessing the organizational and industrial context of technology. Prerequisite: Senior or Graduate Standing.

**IS&T 5420 Business Analytics and Data Science** (LEC 3.0)

Analysis of large business data sets via statistical summaries, cross-tabulation, correlation, and variance matrices. Techniques in model selection, prediction, and validation utilizing general linear and logistic regression, Bayesian methods, clustering, and visualization. Extensive programming in R is expected. Prerequisites: Calculus, Statistics, and Programming knowledge.

**IS&T 5423 Foundations of Data Management** (LEC 3.0)

Foundational concepts of database management systems. Issues in database architecture, design, administration, and implementation. Extensive use of SQL with Oracle to create and manage databases. Significant project dealing with triggers or stored procedures. Prerequisites: IS&T 1750, IS&T 1552, and graduate standing.

**IS&T 5520 Data Methodologies in Python** (LEC 3.0)

Python methodologies for manipulating, processing, cleaning, grouping, slicing, reshaping and summarizing information in data-intensive applications; managing files, scraping web pages, mining social media; describing, modeling, analyzing, and visualizing data. Tools include pandas, NumPy, SciPy, and Matplotlib libraries. Prerequisites: One of Stat 3111, Stat 3113, Stat 3115, Stat 3117 and either IS&T 1552 or Comp Sci 1510; for Graduate Students: Graduate Standing and Knowledge of Calculus, Statistics, and Programming.

**IS&T 5652 Advanced Web Development** (LEC 3.0)

Advanced Web development techniques to provide dynamic interaction; methods for extracting and delivering dynamic information to/from Web servers - a hands-on approach. Emphasis on interaction with servers; mobile software development; processing of graphics and web video. Project work is required. Prerequisites: IS&T 1551 and IS&T 4654.

**IS&T 5885 Human-Computer Interaction** (LEC 3.0)

Introduction to the field of Human-Computer Interaction (HCI). Students examine issues and challenges related to the interaction between people and technology. The class explores the social and cognitive characteristics of people who use information systems. Students learn techniques for understanding user needs, interface prototyping & interface evaluation.

**IS&T 5886 Prototyping Human-Computer Interactions** (LEC 3.0)

This course explores novel HCI and UX technologies as well as methods and tools for creating system prototypes, including best practices and guidelines for optimal user experiences. Example concepts include mobile applications, behavioral monitoring, gamification, natural user interfaces, haptics, and computers as social actors. Prerequisite: Preceded or accompanied by IS&T 5885.

**IS&T 5887 Human-Computer Interaction Evaluation** (LEC 1.5 and LAB 1.5)

This course covers research and analysis methods and tools for evaluation of the impact of information technology systems on humans and organizations. The focus will be on practical evaluation with the goal of providing recommendations for improving system functionality and usability. Prerequisite: Preceded or accompanied by IS&T 5885.

## Latin American Studies for Technical Applications Minor

The minor in Latin American Studies for Technical Applications is an interdisciplinary minor that allows students to develop deeper understanding of the cultures and languages of Latin America while simultaneously honing and implementing the technical skills they are acquiring in the courses needed for their majors. This minor aims to include students of all levels of Spanish language, including heritage and native speakers.

The minor requires 12 credit hours from an approved list of courses and at least two weeks (14 days) of experience in a Latin American country as part of an S&T-approved program. The lists for Areas 2 and 3 will grow as other faculty on campus develop courses as part of the minor. The minor also aims for breadth of knowledge. Therefore, courses from one area cannot count twice.

Area 1: Spanish Proficiency. To fulfill this, students must complete 6 hours of Spanish at the level of 1180 (Intermediate Spanish) or above. Courses that count towards this area include:

- SPAN 1180 Intermediate Spanish (4)
- SPAN 2000 Special Problems (0-6)
- SPAN 2001 Special Topics (3)
- SPAN 2110 Basic Spanish Conversation (2)
- SPAN 2160 Hispanic Culture (3)
- SPAN 2161 Contemporary Latin America (3)
- SPAN 2170 Masterpieces of Hispanic Literature (3)
- SPAN 2180 Intermediate Spanish Composition (3)
- SPAN 3000 Special Problems (0-6)
- SPAN 3001 Special Topics (3)
- SPAN 3100 Spanish Translation for Technical Applications
- SPAN 4000 Special Problems (0-6)

- SPAN 4001 Special Topics (3)
- SPAN 4302 Phonetics and Phonology of Spanish (3)
- SPAN 4311 Advanced Spanish Conversation (2)
- SPAN 4370 Survey of Spanish Literature (3)
- SPAN 4377 Spanish-American Novel and Short Story (3)

Area 2: Technical Applications in Latin America. Students must take one of the following courses, for a total of 3 credits. Other courses will be added to Area 2 as they are developed.

- GEO ENG 5092 International Engineering and Design
- GEO ENG 2407 Geology and Engineering of Ancient and Modern Peru
- SPAN 3100 Spanish Translation for Technical Applications
- SP&MS 3235 Intercultural Communication, when the course is focused on Latin America
- GEO ENG 5556 Renewable Energy Systems, when the course is focused on Latin America
- CHEM ENG 5001 Special Topics (TBD)

Area 3: General Latin American Studies. Students must take one of the following, for a total of 3 credits. Other courses will be added to Area 3 as they are developed.

- ENGLISH 3001 / TCH COM 3001 Special Topics (Costa Rica in Text) (3)
- HIST 3001 Special Topics (History of Science & Technology in Latin America) (3)
- SPAN 2160 Hispanic Culture (3)
- SPAN 2161 Contemporary Latin America (3)

Area 4: Experience abroad in Latin America. Students must spend at least 14 days in a Latin American country as part of an S&T-approved program, such as faculty-led study abroad, a semester- or year-long program at partner institutions, an internship, or EWB. This may be fulfilled via multiple trips to multiple locations within Latin America.

## Marketing

**Nobuyuki Fukawa**, Associate Professor  
PHD Louisiana State University

**Sarah Margaret Stanley**, Assistant Professor  
PHD Saint Louis University

### **MKT 2000 Special Problems** (IND 0.0-6.0)

(Variable) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### **MKT 2001 Special Topics** (LEC 0.0-6.0)

(Variable) This is designed to give the department an opportunity to test a new course. Variable title.

### **MKT 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in marketing. Prerequisite: Consent of instructor required.

### **MKT 3001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

### **MKT 3105 Marketing and Strategy Essentials** (LEC 1.5)

This course is an introduction to the essentials of marketing and strategy for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Bachelor Degree.

### **MKT 3110 Marketing** (LEC 3.0)

The course examines the distribution, product, price, and promotion policies that underlie the activities of marketing institutions and the managerial, economic, and societal implications of such policies.

### **MKT 3210 Consumer Behavior** (LEC 3.0)

Introduces and applies important concepts, principles, and theories to understand consumer decision-making processes in the purchase, usage and disposal of goods and services. Examines the influence of cultural, social, and psychological factors on consumer behavior. Prerequisite: MKT 3110.

### **MKT 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Prerequisite: Consent of instructor required.

### **MKT 4150 Customer Focus and Satisfaction** (LEC 3.0)

Major emphasis is given to the concept of customer focus, with coverage of techniques for obtaining customer needs, measuring customer satisfaction, developing products and services to satisfy customers, and maximizing the benefits of customer feedback. A semester long HoQ project will be done. Prerequisites: MKT 3110 or MKT 3105 or ENG MGT 3510. (Co-listed with BUS 4150).

### **MKT 4580 Marketing Strategy** (LEC 3.0)

Identification and analysis of strategic managerial marketing issues. Integration of marketing concepts through theoretical overview and practical analysis, including extensive use of simulation. Prerequisite: MKT 3110 or MKT 5105 or Eng Mgt 3510.

### **MKT 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in marketing. Prerequisite: Consent of instructor required.

### **MKT 5001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

### **MKT 5099 Research** (IND 0.0-9.0)

Research investigation of an advanced nature leading to a major report suitable for publication in a journal or in a conference proceedings. Prerequisite: Consent of instructor required.

### **MKT 5105 Graduate Marketing and Strategy Essentials** (LEC 1.5)

This course is an introduction to the essentials of marketing and strategy for running a business. It's designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit cannot be applied to any major or minor in Business, IS&T or Economics. Additional case study or report required. Prerequisite: Bachelor Degree.

### **MKT 5310 Digital Marketing and Promotions** (LEC 3.0)

A managerial examination of integrated marketing communication (IMC) and creativity, with a focus on digital media and new marketing concepts. Specifically, we will look at innovative marketing techniques such as viral marketing, brand communities, experiential marketing and guerilla tactics. Prerequisites: At least Junior standing.

### **MKT 5320 Marketing for Non-Profits** (LEC 3.0)

Illustrates the importance of creating synergy within a marketing campaign. Speaking with "one voice" allows a brand to make a stronger impact; students will work with a local non-profit to improve their marketing message at each customer touch point. Students will analyze a marketing plan and work to improve it, including brochures & donation letters. Prerequisites: At least Junior standing.



# Materials Science and Engineering

## Biomedical Engineering Minor

Minimum number of credit hours: 15 hours, consisting of 1 required course, Cer Eng 3110: Introduction to Biomedical Engineering, plus at least 4 courses from an approved list. At least 2 of the elective courses will be at or above the 4000 level. Core courses used toward a student's major degree requirements cannot be used for the minor degree program in BME. Elective courses used toward a student's major degree requirements or another minor degree program cannot be used unless they are approved by the biomedical engineering program committee.

Elective courses:

BIO SCI 2213	Cell Biology	3
BIO SCI 2219	Cell Biology Laboratory	1
BIO SCI 2223	General Genetics	3
BIO SCI 3313	Microbiology	3
BIO SCI 3319	Microbiology Lab	2
BIO SCI 3333	Human Anatomy and Physiology I	3
BIO SCI 3339	Human Anatomy Physiology I Lab	1
BIO SCI 3343	Human Anatomy and Physiology II	3
BIO SCI 3349	Human Anatomy and Physiology II Laboratory	1
BIO SCI 3483	Biomedical Problems	3
CHEM ENG 4210	Biochemical Reactors	3
BIO SCI 4323	Molecular Genetics	3
BIO SCI 4353	Cancer Cell Biology	3
BIO SCI 4383	Toxicology	3
CHEM 4610	General Biochemistry	3
CHEM 4620	Metabolism	3
BIO SCI 5001	Special Topics	0-6
BIO SCI 5240/ MS&E 5210	Tissue Engineering I	3
MS&E 5310/ BIO SCI 5210/ CHEM ENG 5200	Biomaterials I	3
CHEM ENG 5320	Introduction to Nanomaterials	3
BIO SCI 5323	Bioinformatics	3
STAT 5425	Introduction to Biostatistics	4
ENG MGT 5511	Technical Entrepreneurship	3
MET ENG 4099	Undergraduate Research <sup>1</sup>	0-6

<sup>1</sup> Undergraduate Research may be taken in any science or engineering discipline.

**Mohsen Asle Zaeem**, Assistant Professor  
PHD Washington State University

**Richard K Brow**, Curators Professor  
PHD Pennsylvania State University

**Fatih Dogan**, Professor  
PHD Technical University of Berlin

**William G Fahrenholtz**, Curators Professor  
PHD University of New Mexico

**Gregory E Hilmas**, Curators Professor  
PHD University of Michigan-Ann Arbor

**Wayne Huebner**, Professor  
PHD University of Missouri-Rolla

**F Scott Miller**, Teaching Professor  
PHD University of Missouri-Rolla

**Michael Scott Moats**, Associate Professor  
PHD University of Arizona

**Joseph W Newkirk**, Associate Professor  
PHD University of Virginia

**Matthew J O'Keefe**, Professor  
PHD University of Illinois Urbana

**Ronald J O'Malley**, Professor  
PHD Massachusetts Institute of Technology

**Mohamed N Rahaman**, Professor  
PHD University of Sheffield (UK)

**Von L Richards**, Professor  
PHD University of Michigan-Ann Arbor

**Mark E Schlesinger**, Professor  
PHD University of Arizona

**Jeffrey D Smith**, Associate Professor  
PHD University of Missouri-Rolla

**David C Van Aken**, Curators Teaching Professor  
PHD University of Illinois Urbana

**Jeremy Lee Watts**, Research Assistant Professor  
PHD Missouri S&T

**Caizhi Zhou**, Assistant Professor  
PHD Iowa State University

**MS&E 4001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MS&E 4810 Chemistry And Inherent Properties Of Polymers** (LEC 3.0)

A basic study of the organic chemistry of natural and synthetic high polymers, their inherent properties and their uses in plastic, fiber, rubber, resin, food, paper and soap industries. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with Chem 4810).

**MS&E 4819 Polymer Science Laboratory** (LEC 1.0 and LAB 2.0)

Lectures and laboratory experiments dealing with polymerization reactions, solution properties and bulk or solid properties will be presented. Each student will prepare polymers and carry out all characterization experiments on actual samples. Prerequisite: Chem 4810 or MS&E 4810 and preceded or accompanied by Chem 1100. (Co-listed with Chem 4819).

**MS&E 4850 Fundamentals Of Protective Coating I** (LEC 3.0)

Study of the basic principles of protective coatings with particular reference to the paint and varnish industry. Classifications, manufacture, properties and uses of protective coatings. Prerequisite: Chem 1320. (Co-listed with Chem 4850).

**MS&E 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MS&E 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MS&E 5010 Seminar** (RSD 0.0-6.0)  
(Variable) Discussion of current topics.

**MS&E 5040 Oral Examination** (IND 0.0)  
(Variable) After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D students may be processed during intercession. Off-campus M.S. students must be enrolled in an oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**MS&E 5099 Research** (IND 0.0-15)  
(Variable) Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**MS&E 5210 Tissue Engineering I** (LEC 3.0)  
The course will introduce senior undergraduate students to the principles and clinical applications of tissue engineering including the use of biomaterials scaffolds, living cells and signaling factors to develop implantable parts for the restoration, maintenance, or replacement of biological tissues and organs. Prerequisite: Senior standing. (Co-listed with Bio Sci 5240).

**MS&E 5220 Advanced Phase Equilibria** (LEC 3.0)  
Advanced aspects of unary, binary and ternary organic, phase equilibria. Includes practical examples of the applications of phase diagrams to solve engineering problems. Prerequisite: Graduate standing.

**MS&E 5230 Energy Materials** (LEC 3.0)  
The objectives of the course are to understand how the rational design and improvement of chemical and physical properties of materials can lead to energy alternatives that can compete with existing technologies. Discussions on the present and future energy needs from a view point of multidisciplinary scientific and technological approaches. Prerequisite: Senior standing.

**MS&E 5310 Biomaterials I** (LEC 3.0)  
This course will introduce senior undergraduate students to a broad array of topics in biomaterials, including ceramic, metallic, and polymeric biomaterials for in vivo use, basic concepts related to cells and tissues, host reactions to biomaterials, biomaterials-tissue compatibility, and degradation of biomaterials. Prerequisites: Senior undergraduate standing. (Co-listed with BIO SCI 5210, CHEM ENG 5200).

**MS&E 5517 Materials Selection in Mechanical Design** (LEC 3.0)  
This course will introduce the basics of materials selection in mechanical design. It will also introduce the benefits of computational materials and process selection. The students will also learn to use a commercially available materials selection software. This course will be offered as Distance Ed. Prerequisite: Met Eng 2110.

**MS&E 5810 Introduction to Polymeric Materials** (LEC 3.0)  
A basic study of the organic chemistry of natural and synthetic high polymers, their inherent properties and their uses in plastic, fiber, rubber, resin, food, paper and soap industries. Credit may not be given for both Chem 5810 and Chem 4810. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with Chem 5810).

**MS&E 5819 Polymer Synthesis and Characterization Lab** (LEC 1.0 and LAB 2.0)

Laboratory experiments dealing with polymerization syntheses and solution, bulk and solid properties will be presented. Each student will prepare polymers and carry out all characterization experiments on actual samples. Credit may not be given for both Chem 5819 and Chem 4819. Prerequisite: Chem 4810 or MS&E 4810 or Chem 5810 or MS&E 5810 or Chem Eng 5310, preceded or accompanied by Chem 1100 or Chem 5100 or an equivalent training program approved by S&T. (Co-listed with Chem 5819).

**MS&E 5850 Introduction to Coating Chemistry** (LEC 3.0)  
Study of the basic principles of protective coatings with particular reference to the paint and varnish industry. Classifications, manufacture, properties and uses of protective coatings. Credit may not be given for both Chem 5850 and Chem 4850. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with Chem 5850).

## Mathematics

**Emphasis areas at the bachelor of science level include actuarial science, algebra/discrete mathematics, applied analysis, computational mathematics, secondary education, and statistics.**

Mathematics is a universal language. It is one which scientists use to express ideas and relationships concisely. It is a tool, which they use to investigate problems.

As a mathematician, you will set up and analyze models of physical situations in order to deduce new information and to predict results.

Most students pursue their study of mathematics through a differential equations course and then elect courses in specialized areas such as algebra, analysis, geometry, topology, and statistics. Supporting study in technical electives is required from other departments. Such study includes analytical mechanics, communication theory, control theory, and others.

Your classes, for the most part, will be held in the Rolla Building. You will be provided data processing and computational services to solve complex problems through the computer facilities. (See computer science description.)

You will find that mathematics contributes to the growth in knowledge in most areas. Your program at Missouri S&T will emphasize breadth in mathematics and depth in an associated area of application.

## Bachelor of Science Applied Mathematics

A minimum of 128 credit hours is required for a bachelor of science degree in applied mathematics. A minimum grade of "C" is required by the department in each course counted toward the math/stat requirement for the B.S. in applied mathematics. Moreover, the department requires that an average of at least two grade points per credit hour must be obtained for all courses taken within the department. These requirements for the B.S. degree are in addition to credit received for algebra, trigonometry, and basic ROTC.

The applied mathematics curriculum requires fifteen semester hours of technical electives, except where this requirement is reduced to compensate for extra requirements of emphasis areas, in addition to basic courses in chemistry or biology, physics, computer science, and economics. Two semesters of language and communication,

ENGLISH 1160 or ENGLISH 3560, and either HISTORY 1300, HISTORY 1310, HISTORY 1200, or POL SCI 1200 are also required. Specific requirements for the bachelor’s degree are outlined in the sample program below.

Freshman Year			
First Semester	Credits	Second Semester	Credits
MATH 1101	1	MATH 1215 or 1221 <sup>1</sup>	4
MATH 1208 or 1214 <sup>1</sup>	4	Science Requirement <sup>5</sup>	5
CHEM 1100	1	COMP SCI 1570, or 1970 <i>and</i> 1980, or 1971 <i>and</i> 1981, or 1972 <i>and</i> 1982 <sup>12</sup>	3
ENGLISH 1120	3	Language and Communication Requirement <sup>3</sup>	3
Campus History Requirement <sup>2</sup>	3	Basic ROTC (if elected) <sup>4</sup>	0
Language and Communication Requirement <sup>3</sup>	3		
Basic ROTC (if elected) <sup>4</sup>	0		
	15		15
Sophomore Year			
First Semester	Credits	Second Semester	Credits
MATH 2222 <sup>1</sup>	4	MATH 3304 <sup>1</sup>	3
MATH 3108 <sup>1</sup>	3	MATH 3109 <sup>1</sup>	3
Statistics Requirement <sup>1,6,7</sup>	3	ECON 1100 or 1200	3
PHYSICS 1135 or 1111 <i>and</i> 1119	4	PHYSICS 2135 or 2111 <i>and</i> 2119	4
ENGLISH 1160 <sup>13</sup>	3	COMP SCI Requirement <sup>7,8</sup>	3
Basic ROTC (if elected) <sup>4</sup>	0	Basic ROTC (if elected) <sup>4</sup>	0
	17		16
Junior Year			
First Semester	Credits	Second Semester	Credits
MATH 4209 <sup>1</sup>	3	MATH 4211 <sup>1</sup>	3
Literature	3	Literature	3
Electives-Math or Stat <sup>1,7,9</sup>	3	Electives-Math or Stat <sup>1,7,9</sup>	3
Electives-Technical <sup>10</sup>	3	Electives-Technical <sup>10</sup>	3
Electives	3	Electives	3
	15		15
Senior Year			
First Semester	Credits	Second Semester	Credits
Capstone Course <sup>1,7,11</sup>	3	Electives-Math or Stat <sup>1,7,9</sup>	3
Electives-Math or Stat <sup>1,7,9</sup>	3	Electives-Technical <sup>10</sup>	3
Electives-Technical <sup>10</sup>	6	Electives	11
Electives	6		
	18		17
Total Credits: 128			

<sup>1</sup> A minimum grade of “C” is required by the department in each course counted toward the math/stat requirement for the B.S. in applied mathematics. Moreover, the department requires that an average of at least two grade points per credit hour must be obtained for all courses taken within the department.

<sup>2</sup> May be met by HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200.

<sup>3</sup> This requirement will be satisfied by either (1) six credits of Speech and Media Studies course work; or (2) a modern language approved by the advisor with competency at the level of second semester college/university course work or, with approval of the department, by completion of Level III of a foreign language in high school.

<sup>4</sup> Basic ROTC may be elected in the freshman and sophomore years, but is not creditable toward a degree. Up to six credit hours of advanced ROTC may be credited as free electives towards a degree.

<sup>5</sup> May be met by CHEM 1310 and CHEM 1319 or by BIO SCI 1113 and BIO SCI 1219.

<sup>6</sup> May be met by STAT 3115, STAT 3117, or STAT 5643.

<sup>7</sup> No course may be used to satisfy more than one degree requirement, except as otherwise noted.

<sup>8</sup> May be met by COMP SCI 1510, COMP SCI 1200 or COMP SCI 3200.

<sup>9</sup> The student must choose two from the following five groups and then complete six hours in each of the chosen groups

1. MATH 5105, MATH 5106, MATH 5107, MATH 5108
2. MATH 5105, MATH 5215, MATH 4530 or MATH 5530, MATH 5351, MATH 5585
3. MATH 5222, MATH 5302, MATH 5325, MATH 5351, MATH 5483, MATH 5603, MATH 5604
4. STAT 5814, STAT 5643, STAT 5644, STAT 5346, STAT 5353, STAT 5755, STAT 5756
5. COMP SCI 3200, COMP SCI 5201, COMP SCI 5202, MATH 5603, MATH 5604, MATH 5737

<sup>10</sup> Courses in chemistry, physics, mechanics, geology, computer science, economics or engineering approved by advisor. The general math curriculum requires 15 credit hours; actuarial science emphasis area, 12 credit hours; algebra/discrete math, 15 credit hours; computational math, 9 credit hours; statistics, 12 credit hours.

<sup>11</sup> The capstone experience for all applied mathematics majors (other than students completing the secondary education emphasis area) consists of a course chosen from the following list: MATH 4098 (three credits), MATH 4099 or STAT 4099 (three credits), MATH 5107, MATH 5215, MATH 5603, STAT 5346, STAT 5353, STAT 5755 or STAT 5756.

<sup>12</sup> COMP SCI 1570 if not transferred in will require COMP SCI 1580, requiring one extra credit hour which will count either towards technical electives or free electives.

<sup>13</sup> May also be satisfied by ENGLISH 3560.

## Emphasis Areas at the Bachelor of Science Level<sup>10</sup>

### Actuarial Science Emphasis Area<sup>10</sup>

Required courses:		
STAT 5643	Probability And Statistics	3
STAT 5644	Mathematical Statistics	3
ECON 1100	Principles Of Microeconomics	3
ECON 1200	Principles Of Macroeconomics	3
ECON 2200	Intermediate Macroeconomic Theory	3
MATH 5737	Financial Mathematics	3
And six hours from:		
STAT 5814	Applied Time Series Analysis	
STAT 5346	Regression Analysis	
STAT 5353	Statistical Data Analysis	
STAT 5755	Statistical Models in Actuarial Science	
STAT 5756	Statistical Models for Life Contingencies	

In addition, the student must pass the first actuarial science exam. Note that the capstone requirement is included in, not separate from, this list of courses.

### Algebra/Discrete Mathematics Emphasis Area<sup>10</sup>

Required courses:

MATH 5105	Modern Algebra I	3
MATH 5106	Modern Algebra II	3
or MATH 6105	Finite Fields And Applications	
MATH 5107	Combinatorics And Graph Theory (Satisfies Capstone requirement)	3
MATH 5108	Linear Algebra II	3
STAT 5643	Probability And Statistics	3
Select one of the following:		3
STAT 5644	Mathematical Statistics	
COMP SCI 2200	Theory of Computer Science	
COMP SCI 3200	Introduction To Numerical Methods	
COMP SCI 5200	Analysis Of Algorithms	

## Computational Mathematics Emphasis Area<sup>10</sup>

Required courses:

STAT 5353	Statistical Data Analysis (Satisfies Capstone requirement)	3
STAT 5346	Regression Analysis	3
COMP SCI 3200	Introduction To Numerical Methods	3
Select three of the following:		
MATH 5302	Intermediate Differential Equations	3
MATH 5325	Partial Differential Equations	3
MATH 5603	Methods of Applied Mathematics	3
MATH 5604	Introduction to Numerical Methods for Differential Equations	3
Select one of the following:		3
COMP SCI 5201	Object-Oriented Numerical Modeling I	3
COMP SCI 5402	Data Mining & Machine Learning	3
MECH ENG 5139	Computational Fluid Dynamics	3
AERO ENG 5139	Computational Fluid Dynamics	3
MECH ENG 5212	Introduction to Finite Element Analysis	3
AERO ENG 5212	Introduction to Finite Element Analysis	3
MECH ENG 5830	Applied Computational Methods	3
AERO ENG 5830	Applied Computational Methods	3

## Applied Analysis Emphasis Area

Required:

COMP SCI 3200	Introduction To Numerical Methods	3
and two of groups 3, 4, and 5 under Mathematics and Statistics electives (plus the Capstone requirement) must be satisfied,		
and choose Technical Electives and Free Electives to satisfy one of the following two options:		

## Engineering Option

Required courses:

CIV ENG 2200	Statics	3
CIV ENG 2210	Mechanics Of Materials	3
Select one of the following:		
MECH ENG 2350	Engineering Mechanics-Dynamics	
MECH ENG 2360	Dynamics	
Select three of the following:		9
Courses, which have any of the listed courses as prerequisites, may also be used to fulfill this requirement.		
AERO ENG 3613	Aerospace Mechanics I	
AERO ENG 5313	Intermediate Dynamics of Mechanical and Aerospace Systems	
AERO ENG 5614	Spaceflight Mechanics	
CHEM ENG 2100	Chemical Engineering Material & Energy Balances	
CHEM ENG 2110	Chemical Engineering Thermodynamics I	
ELEC ENG 2800	Electrical Circuits	
MECH ENG 3313	Machine Dynamics	
MECH ENG 2519	Thermodynamics	
or MECH ENG 2527	Thermal Analysis	

MECH ENG 5131	Intermediate Thermofluid Mechanics *	
NUC ENG 3103	Interactions Of Radiation With Matter	
NUC ENG 4203	Reactor Physics I	
PET ENG 4621	Fundamentals Of Petroleum Reservoir Simulation	
CIV ENG 3330	Engineering Fluid Mechanics	
or NUC ENG 322	Reactor Fluid Mechanics	
or MECH ENG 31	Thermofluid Mechanics I	
CIV ENG 5207	Computer Methods of Structural Analysis	
CIV ENG 5333	Intermediate Hydraulic Engineering	
ELEC ENG 5370	Introduction to Neural Networks and Applications	
MECH ENG 5307	Vibrations I	
MECH ENG 5211	Introduction To Continuum Mechanics	
MECH ENG 5234	Stability of Engineering Structures *	
MECH ENG 5254	Variational Formulations Of Mechanics Problems	
GEO ENG 4115	Statistical Methods in Geology and Engineering	
GEOPHYS 3211	Introduction To Geophysical Data Analysis	
GEOPHYS 3221	Potential Field Theory	

\* Courses with an asterisk (\*) are co-listed in more than one department.

## Physics Option

Required courses:

PHYSICS 2311	Modern Physics I	3
PHYSICS 3311	Modern Physics II	3
And take at least nine additional hours of physics courses at the 2000 level or above.		9

Note that the requirements for a minor in physics will be satisfied with this option.

## Secondary Education Emphasis Area

You may earn a B.S. degree in applied mathematics from Missouri S&T and certification to teach at the secondary level in the schools of Missouri with this emphasis area program. This program can be completed in four academic years and student teaching is arranged with public schools within 30 miles of the Missouri S&T campus.

Students interested in this emphasis area should consult with the advisor for mathematics education majors in the mathematics and statistics department.

In order to successfully complete this emphasis area, students must maintain a cumulative GPA of at least 2.75, and attain at least a 3.0 GPA in all mathematics courses. Current Missouri S&T or transfer students who wish to pursue this emphasis area must meet both these GPA requirements to be accepted into the program. Students must also meet all requirements listed under the teacher education program in the catalog. Students who do not meet all the teacher certification requirements will not be eligible for the secondary education emphasis area, even if they have completed all course work.

A degree in this emphasis area requires 128 credit hours. The required courses and a sample four-year program are provided below. (A minimum grade of "C" is required by the department in all mathematics and statistics courses counted toward this degree. No course may be used to satisfy more than one degree requirement, except as otherwise noted.)

Freshman Year			
First Semester	Credits	Second Semester	Credits
MATH 1101	1	MATH 1215 or 1221	4
MATH 1208 or 1214	4	BIO SCI 1113	3



CHEM 1100	1	BIO SCI 1219 (Science Lab Requirement) <sup>1</sup>	2
ENGLISH 1120	3	PSYCH 1101	3
HISTORY 1300 or 1310	3	EDUC 1164	2
EDUC 1040	2	EDUC 1174	2
EDUC 1104	2		
	16		16

**Sophomore Year**

First Semester	Credits	Second Semester	Credits
MATH 2222	4	MATH 3304	3
MATH 3108	3	MATH 3109	3
PHYSICS 1135 or 1111 <i>and</i> 1119	4	ENGLISH 1160	3
COMP SCI 1570, or 1970 <i>and</i> 1980, or 1971 <i>and</i> 1981, or 1972 <i>and</i> 1982 <sup>5</sup>	3	PHYSICS 2135 or 2111 <i>and</i> 2119	4
SP&M S 1185	3	PSYCH 3311	3
	17		16

**Junior Year**

First Semester	Credits	Second Semester	Credits
MATH 4209	3	MATH 4211	3
STAT 3115, or 3117, or 5643	3	MATH 4530	3
ECON 1100 or 1200	3	EDUC 3280	6
EDUC 2216	3	Fine Art Elective <sup>2</sup>	3
ENGLISH 3170	3	PSYCH 2300 or EDUC 2102	3
	15		18

**Senior Year**

First Semester	Credits	Second Semester	Credits
Electives-Math or Stat <sup>4</sup>	6	EDUC 4298 & EDUC 4299 <sup>3</sup>	13
PSYCH 4310 or EDUC 4310	3		
POL SCI 1200	3		
Literature	3		
Electives	2		
	17		13

Total Credits: 128

<sup>1</sup> May be met by BIO SCI 1219 or CHEM 1319, but if CHEM 1319 is used, one extra hour must be attained in any elective area to fulfill the 128 total hour requirement.

<sup>2</sup> Any three-hour course from the areas of foreign language, music, theater, philosophy or art.

<sup>3</sup> Student Teaching satisfies the capstone requirement for students completing this emphasis area.

<sup>4</sup> p>Any two three-hour courses from the following list with the approval of the mathematics education advisor. MATH 5302, MATH 5105, MATH 5106, MATH 5107, MATH 5108, MATH 5215, MATH 5222, MATH 5325, MATH 5351, MATH 5483, MATH 5585, STAT 5643, STAT 5644, STAT 5346, STAT 5353, COMP SCI 3200, COMP SCI 5201, COMP SCI 5202, MATH 5737.

<sup>5</sup> COMP SCI 1570 if not transferred in will require COMP SCI 1580, requiring one extra credit hour which will count either towards technical electives or free electives.

**Statistics Emphasis Area**<sup>10</sup>

Required courses:

STAT 5643	Probability And Statistics	3
STAT 5644	Mathematical Statistics	3
STAT 5346	Regression Analysis	3

STAT 5353	Statistical Data Analysis (Satisfies Capstone requirement)	3
Select two of the following:		6
BIO SCI 2223	General Genetics	3
COMP SCI 3200	Introduction To Numerical Methods	3
COMP SCI 5402	Data Mining & Machine Learning	3
STAT 5260	Statistical Data Analysis Using SAS	3
STAT 5814	Applied Time Series Analysis	3
And complete either A or B:		6
(A) Complete the following 2 courses:		
MATH 5215	Introduction To Real Analysis	3
MATH 5351	Introduction To Complex Variables	3
(B) Complete 6 hours from:		
MATH 5107	Combinatorics And Graph Theory	3
MATH 5108	Linear Algebra II	3
MATH 5603	Methods of Applied Mathematics	3

**Note:** It is not required that students complete an emphasis area to obtain the bachelor of science degree in applied mathematics. The emphasis area requirements often specify most, if not all, of the electives in mathematics, statistics and computer science as well as many technical or free electives.

**Bioinformatics Minor**

Students majoring in mathematics are eligible to pursue a minor in bioinformatics. See the description of the bioinformatics minor (p. 62).

**Mathematics Minor Curriculum**

The minor will consist of at least 12 hours of mathematics/statistics courses at the 3000 or higher level\*, 9 hours of which must be completed in residence at Missouri S&T and 3 hours of which must be at the 4000 or higher level, and passing all of them with at least a grade of "C". Further, MATH 3304 and MATH 3329 cannot both be counted, MATH 3103 and MATH 3108 cannot both be counted, and at most one of STAT 3111, STAT 3113, STAT 3115 and STAT 3117 may be counted. Finally, the specific choice of courses is subject to the approval of the minor advisor.

\* COMP SCI 3200 Introduction To Numerical Methods may be substituted for one of these courses.

**Akim Mouhamadou Adekpedjou**, Associate Professor  
PHD University of South Carolina Columbia

**Elvan Akin**, Associate Professor  
PHD University of Nebraska Lincoln

**Martin Bohner**, Curators' Distinguished Professor  
PHD University of Ulm, Germany

**Wlodzimierz Jan Charatonik**, Professor  
PHD University of Warsaw, Poland

**Stephen L Clark**, Professor  
PHD Univ. of Tennessee-Knoxville

**Stephanie L Fitch**, Associate Teaching Professor  
MA University of Texas-Austin

**David E Grow**, Associate Professor  
PHD University of Nebraska Lincoln

**Xiaoming He**, Associate Professor  
PHD Virginia Polytechnic Institute

**Wenqing Hu**, Assistant Professor  
PHD University of Maryland-College Park

**Eugene M Insall Jr**, Associate Professor  
PHD University of Houston

**Nan Jiang**, Assistant Professor  
PHD University of Pittsburgh

**Kimberly S Kinder**, Assistant Teaching Professor  
MS Central Missouri State University

**Vy Khoi Le**, Professor  
PHD University of Utah

**Gayla Renee Olbricht**, Assistant Professor  
PHD Purdue University

**Robert L Paige**, Professor  
PHD Colorado State University

**Robert Paul Roe**, Associate Professor  
PHD University of Wyoming

**Paul N Runnion**, Assistant Teaching Professor  
MS University of Missouri-Rolla

**V A Samaranayake**, Curators' Distinguished Teaching Professor  
PHD Kansas State University

**John R Singler**, Associate Professor  
PHD Virginia Polytechnic Institute

**Xuerong (Meggie) Wen**, Associate Professor  
PHD University of Minnesota

**Yanzhi Zhang**, Assistant Professor  
PHD National University of Singapore

**Peizhen Zhu**, Assistant Teaching Professor  
PHD University of Colorado-Denver

**MATH 1000 Special Problems** (IND 0.0-6.0)  
Problems or readings in specific subjects or projects in the department.  
Consent of instructor required.

**MATH 1001 Special Topics** (LEC 0.0 and LAB 0.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**MATH 1101 Introduction To Mathematics** (LEC 1.0)  
Introduction to the department, program of study, methods of study, and an introduction of the various areas of mathematics. Required of fall semester freshman mathematics majors.

**MATH 1103 Fundamentals Of Algebra** (LEC 3.0)  
Basic principles of algebra including the number line and an introduction to equations and inequalities, polynomials, rational expressions, exponents and radicals, the quadratic formula and functions.  
Prerequisite: Entrance requirements.

**MATH 1110 Introduction To Mathematical Ideas** (LEC 3.0)  
A course for non-science majors, including liberal arts and education majors. A study of the nature of mathematics and its relation to western culture, number systems, sets, functions, and selected topics from algebra, computer science and other areas of mathematics. Prerequisite: Two years high school mathematics.

**MATH 1120 College Algebra** (LEC 5.0)  
Contains the same topics as covered in Math 1140, and preceded by a thorough review of the basic principles of algebra. Prerequisite: By placement examination.

**MATH 1140 College Algebra** (LEC 3.0)  
A study of linear equations, rational functions, radicals, quadratic equations, inequalities, determinants, progressions, theory of equations, permutations, combinations, and the binomial theorem. Prerequisite: By placement examination.

**MATH 1160 Trigonometry** (LEC 2.0)  
A study of the trigonometric functions, radian measure, graphing trigonometric functions, identities, trigonometric equations and inverse trigonometric functions. Solutions of general triangles and trigonometric representation of complex numbers are included. Prerequisite: Math 1120 or 1140 with a grade of "C" or better; or by placement exam.

**MATH 1190 Success for Calculus** (LEC 3.0 and LAB 1.0)  
This course focuses on the use of college algebra and trigonometry skills within the context of calculus, providing students with the opportunity to improve their preparedness for future calculus coursework. Pass/Fail only. Prerequisites: Consent of instructor.

**MATH 1208 Calculus With Analytic Geometry I** (LEC 5.0)  
A study of limits, continuity, differentiation and integration of algebraic and trigonometric functions. Applications of these concepts in physical as well as mathematical settings are considered. Credit will only be given for one of Math 1208 or Math 1214. Prerequisites: Math 1160; Math 1120 or 1140, both with a grade of "C"; or better; or by placement exam.

**MATH 1212 Business Calculus** (LEC 3.0 and LAB 1.0)  
Calculus for Bus. & Mgt. Sys, Econ & Finance, or Info. Sci. & Tech; also possibly Bio. Sci, Soc. Sci. or Humanities. Derivatives, optimization, exponential and logarithmic functions, integration, multivariate functions, partial derivatives, Lagrange multipliers, applications. May not be used as a prerequisite for either Math 1215 or Math 1221. Prerequisite: A grade of "C" or better in either 1120 or Math 1140; or by placement exam.

**MATH 1214 Calculus For Engineers I** (LAB 1.0 and LEC 3.0)  
Introduction to limits, continuity, differentiation and integration of algebraic and elementary transcendental functions. Applications in physical science and engineering. Credit will be given for only one of Math 1208 or Math 1214. Math 1214 may be accompanied by Math 1160 with Math department approval. Prerequisites: A grade of "C" or better in both Math 1160 and one of Math 1120 or Math 1140; or by placement exam.

**MATH 1215 Calculus For Engineers II** (LAB 1.0 and LEC 3.0)  
Continuation of Math 1214. Transcendental functions, techniques of integration, sequences, series including power series, polar coordinates, polar and parametric equations. Applications in physical science and engineering. Credit will be given for only one of Math 1215 or Math 1221. Prerequisites: Math 1160 and either Math 1208 or Math 1214 both with a grade of "C" or better; or by placement exam.

**MATH 1221 Calculus With Analytic Geometry II** (LEC 5.0)  
A continuation of Math 8; differentiation and integration of elementary transcendental functions, integration techniques, improper integrals, conic sections, polar coordinates, introduction to sequences and series. Credit will only be given for one of Math 1221 or Math 1215. Prerequisites: Math 1160 and either Math 1208 or Math 1214 both with a grade of "C" or better; or by placement exam.

**MATH 2002 Cooperative Work Training** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry. Variable credit arranged with the advisor. P/F grading option is required and maximum credit per semester is 3 hrs., maximum for entire program is 6 hrs.

**MATH 2222 Calculus with Analytic Geometry III** (LEC 3.0 and LAB 1.0)

An introduction to multivariable calculus. Vector valued functions, curves and surfaces in two and three dimensions, partial differentiation, multiple integration, line and surface integrals, the major theorems of vector calculus, and applications of these ideas are studied. Prerequisites: Math 1215 or Math 1221 with a grade of "C" or better.

**MATH 3000 Special Problems** (IND 0.0-6.0)

Problems or readings in specific subjects or projects in the department. Consent of instructor required.

**MATH 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MATH 3010 Undergraduate Seminar** (SEM 1.0-3.0)

Discussion of advanced or current topics. (Course cannot be used for graduate credit).

**MATH 3103 Matrix Algebra** (LEC 3.0)

Matrix algebra is introduced by means of systems of linear algebraic equations. Gaussian elimination, least squares solutions, orthogonalization, determinants, eigenvalues and an introduction to vector spaces are discussed. Credit will not be given for both Math 3103 and 3108. Prerequisite: Math 2222 with a grade of "C" or better.

**MATH 3108 Linear Algebra I** (LEC 3.0)

Systems of linear equations, matrices, vector spaces, inner products, linear transformations, determinants, and eigenvalues are studied. Prerequisite: Math 1215 or 1221 or 2222 with a grade of "C" or better.

**MATH 3109 Foundations Of Mathematics** (LEC 3.0)

Introduction to mathematical reasoning through an axiomatic development of mathematical systems. Strong emphasis is placed on learning to understand what constitutes a sound mathematical argument. Communication, both written and spoken, is emphasized. Prerequisite: Math 1215 or 1221 with a grade of "C" or better.

**MATH 3304 Elementary Differential Equations** (LEC 3.0)

First order differential equations and linear differential equations of higher order are studied. The Laplace transform and systems of linear equations as well as selected physical applications are covered. Credit will not be given for both Math 3329 and Math 3304. Prerequisite: Math 2222 with a grade of "C" or better.

**MATH 3329 Elementary Differential Equations And Matrix Algebra** (LEC 3.0)

This course is a combination of selected topics from Math 3103 and 3304. Solutions of linear differential equations and systems of linear algebraic equations are emphasized. Credit will not be given for both 3304 and 3329. Prerequisite: Math 2222 with a grade of "C" or better.

**MATH 3921 Teaching Math in Elementary and Middle Schools** (LEC 3.0)

The course presents an overview of how children learn mathematics, various techniques in teaching mathematics, and examples of applying these techniques to specific mathematical concepts (such as geometry, measurement, basic operations, statistics and probability, etc.). Prerequisite: Math 1120 or Math 1140. (Co-listed with Educ 3221).

**MATH 3922 Geometric Concepts for Elementary Teachers** (LEC 3.0)

The course covers methods of teaching the study of points, lines, polygons, similarity, congruence, constructions, and proof in Euclidean Plane Geometry. Transformational geometry and trigonometry are introduced to elementary teachers. Prerequisites: Math 1120 or Math 1140. (Co-listed with Educ 3222).

**MATH 3940 Mathematical Software Applications In The Classroom** (LEC 3.0)

Students will be introduced to a variety of Mathematical Software applications, both PC and calculator based which will aid teachers in presenting concepts and in classroom management. Specific topics covered will be selected based on student interest. Prerequisites: Math 2222 and admission to the MST program.

**MATH 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MATH 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MATH 4010 Undergraduate Seminar** (SEM 1.0-3.0)

Discussion of advanced or current topics. (Course cannot be used for graduate credit).

**MATH 4096 Problem Solving In Pure Mathematics** (LEC 1.0)

Problems from pure mathematics, including analysis, algebra, number theory, set theory, finite mathematics, probability and statistics. Emphasis on identifying or inventing ways to solve problems based on the student's entire mathematics background. Prerequisites: Corequisite Math 4209 and Senior standing.

**MATH 4097 Problem Solving In Applied Mathematics** (LEC 1.0)

Problems from applied mathematics which are open-ended, and do not always have a unique correct solution. Emphasis on developing mathematical models and writing solution narratives, including clarity, analysis, and design. Prerequisites: Math 3109 and Senior standing.

**MATH 4098 Explorations in Pure Mathematics** (LEC 3.0)

Students interested in pure mathematics will be encouraged to use their entire mathematics background as a context for learning about some of the great theorems which have shaped the development of mathematics and solving novel problems in areas such as, but not limited to, analysis, algebra, number theory, set theory, topology, and finite mathematics. Prerequisites: Senior standing; preceded or accompanied by Math 4209.

**MATH 4099 Undergraduate Research** (IND 0.0-6.0)

This course is designed for the undergraduate student who wishes to engage in research. It is not to be used for graduate credit nor for more than six credit hours of undergraduate credit. The subject and credit are to be arranged with the instructor. Prerequisite: Consent of instructor.

**MATH 4209 Advanced Calculus I** (LEC 3.0)

Completeness of the set of real numbers, sequences and series of real numbers, limits, continuity and differentiability, uniform convergence, Taylor series, Heine-Borel theorem, Riemann integral, fundamental theorem of calculus, Cauchy-Riemann integral. Prerequisite: Math 2222 and Math 3109, or a 4000-level or higher mathematics course, or graduate standing.

**MATH 4211 Advanced Calculus II** (LEC 3.0)

Euclidean n-space, differentiation and integration of scalar functions of several variables, maxima and minima theory, change of variables, differentiation and integration of vector functions of several variables, Divergence theorem, Stokes' theorem. Prerequisite: Math 4209.

**MATH 4530 Topics In Geometry** (LEC 3.0)

A survey of non-Euclidean geometries, finite geometries, affine and projective planes, metric postulates for the Euclidean plane, and selected topics. Credit will not be given for both Math 4530 and Math 5530.

Prerequisites: MATH 3108.

**MATH 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MATH 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MATH 5010 Graduate Seminar** (SEM 1.0)

Discussion of advanced or current topics.

**MATH 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**MATH 5099 Graduate Research** (IND 0.0-6.0)

Investigation of an advanced nature leading to the preparation of a MS thesis or dissertation.

**MATH 5105 Modern Algebra I** (LEC 3.0)

Equivalence relations and functions, basic properties of groups, subgroups, permutations, cosets and Lagrange's Theorem, homomorphisms and isomorphisms, factor groups. Prerequisite: Math 3109 or graduate standing; preceded or accompanied by Math 3108.

**MATH 5106 Modern Algebra II** (LEC 3.0)

This course is a continuation of Math 5105. Rings and fields are discussed. Euclidean domains, principal ideal domains, unique factorization domains, vector spaces, finite fields and field extensions are studied. Prerequisite: Math 5105.

**MATH 5107 Combinatorics And Graph Theory** (LEC 3.0)

Covers some basics of enumeration and graph theory. Topics are selected from the following: permutations combinations, the inclusion/exclusion principle, generating functions, recurrence relations, trees, networks, graph connectivity and graph coloring. Prerequisite: Comp Sci 1200 or Math 3109.

**MATH 5108 Linear Algebra II** (LEC 3.0)

Eigenvalue problems, Cayley-Hamilton theorem, Jordan normal form, linear functionals, bilinear forms, quadratic forms, orthogonal and unitary transformations, selected applications of linear algebra. Prerequisite: Math 3108.

**MATH 5154 Mathematical Logic I** (LEC 3.0)

A mathematical introduction to logic with some applications. Functional and relational languages, satisfaction, soundness and completeness theorems, compactness theorems. Examples from Mathematics, Philosophy, Computer Science, and/or Computer Engineering. Prerequisite: Philos 3254 or Math 5105 or Comp Sci 2500 or Comp Eng 2210. (Co-listed with Comp Eng 5803, Comp Sci 5203 and Philos 4354).

**MATH 5215 Introduction To Real Analysis** (LEC 3.0)

Riemann-Stieltjes integration, sequences and series of functions, uniform approximation, the Banach Space  $C(a,b)$ , Lebesgue measure and integration, the space  $LP(a,b)$ , Fourier series. Prerequisite: Math 4209.

**MATH 5222 Vector And Tensor Analysis** (LEC 3.0)

Vector algebra, vector differential and integral calculus, line and surface integrals, theorems of Stokes and Gauss, tensor algebra and tensor analysis, applications to problems in kinematics, elasticity theory, fluid mechanics, electromagnetic theory, relativity theory. Prerequisite: Math 2222; Math 3103 or Math 3108.

**MATH 5302 Intermediate Differential Equations** (LEC 3.0)

Linear differential equations, vector-matrix systems, existence and uniqueness theory, nonlinear systems, phase-plane analysis, introduction to stability theory. Prerequisite: Math 3304 or Math 3329.

**MATH 5325 Partial Differential Equations** (LEC 3.0)

Linear equations, heat equation, eigenfunction expansions, Green's formula, inhomogeneous problems, Fourier series, wave equation. Prerequisite: Math 3304 with a grade of "C" or better.

**MATH 5351 Introduction To Complex Variables** (LEC 3.0)

The basic tools of complex variables are studied. These include the Cauchy-Riemann equations, complex contour integration, the Cauchy-Goursat theorem, conformal mappings, the calculus of residues and applications to boundary value problems. Prerequisite: Math 3304.

**MATH 5483 Operational Calculus** (LEC 3.0)

The Laplace transformation, properties of the transformation, various applications to ordinary and partial differential equations, systems with step and Dirac functions as driving forces, various non-elementary functions and their transforms, problems in heat conduction and wave motion, Fourier transforms and their operational properties. Prerequisite: Math 3304.

**MATH 5530 Topics in Geometry - Graduate Option** (LEC 3.0)

A survey of non-Euclidean geometries, finite geometries, affine and projective planes, metric postulates for the Euclidean plane, and selected topics. Students will demonstrate graduate-level mastery of the subject matter. Credit will not be given for both Math 4530 and Math 5530. Prerequisites: MATH 3108.

**MATH 5585 Introduction To Topology** (LEC 3.0)

Metric spaces; general topological spaces; connectedness, compactness, separation properties, functions and continuity. Prerequisite: Math 4209.

**MATH 5603 Methods of Applied Mathematics** (LEC 3.0)

Methods to develop and analyze mathematical models. Topics include dimensional analysis and scaling, perturbation methods, and the construction of ordinary and partial differential equation models. Prerequisites: Math 3304 or 3329 with a grade of "C" or better, programming competency.

**MATH 5604 Introduction to Numerical Methods for Differential Equations** (LEC 3.0)

An introduction to finite difference methods for ordinary and partial differential equations, including (1) the derivation of the numerical methods, (2) implementation of the methods in Matlab, and (3) the mathematical accuracy and stability analysis of the methods. Prerequisites: MATH 3304 and programming competency (preferably Matlab).

**MATH 5737 Financial Mathematics** (LEC 3.0)

The course objective is to provide an understanding of the fundamental concepts of financial mathematics. Topics include pricing, assets-liability management, capital budgeting, valuing cash flow, bonds, futures, swaps, options. Preparation for the financial mathematics actuarial exam will be provided. Prerequisites: Math 1215 or Math 1221, Econ 2100 or Econ 2200 or Finance 2150 or Finance 5160, Stat 3111 or Stat 3113 or Stat 3115 or Stat 3117 or Stat 5643. (Co-listed with Econ 5337).



**MATH 5940 Mathematical Analysis For Secondary Teachers** (LEC 3.0)

Designed to help teachers gain a deeper understanding of the fundamental idea in analysis, that of a limit. A discovery method is used which includes both individual and group work. Students will present their results in written and oral format. Prerequisite: Math 2222 or equivalent.

**MATH 5948 Mathematical Analysis For Secondary Teachers Practicum** (LEC 1.0)

An instructional unit based on the discovery method used in Math 340 will be designed by each student. These units will be class tested. The unit and results of class testing will be presented both in written and oral format. Prerequisite: Math 5940.

## Mechanical Engineering

**Emphasis areas at all levels in control systems, energy conversion, environmental systems, instrumentation, manufacturing processes, materials science, mechanical design and analysis, and thermal science.**

The mechanical engineering program is offered in the department of mechanical and aerospace engineering.

Mechanical engineering has broad applications and is one of the most basic of all branches of engineering.

As a mechanical engineer you will be concerned with the conversion and transfer of energy from one form to another; with the design, construction, and operation of all types of machines; and with the selection and design of instrumentation and systems for the control of all types of physical and environmental systems.

You may design products and manufacturing processes, supervise production methods and operations, design and supervise fabrication and testing of individual machines and complete plants, or be involved in applied or basic research.

In your first few semesters as a mechanical engineering student, you will develop a sound background in the fundamental sciences of mathematics, physics, and chemistry, and you will take a broad selection of liberal arts courses. You will also learn to work with computers. Onto this foundation you will add the basic required courses of engineering sciences and technology including stress analysis, machine design, machine dynamics, electricity, electronics, control theory, thermodynamics, heat transfer, energy conversion, fluid mechanics, computer-aided engineering (CAE), and computer-aided design (CAD).

To provide some degree of specialization for those students who are interested in a particular area of mechanical engineering, there are nine hours of technical electives that you can select to concentrate in an emphasis area (such as robotics, manufacturing automation, fluid mechanics, heat transfer, dynamics and controls, solid mechanics, vibrations, and design). If you are interested in getting some background in a closely allied field such as aerospace, petroleum, or nuclear engineering, you can, with the aid of your advisor, select some of your desired technical electives in those fields.

## Mission Statement

We will provide a rigorous, productive, and relevant academic learning environment for students, faculty, and staff in the mechanical and aerospace engineering department by continually focusing on our core missions of teaching, research, and service.

We will ensure that graduating students are well-educated and sufficiently prepared in the fundamentals of mechanical and aerospace

engineering practice and science, such that they have the ability to solve open-ended problems in these disciplines and the capabilities required in order to become competent, productive, and well-rounded professionals.

We will emphasize scholarship, graduate education, and the development of new knowledge and skills in the traditional areas associated with mechanical and aerospace engineering. Additionally, we will develop cross-cutting multi-disciplinary efforts such that we are widely recognized by local, national, and international research and business communities as respected leaders in research, innovation, and discovery.

We will render meritorious service to our profession through active participation and engagement in service activities in our professional communities at all levels (local, national, and international), as well as in fulfilling campus and departmental governance, outreach, and service activities.

## Program Educational Objectives

The mechanical engineering program seeks to prepare its graduates for the following early career and professional accomplishments in their employment by industry, government agencies, academia, or private practice:

- Demonstrated engineering competence, successfully contributing within their career fields with increasing levels of responsibility and influence
- Continuous growth in knowledge and capability, within the mechanical engineering field as well as across interdisciplinary boundaries

It is the goal of the program that graduates will be personally satisfied with how their education from Missouri S&T prepared them for their career.

## Student Outcomes

1. Students graduating from this program should have:
  - A. an ability to apply knowledge of mathematics, science, and engineering
  - B. an ability to design and conduct experiments, as well as to analyze and interpret data
  - C. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
  - D. an ability to function on multidisciplinary teams
  - E. an ability to identify, formulate, and solve engineering problems
  - F. an understanding of professional and ethical responsibility
  - G. an ability to communicate effectively
  - H. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
  - I. a recognition of the need for, and an ability to engage in life-long learning
  - J. a knowledge of contemporary issues
  - K. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
  - L. an ability to work professionally in both thermal and mechanical systems areas

## Bachelor of Science Mechanical Engineering

Entering freshmen desiring to study mechanical engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a mechanical engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major.

For the bachelor of science degree in mechanical engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. An average of at least two grade points per credit hour must also be attained in all courses taken in mechanical engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1. All students are required to take one history course, one economics course, one humanities course, and ENGLISH 1120. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200. The humanities course must be selected from "The Approved List of Humanities and Social Science Courses for Engineering Degrees" maintained by the Office of Undergraduate Studies.
2. Depth requirement. Three credit hours must be taken in humanities or social sciences at the 2000-level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 1180 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 4000-level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.
3. The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to ENGLISH 1120.
4. Special topics and special problems and honors seminars are allowed only by petition to and approval by the student's department chair.

The mechanical engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

Freshman Year			
First Semester	Credits	Second Semester	Credits
FR ENG 1100	1	ECON 1100 or 1200	3
CHEM 1310 <sup>a</sup>	4	MECH ENG 1720	3

ENGLISH 1120	3	PHYSICS 1135 <sup>a</sup>	4
HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3	MATH 1215 <sup>a, b</sup>	4
CHEM 1319	1	Elective-Hum or Soc Sci <sup>f</sup>	3
MATH 1214 <sup>a, b</sup>	4		

16 17

Sophomore Year			
First Semester	Credits	Second Semester	Credits
MATH 2222 <sup>a</sup>	4	MECH ENG 2761	3
Programming Elective <sup>a, c</sup>	3	MECH ENG 2519 <sup>a</sup>	3
CIV ENG 2200 <sup>a</sup>	3	MECH ENG 2360 <sup>a</sup>	3
PHYSICS 2135 <sup>a</sup>	4	MATH 3304 <sup>a</sup>	3
MECH ENG 2653	3	MET ENG 2110 <sup>a</sup>	3

17 15

Junior Year			
First Semester	Credits	Second Semester	Credits
MECH ENG 3313	3	MECH ENG 3411 <sup>a</sup>	3
MECH ENG 3521	3	MECH ENG 3131	3
ELEC ENG 2800	3	MECH ENG 4840	2
CIV ENG 2210 <sup>a</sup>	3	Elective-Communications <sup>d</sup>	3
CIV ENG 2211	1	MECH ENG 3708	3
Elective-Advanced Math/Stat or Comp Sci <sup>e</sup>	3	MECH ENG 3525	3

16 17

Senior Year			
First Semester	Credits	Second Semester	Credits
MECH ENG 4842	2	ENG MGT 1100	1
MECH ENG 4479	3	ENG MGT 1210	2
MECH ENG technical elective <sup>g</sup>	3	MECH ENG 4761	3
Literature elective <sup>f</sup>	3	MECH ENG 4480	1
Technical elective <sup>h</sup>	3	MECH ENG 5000-level technical elective <sup>g</sup>	3
Elective-Advanced Hum or Soc Sci <sup>f</sup>	3	Breadth elective <sup>i</sup>	3

17 13

Total Credits: 128

**Note:** Students must satisfy the common engineering freshman year course requirements, and be admitted into the department, in addition to the sophomore, junior and senior year requirements listed above with a minimum of 128 hours.

- A grade of "C" or better is required in CHEM 1310, MATH 1214, MATH 1215, MATH 2222, MATH 3304, PHYSICS 1135, PHYSICS 2135, programming elective, MET ENG 2110, CIV ENG 2200, CIV ENG 2210, MECH ENG 2519, MECH ENG 2360, and MECH ENG 3411, both as prerequisite for follow-up courses in the curriculum and for graduation.
- MATH 1208 and MATH 1221 may be substituted for MATH 1214 and MATH 1215, respectively.
- The programming elective consists of a lecture and lab combination, and may be selected from COMP SCI 1970/COMP SCI 1980, COMP SCI 1971/COMP SCI 1981, or COMP SCI 1972/COMP SCI 1982, or COMP SCI 1570/COMP SCI 1580. Note that COMP SCI 1570/COMP SCI 1580 requires one more credit hour than the other options.

- d This course must be selected from the following: ENGLISH 1160, ENGLISH 3560 or SP&M S 1185, or the complete four course sequence in Advanced ROTC (MIL ARMY 3250, MIL ARMY 3500, MIL ARMY 4250, and MIL ARMY 4500; or MIL AIR 3110, MIL AIR 3120, MIL AIR 4110 and MIL AIR 4120).
- e This course must be selected from the following: COMP SCI 3200, MATH 3103, MATH 3108, STAT 3113, STAT 3115 or any 5000-level math or computer science course approved by the student's advisor.
- f All electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog.
- g Six hours of technical electives, subject to approval by the student's advisor, must be in the department of mechanical and aerospace engineering. At least three of these technical elective hours must be at the 5000 level. This elective may not include co-op, special problems, or research credits, such as as 3002, 4000, or 4099. Honors students have special requirements for technical electives.
- h This elective must be a three credit hour course, subject to approval by the student's advisor, from any of the following areas: math, statistics, science, engineering, or computer science. The course must be at the 3000 or higher level, or have a prerequisite that is part of the required mechanical engineering curriculum. Exceptions to the course level may be approved by the student's advisor. The elective may not include co-op, special problems, or research credits, such as 3002, 4000, or 4099.
- i This elective consists of three credit hours, subject to approval by the student's advisor, and may be satisfied by any of the following: (1) A three credit hour course from any of the following areas: math, statistics, science, engineering, computer science, business, or IST. The course must be at the 3000 or higher level, or have a prerequisite that is part of the required mechanical engineering curriculum. Exceptions to the course level may be approved by the student's advisor; (2) Any three credit hour course in the list of approved courses for the global studies minor; or (3) Any combination of three credit hours from co-op (3002), special problems (3000, 4000, or 5000), research (4099), or design team credit (ENG MGT 2011, 2012, or 2013).
- j All mechanical engineering students must take the Fundamentals of Engineering Examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree. However, it is the first step toward becoming a registered professional engineer. This requirement is part of the Missouri S&T assessment process as described in assessment requirements found elsewhere in this catalog. Students must sign a release form giving the university access to their Fundamentals of Engineering Examination score.

## Energy Conversion Emphasis Area for Mechanical Engineering

Students desiring to obtain a bachelor of science degree in mechanical engineering with an emphasis area in energy conversion must satisfy all the requirements of the bachelor of science degree in mechanical engineering, with the additional stipulation that four courses must be taken as follows:

a. Two courses from the following list:	6
MECH ENG 5527 Combustion Processes	3
or AERO ENG 5527 Combustion Processes	
MECH ENG 5533 Internal Combustion Engines	3
MECH ENG 5566 Solar Energy Technology	3

MECH ENG 5567	Heat Pump And Refrigeration Systems	3
MECH ENG 5571	Environmental Controls	3
MECH ENG 5575	Mechanical Systems For Environmental Control	3
AERO ENG 5169	Introduction to Hypersonic Flow	3
AERO ENG 5535	Aerospace Propulsion Systems	3
b. One course from the following list:		3
MECH ENG 5519	Advanced Thermodynamics	3
or AERO ENG 5519	Advanced Thermodynamics	
MECH ENG 5525	Intermediate Heat Transfer	3
or AERO ENG 5525	Intermediate Heat Transfer	
MECH ENG 5131	Intermediate Thermofluid Mechanics	3
or AERO ENG 5131	Intermediate Thermofluid Mechanics	
MECH ENG 5139	Computational Fluid Dynamics	3
or AERO ENG 5139	Computational Fluid Dynamics	
c. One additional course from either list "a" or list "b", or from the following list:		3
ECON 4540	Energy Economics	3
ELEC ENG 5150	Photovoltaic Systems Engineering	3
ENV ENG 5660	Introduction To Air Pollution	3
NUC ENG 4257	Two-phase Flow in Energy Systems - I	3

**Note:** By using the breadth elective and technical electives to satisfy the above requirements, this emphasis area requires the same total number of credit hours as the BSME degree. A change of major form should be submitted to designate the energy conversion emphasis area.

## Manufacturing Processes Emphasis Area for Mechanical Engineering

Students desiring to obtain a bachelor of science in mechanical engineering with an emphasis area in manufacturing processes must satisfy all requirements of the bachelor of science in mechanical engineering with the additional stipulation that four courses must be taken as follows:

a. The following course:	3
MECH ENG 3653 Manufacturing	3
b. One course from the following Manufacturing/Automation courses:	3
MECH ENG 5653 Computer Numerical Control of Manufacturing Processes	3
MECH ENG 5655 Manufacturing Equipment Automation	3
MECH ENG 5449 Robotic Manipulators and Mechanisms	3
MECH ENG 5606 Material Processing By High-Pressure Water Jet	3
c. One course from the following Design courses:	3
MECH ENG 5763 Principles And Practice Of Computer Aided Design	3
MECH ENG 5656 Design For Manufacture	3
MECH ENG 5702 Synthesis Of Mechanisms	3
d. One course from the following list:	3
MECH ENG 5708 Rapid Product Design And Optimization	3
MECH ENG 5758 Integrated Product Development	3
e. The Math/Stat elective must be one of the following:	3
STAT 3113 Applied Engineering Statistics	3
STAT 3115 Engineering Statistics	3

A suggested sequence for the junior and senior years is given below. Note that by using the breadth elective and technical electives to satisfy the above requirements, this emphasis area requires the same total number of credit hours as the BSME degree. A change of major form should be submitted to designate the manufacturing processes emphasis area.

Junior Year			
First Semester	Credits	Second Semester	Credits
MECH ENG 3313	3	MECH ENG 3411 <sup>a</sup>	3

ELEC ENG 2800	3	MECH ENG 3131	3
MECH ENG 3521	3	MECH ENG 3525	3
CIV ENG 2210 <sup>a</sup>	3	MECH ENG 4840	2
CIV ENG 2211	1	MECH ENG 3653	3
STAT 3113 or 3115	3	Elective-Communications <sup>d</sup>	3
16		17	

**Senior Year**

First Semester	Credits	Second Semester	Credits
MECH ENG 4842	2	ENG MGT 1100	1
MECH ENG 4479	3	ENG MGT 1210	2
MECH ENG 3708	3	MECH ENG 4761	3
Manufacturing Technical Elective <sup>f</sup>	3	MECH ENG 4480	1
Manufacturing Technical Elective <sup>f</sup>	3	Manufacturing Technical Elective <sup>f</sup>	3
Elective Literature	3	Electives-Hum or Soc Sci	3
17		13	

Total Credits: 63

- a A grade of "C" or better is required in CHEM 1310, MATH 1214, MATH 1215, MATH 2222, MATH 3304, PHYSICS 1135, PHYSICS 2135, programming elective, MET ENG 2110, CIV ENG 2200, CIV ENG 2210, MECH ENG 2519, MECH ENG 2360 and MECH ENG 3411, both as prerequisite for follow-up courses in the curriculum and for graduation.
- b MATH 1208 and MATH 1221 may be substituted for MATH 1214 and MATH 1215, respectively.
- c The programming elective consists of a lecture and lab combination, and may be selected from COMP SCI 1970/COMP SCI 1980, COMP SCI 1971/COMP SCI 1981, COMP SCI 1972/COMP SCI 1982, or COMP SCI 1570/COMP SCI 1580. Note that COMP SCI 1570/COMP SCI 1580 requires one more credit hour than the other options.
- d This course must be selected from the following: ENGLISH 1160, ENGLISH 3560 or SP&M S 1185, or the complete four course sequence in Advanced ROTC (MIL ARMY 3250, MIL ARMY 3500, MIL ARMY 4250, and MIL ARMY 4500; or MIL AIR 3110, MIL AIR 3120, MIL AIR 4110 and MIL AIR 4120).
- e To include at least one course in literature. All electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog.
- f The nine hours of manufacturing technical elective must be selected as follows:  
One course from the following manufacturing/automation courses: MECH ENG 5653, MECH ENG 5655, MECH ENG 5449, MECH ENG 5606.  
One of the following design courses:  
MECH ENG 5763, MECH ENG 5656, MECH ENG 5702.  
One course from the following list: MECH ENG 5708, MECH ENG 5758.
- g All mechanical engineering students must take the Fundamentals of Engineering Examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree, however, it is the first step toward becoming a registered professional engineer. This requirement is part of the Missouri S&T assessment process as described in Assessment Requirements found elsewhere in this catalog. Students must sign a release form giving the university access to their Fundamentals of Engineering Examination score.

## Mechanical Design and Analysis Emphasis Area

Students desiring to obtain a bachelor of science in mechanical engineering with an emphasis area in mechanical design and analysis must satisfy all requirements of the bachelor of science in mechanical engineering, with the additional stipulation that four courses must be taken as follows:

a. One design course from the following list:		3
MECH ENG 5709	Machine Design II	3
MECH ENG 5702	Synthesis Of Mechanisms	3
MECH ENG 5704	Compliant Mechanism Design	3
MECH ENG 5708	Rapid Product Design And Optimization	3
MECH ENG 5715	Concurrent Engineering	3
MECH ENG 5656	Design For Manufacture	3
MECH ENG 5757	Integrated Product And Process Design	3
MECH ENG 5760	Probabilistic Engineering Design	3
MECH ENG 5763	Principles And Practice Of Computer Aided Design	3
MECH ENG 5761	Engineering Design Methodology	3
b. One analysis course from the following list:		3
MECH ENG 5307	Vibrations I	3
MECH ENG 5211	Introduction To Continuum Mechanics	3
MECH ENG 5212	Introduction to Finite Element Analysis	3
MECH ENG 5313	Intermediate Dynamics Of Mechanical And Aerospace Systems	3
MECH ENG 5222	Introduction To Solid Mechanics	3
MECH ENG 5238	Fatigue Analysis	3
MECH ENG 5449	Robotic Manipulators and Mechanisms	3
MECH ENG 5478	Mechatronics	3
c. Two additional courses from either of the previous lists.		6

Note that by using the breadth elective and technical electives to satisfy the above requirements, this emphasis area requires the same total number of credit hours as the BSME degree. A change of major form should be submitted to designate the mechanical design and analysis emphasis area.

**Darryl Alofs**, Emeritus Professor  
PHD University of Michigan at Ann Arbor

**Xavier Avula**, Emeritus Professor  
PHD Iowa State University

**Clark Barker**, Emeritus Professor  
PHD University of Illinois

**Charles Benjamin Basye**, Emeritus Professor<sup>1</sup>  
PHD Iowa State University

**Victor Birman**, Professor  
PHD Technion, Haifa, Israel

**Douglas A Bristow**, Associate Professor  
PHD University of Illinois Urbana-Champaign

**Douglas Carroll**, Professor  
PHD University of Missouri-Rolla

**K Chandrashekara**, Curators Professor  
PHD Virginia Polytechnic Institute

**Ta-Shen Chen**, Curators Professor Emeritus  
PHD University of Minnesota



**Lianyi Chen**, Assistant Professor  
PHD Zhejiang University

**Donald Cronin**, Emeritus Professor  
PHD California Institute of Technology

**Alfred Linden Crosbie**, Curators Professor  
PHD Purdue University

**L R Dharani**, Curators Professor  
PHD Clemson University

**James A Drallmeier**, Curator's Teaching Professor  
PHD University of Illinois Urbana-Champaign

**Xiaoping Du**, Professor  
PHD University of Illinois at Chicago

**Lian Duan**, Assistant Professor  
PHD Princeton University

**Charles Edwards**, Emeritus Professor<sup>1</sup>  
PHD University of Arkansas

**Walter Eversman**, Professor Emeritus<sup>1</sup>  
PHD Stanford University

**Jie Gao**, Assistant Professor  
PHD Columbia University

**Kelly O Homan**, Associate Professor  
PHD University of Illinois Urbana-Champaign

**Ronald Howell**, Emeritus Professor<sup>1</sup>  
PHD University of Illinois

**Ryan S Hutcheson**, Associate Teaching Professor  
PHD Texas A&M University-College Station

**Edward C Kinzel**, Assistant Professor  
PHD Purdue University

**Leslie Koval**, Emeritus Professor<sup>1</sup>  
PHD Cornell University

**Umit O Koylu**, Professor  
PHD University of Michigan

**K Krishnamurthy**, Professor  
PHD Washington State University

**Nishant Kumar**, Associate Teaching Professor  
PHD New Mexico State University

**Robert G Landers**, Professor  
PHD University of Michigan

**Shen Ching Lee**, Emeritus Professor<sup>1</sup>  
PHD University of Washington

**Terry Lehnhoff**, Emeritus Professor<sup>1</sup>  
PHD University of Illinois

**Ming C Leu**, Professor  
PHD University of California-Berkeley

**Fue-Wen Frank Liou**, Professor  
PHD University of Minnesota at Twin Cities

**Dwight Look**, Emeritus Professor  
PHD University of Oklahoma

**Gearoid P MacSithigh**, Associate Professor  
PHD University of Minnesota

**Robert Medrow**, Emeritus Professor  
PHD University of Illinois

**Warner Meeks**, Assistant Teaching Professor  
PHD Missouri University of Science and Technology

**Ashok Midha**, Professor  
PHD University of Minnesota at Twin Cities

**J Keith Nisbett**, Associate Professor  
PHD University of Texas-Arlington

**Robert Oetting**, Emeritus Professor<sup>1</sup>  
PHD University of Maryland

**Anthony Chukwujekwu Okafor**, Professor  
PHD Michigan Technological University

**Heng Pan**, Assistant Professor  
PHD University of California-Berkeley

**Jonghyun Park**, Assistant Professor  
PHD University of Michigan-Ann Arbor

**Josef Podzimek**, Emeritus Professor  
PHD Charles University, Prague

**Jillian Schmidt**, Assistant Teaching Professor  
PHD University of Minnesota

**John Sheffield**, Emeritus Professor  
PHD North Carolina State University

**Yun Seong Song**, Assistant Professor  
PHD Massachusetts Institute of Technology

**Daniel S Stutts**, Associate Professor  
PHD Purdue University

**Hai-Lung Tsai**, Professor  
PHD University of California-Berkeley

**Cheng Wang**, Assistant Professor  
PHD University of Illinois at Urbana-Champaign

**Xiaodong Yang**, Assistant Professor  
PHD Columbia University

**MECH ENG 1720 Introduction to Engineering Design** (LAB 1.0 and LEC 2.0)  
Introduction to a systematic approach to engineering design (problem clarification, concept generation, concept selection, prototyping methods, engineering ethics) and fundamental design communication techniques. Computer aided design tools are introduced to assist in design analysis.

**MECH ENG 2001 Special Topics** (IND 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**MECH ENG 2340 Statics and Dynamics** (LEC 3.0)

An introduction to the principles of mechanics pertaining to problems of equilibrium, motion, and acceleration in two dimensions. Particle and rigid body equilibrium and applications; general planar motion; force, mass, and acceleration; impulse/ momentum; work/energy. This course will not satisfy the prerequisite for Civ Eng 2210. Prerequisites: A grade of "C" or better in Physics 1135 or Physics 1111; preceded or accompanied by Math 2222.

**MECH ENG 2350 Engineering Mechanics-Dynamics** (LEC 2.0)

Application of the principles of mechanics to engineering problems of motion and acceleration. Topics include plane motion; force, mass and acceleration; work and energy; and impulse and momentum. Prerequisites: A grade of "C" or better in each of Civ Eng 2200 and Math 2222.

**MECH ENG 2360 Dynamics** (LEC 3.0)

The principles of mechanics are used to model engineering systems. Kinematics of particle motion, kinematics of plane- and three-dimensional motions of rigid bodies. Kinetics of particles and of rigid bodies. Energy and momentum methods. Prerequisite: Grade of "C" or better in each of Civ Eng 2200, Math 2222. (Co-listed with Aero Eng 2360).

**MECH ENG 2519 Thermodynamics** (LEC 3.0)

Energy transformations and the relation of energy to the status of matter. Fundamental laws, concepts, and modes of analysis which underlie all applications of energy conversion in engineering. Prerequisites: A grade of "C" or better in each of Comp Sci 1570 or Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972, Math 1214 (or Math 1208), Math 1215 (or Math 1221), Math 2222, and Physics 1135.

**MECH ENG 2527 Thermal Analysis** (LEC 3.0)

Basic principles of thermodynamics and heat transfer. First and second laws of thermodynamics and applications to engineering systems. Fundamentals of heat transfer by conduction, convection, and radiation with applications. Not for mechanical engineering majors. Prerequisites: Math 1215 (or 1221), Physics 1135.

**MECH ENG 2653 Introduction To Manufacturing Processes** (LEC 2.0 and LAB 1.0)

Introduction into the fundamentals of manufacturing processes. Welding, joining, casting, forming, powder metallurgy and material removal are covered. The material is presented in a descriptive fashion with emphasis on the fundamental working of the processes, their capabilities, applications, advantages and limitations. Prerequisite: Mech Eng 1720.

**MECH ENG 2761 Introduction To Design** (LEC 2.0 and LAB 1.0)

Introduces the process of design with emphasis on creativity and design visualization. Solid modeling is presented as a design tool. The solid modeling environment will also be used to reinforce the concepts of tolerancing, dimensioning, and multiview representation. Concurrent engineering will be introduced in a group design project. Prerequisites: Mech Eng 1720, Mech Eng 2653, preceded or accompanied by Civ Eng 2200; a grade of "C" or better in each of Math 1214 (or 1208), Physics 1135.

**MECH ENG 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MECH ENG 3002 Cooperative Engineering Training** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation.

**MECH ENG 3010 Seminar** (LEC 1.0)

Discussion of current topics.

**MECH ENG 3131 Thermofluid Mechanics I** (LEC 3.0)

Principles of viscous and inviscid flow in ducts, nozzles, diffusers, blade passages and application to design; dimensional analysis and laws of similarity; external flows; compressible flows. Prerequisite: A grade of "C" or better in Mech Eng 2519.

**MECH ENG 3313 Machine Dynamics** (LEC 3.0)

Motion analysis using vector methods is considered for machine elements including linkages, cams, and gears. Dynamic force analysis methods are applied to balancing, flywheels, and single and multicylinder engines. Prerequisites: A grade of "C" or better in each of Comp Sci 1570 or Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972, Mech Eng 2360 (or Aero Eng 2360), Math 1214 (or Math 1208), Math 1215 (or Math 1221), Math 2222, and Physics 1135.

**MECH ENG 3411 Modeling and Analysis of Dynamic Systems** (LEC 3.0)

Concepts of modeling mechanical systems as linear systems are studied and applied to hydraulic, pneumatic, and electromechanical systems. Analysis techniques described include matrix formulations, Laplace transforms, and time domain response methods. Prerequisites: A grade of "C" or better in each of Comp Sci 1570 or Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972, Mech Eng 2360 (or Aero Eng 2360), Math 1214 (or Math 1208), Math 1215 (or Math 1221), Math 2222, Math 3304, Physics 1135, Physics 2135.

**MECH ENG 3521 Applied Thermodynamics** (LEC 3.0)

Extended study of the laws and concepts of thermodynamics with emphasis on applications to power and refrigeration cycles, gas mixtures, psychrometrics, behavior of real gases and combustion processes. Prerequisite: A grade of "C" or better in Mech Eng 2519.

**MECH ENG 3525 Heat Transfer** (LEC 3.0)

Fundamental principles of heat transmission by radiation, conduction and convection; application of these principles to the solution of engineering problems. Prerequisites: A grade of "C" or better in each of Comp Sci 1570 or Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972, Math 3304, Mech Eng 2519.

**MECH ENG 3653 Manufacturing** (LEC 3.0)

Advanced analytical study of metal forming and machining processes such as forging, rolling, extrusion, wire drawing and deep drawing; mechanics of metal cutting - orthogonal, turning, milling, cutting temperature, cutting tool materials, tool wear and tool life, and abrasive processes. Prerequisites: Mech Eng 2653, Civ Eng 2211, and a grade of "C" or better in Civ Eng 2210.

**MECH ENG 3708 Machine Design I** (LEC 3.0)

Analysis of machine elements such as shafts, springs, screws, belts, bearings, and gears; analytical methods for the study of fatigue; comprehensive treatment of failure, safety, and reliability. Introduction to finite element methods in mechanical design. Prerequisites: Mech Eng 2653; accompanied or preceded by Mech Eng 2761; Met Eng 2110 or Aero Eng 3877; and a grade of "C" or better in Civ Eng 2210.

**MECH ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MECH ENG 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MECH ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**MECH ENG 4479 Automatic Control Of Dynamic Systems** (LEC 3.0)

Use of classical control methods to analyze mechanical systems. Topics include root locus, Bode plots, and Nyquist diagrams. Applications to design situations are examined. Prerequisite: A grade of "C" or better in Mech Eng 3411.

**MECH ENG 4480 Control System Laboratory** (LAB 1.0)

Experiments dealing with data acquisition, manipulation, and control of systems with particular emphasis on computer data acquisition and control applied to mechanical engineering systems. Microcomputer systems are used as measurement and control devices. Prerequisites: Preceded or accompanied by Mech Eng 4479.

**MECH ENG 4761 Engineering Design** (LEC 1.0 and LAB 2.0)

Real-life design projects emphasize problem definition, conceptualization, modeling, approximation techniques and optimization. Teamwork, communication, leadership and group discussions are encouraged. Student group and professional expert presentations bring awareness to diverse design issues and methodology, and professional engineering practice. Prerequisites: Preceded or accompanied each of Mech Eng 3708, 3525, 3131, 4479.

**MECH ENG 4840 Mechanical Instrumentation** (LAB 2.0)

A basic course in the theory and application of instrumentation to typical measurement problems in mechanical and aerospace engineering. Experiments employing basic devices to measure quantities such as strain, pressure, force, temperature, motion, flow, sound level are performed. Accepted procedures for recording, interpretation, and presentation of experimental results are illustrated. Prerequisites: A grade of "C" or better each of Math 3304, Mech Eng 2519, Physics 2135.

**MECH ENG 4842 Mechanical Engineering Systems** (LAB 2.0)

A laboratory course focusing on experimental design and evaluation of complete mechanical engineering systems. Analysis of both mechanical and thermodynamic systems is included. Emphasis is on evaluating system performance and improving student written and oral communication skills. Prerequisites: Mech Eng 4840, 3521, 3131, 3525, 3313.

**MECH ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MECH ENG 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title. (Co-listed with Aero Eng 5001).

**MECH ENG 5131 Intermediate Thermofluid Mechanics** (LEC 3.0)

Derivation of Navier-Stokes equations, analytical solutions of viscous flows; flow in pipes, flow networks; intermediate treatment of boundary layer theory; micro-fluidics and MEMS; introduction to numerical methods for solving fluid flows; and, preliminary treatise on turbulence. Prerequisite: Mech Eng 3131 or Aero Eng 3131. (Co-listed with Aero Eng 5131).

**MECH ENG 5135 Fluid Machinery** (LEC 3.0)

Fundamental investigation of positive displacement and turbomachinery including pumps, fans, compressors, turbines, and oil hydraulic systems. Operating characteristics, selection, and comparison of types are studied. Prerequisite: Mech Eng 3131 or Aero Eng 5135.

**MECH ENG 5139 Computational Fluid Dynamics** (LEC 3.0)

Introduction to the numerical solution of the Navier-Stokes equations, by finite difference methods, in both stream function-vorticity and primitive variable formulations. Course format emphasizes student development of complete computer programs utilizing a variety of solution methods. Prerequisites: Comp Sci 1570 or 1970 or 1971; one course in fluid mechanics. (Co-listed with Aero Eng 5139).

**MECH ENG 5205 Lubrication** (LEC 3.0)

Development of basic principles of bearing analysis including manufacture and properties of lubricants, hydrodynamics and hydrostatic lubrication, journal and thrust bearings, ball and roller bearings, boundary considerations, and bearing materials. Prerequisite: Mech Eng 3131.

**MECH ENG 5211 Introduction To Continuum Mechanics** (LEC 3.0)

Introductory cartesian tensor analysis to aid in the development of the theory of a continuum. Kinematics of deformation, stress tensor, equations of motion, equations of mass and energy balance. Examples from specific material theories in solid and fluid mechanics. Prerequisites: Civ Eng 2210, Math 3304.

**MECH ENG 5212 Introduction to Finite Element Analysis** (LEC 3.0)

Variational formulation of the governing equations. Finite element model, interpolation functions, numerical integration, assembly of elements and solution procedures. Applications to solid mechanics, fluid mechanics and heat transfer problems. Two-dimensional problems. Computer implementation and use of commercial finite element codes. Prerequisite: Mech Eng 3708 or Aero Eng 4253 or consent of instructor for majors that do not require either of these courses, or graduate standing. (Co-listed with Aero Eng 5212).

**MECH ENG 5214 Applications Of Numerical Methods To Mechanics Problems** (LEC 3.0)

Numerical solutions of statics, vibrations, and stability problems. Direct stiffness formulations are developed and user-oriented computer codes are used to solve practical structures problems. Computer graphics techniques are utilized to prepare data and display results. Prerequisites: Civ Eng 2210; Mech Eng 2360 or Aero Eng 2360.

**MECH ENG 5220 Advanced Mechanics of Materials** (LEC 3.0)

Comprehensive insight into mechanics of materials. Topics to include: theories of failure, torsion of noncircular sections, shear flow and shear center, unsymmetric bending, bending of curved members, beams on elastic foundation and pressurization of thick walled cylinders. Prerequisites: Civ Eng 2210, Math 3304. (Co-listed with Aero Eng 5220).

**MECH ENG 5222 Introduction To Solid Mechanics** (LEC 3.0)

Review of basic concepts in continuum mechanics. Finite elasticity: some universal solutions for isotropic materials, application of special mechanical models. Linear elasticity: compatibility, stress functions, superposition, special examples such as extension, torsion, bending, and plane problems. Elements of plasticity. Prerequisite: Mech Eng 5211. (Co-listed with Aero Eng 5222).

**MECH ENG 5229 Smart Materials And Sensors** (LEC 2.0 and LAB 1.0)

Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multi-disciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior standing and Math 3304. (Co-listed with Aero Eng 5229, Elec Eng 5270 and Civ Eng 5118).

**MECH ENG 5234 Stability of Engineering Structures** (LEC 3.0)

Solution of stability problems with applications to columns, plates and shell structures. Torsional and lateral buckling of columns. Buckling under high temperatures. Effect of imperfections introduced by a technological process on stability. Design issues related to stability requirements. Prerequisites: Civ Eng 2210; Math 3304; and Mech Eng 2350 or Mech Eng 2360 or Aero Eng 2360. (Co-listed with Aero Eng 5234).

**MECH ENG 5236 Fracture Mechanics** (LEC 3.0)

Linear elastic and plastic mathematical models for stresses around cracks; concepts of stress intensity; strain energy release rates; correlation of models with experiment; determination of plane stress and plane strain parameters; application to design. Prerequisite: Civ Eng 2210. (Co-listed with Aero Eng 5236).

**MECH ENG 5238 Fatigue Analysis** (LEC 3.0)

The mechanism of fatigue, fatigue strength of metals, fracture mechanics, influence of stress conditions on fatigue strength, stress concentrations, surface treatment effects, corrosion fatigue and fretting corrosion, fatigue of joints, components and structures, design to prevent fatigue. Prerequisite: Civ Eng 2210. (Co-listed with Aero Eng 5238).

**MECH ENG 5254 Variational Formulations Of Mechanics Problems** (LEC 3.0)

Introduction and study of variational problems in classical dynamics and solid mechanics emphasizing the concepts of virtual work, minimum potential energy, and complementary energy. Variational inequalities. Prerequisites: Civ Eng 2210; Math 3304; and Mech Eng 2350 or Mech Eng 2360 or Aero Eng 2360. (Co-listed with Eng Mech 354).

**MECH ENG 5282 Introduction to Composite Materials & Structures** (LEC 3.0)

Introduction to fiber-reinforced composite materials and structures with emphasis on analysis and design. Composite micromechanics, lamination theory and failure criteria. Design procedures for structures made of composite materials. An overview of fabrication and experimental characterization. Prerequisite: Civ Eng 2210. (Co-listed with Aero Eng 5282).

**MECH ENG 5283 Industrial Applications Of Composite Materials Technology** (LEC 3.0)

Composite materials-industrial applications. Fibers and matrices. Fabrication and NDI. Lamination theory overview. Composite joints. Postbuckling. Fatigue and environmental effects. Testing and certification of composite structures. A majority of the presentations will be made by engineers in the industry. Prerequisite: Civ Eng 2210. (Co-listed with Eng Mech 303).

**MECH ENG 5307 Vibrations I** (LEC 3.0)

Equations of motion, free and forced vibration of single degree of freedom systems and multidegree of freedom systems. Natural frequencies, resonance, modes of vibration and energy dissipation are studied. The vibration of continuous systems is introduced. Prerequisites: Mech Eng 3411 and 3313, or Aero Eng 3613 and Math 3304. (Co-listed with Aero Eng 5307).

**MECH ENG 5309 Engineering Acoustics I** (LEC 3.0)

Introduction to acoustical theory and measurement with emphasis on mechanical and aerospace engineering applications. Plane and spherical wave propagation, resonators and filters, absorption, room acoustics, human response to noise, noise legislation, noise control. Use of common instrumentation in several projects. Prerequisites: Mech Eng 3411 and 3313, or Aero Eng 3613 and Math 3304. (Co-listed with Aero Eng 5309).

**MECH ENG 5313 Intermediate Dynamics Of Mechanical And Aerospace Systems** (LEC 3.0)

Principles of dynamics are applied to problems in the design of mechanical and aerospace systems; basic concepts in kinematics and dynamics; dynamics of systems of particles; dynamics of rigid bodies, three-dimensional effects in machine elements; dynamic stability, theory and applications; methods of analytical dynamics. Prerequisite: Mech Eng 3313 or Aero Eng 3613. (Co-listed with Aero Eng 5313).

**MECH ENG 5420 Signal Processing for Instrumentation and Control** (LEC 3.0)

The course presents fundamental techniques for analysis and processing of experimental data and real-time signals. Continuous- and discrete-time development of signal spectra, Fourier Transform, convolution, filter design, and system identification. The emphasis is on practical problems that arise in instrumentation and control applications. Prerequisites: Math 3304; Mech Eng 3411 or permission of instructor for non-Mech Eng majors.

**MECH ENG 5449 Robotic Manipulators and Mechanisms** (LAB 1.0 and LEC 2.0)

Overview of industrial applications, manipulator systems and geometry. Manipulator kinematics; hand location, velocity and acceleration. Basic formulation of manipulator dynamics and control. Introduction to machine vision. Projects include robot programming, vision-aided inspection and guidance, and system integration. Prerequisites: Mech Eng 3313; Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972 or Comp Sci 1570. (Co-listed with Aero Eng 5449).

**MECH ENG 5478 Mechatronics** (LEC 2.0 and LAB 1.0)

This course will introduce students to the basics of mechatronics (i.e., the integration of mechanical, electrical, computer, and control systems). Students will learn the fundamentals of sensors and actuators for mechanical systems, computer interfacing, microcontrollers, real-time software, and control. Prerequisite: Mech Eng 4479 or equivalent. (Co-listed with Aero Eng 5478, Elec Eng 5870 and Comp Eng 5820).

**MECH ENG 5481 Mechanical And Aerospace Control Systems** (LEC 3.0)

Synthesis of mechanical and aerospace systems to perform specific control functions. Response and stability are studied. Singular value analysis for stability margins is introduced. Prerequisite: Mech Eng 4479 or Aero Eng 3361. (Co-listed with Aero Eng 5481).

**MECH ENG 5519 Advanced Thermodynamics** (LEC 3.0)

After a short review of classical thermodynamics, the elements of chemical reactions, chemical equilibrium, statistical thermodynamics, and the basic concepts of kinetic theory are presented. Prerequisite: Mech Eng 2519. (Co-listed with Aero Eng 5519).

**MECH ENG 5523 Transport Phenomena In Manufacturing Processes** (LEC 3.0)

A study of the important role that transport phenomena (heat and mass transfer and fluid flow) play during various manufacturing processes including metal casting, joining and welding extrusion, forging, crystal growth, chemical deposition, and thermal spray deposition. Prerequisites: Mech Eng 3525 and 3131.

**MECH ENG 5525 Intermediate Heat Transfer** (LEC 3.0)

Analytical study of conduction; theory of thermal radiation and applications; energy and momentum equations in convective heat transfer and review of empirical relations. Current topics are included. Prerequisite: Mech Eng 3525. (Co-listed with Aero Eng 5525).



**MECH ENG 5527 Combustion Processes** (LEC 3.0)

Application of chemical, thermodynamic, and gas dynamic principles to the combustion of solid, liquid, and gaseous fuels. Includes stoichiometry, thermochemistry, reaction mechanism, reaction velocity, temperature levels, and combustion waves. Prerequisite: Mech Eng 3521. (Co-listed with Aero Eng 5527).

**MECH ENG 5533 Internal Combustion Engines** (LEC 3.0)

A course dealing primarily with spark ignition and compression ignition engines. Topics include: thermodynamics, air and fuel metering, emissions and their control, performance, fuels, and matching engine and load. Significant lecture material drawn from current publications. Prerequisite: Mech Eng 3521.

**MECH ENG 5537 Fuel Cell Principles** (LEC 3.0)

Fuel cell fundamentals including thermodynamics, reaction kinetics, mass transport, characterization, and modeling are discussed. Different types of fuel cells such as proton exchange membrane and solid oxide are covered together with subsystem design and system integration as well as environmental impacts. Prerequisites: MECH ENG 3521.

**MECH ENG 5541 Applied Energy Conversion** (LEC 3.0)

The study of the principles of energy conversion. Specific applications include fuel cells and other direct energy conversion devices used in plug-in hybrid electric vehicles. Prerequisite: Mech Eng 3521.

**MECH ENG 5544 Non-Intrusive Measurement Methods** (LEC 3.0)

Fundamentals of non-contact measurement methods for engineers. Basic engineering optics with a focus on radiation measurement methods including the effects of various sources and detectors. Prerequisites: Phys 2135; Mech 3525 or consent of instructor for non-Mech Eng majors.

**MECH ENG 5566 Solar Energy Technology** (LEC 3.0)

Introduction to the nature of solar radiation and associated thermal energy transfers. Methods of collecting and storing solar energy. Analysis and design of systems for utilizing solar energy, including heating and cooling. Prerequisite: Mech Eng 3525, or consent of instructor for non-Mech Eng majors.

**MECH ENG 5567 Heat Pump And Refrigeration Systems** (LEC 3.0)

The various methods used in the thermal design and analysis of both refrigeration and heat pumps systems are investigated. Various methods of producing heating and cooling are examined including vapor compression, absorption, air cycle, steam jet, and thermoelectric systems. Prerequisites: Mech Eng 3521, 3525.

**MECH ENG 5570 Plasma Physics I** (LEC 3.0)

Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Aero Eng 5570, Nuc Eng 4370, Physics 4543).

**MECH ENG 5571 Environmental Controls** (LEC 3.0)

Theory and applications of principles of heating, ventilating, and air conditioning equipment and systems; design problems. Physiological and psychological factors relating to environmental control. Prerequisites: Mech Eng 3521 and accompanied or preceded by Mech Eng 3525; or Mech Eng 2527 and Civ Eng 3330. (Co-listed with Arch Eng 5872).

**MECH ENG 5575 Mechanical Systems For Environmental Control** (LEC 3.0)

Analysis of refrigeration, heating, and air-distribution systems. Synthesis of environmental control systems. Prerequisites: Mech Eng 3521 and 3525; or Mech Eng 2527 and Civ Eng 3330.

**MECH ENG 5606 Material Processing By High-Pressure Water Jet** (LEC 3.0)

Methods of generating high pressure water jets; standard equipment, existing techniques, and basic calculations. Application of water jets to materials cutting and mineral processing. Safety rules. The course will be supported by laboratory demonstrations. Prerequisite: Mech Eng 3131 or undergraduate fluids course. (Co-listed with Min Eng 4413).

**MECH ENG 5644 Interdisciplinary Problems In Manufacturing Automation** (LEC 2.0 and LAB 1.0)

The course will cover material necessary to design a product and the fixtures required to manufacture the product. Participants will gain experience with CAD/CAM software while carrying out an actual manufacturing design project. (Co-listed with Chem Eng 4310, Eng Mgt 5315).

**MECH ENG 5653 Computer Numerical Control of Manufacturing Processes** (LEC 2.0 and LAB 1.0)

Fundamental theory and application of computer numerical controlled machine tools from the viewpoint of design principles, machine structural elements, control systems, and programming. Projects include manual and computer assisted part programming and machining. Prerequisites: Preceded or accompanied by Mech Eng 3653.

**MECH ENG 5655 Manufacturing Equipment Automation** (LEC 2.0 and LAB 1.0)

Manufacturing automation at the equipment level. Topics include sensors, actuators, and computer interfacing for manufacturing equipment, dynamic modeling and control of manufacturing equipment, interpolation, coordinated motion control, kinematic and geometric error modeling, and runout. Prerequisites: Preceded or accompanied by Mech Eng 4479 or equivalent.

**MECH ENG 5656 Design For Manufacture** (LEC 3.0)

Course covers the approach of concurrent product and process design. Topics includes: principle of DFM, New product design process, process capabilities and limitations, Taguchi method, tolerancing and system design, design for assembly and AI techniques for DFM. Prerequisites: Mech Eng 3708, Mech Eng 3653.

**MECH ENG 5702 Synthesis Of Mechanisms** (LEC 3.0)

Synthesis of planar mechanisms for function generation, path generation, and motion generation. Emphasis is on analytical methods for synthesis. Prerequisite: Mech Eng 3313.

**MECH ENG 5704 Compliant Mechanism Design** (LEC 3.0)

Introduction to compliant mechanisms; review of rigid-body mechanism analysis and synthesis methods; synthesis of planar mechanisms with force/energy constraints using graphical and analytical methods; pseudo-rigid-body models; force-deflection relationships; compliant mechanism synthesis methods; and special topics, e.g. bistable mechanisms, constant-force mechanisms, parallel mechanisms, and chain algorithm in design. Emphasis will be on applying the assimilated knowledge through a project on compliant mechanisms design. Prerequisites: Mech Eng 3313, Civ Eng 2210.

**MECH ENG 5708 Rapid Product Design And Optimization** (LEC 3.0)

Product Life cycle design; Finding design solutions using optimization technique; Rapid product realization using rapid prototyping and virtual prototyping techniques. Prerequisite: Mech Eng 3708.

**MECH ENG 5709 Machine Design II** (LEC 3.0)

A continuation of the study of machine elements; bearings, spur, bevel, worm, and helical gearing, and indeterminate machine elements; impact and shrink stresses. Prerequisite: Mech Eng 3708.

**MECH ENG 5715 Concurrent Engineering** (LEC 3.0)

Students will be introduced to the concurrent engineering approach to product development. They will learn to set up quantitative requirements and then use a quantitative rating process to identify the critical requirements relating to the desired product. The interaction between design, manufacturing, assembly, cost, and supportability will be covered. The students will form teams and practice the concurrent engineering process for simple products. Prerequisites: Mech Eng 3313 or Aero Eng 3131, and Civ Eng 2210. (Co-listed with Aero Eng 5715).

**MECH ENG 5757 Integrated Product And Process Design** (LEC 3.0)

Emphasize design policies of concurrent engineering and teamwork, and documenting of design process knowledge. Integration of product realization activities covering important aspects of a product life cycle such as "customer" needs analysis, concept generation, concept selection, product modeling, process development, and end of product life options. Prerequisites: Junior or above standing. (Co-listed with ENG MGT 5515).

**MECH ENG 5758 Integrated Product Development** (LEC 1.0 and LAB 2.0)

Students in design teams will simulate the industrial concurrent engineering development process. Areas covered will be design, manufacturing, assembly, process quality, cost, supply chain management, and product support. Students will produce a final engineering product at the end of the project. Prerequisite: Eng Mgt 5515 or Mech Eng 5757 or Mech Eng 3653 or Mech Eng 5708. (Co-listed with Eng Mgt 5516).

**MECH ENG 5760 Probabilistic Engineering Design** (LEC 3.0)

The course deals with uncertainties in engineering analysis and design at three levels - uncertainty modeling, uncertainty analysis, and design under uncertainty. It covers physics-based reliability analysis and reliability-based design, robustness assessment and robust design, their integration with design simulations, and their engineering applications. Prerequisite: Mech Eng 3708 or Aero Eng 3361. (Co-listed with Aero Eng 5760).

**MECH ENG 5761 Engineering Design Methodology** (LEC 3.0)

This course examines structured engineering design theory and methodologies for conceptual design and redesign of products. Topical coverage includes customer needs gathering, functional modeling, engineering specifications creation (OFD), concept generation, selection and design embodiment. Team work/hands-on projects emphasized. Prerequisite: At least Senior standing in engineering.

**MECH ENG 5763 Principles And Practice Of Computer Aided Design** (LEC 2.0 and LAB 1.0)

Lectures cover the fundamentals of computer-aided design with emphasis on geometric modeling of curves, surfaces and solids, CAD/CAM data exchange, and computer graphics. In the lab session, students practice with commercial CAD/CAM systems including NX and SolidWorks to gain practical experience. Prerequisites: Comp Sci 1570 or Comp Sci 1970 or Comp Sci 1971, Mech Eng 2761, Math 2222, at least Junior standing.

**MECH ENG 5764 Introduction to Decision Analysis** (LEC 3.0)

This course is an introduction to decision analysis, a decision-making method under uncertainty. The course topics include probability theory, influence diagram, decision tree, subjective probability, sensitivity analysis, value of information, risk attitude, and utility models. Prerequisite: Stat 3111 or Stat 3113 or Stat 3115 or Stat 3117.

**MECH ENG 5830 Applied Computational Methods** (LEC 3.0)

Detailed study of computational methods for efficient solution of selected fluids, structures, thermodynamics, and controls problems in aerospace and mechanical engineering. Besides basic numerical techniques, topics covered include gradient-based optimization and uncertainty quantification. Prerequisite: Comp Sci 1570 or 1970 or 1981; Math 3304. (Co-listed with Aero Eng 5830).

## Metallurgical Engineering

Metallurgical engineering is one of two B.S. degrees offered by the materials science and engineering department. Metallurgical engineering is a broad discipline that studies metals production and recycling, the manufacturing of components from metals and alloys, the processing and treatment of metals to achieve improved properties, and the design of metallic materials for specific applications. Missouri S&T has one of the largest and most comprehensive metallurgical engineering programs in the United States. It is the only such program in Missouri or in any of the surrounding states.

The field of metallurgical engineering starts with the production and recycling of metals such as aluminum, steel, copper, magnesium and titanium. Once these metals are made, metallurgical engineers design forming and processing techniques to transform these metals into useful shapes with the properties required for their application. For example, light-weight magnesium is cast to make cell phones, zinc-coated steel is stamped to make corrosion resistant auto bodies, aluminum is formed to make the strong but lightweight wings of jet aircraft, tungsten powder is consolidated and drawn into filaments for incandescent light bulbs, and steel I-beams are hot-rolled for the construction of skyscrapers. Metallurgical engineers control the properties of metallic materials by altering the microscopic structure with alloying additions and special treatments. This approach leads to products such as corrosion-resistant stainless steels, ultra-lightweight alloys for aircraft, wear-resistant alloys for engines, and shape-memory alloys for space structures. In addition, investigating material failures and monitoring service life are tasks that are performed by metallurgists.

Although all metallurgical engineering students take the same basic required courses in metallurgical engineering, students can select several technical electives to emphasize their particular area of interest. Students are also encouraged to undertake summer and cooperative training employment to supplement both their academic studies and incomes.

The department is housed in McNutt Hall and has outstanding facilities for both classroom and laboratory learning. There are several optical and electron microscopes, a well equipped metals casting and joining laboratory, and comprehensive metal testing facilities. The department continuously upgrades its facilities for classroom and laboratory learning. The department has also enhanced its computer applications laboratory with the addition of new software and computers, and improved network access. Additional information is available at <http://mse.mst.edu/>.

## Mission Statement

The mission of the program is to provide a quality, comprehensive undergraduate and graduate education in the traditional areas of metallurgical engineering. The major program goal is to produce a bachelor of science graduate with a sound fundamental knowledge and extensive hands-on technical, communication, and leadership skills, capable of contributing in any technical area associated with metallurgy.

The program is also committed to a strong graduate program, which ensures significant research activity, an active and involved faculty, and a robust, healthy environment for education. The provision of service course work for students in other engineering disciplines is also an important goal, as is interaction with professional societies and industry to promote continuing education, research, and technical information transfer. The utilization of the departmental resources to assist the state agencies and industry of Missouri and the mid-west is an integral part of the departmental mission.

The program educational objectives of the metallurgical engineering program:

- Our graduates will be leaders in the science, technology, and management of metallurgical engineering
- Our graduates will serve their profession and society
- Our graduates will continually enhance their professional skills and educational background

The specific outcomes of the metallurgical engineering program are:

- Ability to apply mathematical, science and engineering principles to metallurgical systems
- An ability to utilize experimental, statistical and computational methods to solve metallurgical problems
- Ability to design a system, component, or process to meet desired needs
- Ability to function on diverse teams
- Ability to identify, formulate, and solve engineering problems
- Understanding of professional and ethical responsibility
- Ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global and societal context
- Recognition of the need for, and an ability to engage in life-long learning
- Knowledge and understanding of contemporary issues
- Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- Integrated understanding of scientific and engineering principles of metals structure
- Integrated understanding of scientific and engineering principles of metals properties
- Integrated understanding of scientific and engineering principles of metals processing
- Integrated understanding of scientific and engineering principles of metals performance
- Ability to apply and integrate knowledge of structure, properties, processing and performance to metals selection and process design

## Bachelor of Science Metallurgical Engineering

Entering freshmen desiring to study metallurgical engineering will be admitted to the Freshman Engineering Program. They will be permitted to state a metallurgical engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering program is on enhanced advising and career counseling, with the goal of providing to the student the

information necessary to make an informed decision regarding the choice of a major.

For the bachelor of science degree in metallurgical engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. A student must maintain an average of at least two grade points per credit hour in metallurgical engineering.

The metallurgical engineering curriculum contains a required number of hours in humanities and social sciences as specified by the Engineering Accreditation Commission of ABET. Each student's program of study must contain a minimum of 18 credit hours of course work from the humanities and the social sciences areas and should be chosen according to the following rules:

1. All students are required to take one American history course and one economics course. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200.
2. Of the remaining hours, six credit hours must be taken in humanities or social sciences from the approved list of humanities and social science (HSS) courses posted on the undergraduate studies website (<http://ugs.mst.edu/>). Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 4000 level.)
3. Special topics, special problems courses and honors seminars are allowed only by petition to and approval by the student's department chair.

Freshman Year			
First Semester	Credits	Second Semester	Credits
FR ENG 1100	1	CHEM 1320	3
CHEM 1310	4	MATH 1215	4
CHEM 1319	1	PHYSICS 1135	4
MATH 1214	4	Hum/Soc Sci Elective <sup>1</sup>	3
ENGLISH 1120	3	MECH ENG 1720	3
Hum/Soc Sci Elective <sup>1</sup>	3		
		16	17

Sophomore Year			
First Semester	Credits	Second Semester	Credits
PHYSICS 2135	4	CER ENG 3230	3
MATH 2222	4	CIV ENG 2210	3
MET ENG 2110	3	MET ENG 2125	2
CIV ENG 2200	3	MET ENG 3130	3
Hum/Soc Sci Elective <sup>1</sup>	3	MET ENG 3420	3
		MET ENG 3425	1
		17	15

Junior Year			
First Semester	Credits	Second Semester	Credits
MET ENG 3320	3	MET ENG 3225	1
MATH 3304 <sup>2</sup>	3	MET ENG 3220	3
MET ENG 3120	3	CER ENG 3410	3
MET ENG 3125	2	Core Elective <sup>4</sup>	3
MET ENG 4420	3	Out of Department Technical Elective <sup>3</sup>	3
Communication Elective <sup>1</sup>	3	Hum/Soc Sci Elective <sup>1</sup>	3
		17	16

**Senior Year**

First Semester	Credits	Second Semester	Credits
MET ENG 4096	3	MET ENG 4097	3
Statistics Course <sup>2</sup>	3	Hum/Soc Sci Elective <sup>1</sup>	3
MET ENG 4350	3	Technical Elective <sup>5</sup>	3
Core Elective <sup>4</sup>	3	Free Elective <sup>6</sup>	3
Technical Elective <sup>5</sup>	3	Core Elective <sup>4</sup>	3
	15		15

Total Credits: 128

- <sup>1</sup> Eighteen hours of required H/SS electives of which three hours must be history (HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200), three hours of economics (ECON 1100 or ECON 1200) and three hours communications (ENGLISH 1160, ENGLISH 3560, or SP&M S 1185)
- <sup>2</sup> All metallurgical engineering students must take MATH 3304 and one statistics course (STAT 3113 or STAT 3115)
- <sup>3</sup> CHEM ENG 5320, CHEM 2210 or CHEM 2310 or CHEM 3410 or CHEM 4810, ELEC ENG 2100 & ELEC ENG 2101 or ELEC ENG 2800, GEOLOGY 2610, MATH 5603 or MATH 5325, MECH ENG 5212 or MECH ENG 5220 or MECH ENG 5229 or MECH ENG 5236 or MECH ENG 5238 or MECH ENG 5282, MIN ENG 2412, PHYSICS 2305 or PHYSICS 2311, STAT 5120 or STAT 5346 or STAT 5353.
- <sup>4</sup> Metallurgical Core Electives (9 hours): Core Elective I - Introduction to Particulate Materials (MET ENG 5150) or Corrosion And Its Prevention (MET ENG 4230), Core Elective II - Steelmaking (MET ENG 4450) or Steels And Their Treatment (MET ENG 4320), Core Elective III - Intro to ICME (CER ENG 4410) or Phase Equilibria (CER ENG 3220) or Refractories (CER ENG 5250) or Chemistry and Inherent Properties of Polymers (CHEM 4810).
- <sup>5</sup> Technical Electives (MET ENG or approved listing)
- <sup>6</sup> Free Electives (3 hours)-algebra, trigonometry, basic ROTC, and courses considered remedial excluded

**Mohsen Asle Zaeem**, Assistant Professor  
PHD Washington State University

**F Scott Miller**, Teaching Professor  
PHD University of Missouri-Rolla

**Michael Scott Moats**, Associate Professor  
PHD University of Arizona

**Joseph W Newkirk**, Associate Professor  
PHD University of Virginia

**Matthew J O'Keefe**, Professor  
PHD University of Illinois Urbana

**Ronald J O'Malley**, Professor  
PHD Massachusetts Institute of Technology

**Von L Richards**, Professor  
PHD University of Michigan-Ann Arbor

**Mark E Schlesinger**, Professor  
PHD University of Arizona

**David C Van Aken**, Curators Teaching Professor  
PHD University of Illinois Urbana

**Caizhi Zhou**, Assistant Professor  
PHD Iowa State University

**MET ENG 1017 Introduction To Metallurgical Engineering** (LEC 1.0)  
Introduction to the field of metallurgical engineering with specific reference to the emphasis areas of extractive, manufacturing and physical metallurgy. The course will include lectures, videos and field trips to local industry.

**MET ENG 1027 Computer Application In Metallurgical Engineering** (LEC 2.0 and LAB 1.0)

Introduction to the use of microcomputers for simulation, data analysis including statistics, data acquisition from laboratory instruments, and automatic process control systems. The course will provide instruction in programming and software usage, and the laboratory will enable students to fully utilize the potential of microcomputer in later courses.

**MET ENG 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MET ENG 2110 Metallurgy For Engineers** (LEC 3.0)

Introduction to the structure and properties of metals and alloys and to processes used to modify the structure and properties of metallic materials, including alloying, deformation and heat treating. Prerequisite: Preceded or accompanied by Chem 1310, prior or concurrent.

**MET ENG 2125 Microstructural Development Laboratory** (LAB 1.0 and LEC 1.0)

Investigation of the relationships between microstructures, and processing for various materials. Prerequisite: Accompanied or preceded by Met Eng 3130.

**MET ENG 2410 Applied Metal Forming** (LEC 1.0 and LAB 1.0)

Introduction to the art and science of blacksmithing. Students to use forges to heat steel for shaping it. Techniques for shaping, cutting, chiseling, twisting, etc. Knowledge of hand and power tools and their use. Safety in the shop will be emphasized. History of blacksmithing will also be covered. Includes a lab portion which will work on projects. Prerequisite: Chem 1100.

**MET ENG 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MET ENG 3001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MET ENG 3002 Cooperative Training** (IND 1.0-2.0)

On-the-job experience gained through cooperative education in the field of metallurgical engineering with credit arranged through department cooperative advisor. A pass/fail grade will be given based on the quality of reports submitted and work supervisor's evaluation.

**MET ENG 3120 Fundamentals Of Materials Behavior** (LEC 3.0)

An introduction to crystal defects and deformation; mechanical testing; creep; fracture mechanics and fatigue. Prerequisite: "C" or better grade in both Met Eng 2110 and Civ Eng 2210.

**MET ENG 3125 Mechanical Testing of Materials** (LAB 1.0 and LEC 1.0)

Deformation of materials and mechanical testing of materials; tensile testing, creep; impact testing; fracture mechanics and fatigue. Prerequisite: "C" or better in Met Eng 2110 and preceded or accompanied by Met Eng 3120.



**MET ENG 3130 Metals Microstructural Development** (LEC 3.0)

Fundamentals of microstructural developments as relating to solid solutions, solidification and transformations; phase diagrams; case studies. Prerequisites: "C" or better grade in MET ENG 2110; accompanied or preceded by CER ENG 3230.

**MET ENG 3220 Introduction To Extractive Metallurgy** (LEC 3.0)

Production and refining of metals by pyrometallurgy, hydrometallurgy, and electrometallurgy. Emphasis on heat and mass balance calculations for the unit processes of metals extraction. Introduction to the principles of combustion, heat utilization and recovery. Prerequisites: A grade of "C" or better in either Chem 1320 or Met Eng 1210. Preceded or accompanied by Met Eng 3330 or Cer Eng 3230 or Chem Eng 2210.

**MET ENG 3225 Extractive Metallurgy Laboratory** (LAB 1.0)

A series of laboratory experiments designed to illustrate the principles of pyrometallurgy, hydrometallurgy, and electrometallurgy. Prerequisite: Preceded or accompanied by Met Eng 3220.

**MET ENG 3320 Transport Phenomena In Metallurgy** (LEC 3.0)

The application of the principles of fluid flow and heat transfer to the solution of practical problems in metallurgical engineering. Prerequisite: "C" or better grade in Civ Eng 2200.

**MET ENG 3330 Metallurgical Thermodynamics I** (LEC 3.0)

Thermodynamic laws and thermodynamic functions and their relation to problems of metallurgical interest, thermochemistry, thermophysics, and chemical or phase equilibria. Prerequisite: Met Eng 1210 or Chem 1320.

**MET ENG 3420 Principles Of Materials Processing** (LEC 3.0)

An introduction to various methods of processing of metals and influences of processing on design. Includes: casting, welding, shaping, inspection and testing. Prerequisite: "C" or better grade in Met Eng 2110.

**MET ENG 3425 Metals Processing** (LAB 1.0)

Laboratory study of the methods of processing of metals. Prerequisite: Accompanied or preceded by Met Eng 3420.

**MET ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MET ENG 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MET ENG 4002 Cooperative Training** (IND 1.0-2.0)

On-the-job experience gained through cooperative education in the field of metallurgical engineering with credit arranged through department cooperative advisor. A pass/fail grade will be given based on the quality of reports submitted and work supervisor's evaluation.

**MET ENG 4010 Seminar** (IND 0.0-3.0)

Discussion of current topics.

**MET ENG 4096 Materials Senior Design I** (LEC 3.0)

Overview of the methods, approaches, and techniques required to execute materials related capstone senior design projects. Formation of teams, assignment of projects, review of department curriculum concepts and topics, and comprehensive project management skills needed to complete projects will be used as means to learn the design process. Prerequisites: Met Eng 3125 and Met Eng 2125, or Cer Eng 3315 with a "C" or better. (Co-listed with Cer Eng 4096).

**MET ENG 4097 Materials Senior Design II** (LAB 3.0)

A continuation of the Materials Senior Design I. Students working in groups will complete a capstone design project including process and product simulation and/or fabrication, safety aspects, environmental impact and capital and operating economics. Prerequisite: "C" or better in either Cer Eng 4096 or Met Eng 4096. (Co-listed with Cer Eng 4097).

**MET ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**MET ENG 4230 Corrosion And Its Prevention** (LEC 3.0)

A study of the theories of corrosion and its application to corrosion and its prevention. Prerequisite: A grade of "C" or better in either Chem Eng 3120 or Cer Eng 3230. (Co-listed with Chem Eng 5315).

**MET ENG 4320 Steels And Their Treatment** (LEC 3.0)

Industrially important ferrous alloys are described and classified. The selection of proper heat treatments to facilitate fabrication and to yield required service properties in steels suitable for various applications is considered. Prerequisite: "C" or better grade in both Met Eng 3130 and Met Eng 2125.

**MET ENG 4350 Process Metallurgy Applications** (LEC 3.0)

Application of thermodynamics to process metallurgy. Equilibrium calculations with stoichiometry and heat balance restrictions, phase transformations, and solution thermodynamics. Use of thermodynamic software to solve complex equilibria in metallurgical applications. Prerequisite: "C" or better grade in Cer Eng 3230.

**MET ENG 4420 Metals Casting** (LEC 3.0)

An advanced course in the materials and methods used in modern metals casting processes. Application of metallurgical principles to the casting of metals. Design of castings and metals casting mold features using commercial casting process simulation software. Prerequisite: "C" or better grade in either Met Eng 3420 or Mech Eng 2653.

**MET ENG 4425 Metals Casting Lab** (LAB 1.0)

A laboratory study of mold materials, metal flow, and cast metals. Emphasis is given to design of gating, risering, and ladle treatment techniques required for economical, high quality castings. Prerequisites: Accompanied or preceded by MET ENG 4420.

**MET ENG 4450 Steelmaking** (LEC 3.0)

Introduction to the fundamentals and unit processes used to turn impure iron and scrap into steel. Includes desulfurization, BOF and electric furnace operations, ladle metallurgy, casting, and stainless steel manufacture. Prerequisite: Grade of "C" or better in Cer Eng 3230 or Met Eng 3330.

**MET ENG 4510 International Engineering and Design** (LEC 3.0)

A multi-disciplinary engineering course focused on sustainable design and technology transfer to developing countries. Course includes elements of traditional capstone design classes. Experiential learning through competitions and/or field work is a major component of the class. Prerequisites: Senior standing, instructor approval, Geo Eng 5211, Geo Eng 5247. (Co-listed with Geo Eng 5092 and Cer Eng 4510).

**MET ENG 4617 Metallurgical Process Design Principles** (LEC 2.0)

Application of mass, component and energy balances for metallurgical design. The fundamentals of engineering economic analysis will be examined and experimental design techniques will be introduced. Students will be prepared for the selection and planning of the subsequent design project. Prerequisite: Senior standing in Met Eng.

**MET ENG 4627 Metallurgical Design Project** (LAB 2.0)

Student groups will undertake selected projects, which will represent a capstone design experience utilizing skills, understanding and data from previous courses. The faculty supervised open-ended design projects will involve a variety of tasks appropriate to the metallurgical engineer. Prerequisite: Met Eng 4617.

**MET ENG 4637 Material Selection, Fabrication, And Failure** (LEC 3.0)

Factors governing the selection of materials for specific needs, fabrication, heat treatment, surface treatment, and other aspects in the production of a satisfactory component. Failure analysis and remedies. Lecture plus assigned problems. Prerequisite: "C" or better grade in all of Met Eng 3130, Met Eng 2125, and Met Eng 3420.

**MET ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MET ENG 5001 Graduate Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MET ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**MET ENG 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**MET ENG 5110 High Temperature And Corrosion Resistant Alloys** (LEC 3.0)

Fabrication and use of nickel, titanium, and refractory metal based alloys for use at high temperatures or in chemically corrosive environments. Properties and strengthening mechanisms of these alloys. Theory of high temperature oxidation and corrosion and design of alloys to prevent them. Prerequisites: Met Eng 3130, 2125.

**MET ENG 5150 Introduction to Particulate Materials** (LEC 3.0)

Powder metallurgy and ceramic components, filters, catalysts, nanomaterials, vitamins and more depend strongly on particulate, or powder, characteristics and processing. Aspects of powder fabrication, characterization, safety, handling, component fabrication, secondary processing, and applications will be covered. Prerequisite: Met Eng 2110.

**MET ENG 5160 Mechanical Metallurgy** (LEC 3.0)

Elastic and plastic behavior of metallic single crystals and polycrystalline aggregates. Resulting changes in mechanical properties are considered. Included are applications to metal fabrication. Prerequisites: Met Eng 3120, 3125, Civ Eng 2210.

**MET ENG 5170 Nuclear Materials I** (LEC 3.0)

Fundamentals of materials selection for components in nuclear applications. Design and fabrication of UO<sub>2</sub> fuel; reactor fuel element performance; mechanical properties of UO<sub>2</sub>; radiation damage and effects, including computer modeling; corrosion of materials in nuclear reactor systems. Prerequisites: Civ Eng 2210; Nuc Eng 3205; Nuc Eng 3223; Met Eng 2110.(Co-listed with Nuc Eng 4241).

**MET ENG 5171 Nuclear Materials II** (LEC 3.0)

Extractive metallurgy of uranium, thorium, and zirconium. Equation of state of UO<sub>2</sub> and fuel chemistry. LMFBR fuel and interaction of sodium and stainless steel. Materials for fusion and other advanced nuclear applications. Reprocessing of spent fuel and disposal. Prerequisite: Met Eng 5170.

**MET ENG 5220 Recent Advances In Extractive Metallurgy** (LEC 2.0)

A survey of extractive processes recently developed in the light of modern requirements with respect to raw materials, product quality, environmental impact, energy consumption, capital cost and process control. Prerequisite: Met Eng 4350.

**MET ENG 5270 Mineral Processing II (Mechanics and Design)** (LAB 1.0 and LEC 2.0)

Mineral particle mechanics of comminution, sizing, classification, concentration, filtering and thickening. Mill and equipment selection and design including flowsheet, development and plant assessment. Prerequisite: Min Eng 3412. (Co-listed with Min Eng 4424).

**MET ENG 5330 Nonferrous Alloys** (LEC 3.0)

Structure and properties of nonferrous alloys (Al, Ti, Mg, Ni and Cu) are described. The role of processing and microstructure in the development of mechanical properties is emphasized. Prerequisite: Met Eng 3130 or Met Eng 5810.

**MET ENG 5420 Advanced Metals Casting** (LEC 3.0)

An advanced course in the materials and methods used in modern metals casting processes. Application of metallurgical principles to the casting of metals. Design of castings and metals casting mold features using commercial casting process simulation software. Prerequisite: Met Eng 3420 or Mech Eng 2653.

**MET ENG 5425 Metals Casting Laboratory** (LAB 1.0)

An advanced laboratory study of mold materials, metal flow, and cast metals. Emphasis is given to design of gating, risering, and ladle treatment techniques required for economical, highquality castings. Prerequisite: Accompanied or preceded by Met Eng 4420.

**MET ENG 5430 Metals Joining** (LEC 2.0)

Metals joining processes such as welding and brazing. Effects of welding on materials. Treatment and properties of welded joints. Welding defects and quality control. Prerequisite: Met Eng 2110 or 3420.

**MET ENG 5440 Metal Deformation Processes** (LEC 3.0)

An introduction to metal deformation concepts followed by a study of various forming processes from both the analytical and applied viewpoints. Processes to include: forging, wire drawing, extrusion, rolling, sheet metal forming, and others. Prerequisite: Met Eng 3120 and Met Eng 3420 both with "C" or better grade.

**MET ENG 5450 Advanced Steelmaking** (LEC 3.0)

This course is designed to provide students with an enhanced understanding of the chemistry and physics of ironmaking, steelmaking and casting, to apply these concepts to a wide range of problems in modern steelmaking and casting operations, and to perform advanced design and operational calculations associated with refining and continuous casting processes. Prerequisite: Grade of "C" or better in Cer Eng 3230 or Met Eng 3330.

**MET ENG 5460 Metal Coating Processes** (LEC 3.0)

Introduction to the current technologies used to enhance metal performance, particularly corrosion resistance, by overlay coatings. Deposition processes are emphasized and the fundamentals of the behavior of the films in high technology and electronic materials applications is discussed. Prerequisite: Senior or Graduate Standing.

**MET ENG 5470 Ferrous Metals Casting** (LEC 3.0)

An advanced study of the metallurgy of cast irons and net shape cast steel alloys. Includes theories of nucleation and growth in gray, nodular, compacted graphite and malleable irons. The effects of deoxidation practice and inclusion shape control for cast steels are also included. The effects of alloying elements, processing variables and heat treatment. Prerequisite: Met Eng 4420 or Met Eng 5420 or graduate standing with permission of instructor.

**MET ENG 5480 Refining Of Metals** (IND 2.0-3.0)

Principles and applications of thermochemistry, phase equilibria, and kinetics as applied to the refining of metals and alloys. Theory of dilute solutions, interaction coefficients and reactions of metals with gases and slags. Analysis and design of refining processes. Optional third credit hour requires a term paper. Prerequisite: Met Eng 4350 or Cer Eng 3230.

**MET ENG 5510 Nondestructive Testing** (LEC 3.0)

Principles and applications of various means of non-destructive testing of metallic materials. Radiological inspection methods, ultrasonic testing, magnetic methods, electrical and eddy current methods and others. Prerequisite: Physics 2135 or 2111. (Co-listed with Elec Eng 5670).

**MET ENG 5515 Nondestructive Testing Laboratory** (LAB 1.0)

Application of radiological and ultrasonic methods of nondestructive testing of metallic materials. A radiographic X-ray units and ultrasonic equipment are used in the inspection of a variety of materials and manufactured parts. Prerequisite: Accompanied or preceded by Met Eng 5510.

**MET ENG 5520 Electron Microscopy** (LEC 3.0)

A course in the theory and application of both scanning and transmission electron microscopy and x-ray microanalysis. Topics considered are electron optics, image formation and analysis; x-ray generation, detection and analysis; and characterization of fracture surfaces. Prerequisites: Met Eng 3130 and Met Eng 2125, or a course in optical microscopy.

**MET ENG 5525 Scanning Electron Microscopy Lab** (LAB 1.0)

A course in the practical use and operation of scanning electron beam instruments and their associated techniques. Prerequisite: Preceded or accompanied by Met Eng 5520.

**MET ENG 5620 Materials Behavior** (LEC 3.0)

A course in crystal defects and deformation; mechanical testing; creep; fracture mechanics and fatigue. Prerequisites: Grade of "C" or better in both Met Eng 2110 and Met Eng 3120.

**MET ENG 5630 Environmental Aspects Of Metals Manufacturing** (LEC 3.0)

Introduction to environmental aspects of metal extraction, melting, casting, forming, and finishing. Subjects include history of environmental movement and regulations permitting, risk analysis, disposal and recycling of metal manufacturing residues, environmental ethics, environmental technologies and case studies. Prerequisite: Junior/Senior standing.

**MET ENG 5810 Principles Of Engineering Materials** (LEC 3.0)

Examination of engineering materials with emphasis on selection and application of materials in industry. Particular attention is given to properties and applications of materials in extreme temperature and chemical environments. A discipline specific design project is required. (Not a technical elective for undergraduate metallurgy or ceramic majors) (Co-listed with Aero Eng 3877, Chem Eng 5300, Physics 4523, Cer Eng 5810).

## Military Science

### Army ROTC

The department of military science is responsible for the Army Reserve Officers' Training Corps Program. ROTC is a program of leadership and basic military skills training which prepares students to serve as officers in the Total Army—the Active Army, the Army Reserve, and the Army National Guard—after graduation. Army ROTC can help you succeed during college and after graduation. You can gain the confidence and self-discipline needed to meet the academic challenge of Missouri S&T through military science courses and can acquire the leadership skills, which will impress employers when you enter the work force.

The Army ROTC program is flexible, and allows students to participate in the first two years of the program without obligation. Alternate entry programs for students with prior military service, transfer students, and students serving in the Army Reserve or National Guard are available. The advanced course (junior and senior years), focuses on preparing cadets for officership, and requires a commitment to the ROTC program. Students who wish to take military science courses, but who do not wish to participate in Army ROTC, may do so with the approval of the department chairman.

Military Science classes are taught on the Missouri S&T campus and are supplemented by one weekend field training exercise at Fort Leonard Wood, MO. each semester for contracted ROTC cadets. The ROTC program concentrates on the whole person and includes physical training, leadership development, marksmanship, individual tactical skills, and essential knowledge of today's Army and its role in our society.

The minor in military science gives formal academic recognition for the leadership and management training received by those completing the minor requirements.

The military science program at Missouri S&T is described in detail in the Army ROTC (military science) section of this catalog. For more information on the military science program, scholarships, qualifications and obligation, and extracurricular activities, contact the department in 301 Harris Hall or phone 573-341-4744.

## Adaptive Leadership Minor Curriculum

The minor in adaptive leadership provides students the opportunity to learn how to analyze, identify key elements and risk, ethically solve, package, communicate and lead the solution to a variety of problems as an individual and as part of a group. Students will progressively improve leadership skill through knowledge and practice of small group leadership, versatility and critical thinking through changing conditions/ environments, interpersonal skills in depth and leadership capacity, ability to affect others' skills in depth and leadership capacity, and understanding of how to develop group solutions in a complex and changing world. Feedback throughout the military science portions of the minor is provided both via the academic process and an after-action review process where successes and failures are defined using the U.S. Army's leadership attributes (as described in the U.S. Army Doctrinal Publication 6-22). The goal of the minor is to develop and provide lifelong learning tools to build confidence, leadership skills and character to, as a leader, provide a team with the purpose, direction and motivation needed to ethically solve future challenges.

The minor consists of 18 credit hours.

**Required courses:**

MIL ARMY 3250	Adaptive Tactical Leadership	3
MIL ARMY 3500	Leadership in Changing Environments	3
MIL ARMY 4250	Developing Adaptive Leaders	3
MIL ARMY 4500	Leadership in a Complex World	3

**Elective courses:**

History	(select one course)	3
HISTORY 2440		
HISTORY 3240	Contemporary Europe	
HISTORY 3440	20th Century Americans In Combat	
HISTORY 3762	American Foreign Policy Since 1945	
Human Behavior	(select one course)	3
PSYCH 1101	General Psychology	
PHILOS 1115	Introduction To Logic	
PHILOS 1110	Practical Reasoning	

**Chad D Pense**, Assistant Professor  
MED University of Central Oklahoma

**Otis E Register**, Professor  
MASTER Webster University

**MIL ARMY 1000 Army Physical Readiness Program** (LAB 1.0)

Course instruction includes planning, implementing and managing the Army physical fitness program; the conducting of an Army physical fitness test; physical fitness training to include conditioning, calisthenics, and cross-country running. Fundamentals of drills and ceremony will also be taught.

**MIL ARMY 1250 Leadership and Personal Development** (LEC 1.0)

Introduces cadets to the personal challenges and competencies that are critical for effective leadership. Cadets learn how the personal development of life skills such as critical thinking, goal setting, time management, physical fitness, and stress management relate to leadership, officership, and the Army profession.

**MIL ARMY 1500 Introduction to Tactical Leadership** (LEC 1.0)

Overviews leadership fundamentals such as setting direction, problem-solving, listening, presenting briefs, providing feedback, and using effective writing skills. Cadets explore dimensions of leadership values, attributes, skills, and actions in the context of practical, hands-on, and interactive exercises.

**MIL ARMY 1700 Rifle Marksmanship** (LEC 1.0)

The course teaches basic rifle marksmanship and firearm safety. Students will be required to learn common rules of firearms safety and fire airguns using standard firing positions. Targets will be scored. Students will also become familiar with military marksmanship techniques and weapons.

**MIL ARMY 1750 Wilderness Survival And Life-Saving Techniques** (LEC 1.0)

Basic life-saving techniques that will enable the student to assist an injured person or himself in an emergency, and survival techniques that will help the student survive in the wilderness.

**MIL ARMY 1800 Ranger Operations** (LEC 1.0)

Learn about one of the world's most elite fighting forces -the U. S. Army Rangers. Get some hands-on training with actual army equipment. Learn rappelling, land navigation, orienteering and combat patrolling.

**MIL ARMY 2250 Innovative Team Leadership** (LEC 3.0)

Develop knowledge of self, self-confidence and individual leadership techniques through problem solving and critical thinking skills. Apply communication, feedback, and conflict resolution skills.

**MIL ARMY 2500 Foundations of Tactical Leadership** (LEC 3.0)

Examines the challenges of leading tactical teams in the complex contemporary operating environment (COE). The course highlights dimensions of terrain analysis, patrolling, and operation orders. Further study of the theoretical basis of the Army leadership framework explores the dynamics of adaptive leadership in the context of military operations.

**MIL ARMY 2750 Basic Leadership Laboratory** (LAB 1.0)

Hands-on experience in basic military leadership skills, supplementing, but not duplicating classroom instruction in MSI and MSII courses. Training is conducted at squad (8 person group) level with emphasis on leadership development at that level. Topics include oral communication and presentations, decision making, drill and ceremonies, squad tactics, land nav, and the tactical bivouac. Prerequisite: To accompany Mil Army 2500.

**MIL ARMY 3250 Adaptive Tactical Leadership** (LEC 2.0 and LAB 1.0)

Challenges cadets to study, practice, and evaluate adaptive leadership skills as they are presented with scenarios related to squad operations. Cadets receive systematic and specific feedback on their leadership attributes and actions. Based on such feedback and self-evaluations, cadets continue to develop their leadership and critical thinking abilities. Prerequisites: Mil Army 1250, 1500, 2250, 2500 - Exceptions to be made by Dept Chair Only In Accordance with Army (Cadet Command) Policies.

**MIL ARMY 3500 Leadership in Changing Environments** (LAB 1.0 and LEC 2.0)

Uses increasingly intense situational leadership challenges to build cadet awareness and skills in leading tactical operations up to platoon level. Cadets review aspects of combat, stability, and support operations. They also conduct military briefings and develop proficiency in garrison operation orders. Prerequisites: Mil Army 3250 - Exceptions to be made by Department Chair Only In Accordance With Army (Cadet Command) Policies.

**MIL ARMY 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required. Prerequisites: Mil Army 4250 and 4500 - Exceptions to be made by Dept Chair Only in accordance with Army (Cadet Command) policies.

**MIL ARMY 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course.

**MIL ARMY 4250 Developing Adaptive Leaders** (LEC 2.0 and LAB 1.0)

Develops cadet proficiency in planning, executing, and assessing operations, functioning as a member of a staff, and providing performance feedback to subordinates. Cadets assess risk, make ethical decisions, and lead fellow ROTC cadets. Lessons on military justice and personnel processes prepare cadets to make the transition to Army officers. Prerequisites: Mil Army 3250 and 3500 - Exceptions to be made by Dept Chair Only in accordance with Army (Cadet Command) policies.

**MIL ARMY 4500 Leadership in a Complex World** (LAB 1.0 and LEC 2.0)

Explores the dynamics of leading current military operations in the contemporary operating environment. Cadets examine differences in customs, military law, principles of war, and rules of engagement in terrorism. They also explore aspects of interacting with non-government organizations, civilians on the battlefield, and host nation support. Prerequisite: Mil Army 4250 - Exceptions to be made by Department Chair Only In Accordance With Army (Cadet Command) Policies.



# Mining Engineering

**Emphasis areas at the bachelor level in explosives engineering, mining health and safety, quarry engineering, coal, mining and the environment, and sustainable development.**

The mining and explosives engineering programs are offered under the department of mining and nuclear engineering. The overall objectives of the mining engineering program are to provide a broad engineering education with strong expertise in mining engineering, a cultural foundation for the mining industry and a strong basis for future growth and development. These objectives are achieved at the B.S. level by providing education in basic sciences, engineering sciences and design, core mining engineering, humanities and social sciences.

## ABET Educational Objectives

The objectives establish broad career and professional attributes that the mining engineering program prepares students to achieve in industry. The educational objectives include:

1. Graduates will become frontline supervisors and middle level managers within three to five years in industry.
2. Graduates will have a vital interest and a passion to remain and promote industry growth.
3. Graduates will be capable of solving industrial problems toward growth and competitiveness of their respective companies.
4. Graduates will become functional and effective leaders or members of industrial teams for carrying out the mission of their respective companies.
5. Graduates will communicate effectively the technical, social and economic aspects of the job requirements to subordinates, peers and superiors.
6. Graduates will carry out their functional responsibilities with supreme understanding of safety and health, environment and ethics.
7. Graduates will cultivate and maintain an interest in life-long learning through professional development and memberships in professional societies.
8. Graduates will continue to grow in the knowledge of relevant technologies, skills and tools for modern mining engineering practice.

## ABET Student Outcomes

Consistent with the definition of ABET student outcomes, the mining engineering program is designed and delivered to allow students opportunities to acquire the following skills, knowledge and behaviors by the time of graduation.

1. Become proficient in the basic sciences, including mathematics, statistics, physics and chemistry and their applications in solving mining engineering problems (ABET Outcome a).
2. Understand fundamental engineering principles in statics and dynamics, mechanics of rock structures, electrical circuits, thermodynamics, fluid mechanics and engineering design and their applications in solving mining engineering problems (ABET Outcome a).
3. Become knowledgeable in the humanities, social sciences and management for understanding the non-technical aspects of the mining engineering profession, including environmental, socio-economic, and the health and safety impacts exemplified by the knowledge of the regulatory regime (ABET Outcome h).
4. Become proficient in core mining engineering subjects required to carry out the professional duties of an entry level mining engineer upon graduation (ABET Outcome a).
5. Understand geological and mineral processing dimensions for comprehensive mine design, extraction and mineral beneficiation (ABET Outcome a).
6. Understand geomechanics, geometric and computer-aided mine design, and optimization of flow processes for designing mine layouts to maximize health and safety, economics and production efficiency, and to minimize environmental impacts (ABET Outcome c).
7. Have the ability to outline and conduct experiments, with relevant input data and information, analysis and interpretation to draw inferences for making decisions on maintenance, improvement, or modification of an operating system (ABET Outcome b).
8. Function effectively on a team by understanding team dynamics, communication, social norms and conflict management (ABET Outcome d).
9. Have the ability to identify, formulate and solve closed and open-ended problems in science, engineering, humanities, social sciences, and management from verbal and/or written statements (ABET Outcome e).
10. Understand engineering code of ethics and its impact on professional engineering practice, especially in mine design, mine health and safety, and quality control (ABET Outcome c and f).
11. Develop creative abilities for effective oral and written communication of both technical and non-technical materials for presentations to peers, superiors and subordinates with proficiency (ABET Outcome g).
12. Know contemporary engineering issues through general education requirements, involvement in professional societies, participation in student activities, and reading of professional journals (ABET Outcome j).
13. Develop leadership skills in competitive environments, project teams and organizational units through student chapter organizations, mine rescue, mine design and mucking competitions, student-initiated and student-led field trips, fund raising and community involvement (Program Core Value).
14. Have the desire and motivation toward a life-long learning process via the online Master of Engineering program, preparation toward professional engineering certification, opportunities for conference attendance and research exposure (ABET Outcome i).
15. Acquire the knowledge of the Mining Engineering profession through cooperative and summer internships, field trips and practical working laboratories in the Missouri S&T Experimental Mine (Program Core Value).
16. Acquire the knowledge and familiarity of the complex relationships among technology, government, society, investors, and the environment and their impact on tomorrow's mining industry through guest lectures, in-class presentations, general education subjects and community involvement (ABET Outcome k).
17. Understand global mining issues by participating in exchange programs, internships, and in-class presentations (Program Core Value).
18. Develop a sense of responsibility and appreciation for the continuous well-being of the mining engineering program and Missouri S&T (Program Core Value).

## General Program Information

The mining engineering courses provide students with the knowledge necessary to enter a variety of segments of the mining industry. Graduate mining engineers, who satisfactorily complete the program criteria, usually obtain employment in one or more of the following areas: mine engineering, operations management, extraction or processing, base metals, precious metals, industrial minerals, quarry industry, explosives industry, construction or demolition, mining equipment suppliers and mining/geotechnical consulting firms.

The mining engineering profession deals with location, extraction, and use of mineral resources and mineral policy. Lunar and ocean mining constitute new frontiers. The mining engineer is concerned with all phases of mineral recovery, including exploration, evaluation, development, extraction, mine evaluation, reclamation, processing, and marketing of minerals. In addition to engineering, science and liberal arts courses, appropriate courses are taken in explosives engineering, geology, mineral beneficiation, coal mine development and production, mining of metallic and aggregate minerals, mine systems design, mining economics and law, mine hygiene and safety, mine management, mine ventilation, rock mechanics, ground support, and reclamation.

The mining engineer relies upon geologic knowledge and highly sensitive instruments for the location and evaluation of mineral deposits. Problems involved in the development, exploitation and the beneficiation of minerals and marketing of valuable constituents must be determined in advance. Mining must be carried out efficiently, safely, and economically, with the welfare of the public as a primary consideration. Land must be restored to a useful condition after mining ceases and pollution controls must be designed to prevent harmful environmental effects.

Intensive research programs are conducted at Missouri S&T in surface and underground mining, heavy mining machinery, explosives engineering, mine health and safety, oil sands recovery, waterjet excavation, mineral economics, mine operations and design, mine atmospheric control and ventilation, minerals transportation, rock mechanics and applied geophysics. Appropriate research by faculty and graduate students ensures program relevance to industry.

An Experimental Mine and the Rock Mechanics and Explosives Research Center are located close to the campus and provide facilities for laboratory instruction and research. Trips to coal, metal, and industrial mineral operations supplement classroom activities. Summer employment and co-op training provide valuable practical mining and engineering expertise.

## Program Mission and Core Values

The Mining Engineering Program at Missouri S&T provides superb education and training to undergraduate and graduate students for the mining and construction industries of Missouri, USA and those global mining companies with strategic interests in the USA. *The programs provide students with total quality education and research capabilities to make a difference in our state and the technological world.*

### Core Values

Our vision of global leadership will be achieved through the following seven core values that form the basis of Missouri S&T's tradition of excellence in mining engineering education and research.

**Excellence:** The efforts of faculty, staff, alumni, industry partners and related organizations create an environment that promotes excellence in education and research.

**Ethics:** We value truth, honesty, integrity and hard work as abiding principles for professional excellence.

**Experience:** Through its experimental mine facilities, internships, cooperative education and field trips, students receive hands-on experience, which is vital to the practice of the profession.

**Exposure:** S&T reaches out to global frontiers through its board of industry executives, alumni, research and professional societies, and our global partners.

**Passion:** S&T educates graduates with a passion for the mining industry's growth and competitiveness.

**Tradition:** S&T maintains the tradition of excellence, unity, collegiality and family that have been the bedrock of its mining engineering programs.

## Bachelor of Science Mining Engineering

Entering freshmen desiring to study Mining Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Mining Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering program is on fundamental sciences and mathematics, enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major. In addition, students who state the Mining Engineering preference are required to complete Mining Engineering 2126 during the first or second semester on campus.

For the Bachelor of Science degree in Mining Engineering a minimum of 128 credit hours is required, although completion of an emphasis area may require up to 132 credits. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. A student must maintain at least two grade points per credit hour for all courses taken in the student's major department, and an average of at least two grade points per credit hour must be maintained in Mining Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1. All students are required to take one American History course, two economics courses, one humanities course, ENGLISH 1120 and either ENGLISH 1160, ENGLISH 3560 or TCH COM 1600. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics courses must be either ECON 1100 or ECON 1200, and ECON 3512. The humanities course must be selected from "The Approved List of Humanities and Social Science Courses for Engineering Degrees", maintained by the Office of Undergraduate Studies.
2. The remaining three credit hours must be taken from "The Approved List of Humanities and Social Science Courses for Engineering Degrees". Foreign language courses can be considered to be one of these courses. (Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 4000 or 5000 level.)

3. Special topics, special problems courses and honors seminars are allowed only by petition to and approval by the student's department chairman.

The Mining Engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

Freshman Year			
First Semester	Credits	Second Semester	Credits
MATH 1214	4	MATH 1215	4
CHEM 1310	4	PHYSICS 1135	4
CHEM 1319	1	MECH ENG 1720	3
CHEM 1100	1	MIN ENG 1912	2
FR ENG 1100	1	MIN ENG 2126	1
HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3	GEO ENG 1150	3
ENGLISH 1120	3		
	17		17

Sophomore Year			
First Semester	Credits	Second Semester	Credits
MATH 2222	4	MATH 3304	3
MIN ENG 2925	2	MIN ENG 2412	3
MIN ENG 3912	3	MECH ENG 2527	3
MIN ENG 3913	3	MECH ENG 2350	2
CIV ENG 2200	3	PHYSICS 2135	4
ECON 1100 or 1200	3		
	18		15

Junior Year			
First Semester	Credits	Second Semester	Credits
STAT 3113 or 3115	3	MIN ENG 4522	3
NUC ENG 3221 or CIV ENG 3330	3	MIN ENG 4512	3
MIN ENG 4932	3	MIN ENG 4933	3
CIV ENG 2210	3	MIN ENG 4823	3
ECON 3512	3	ENGLISH 1600, or 1160, or 3560	3
GEOLOGY 3310	3		
	18		15

Senior Year			
First Semester	Credits	Second Semester	Credits
MIN ENG 5612	3	MIN ENG 4742	3
MIN ENG 4912	3	MIN ENG 4097	4
MIN ENG 4096	3	Technical Elective <sup>1,2,3,4,5,6</sup>	3
MIN ENG 4113	3	H/SS Elective	3
H/SS Elective	3		
	15		13

Total Credits: 128

- <sup>1</sup> **Explosives Engineering Emphasis:** MIN ENG 5622 (Blasting Tech) and either MIN ENG 4001 (Special Topics Explosives), MIN ENG 4099 (Undergraduate Research in Explosives), MIN ENG 4823 (Rock Mechanics) or MIN ENG 4922 (Tunneling/Construction) have to be taken as Technical Electives.
- <sup>2</sup> **Quarrying Emphasis:** Two of CIV ENG 3116 (Construction Materials); MIN ENG 4212 (Advanced Aggregate and Quarrying); and MIN ENG 4412 (Aggregate Materials) have to be taken as Technical Electives.
- <sup>3</sup> **Coal Emphasis:** Two of MIN ENG 4322 (Coal Mine Development and Production), MIN ENG 4414 (Mine Plant Management) or an approved substitute course must be taken as Technical Electives.
- <sup>4</sup> **Mining and the Environment Emphasis:** GEO ENG 5235 (Environmental Geological Engineering) and GEO ENG 5233 (Risk Assessment in Environmental Studies), or approved substitute courses have to be taken as Technical Electives.
- <sup>5</sup> **Mining Health and Safety Emphasis:** MIN ENG 3002 (Mine Rescue), ENG MGT 4330 (Human Factors), or other approved substitute courses must be taken as Technical Electives.
- <sup>6</sup> **Sustainable Development Emphasis:** POL SCI 3310 (Public Policy Analysis), ECON 4440 (Environmental and Natural Resource Economics), or other approved substitute courses must be taken as Technical Electives.

## Graduating Mining Engineers Examination

Mining engineering students must complete the Fundamentals of Engineering Examination prior to graduation as a senior assessment requirement. A passing grade is not required to earn a B.S. degree in mining engineering; however it is the first step toward becoming a registered professional engineer. This requirement is part of the Missouri S&T assessment process. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.

## Mining Health and Safety Emphasis

### Junior and Senior Years

MIN ENG 3002	Mine Rescue (or approved substitute course in lieu of Technical Elective.)	3
ENG MGT 4330	Human Factors (or approved substitute course in lieu of Technical Elective.)	3

## Sustainable Development Emphasis

### Junior and Senior Years

POL SCI 3300	Principles Of Public Policy (or approved substitute course in lieu of Technical Elective.)	3
ECON 4440	Environmental And Natural Resource Economics (or approved substitute course in lieu of Technical Elective.)	3

## Quarrying Engineering Emphasis

### Senior Year

CIV ENG 3116	Construction Materials, Properties And Testing (in lieu of Technical Elective.)	3
MIN ENG 4212	Advanced Aggregate and Quarrying (in lieu of Technical Elective.)	3

## Explosives Engineering Emphasis

### Junior and Senior Years

Choose one of the following courses in lieu of Technical Elective in Junior Year:

A three-credit hour explosives engineering (EXP ENG) course

MIN ENG 4922	Tunneling & Underground Construction Techniques or MIN ENG 5922 Advanced Tunneling & Underground Construction Techniques
GEO ENG 5471	Rock Engineering
In lieu of Technical Elective in Senior Year:	
EXP ENG 5622	Blasting Design And Technology

## Coal Emphasis

### Junior and Senior Years

MIN ENG 4322	Coal Mine Development And Production (in lieu of Technical Elective.)	3
MIN ENG 4414	Mine Plant Management (or approved substitute course in lieu of Technical Elective.)	2

## Mining and the Environment Emphasis

### Junior and Senior Years

ENV ENG 5640	Environmental Law And Regulations	3
GEO ENG 5233	Risk Assessment In Environmental Studies (or approved substitute course in lieu of Technical Elective.)	3

## Minor in Mining Engineering

A student who receives a Bachelor of Science degree in an accredited engineering program from Missouri S&T may receive the Minor in Mining Engineering by completing 15 credit hours from the courses listed below. Non-engineering students who have a strong background in mathematics and the physical sciences may also qualify for the Minor in Mining Engineering or Explosives Engineering with the approval of the Department and based on an individually designed program of study. Students will need to consult with the Chair of the Mining Engineering Program to determine pre-requisite requirements for each course. The program granting the Bachelor of Science degree shall determine whether or not courses taken for the Mining Engineering Minor or Explosives Engineering Minor may also be used to fulfill the requirements of the B.S. degree from that program.

The following courses are required for the Minor in Mining Engineering:

MIN ENG 3913	Mineral Identification and Exploration	3
MIN ENG 4932	Underground Mining Methods And Equipment	3
MIN ENG 4933	Surface Mining Methods And Equipment	3

Two other Mi Eng 3000-, 4000-, or 5000-level lecture courses (3 credit hours), or relevant courses from other disciplines, as approved, must be taken to match the student's area of emphasis in Mining Engineering. The following areas of emphasis may be pursued:

Explosives Engineering; Quarrying; Mineral Economics; Mining-Environmental; Mining-Equipment; Mining-Geo-technical; Mining-Health and Safety; Mining Operations Management; Mining-Tunneling; Sustainable Development; Surface Mining; Underground Mining.

The Minor in Mining Engineering is not accredited by the Accreditation Board of Engineering and Technology (ABET).

## Minor in Mineral Processing

The minor in Mineral Processing provides an in-depth study of the fundamental theories and applications of mineral and coal processing and aggregate materials sizing and classification. Any student who receives a Bachelor of Science degree in an accredited engineering program from Missouri S&T may also receive the minor in Mineral Processing by completing 15 credit hours in this specialty. The B.S. degree granting program shall determine whether or not courses taken

for the minor in Mineral Processing may also be used to fulfill the requirements of the B.S. degree from that program.

The following courses are required for the minor in Mineral Processing:

MIN ENG 3412		3
MIN ENG 4422	Coal Preparation	3
MIN ENG 4412	Aggregate Materials Characterization, Sizing and Dimension Stone	3
MIN ENG 4423	Mineral Processing I (Flotation and Hydrometallurgy)	3
MIN ENG 4424	Mineral Processing II (Mechanics and Design)	3

## Minor in Explosives Engineering

The department of mining and nuclear engineering, mining engineering program, realizing the attractiveness of explosives engineering to students, the potential for jobs in the area (post 9-11), and the use of over 6 billion pounds of explosives in mining, tunneling, construction, and other areas, is offering a minor in explosives engineering so that students interested in explosives engineering have a chance to attain in-depth knowledge of the sub-discipline.

A student who received a bachelor of science degree in an accredited engineering program from Missouri S&T may receive the minor in explosives engineering by completing 15 credit hours from the courses listed below. Non-engineering students who have a strong background in mathematics and the physical sciences may also qualify for the minor in explosives engineering, with the approval of the department and based on an individually designed program of study. Students need to consult with the chair of the explosives engineering program to determine pre-requisite requirements for each course. The program granting the bachelor of science degree shall determine whether or not courses taken for the explosives engineering minor may also be used to fulfill the requirements of the B.S. degree from that program.

The following courses are required for the minor in explosives engineering:

EXP ENG 5612/	Principles of Explosives Engineering	3
MIN ENG 5612		
EXP ENG 5622/	Blasting Design And Technology	3
MIN ENG 5622		

Three other explosives related courses as approved by program coordinator.

The minor in explosives engineering is not accredited by the Accreditation Board of Engineering and Technology (ABET).

## Undergraduate Certificate in Explosives Engineering

This certificate program is designed to provide formalized education in the area of explosives engineering.

Students will be exposed to the theoretical and practical approaches of explosives engineering. Students will be exposed to the analysis and design of explosive-related systems and both natural and built structure effects.

The explosives engineering certificate program is open to all persons holding a high school diploma who have a minimum of 12-months of post-high school, professional employment or college experience.

Once admitted to the program, the student must take four designated courses as given below. In order to receive an undergraduate certificate,



the student must have an average cumulative grade of 2.0 or better in the certificate courses.

Students admitted to the certificate program will have non-matriculated status; however, if they complete the four course sequence with a grade of B or better in each of the courses taken, they may apply to the B.S. mining engineering program if they so choose. The certificate credits taken by students admitted to the B.S. program may be eligible to count toward their bachelors degrees depending on the degree requirements. Prerequisite courses outside of those in this certificate program may be waived at the discretion of the administrative co-coordinators for persons that are not regular Missouri S&T students.

Once admitted to the program, a student will be given three years to complete the program so long as he/she maintains a 2.0 GPA in the courses taken.

Required courses:

MIN ENG 5612	Principles of Explosives Engineering	3
MIN ENG 5622	Blasting Design And Technology	3
Select two of the following:		
MIN ENG 4001	Special Topics	
MIN ENG 309		
MIN ENG 4922	Tunneling & Underground Construction Techniques	
MIN ENG 4099	Undergraduate Research (Explosives Engineering related)	
MIN ENG 4000	Special Problems (1. Explosives Engineering related. 2. At discretion of coordinators)	

Other courses approved by the explosives engineering faculty may be substituted for any of the above listed courses on a case-by-case basis.

Students with a GPA of 3.0 in the certificate program may take postgraduate explosives classes as electives.

**Lana Z Alagha**, Assistant Professor  
PHD University of Texas at Dallas

Mineral processing, tailings management, polymer science, nanotechnology, interfacial science, colloidal interactions in aqueous systems, and clays.

**Nassib S Aouad**, Assistant Professor  
PHD Missouri Science and Technology

Mechanical design and automation, machine health and fatigue analysis, machinery and whole-body vibrations, advanced vibrations modeling and analysis, numerical modeling and simulation, virtual prototyping, and computational fluid dynamics.

**Kwame Awuah-Offei**, Associate Professor  
PHD University of Missouri-Rolla

Life cycle sustainability assessment, community acceptance modeling, energy efficiency modeling, production optimization, CO<sub>2</sub> hazard delineation and innovative post-mining land uses for underground mines.

**Samuel Frimpong**, Professor<sup>1</sup>  
PHD University of Alberta, Canada

Surface mining, formation excavation, heavy machinery imaging and integration, intelligent mining systems, stochastic processes and risks simulation, extra heavy oil extraction, and mine safety, and health and hazards engineering.

**Grzegorz Galecki**, Associate Professor  
PHD Wroclaw Tech University, Poland

System integration, modeling of mining processes supported by waterjets, novel methods of comminution, particulate processing, coal conversion into fuels, borehole mining, and mineral processing.

**Maochen Ge**, Associate Professor  
PHD Penn State University

Rock mechanics and ground control, underground mine design, acoustic emissions, micro-seismic phenomena in underground mines, theory and applications of geotomology, non-destructive structural testing, and numerical methods.

**Catherine Johnson**, Assistant Professor  
PHD University of Kentucky

**Braden Lusk**, Professor<sup>1</sup>  
PHD University of Missouri-Rolla

**Kyle Perry**, Assistant Professor<sup>1</sup>  
PHD University of Kentucky

**Paul Nicholas Worsey**, Professor<sup>1</sup>  
PHD University of Newcastle-upon-Tyne, United Kingdom  
Explosives engineering, drilling and blasting, rock excavation, demolition, and commercial pyrotechnics.

#### ***MIN ENG 1912 Principles Of Mining Engineering*** (LEC 2.0)

Principles and definitions related to mining engineering including one or more field trips to familiarize the student with current mining practices.

#### ***MIN ENG 1913 Computing In Mining Engineering*** (LAB 1.0)

Basic software needed by mining engineers for computer applications in various phases of mine planning, development, and operations will be covered. The overarching goal is developing early familiarity with relevant software so it can be integrated across mining engineering courses.

#### ***MIN ENG 2126 Introduction To Mining Safety*** (LAB 1.0)

Safety aspects of mining in accordance with the MSHA Training Program required for all new miners. Subjects include self-rescue and respiratory protection, ground control, hazard recognition, mine gases, and legal aspects associated with mining.

#### ***MIN ENG 2412 Principles Of Mineral Processing*** (LAB 1.0 and LEC 2.0)

Introduction to the principles of mineral processing including mineral resources; particle comminution, classification, separation and dewatering; flowsheet and equipment design.

#### ***MIN ENG 2914 Surface Mine Design*** (LAB 2.0 and LEC 1.0)

Surface mining methods. Conventional methods for ore reserves estimation. Geomechanics, geometrics and computer-aided mine design, haul roads and waste dump design and layouts optimization. Materials scheduling and sequencing using a commercially available mine design software. Prerequisite: Min Eng 1912.

#### ***MIN ENG 2924 Underground Mine Design*** (LAB 2.0 and LEC 1.0)

Underground mining methods. Parametric statistics and introductory geostatistics. Geomechanics, geometrics and computer-aided mine design. Empirical and numerical methods for mine openings, pillar and roof span design; caving and ore drawing mechanics. Materials scheduling and sequencing using commercially available software. Prerequisite: Min Eng 1912 and Min Eng 2914.

**MIN ENG 2925 Surveying For Mineral Engineers** (LAB 2.0)

Principles of surface and underground survey practice utilizing total station, engineer's level and GPS. Traversing and details, note taking and computations, balancing surveys and error analysis, staking-out new points, and map construction with AutoCAD. Prerequisite: Preceded or accompanied by Min Eng 1912.

**MIN ENG 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MIN ENG 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MIN ENG 3002 Mine Rescue** (LAB 1.0 and LEC 2.0)

Utilization of the principles of mine safety concerning mine gases, ventilation, explosives, fires, and first aid in the organization of mine rescue personnel and techniques. Training in the use of current mine rescue equipment, recognition and control of common recovery hazards, handling of survivors. Prerequisite: Min Eng 2126.

**MIN ENG 3512 Mining Industry Economics** (LEC 3.0)

Importance of the mineral industry to national economy, uses, distribution, and trade of economic minerals, time value of money, mineral taxation, economic evaluation utilizing depreciation, depletion, and discounted cashflow concepts, social and economical significance of mineral resources. Prerequisite: Econ 1100 or 1200. (Co-listed with Econ 3512).

**MIN ENG 3812 Statics And Mechanics Of Rock Materials** (LEC 2.0 and LAB 1.0)

Application of the principles of mechanics to engineering problems of equilibrium, strength, and stiffness concerning rock materials and mine support structures. This course extends the study of statics to rock materials in mines and covers rock-related and support structure-related mechanics of materials. The course is complemented by rock mechanics laboratory. Prerequisites: MECH ENG 2340; or IDE 50 and 150.

**MIN ENG 3912 Materials Handling In Mines** (LAB 1.0 and LEC 2.0)

Mining applications of material transport and handling. Truck haulage and haulroads. Conveyors: belt, armored, and others; feeders; bins and bunkers; material stockpiling and homogenization; rail transport; water transport; slurry transport; mine hoists and hoisting. Prerequisite: Min Eng 1912.

**MIN ENG 3913 Mineral Identification and Exploration** (LEC 3.0)

Characterization of mineral deposits. Ore body definition. Mineral Exploration techniques. Sample methods, errors and mitigation. Rock Identification. Prerequisites: Either both Chem 1310 and Chem 1319 or Chem 1351; either Geo Eng 1150 or Geology 1110.

**MIN ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MIN ENG 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MIN ENG 4096 Computer Aided Mine Design** (LAB 3.0)

Mine planning and design using commercial software. Orebody description. Surface mining: geometric design, pit limits, and production planning. Underground mining: development planning, opening and support design, ventilation and production planning. Group projects with real-world mining data. Preparation for capstone design project. Prerequisites: Min Eng 4522, Min Eng 4932, and Min Eng 4933.

**MIN ENG 4097 Capstone Design Project** (LEC 1.0 and LAB 3.0)

Capstone project with written and oral presentations. Includes mine design and optimization, production plan, equipment and flowsheet design based on geology, resources/reserves, geotechnics, hydrology and hydro-geology. Project also incorporates markets, environmental and permitting, mine-mill organization, support facilities, economic and risk analyses. Prerequisite: Min Eng 4096.

**MIN ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**MIN ENG 4113 Mine Atmosphere Control** (LEC 2.0 and LAB 1.0)

Fundamentals of mine ventilation, including the principles of airflow, control of gases, dust, and temperature, methane drainage, mine fans, network theory, computer network simulation, and economics of airflow, with emphasis on analysis, systems design and practical application. Prerequisites: Chem 3410 and Civ Eng 3330.

**MIN ENG 4122 Advanced Mine Health and Safety** (LEC 3.0)

A detailed study of health and safety principles, practices, analyses, regulations, issues and technology in the mining industry. Prerequisite: Min Eng 2126.

**MIN ENG 4212 Advanced Aggregate and Quarrying** (LEC 3.0)

Advanced coverage of topics on the stone and aggregate industry, including surface and underground operations, plant equipment, economics, marketing, transportation, and environmental topics. The course will include at least one field trip and a design project. Prerequisite: Min Eng 3912, co-requisite: Civ Eng 3116.

**MIN ENG 4322 Coal Mine Development And Production** (LEC 3.0)

An in-depth study of all aspects of coal mining, including an overview of coal industry, reserves and geology, planning and development of coal mines, surface and underground mechanized methods of face preparation, equipment, coal extraction, handling and preparation as practiced in the United States. Prerequisite: Accompanied or preceded by Min Eng 4912.

**MIN ENG 4412 Aggregate Materials Sizing and Characterization** (LAB 1.0 and LEC 2.0)

Geological formation of aggregates; aggregate properties and their measurements; aggregates for specific end-user applications; specifications and standards; processing (crushing, screening, classification, and washing); plant design and flow sheet analysis; quality control and assurance. Prerequisite: Min Eng 3412.

**MIN ENG 4413 Material Processing By High-Pressure Water Jet** (LEC 3.0)

Methods of generating high pressure water jets; standard equipment, existing techniques and basic calculations. Applications of water jets to materials cutting and mineral processing. Safety rules. The course will be supported by laboratory demonstrations. (Co-listed with Mech Eng 5606).

**MIN ENG 4414 Mine Plant Management** (LEC 2.0)

Optimization of mine plant and equipment performance. Availability, utilization and reliability of equipment; matching equipment and plant to minesite specific conditions; maintenance planning, scheduling and control; parts and materials supply systems; mine information and management systems. Basics of mine automation and robotics. Prerequisite: Senior standing or consent of instructor.

**MIN ENG 4422 Coal Preparation** (LEC 2.0 and LAB 1.0)

Coal properties, sampling, testing, breaking, sizing, cleaning and dewatering. Disposal of refuse. Prerequisites: Min Eng 3412 and senior standing.

**MIN ENG 4423 Mineral Processing I (Flotation and Hydrometallurgy)** (LAB 1.0 and LEC 2.0)

Forth flotation including mineral surfaces, double layer theory, zeta potential, hydrophobicity, adsorption, collectors, frothers, modulation, kinetics, and sulphide and acid flotation systems. Hydrometallurgy including leaching, ion exchange and liquid/liquid extraction. Prerequisite: Min Eng 3412.

**MIN ENG 4424 Mineral Processing II (Mechanics and Design)** (LEC 2.0 and LAB 1.0)

Mineral particle mechanics of comminution, sizing, classification, concentration, filtering and thickening. Mill and equipment selection and design including flowsheet, development and plant assessment. Prerequisite: Min Eng 3412. (Co-listed with Met Eng 5270).

**MIN ENG 4512 Mine Management** (LEC 3.0)

Theory and practice of mine management, including basic managerial functions, management theories, communication skills, motivation, leadership, organization, maintenance management, managerial decision making, cost control, labor relations, government relations, ethics and risks management with emphasis in presentation skills. Prerequisite: Completion of 50 credits toward Mining Engineering degree. (Co-listed ECON 4512).

**MIN ENG 4522 Ore Reserve Analysis And Geostatistics** (LAB 1.0 and LEC 2.0)

An introduction to principles of geostatistics, theory of spatially correlated random variables, variance and co-variances and their application on the evaluation of mineral resources, ore reserve estimation, strategic exploration, and production planning. Real case studies from mining industry will be presented. Prerequisite: Stat 3113 or Stat 3115.

**MIN ENG 4523 Environmental And Natural Resource Economics** (LEC 3.0)  
Optimum use of replenishable and non-replenishable resources, public goods and common resources, externalities, private vs. public costs, and quality of the environment; emphasis on public policy related to environmental and natural resource economics. Prerequisite: Econ 2100. (Co-listed with Econ 4440).

**MIN ENG 4524 Energy Economics** (LEC 3.0)

Market structure. World resource development. Supply and demand analysis on energy production and consumption within domestic and global settings. Prerequisite: Econ 2100. (Co-listed with Econ 4540).

**MIN ENG 4742 Environmental Aspects Of Mining** (LEC 3.0)

Permitting: the legal environment of reclamation and environmental impact assessment; post-mining land-use selection and mine planning for optimum reclamation of all mines: metal, nonmetal, and coal; unit operations of reclamation: drainage, backfill, soil replacement, revegetation, maintenance, etc. Prerequisites: Co-requisites: MIN ENG 4933 or GEO ENG 5441 or ENV ENG 5619. (Co-listed with GEO ENG 4276).

**MIN ENG 4823 Rock Mechanics** (LAB 1.0 and LEC 2.0)

Applications of the fundamental principles of mechanics to engineering problems of equilibrium, strength and stiffness of rock materials. Review of in-situ stresses, laboratory and field instrumentation, rock and rockmass properties, pillar design, roof span design, rock reinforcement, surface subsidence, slope stability, and violent failures. Field trip required. Prerequisites: Physics 2135; Civ Eng 2210; Geology 3310.

**MIN ENG 4824 Soils and Overburden Materials for Mining Engineering** (LEC 2.0)

Physical and mechanical properties of soils and overburden materials. Soils and overburden characterization for reclamation and mine closure and overburden blasting. Soil failure modes and slope stability for surface mine layouts, waste dumps, tailings and earth dams, and foundations for heavy mining machinery. Prerequisites: Civ Eng 2210.

**MIN ENG 4912 Mine Power And Drainage** (LEC 2.0 and LAB 1.0)

Engineering principles of mine power distribution and application and mine dewatering. Basics of electrical circuits, AC/DC power, transformers, electric meters, power distribution, power management. Hydraulic power systems. Compressed air in mines. Mine dewatering. Controlling water inflow. Dewatering wells. Water pumping and pumping systems. Prerequisites: Chem 3410 and Civ Eng 3330.

**MIN ENG 4922 Tunneling & Underground Construction Techniques** (LAB 1.0 and LEC 2.0)

Cover both mechanical excavation and conventional excavation techniques to underground tunneling and construction. The emphasis will be on equipment selection and prediction of performance expected of the equipment. Ground control systems will be covered as technology emerges. Excavation methods and support of large caverns, often found in civil structures, will also be discussed. A limited focus will be on underground construction specifications and underground advance rate and cost estimation techniques. Prerequisites: Min Eng 4823, Min Eng 4932 or Civ Eng 3715, Civ Eng 3116 or Geo Eng 5471.

**MIN ENG 4932 Underground Mining Methods And Equipment** (LEC 3.0)

Principles of planning, constructing, and operating economically viable underground mines. Cost effective mining methods: room-and-pillar, sublevel open stoping, VCR, shrinkage, sublevel caving, cut-and-fill, block caving, longwall. Selection of equipment for underground mining operations. Optimization of mine performance. Field Trip Required. Prerequisite: Preceded or accompanied by Min Eng 3913.

**MIN ENG 4933 Surface Mining Methods And Equipment** (LEC 3.0)

Principles of planning, constructing, and operating economically viable surface mines. Cost effective mining methods: placer mining, strip mining, open pit mining, quarrying. Selection of equipment for surface mining operations. Optimization of mine performance. Field trip required. Prerequisites: Min Eng 3912; Min Eng 3512; preceded or accompanied by Min Eng 4823.

**MIN ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of the instructor required.

**MIN ENG 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MIN ENG 5113 Advanced Mine Atmosphere Control** (LEC 2.0 and LAB 1.0)

Advanced mine ventilation network based on airflow requirements, control of gases, dust, and temperature, methane drainage, mine fans, network theory based on the Code of Federal Regulations. Computer simulation of ventilation systems, mine fire simulation, and economics of airflow based on underground mine layouts. Research paper or design project required. Prerequisite: Mi Eng 4113 or Consent of Instructor.

**MIN ENG 5122 Advanced Topics in Mine Health and Safety** (LEC 3.0)

Advanced topics in mine health and safety including practices and regulations; risks and hazards recognition, mitigation and control; disaster prevention and control. Students will complete a research paper or project report. Pre-requisite: Mi Eng 4122 or Consent of Instructor.

**MIN ENG 5212 Advanced Aggregates and Quarrying** (LEC 3.0)

Advanced topics in aggregates mining, mine design and planning, and project valuation. In-pit crushing and conveying, and advances in comminution technology for the aggregates industry. Design project or research paper required. Prerequisite: Mi Eng 4212 or Consent of Instructor.

**MIN ENG 5322 Advanced Coal Mining Methods** (LEC 3.0)

Advanced topics in coal mining methods, planning and development of surface and underground mining systems; planning of logistics, resources, infrastructure for large-scale surface coal mines; face preparation, equipment interface, haulage systems, sequencing and scheduling and extraction from underground coal mines. Students will complete a research paper or project report. Prerequisites: Min Eng 4322 or Consent of Instructor.

**MIN ENG 5412 Advanced Aggregates Sizing and Characterization** (LEC 2.0 and LAB 1.0)

Advanced methods for evaluating aggregate occurrences, extraction, material flow sheet analysis; Advances in processing and classification; advanced statistical methods for quality control and assurance, and standards. Students will complete and present a research paper on the subject. Field trip to a nearby quarry required. Prerequisite: Mi Eng 4412 or Consent of Instructor.

**MIN ENG 5413 Adv Mtl Proc Hghpres Wtr Jet** (LEC 3.0)

Advanced methods for continuously generating high pressure, power calculations, applications of waterjets in the mining and manufacturing industries, and safety considerations. Research paper or design project required. Prerequisite: Mi Eng 4413 or Consent of Instructor.

**MIN ENG 5422 Advanced Coal Preparation** (LEC 2.0 and LAB 1.0)

Advanced methods for designing coal processing circuitry and practices, flowsheet design, sampling, advanced ash and moisture analyzers; coarse, intermediate, and fine coal cleaning; dewatering; dry coal cleaning research. Research paper or design project required. Prerequisite: Mi Eng 4422 or Consent of Instructor.

**MIN ENG 5423 Advanced Flotation and Hydrometallurgy** (LEC 2.0 and LAB 1.0)

Theoretical basis of froth flotation, electrical characteristics at interfaces, interfacial forces, adsorption kinetics and thermodynamics, flotation reagents, flotation process flowsheets. Physicochemical principles of hydrometallurgical processes, leaching methods and reagents. Hydrometallurgical processes flowsheets. Research paper or design project required. Prerequisites: Mi Eng 4423 or Consent of Instructor.

**MIN ENG 5424 Advanced Mechanics And Design** (LAB 1.0 and LEC 2.0)

Strategy of beneficiation as a combination of unit operations: Mineral sampling and particle size distribution, mineral particle mechanics of comminution and energy requirement, mineral crushing and grinding circuits, classification, solid-liquid separation and instrumentation, Mineral processing plant flow sheet design. Research paper or design project required. Prerequisites: Mi Eng 4424 or Consent of Instructor.

**MIN ENG 5522 Advanced Ore Reserve Analysis And Geostatistics** (LEC 2.0 and LAB 1.0)

Advanced discussions on principles of geostatistics, theory of spatially correlated random variables, variance and co-variances and their application on the evaluation of mineral resources, ore reserve estimation, strategic exploration, and production planning. Real case studies from mining industry will be presented. Course project. Prerequisites: Math 3304 & Stat 3113 or instructor consent.

**MIN ENG 5532 Advanced Mining Economics** (LEC 3.0)

Mining industry & national economics. Social & economics significance of mined commodities. Marketing of mined commodities. Innovation approaches to mine financing, project loans, and leasing. Mining feasibility studies, government influence & policy, mining industry foreign investment, investment strategies, mining taxation, cost predictions. Case Studies.

**MIN ENG 5612 Principles of Explosives Engineering** (LEC 2.0 and LAB 1.0)

Theory and application of explosives in the mining industry; explosives, initiating systems, characteristics of explosive reactions and rock breakage, fundamentals of blast design, drilling and blasting, regulatory and safety considerations. Prerequisites: Min Eng 2126; successful background check. (Co-listed with Exp Eng 5612).

**MIN ENG 5622 Blasting Design And Technology** (LEC 2.0 and LAB 1.0)

Advanced theory and application of explosives in excavation; detailed underground blast design; specialized blasting including blast casting, construction and pre-splitting. Introduction to blasting research. Examination of field applications. Prerequisites: Min Eng 5612. Student must be at least 21 years of age. Successful background check. (Co-listed with Exp Eng 5622).

**MIN ENG 5742 Advanced Environmental Aspects of Mining** (LEC 3.0)

Applied and fundamental research issues pertaining to: permitting -- the legal environment of reclamation and environmental impact assessment; post-mining land-use selection and mine planning for optimum reclamation of all mines: metal, nonmetal, and coal; unit operations of reclamation: drainage, backfill, soil replacement, revegetation, maintenance, etc. Course project. Prerequisites: Min Eng 5932 and 5933 or instructor consent. (Co-listed with GE XXXX).

**MIN ENG 5822 Strata Control** (LEC 3.0)

A detailed review of artificial ground support, both above and below ground, including slope stabilization techniques and shaft and tunnel liner design. The use of shotcrete, roofbolts, and solid liners and the principles of underground longwall and room and pillar mine support. Longwall and hydraulic mining practice is covered. Prerequisite: Min Eng 4823.

**MIN ENG 5823 Rock Mechanics III** (LAB 1.0 and LEC 2.0)

Advanced methods for designing rock excavation to resolve geotechnical and ground control problems. Topics including stress analysis, rock properties, instrumentation, pillar design, roof span design, rock reinforcement, surface subsidence, rock burst, and slope stability. Research paper or design project required. Prerequisites: Mi Eng 4823 or Consent of Instructor.

**MIN ENG 5912 Advanced Mine Power And Drainage** (LEC 2.0 and LAB 1.0)

Advanced methods for evaluating electric power requirements and distribution mining geometries; Design and evaluation of mine drainage systems based on power requirements, layouts efficiency, hydraulic gradients, water-bearing formations; Risk evaluation of emergency power failures and mine flooding. Research paper or project required. Prerequisite: Mi Eng 4912 or Consent of Instructor.

**MIN ENG 5913 Advanced Computer Aided Mine Design** (LEC 2.0 and LAB 1.0)

Project-based mine planning and design course. Engineering design process applied to computer-aided mine planning and design. Mine layouts, production planning, and materials scheduling optimization. Prerequisite: Graduate standing.



**MIN ENG 5922 Advanced Tunneling & Underground Construction Techniques** (LEC 2.0 and LAB 1.0)

Advanced topics in mechanical and conventional excavation techniques in underground tunneling and construction. Topics include tunneling layouts design, equipment and performance modeling, ground control systems including support, drainage, and structural integrity. Construction specifications, advance rate and contractual and cost estimation. Prerequisite: Consent of instructor. (Co-listed with Exp Eng 5922).

**MIN ENG 5932 Advanced Underground Mining Methods** (LEC 3.0)

Advanced methods for designing, planning, developing and operating economic and efficient underground mining systems. Systems include mass mining methods, room and pillar, longwall, cut and fill with equipment, ventilation and drainage control interface. Research paper or design project required. Prerequisite: Mi Eng 4932 or Consent of Instructor.

**MIN ENG 5933 Advanced Surface Mining Methods** (LEC 3.0)

Advanced topics in surface mine planning, methods and equipment acquisition, and deployment in surface mining operations. Strategic and tactical mine planning with focus on efficiency, safety, environmental standards and economics. It will also focus on fleet management with emphasis on repair, rebuild and replacement for higher availabilities, utilization and production output. Students will complete a research paper or project report. Prerequisites: Min Eng 4933 or Consent of Instructor.

## Multiculturalism & Diversity

### Multiculturalism & Diversity Minor

The Multiculturalism and Diversity Minor prepares students to function more effectively in a global society as well as enhances Missouri S&T graduates' employment options by providing knowledge, skills, and strategies for appreciating and understanding diverse cultural practices.

The minor requires 15 hours in a minimum of 3 of 4 humanities and social sciences (HSS) departments: the departments of arts, languages and philosophy; English and technical communication; history and political science; and psychological science. The academic home for this minor will be the arts, languages and philosophy department. Courses offered by these departments that can be included in the minor are listed below.

**Arts, Languages & Philosophy:**

One language course at the third semester or above in a foreign language (German, Spanish, French, or Russian) *	
PHILOS 4340	Social Ethics
RUSSIAN 4360	Russian Civilization
SP&M S 3235	Intercultural Communication

**English and Technical Communication:**

ENGLISH 1231	World Literature I: From The Beginnings To The Renaissance
ENGLISH 2242	Literature By Women
ENGLISH 2245	African American Literature
ENGLISH 3228	The American Experience

**History and Political Science:**

HISTORY 3280	European Migrations and Nationalism Formation
HISTORY 3660	Modern East Asia
HISTORY 3665	History of Japan
POL SCI 2500	International Relations
POL SCI 4510	The Politics of the Third World

**Psychology:**

PSYCH 4993	Psychology of Gender
PSYCH 4992	Cross-Cultural Psychology

\* Language Courses at the 3rd Semester or above that qualify for the minor:

FRENCH 1180	Intermediate French
FRENCH 2110	Basic French Conversation
FRENCH 2170	Masterpieces Of French Literature
FRENCH 2180	Basic French Composition
FRENCH 4311	Advanced French Conversation
FRENCH 4320	French and Francophone Cinema
FRENCH 4360	French Culture And Civilization
FRENCH 4370	Survey Of French Literature I (Early Period)
FRENCH 4375	Survey Of French Literature II (Modern Period)
GERMAN 1180	Classical And Modern German Readings
GERMAN 2110	Basic German Conversation
GERMAN 2170	Masterpieces Of German Literature
RUSSIAN 1180	Readings In Science And Literature
RUSSIAN 2110	Basic Russian Conversation
RUSSIAN 2170	Masterpieces Of Russian Literature
RUSSIAN 4320	Russian Phonetics and Intonation
RUSSIAN 4330	Business Russian
RUSSIAN 4360	Russian Civilization
RUSSIAN 4370	Survey Of Russian Literature I (Early Period)
RUSSIAN 4375	Survey Of Russian Literature II (Modern Period)
SPANISH 1180	Intermediate Spanish
SPANISH 2110	Basic Spanish Conversation
SPANISH 2160	Hispanic Culture
SPANISH 2170	Masterpieces Of Hispanic Literature
SPANISH 2180	Intermediate Spanish Composition
SPANISH 4311	Advanced Spanish Conversation
SPANISH 4377	Spanish-American Novel And Short Story
SPANISH 4302	Phonetics and Phonology of Spanish

## Multidisciplinary Studies

The bachelor of arts in multidisciplinary studies reflects Missouri S&T's recognition that technological change, both in the modern workplace and, to a lesser extent, in our leisure lives, increasingly cuts across the traditional boundaries of degrees and disciplines. Offered through the department of arts, languages, and philosophy, this degree permits students whose interests cross these boundaries to combine courses in two or three different "focus areas" to create a coherent and academically sound non-traditional program of study.

All students in the B.A. multidisciplinary studies program will complete the basics skills and concepts and general education requirements and generally comply with the requirements for the B.A. degree. However, in lieu of the traditional major and minor requirements, student will complete two (24 and 21 hours respectively) or three (15 hours each) focus area chosen from among the various disciplines offered at Missouri S&T. GPA requirements for each area are the same as those for major fields. B.A. multidisciplinary studies students will also complete a 3-hour capstone course (ALP 4397) that reflects the students' ability to synthesize methods and knowledge from each focus area into an academically coherent product.

Students design their multidisciplinary programs in coordination with a multidisciplinary studies advisor in the department of arts, languages, and philosophy. For each program, the advisor will work with the student to convene and chair a degree committee consisting of one faculty member from each focus area. Student in the program are expected to develop a sensible rationale for their course of study, justifying both the combination of disciplines and each course chosen within that combination in the context of their own needs and interests. Individual

programs and capstone course activities are subject to approval of the degree committee.

**W Lance Haynes**, Professor  
PHD University of Minnesota

## Music

At Missouri S&T, music offerings include bands, orchestras and choirs. Credit may be earned by participating in these groups.

You can take courses in various areas of music appreciation, music history and theory, special projects courses in music, and private applied music instruction.

## Music Minor Curriculum

1. The following courses will be taken:
  - A. Eight hours of theory.
  - B. Six hours of music history and literature.
  - C. Six hours of applied private instruction (two years), culminating in an approved recital or other appearance.
2. The successful music minor will demonstrate adequate keyboard proficiency or take keyboard until proficiency is attained.
3. The music minor will participate in one or more major ensembles per semester (band, jazz, orchestra, vocal, opera).

**David L Cress**, Assistant Teaching Professor  
MS Troy University

**Lorie Lynne Francis**, Assistant Teaching Professor  
MMUS University of Colorado Boulder

**MUSIC 1111 Individual Music Instruction I** (LAB 1.0)  
Individual music instruction in student's concentration area. Prerequisite: Consent of instructor required.

**MUSIC 1121 Individual Music Instruction II** (LAB 1.0-2.0)  
Individual music instruction in student's concentration area. Prerequisite: Consent of instructor.

**MUSIC 1130 Wind Symphony** (LAB 2.0)  
Open to all students who play a band instrument. Auditions may be used for placement in ensemble.

**MUSIC 1131 Marching Band** (LAB 2.0)  
Open to all students who play a band instrument. Auditions may be used for placement in ensemble.

**MUSIC 1132 University Orchestra** (LAB 2.0)  
Open to all students who play stringed, wind, percussion or keyboard instruments used in the symphony orchestra. Students assigned to the orchestra after satisfactory audition.

**MUSIC 1134 Instrumental Chamber Ensemble-Strings** (LAB 1.0)  
Open to all students who play violin, viola, cello or double bass. Students assigned to the ensemble after satisfactory audition.

**MUSIC 1135 Symphonic Band** (LAB 0.0-2.0)  
Open to all students who play a band instrument. Auditions may be used for placement in ensemble.

**MUSIC 1136 Jazz Ensemble** (LAB 1.0)  
A study of the various instrumental jazz forms. Students are assigned by audition to a jazz ensemble. Prerequisite: Consent of instructor.

**MUSIC 1140 University Choir** (LAB 1.0)  
SATB choral group. Open to all who are interested in learning to sing in a choral setting. No audition required.

**MUSIC 1141 Chamber Vocal Ensembles** (LAB 1.0)  
An SATB choral group. Audition required. Auditions are open to all who are interested and are held during class time the first week of classes.

**MUSIC 1150 Music Understanding And Appreciation** (LEC 3.0)  
A study of the development of music with emphasis on understanding music forms and the role music has played in the various historical periods.

**MUSIC 2000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MUSIC 2001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**MUSIC 2111 Individual Music Instruction III** (LAB 1.0-2.0)  
Individual music instruction in student's concentration area. Prerequisite: Consent of instructor.

**MUSIC 2121 Individual Music Instruction IV** (LAB 1.0-2.0)  
Individual music instruction in student's concentration area. Prerequisite: Consent of instructor.

**MUSIC 2161 Theory of Music I** (LEC 3.0)  
Basic musicianship. Notation, rhythm, meter, scales, intervals, triads, nonharmonic tones, major-minor seventh, modulations of common practice period. Applications of these materials in original composition and analysis of melodies and elementary homophonic form.

**MUSIC 2162 Theory of Music II** (LEC 3.0)  
A continuation of the requisite theory and fundamentals of Music 2161. Prerequisite: Music 2161.

**MUSIC 3000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MUSIC 3001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**MUSIC 3010 Seminar** (IND 0.0-6.0)  
Discussion of current topics.

**MUSIC 3251 History and Analysis of Music I** (LEC 3.0)  
General survey of history of music from Greek period to 18th century. Score reading required.

**MUSIC 3252 History and Analysis of Music II** (LEC 3.0)  
General survey of history of music from the 18th century to the present. Score reading required.

**MUSIC 4000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MUSIC 4001 Special Topics** (LEC 0.0 and LAB 0.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

## Nuclear Engineering

The nuclear engineering program is offered under the department of mining and nuclear engineering.

The nuclear engineering program has a primary mission to provide an outstanding and comprehensive undergraduate and graduate education to tomorrow's leaders in nuclear engineering. The department provides well-educated nuclear engineering professionals and leaders to Missouri and the nation, in the commercial nuclear industry, national laboratories, graduate schools, and the nation's defense and federal agencies. The objectives of the bachelor of science program are to provide each student with fundamental knowledge of nuclear engineering and related technologies, analytical and problem solving ability, ability for technical communications, professional ethics, leadership and interpersonal skills, capability to conduct research, and the ability to recognize the value of life-long learning.

The program is committed to a strong engineering program administered by highly motivated and active nuclear engineering faculty; it is the only B.S. nuclear engineering degree program accredited in the state of Missouri. The nuclear engineering program at Missouri S&T, one of the earliest ABET accredited undergraduate programs in the nation, interacts with professional societies, national laboratories, and the nuclear industry to promote continuing education, research opportunities, and public dissemination of information about issues and advances in the field.

Nuclear engineers develop and promote the utilization of energy released from nuclear fission, fusion, and the decay of radioisotopes. Currently, there are more than 100 nuclear power plants operating in the United States producing about 20 percent of our nation's electricity. These plants use nuclear fission to produce energy and are cooled by ordinary (light) water, hence the name, Light Water Reactors. This technology reduces the emission of greenhouse gases like carbon dioxide significantly, thus contributing to a better environment. In addition, nuclear reactors are used for the propulsion of submarines and aircraft carriers.

In fusion power plants, under development, strong magnetic fields contain a plasma fuel of hydrogen isotopes, such as deuterium, at temperatures hotter than the sun. The deuterium extracted from one gallon of water could produce as much energy as burning several hundred gallons of gasoline.

Radioisotopes are used in industry and research, and in medicine for diagnostic and therapeutic purposes. The medical use of radioisotopes and X-rays saves hundreds of thousands of lives every year throughout the world. Radioisotopes are also used in small power generators for space flights.

If you choose nuclear engineering, you could work in the areas of nuclear reactor design, plant licensing, plant operation, fuel management and development, radioactive waste disposal, health physics, instrumentation and control, fusion research, space nuclear power, and applications of radioisotopes in industry, medicine, and research. As a nuclear engineer, you might be employed by utilities, reactor vendors, architect-engineering firms, consulting firms, industrial research centers, national laboratories, government agencies or universities.

The nuclear engineering curriculum consists of three components: general education, mathematics and basic sciences, and engineering topics. The students apply the principles of physics, chemistry and mathematics to the study of engineering topics which include statics, mechanics of materials, electronic circuits and machines, thermodynamics, and metallurgy. The knowledge gained in these areas is applied to the understanding of nuclear engineering topics including reactor fluid mechanics and heat transfer, reactor physics, nuclear

radiation measurements, radioactive waste management, reactor laboratory and operation, nuclear materials, and nuclear systems design (a capstone design course).

Engineering design is an integral part of a significant number of required courses in the nuclear engineering program. Design topics include but are not limited to reactor cooling systems, radiation protection, structural components, waste disposal and transportation systems, nuclear reactor cores and the design of experiments for radiation detection and measurement. While obtaining experience in these areas the students are prepared for designing a complete nuclear system such as a nuclear plant for electric power generation, space propulsion, desalination, district heating or radioisotope production for industrial, medical or research applications.

In the Senior Nuclear Systems Design course (NUC ENG 4497), students work in small groups on different components of a system. They interact and exchange ideas with the instructor and other groups on a weekly basis both collectively and individually in the form of reports and oral presentations. In this course, all of the knowledge acquired by the students including that in the humanities and social sciences, is brought to bear on the selection of the final design. In addition to the technical considerations, the issues addressed include economics, safety, reliability, ethics, and social impact. At the end of the semester the students write a comprehensive and cohesive final report for their final design and make an oral presentation of their work.

Laboratory facilities available to nuclear engineering students include a radiation measurements laboratory, a 200 kW swimming pool-type nuclear reactor, a materials analysis laboratory, a computer learning center, a radiochemistry lab, and a neutron generator. The students have access to state-of-the-art computing facilities including personal computers, and numerically intensive cluster computers. The department offices and laboratories are primarily housed in Fulton Hall. The nuclear reactor is housed in its own building.

## Mission Statement

The primary mission of the nuclear engineering program is to provide well-educated nuclear engineering professionals and leaders to Missouri and the nation in the commercial nuclear industry, national laboratories, graduate schools, and the nation's defense and federal agencies.

## Educational Objectives

- Fundamental knowledge of nuclear engineering and related technologies. Our graduates will continue to demonstrate a sound fundamental knowledge of nuclear engineering and related technologies as members of their professional community.
- Analytical and problem solving ability. Our graduates will continue to use logical, creative, collaborative, analytical and problem solving abilities to address emerging multidisciplinary endeavors.
- Technical communication and interpersonal skills. Our graduates will continue to demonstrate technical communication and interpersonal skills, enabling them to excel in their profession.
- Leadership and professional ethics. Our graduates will continue to demonstrate leadership with an understanding of, and a commitment to, professional ethics.
- Capability to conduct research. Our graduates will continue to demonstrate the capability to conduct research enabling them to contribute to meeting the needs of their profession.

- Pursuit of life-long learning. Our graduates will continue to demonstrate a recognition of, and a desire for, the pursuit of life long learning that will foster their ability to adapt to change.

## Student Outcomes

- An ability to apply knowledge of mathematics, science, and engineering.
- An ability to design and conduct experiments, as well as to analyze and interpret data.
- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- An ability to function on multidisciplinary teams.
- An ability to identify, formulate, and solve engineering problems.
- An understanding of professional and ethical responsibility.
- An ability to communicate effectively.
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- A recognition of the need for, and an ability to engage in life-long learning.
- A knowledge of contemporary issues.
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

## Bachelor of Science Nuclear Engineering

Entering freshmen desiring to study nuclear engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, to state a nuclear engineering preference, which will be used as a consideration for available departmental scholarships.

For the bachelor of science degree in nuclear engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. A student must maintain an average of at least two grade points overall and for all courses taken in nuclear engineering.

Each student's program of study must contain a minimum of 18 credit hours of course work from the humanities and the social sciences areas and should be chosen according to the following rules:

1. All students are required to take one American history course and one economics course. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200.
2. Students must take ENGLISH 1120. Students are also required to take one humanities course to be selected from "The Approved List of Humanities and Social Science Courses for Engineering Degrees" maintained by the office of undergraduate studies.
3. Of the remaining hours, six credit hours must be taken in humanities or social sciences at the 1000 level or above and must be selected from "The Approved List of Humanities and Social Science Courses for Engineering Degrees" maintained by the office of undergraduate studies. One of these courses must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 1180 can be considered to be one of these courses. (Students may receive humanities credit for foreign

language courses in their native tongue only if the course is at the 4000 level.)

4. Skill courses are not allowed to meet humanities and social sciences requirements except in foreign languages. Students who select the foreign language option are urged to take more than one course.
5. Special topics, special problems courses and honors seminars are allowed only by petition to and approval by the student's department chair.

The nuclear engineering program at Missouri S&T is characterized by its focus on the scientific basics of engineering and its innovative application. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

### Freshman Year

First Semester	Credits	Second Semester	Credits
Freshman Chemistry Requirement <sup>1</sup>	5	Elective-Hum or Soc Sci <sup>3</sup>	3
ENGLISH 1120	3	HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3
FR ENG 1100	1	PHYSICS 1135	4
MATH 1214	4	MECH ENG 1720	3
NUC ENG 1105 <sup>2</sup>	1	MATH 1215	4
	14		17

### Sophomore Year

First Semester	Credits	Second Semester	Credits
CIV ENG 2200	3	STAT 3111, or 3113, or 3115, or 3117	3
Elective <sup>6</sup>	3	ECON 1100 or 1200	3
MATH 2222	4	NUC ENG 2406	1
NUC ENG 2105	2	CIV ENG 2210	3
PHYSICS 2135	4	MATH 3304	3
		PHYSICS 2305	3
	16		16

### Junior Year

First Semester	Credits	Second Semester	Credits
Elective-Hum or Soc Sci <sup>3</sup>	3	ENGLISH 1160 or 3560	3
COMP SCI 3200 (or any 3000-level MATH or 5000-level STAT)	3	NUC ENG 4312	3
MET ENG 2110	3	NUC ENG 3223	3
NUC ENG 3205	3	NUC ENG 4203	3
NUC ENG 3221	3	NUC ENG 4229	3
		Technical Electives-3000 or 4000 level <sup>5</sup>	3
	15		18

### Senior Year

First Semester	Credits	Second Semester	Credits
Elective-Hum or Soc Sc <sup>3</sup>	3	Elective-Hum or Soc Sci <sup>3</sup>	3
NUC ENG 4428	2	Technical Elective-4000 level <sup>5</sup>	3
NUC ENG 4207	3	Free Elective <sup>4</sup>	6
Elective-4000 level MATH	3	NUC ENG 4438	2
NUC ENG 4496	1	NUC ENG 4497	3



NUC ENG 4241	3	
	15	17
Total Credits: 128		

**Note:** Minimum credit hours for graduation is 128.

- <sup>1</sup> CHEM 1310 and CHEM 1319 or CHEM 1351 and CHEM 1100 or an equivalent training program approved by Missouri S&T.
- <sup>2</sup> Nuclear Engineering students are expected to take Nuclear Technology Applications (NUC ENG 1105) during their Freshman year. However, transfer students are exempt.
- <sup>3</sup> Humanities and Social Science to be taken in accordance with the policy described above.
- <sup>4</sup> Courses which do not count towards this requirement are remedial courses such as algebra and trigonometry, physical education courses, extra credits in required courses, and basic Air Force and Army ROTC courses (courses taught in the first two years of the ROTC program).
- <sup>5</sup> Any Math, Science, or Engineering courses.
- <sup>6</sup> The programming elective consists of a lecture and lab combination, and may be selected from COMP SCI 1970 and COMP SCI 1980, or COMP SCI 1971 and COMP SCI 1981, or COMP SCI 1972 and COMP SCI 1982, or COMP SCI 1570 and COMP SCI 1580. Note that COMP SCI 1570 and COMP SCI 1580 requires one more credit hour than the other options.

**Fundamentals of Engineering Exam:** All nuclear engineering students must take the Fundamentals of Engineering Examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree, however, it is the first step toward becoming a registered professional engineer. This requirement is part of the Missouri S&T assessment process as described in assessment requirements found elsewhere in this catalog.

## Nuclear Engineering Minor Curriculum

A nuclear engineering minor enhances the academic credentials of a student and broadens his/her employment choices. A minimum of 15 hours is required for a minor in nuclear engineering.

Before the courses listed below can be taken, the student should have completed MATH 3304 (or equivalent) and PHYSICS 2305 (or NUC ENG 3103 or equivalent). Required courses are:

NUC ENG 3205	Fundamentals Of Nuclear Engineering	3
NUC ENG 3223	Reactor Heat Transfer	3
NUC ENG 4312	Nuclear Radiation Measurements and Spectroscopy	3

The other 6 hours should be selected from nuclear engineering 3000 or 4000 level courses.

**Muthanna Hikmat Al Dahhan**, Professor  
DSc Washington University

**Ayodeji Babatunde Alajo**, Assistant Professor  
PHD Texas A&M University

**Carlos Henry Castano**, Associate Professor  
PHD University of Illinois Urbana-Champaign

**Arvind Kumar**, Professor Emeritus  
PHD University of California-Berkeley

**Hyoungh Koo Lee**, Associate Professor  
PHD University of California-Berkeley

**Xin Liu**, Assistant Professor  
PHD University of Wisconsin-Madison

**Gary Edward Mueller**, Associate Professor<sup>1</sup>  
PHD University of Missouri-Rolla

**Joshua P Schlegel**, Assistant Professor  
PHD Purdue University

**Joseph D Smith**, Professor  
PHD Brigham Young University

**Shoaib Usman**, Associate Professor  
PHD University of Cincinnati

### **NUC ENG 1105 Nuclear Technology Applications** (LEC 1.0)

It is a project oriented course that examines various aspects of nuclear technology, such as radiation detection, radiation protection, food irradiation, medical and industrial applications. The students will work in small groups on stimulating projects.

### **NUC ENG 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

### **NUC ENG 2105 Introduction To Nuclear Engineering** (LEC 2.0)

Atoms and nuclei; nuclear reactions; radioactivity; interactions of radiation with matter; fission and fusion reactors; nuclear fuels; radiation effects on materials and man; radioactive waste disposal; reactor safety; radiation protection. Prerequisite: Math 1215 or Math 1221.

### **NUC ENG 2406 Reactor Operations I** (LAB 1.0)

A first course in reactor operations training and practical approach to nuclear reactor concepts. Students will receive hands-on training and are encouraged to take the NRC Reactor Operator's Exam. Prerequisites: Math 1214 or Math 1208; preceded or accompanied by Nuc Eng 1105.

### **NUC ENG 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### **NUC ENG 3001 Special Topics** (LAB 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

### **NUC ENG 3103 Interactions Of Radiation With Matter** (LEC 3.0)

Atoms and nuclei; relativistic kinematics; quantum theory; nuclear decay; cross sections; neutron, gamma, and charged particle interactions; production of radioisotopes; electrical, thermal and magnetic properties of solids. Prerequisites: Math 2222, Physics 2135.

### **NUC ENG 3205 Fundamentals Of Nuclear Engineering** (LEC 3.0)

An introduction to the principles and equations used in nuclear fission reactor technology including: reactor types; neutron physics and reactor theory; reactor kinetics and control; radiation protection; reactor safety and licensing; and environmental aspects of nuclear power. Prerequisite: Physics 2305 or Nuc Eng 3103; Math 3304.

### **NUC ENG 3221 Reactor Fluid Mechanics** (LEC 3.0)

A study of the fundamental principles of incompressible viscous and inviscid flows in ducts, nozzles, tube bundles and applications to nuclear engineering; fluid statics; dimensional analysis and similitude; boundary layer theory. Prerequisites: Math 3304, Junior standing.

**NUC ENG 3223 Reactor Heat Transfer** (LEC 3.0)

A study of the fundamental principles of conduction, convection and thermal radiation with volumetric source terms for nuclear engineering applications; empirical correlations; finite difference methods; analysis of nuclear reactor cores. Prerequisite: Nuc Eng 3221.

**NUC ENG 3377 Nuclear Forensics and Radiochemistry** (LEC 3.0)

Learn the fundamentals of radiochemistry and its application to the broad field of Nuclear Forensics. Includes a review of nuclear science and cosmochemistry (the origin of the chemical elements), a historical review of spent fuel reprocessing techniques including solvent extraction. A broad review of the modern nuclear forensics field and its importance. Prerequisites: NUC ENG 2105 recommended.

**NUC ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**NUC ENG 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**NUC ENG 4010 Seminar** (RSD 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

**NUC ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**NUC ENG 4203 Reactor Physics I** (LEC 3.0)

Study of neutron interactions, fission, chain reactions, neutron diffusion and neutron slowing down; criticality of a bare thermal homogeneous reactor. Prerequisite: Nuc Eng 3205.

**NUC ENG 4207 Nuclear Fuel Cycle** (LEC 3.0)

Nuclear fuel reserves and resources; milling, conversion, and enrichment; fuel fabrication; in-and-out-of core fuel management; transportation, storage, and disposal of nuclear fuel; low level and high level waste management; economics of the nuclear fuel cycle. Prerequisite: Nuc Eng 3205.

**NUC ENG 4211 Reactor Physics II** (LEC 3.0)

Analytic and computer based methods of solving problems of reactor physics. Prerequisites: Nuc Eng 4203, Comp Sci 3200.

**NUC ENG 4215 Space Nuclear Power And Propulsion** (LEC 3.0)

A study of the design, operation and application of radioisotope power generators and nuclear reactors for space power and propulsion systems used on both manned and unmanned missions. Prerequisites: Nuc Eng 4203 and Nuc Eng 4229.

**NUC ENG 4229 Nuclear Power Plant Systems** (LEC 3.0)

A study of current nuclear power plant concepts and the environmental, economics and safety considerations affecting their design. Includes such topics as: thermodynamics, thermal hydraulics, and mechanical and electrical aspects of nuclear power facilities. Prerequisites: Nuc Eng 3205 and accompanied or preceded by Nuc Eng 3223.

**NUC ENG 4241 Nuclear Materials I** (LEC 3.0)

Fundamentals of materials selection for components in nuclear applications; design and fabrication of UO<sub>2</sub> fuel; reactor fuel element performance; mechanical properties of UO<sub>2</sub>; radiation damage and effects, including computer modeling; corrosion of materials in nuclear reactor systems. Prerequisites: Civ Eng 2210; Nuc Eng 3205; Nuc Eng 3223; Met Eng 2110. (Co-listed with Met Eng 5170).

**NUC ENG 4251 Reactor Kinetics** (LEC 3.0)

Derivation and solutions to elementary kinetics models. Application of the point kinetics model in fast and thermal reactor dynamics, internal and external feedback mechanisms, rigorous derivation and solutions of the space dependent kinetics model fission product and fuel isotope changes during reactor operation. Prerequisite: Nuc Eng 3205.

**NUC ENG 4253 Monte Carlo Approach to Reactor Analysis** (LEC 3.0)

An introduction to a stochastic method for solving particle transport problems with a view to utilize the method in reactor design and analysis, shielding problems, flux calculations, reaction rates determination and general steady state reactor physics analysis. Prerequisites: Accompanied by NUC ENG 3205.

**NUC ENG 4257 Two-phase Flow in Energy Systems - I** (LEC 3.0)

It is an introductory course for both undergraduate or graduate students who are interested in the application of two-phase flow in energy systems. It will acquaint students with governing equations for both single-phase and two-phase fluid flow, state-of-the-art analytical methods and various two-phase flow phenomena related to energy systems. Prerequisite: Nuc Eng 3221 or Chem Eng 3100 or Mech Eng 3131.

**NUC ENG 4259 Licensing Of Nuclear Power Plants** (LAB 1.0 and LEC 2.0)

The pertinent sections of the Code of Federal Regulations, the Nuclear Regulatory Commission's Regulatory Guides and Staff Position Papers, and other regulatory requirements are reviewed. Safety analysis reports and environmental reports for specific plants are studied. Operational aspects of the nuclear power plant will be covered by including field trips. Prerequisite: Nuc Eng 3205.

**NUC ENG 4281 Probabilistic Risk Assessment I** (LEC 3.0)

A study of the techniques for qualitative and quantitative assessment of reliability, safety and risk associated with complex systems such as those encountered in the nuclear power industry. Emphasis is placed on fault tree analysis. Prerequisite: Nuc Eng 3205.

**NUC ENG 4312 Nuclear Radiation Measurements and Spectroscopy** (LAB 1.0 and LEC 2.0)

Contemporary radiation detection theory and experiments with high resolution gamma-ray spectroscopy, solid state detectors, neutron detection and conventional gas filled detectors. Neutron activation analysis of unknown material, statistical aspects of nuclear measurements. Prerequisite: Nuc Eng 3205.

**NUC ENG 4345 Nuclear Engineering Mathematical Methods** (LEC 3.0)

Application of mathematical methods used in the solution of nuclear engineering problems, particularly with the neutron kinetics equations, the Navier-Stokes equations, and the heat conduction equation with nuclear heat generation terms. Prerequisites: Nuc Eng 4203.

**NUC ENG 4347 Radiological Engineering** (LEC 3.0)

Radiation exposure pathways analysis. Modeling of radionuclides transport through atmosphere, surface and ground water. Human health impact. Transportation of nuclear waste. Nuclear Waste characterization. Regulatory structure and requirements. Scenario case studies and computer simulation of transport. Prerequisite: Nuc Eng 3205.

**NUC ENG 4350 Introduction to Nuclear Medical Science** (LEC 3.0)

Introduction to physics and technologies involved in various radiological imaging and treatment systems in the medical field, such as digital radiography, digital mammography, computed tomography and nuclear medicine instruments will be covered. Prerequisites: Nuc Eng 4312 or equivalent. (Co-listed with Nuc Eng 5350).

**NUC ENG 4361 Fusion Fundamentals** (LEC 3.0)

Introduction to the plasma state, single particle motion, kinetic theory, plasma waves, fusion, power generation, radiation mechanisms, inertial confinement and fusion devices, including conceptual fusion power plant designs. Prerequisite: Preceded or accompanied by Math 3304.

**NUC ENG 4363 Applied Health Physics** (LEC 3.0)

Radiation sources; external and internal dosimetry; biological effects of radiation; radiation protection principles; regulatory guides; radioactive and nuclear materials management. Prerequisite: Nuc Eng 3103 or Physics 2305.

**NUC ENG 4365 Radiation Protection Engineering** (LEC 3.0)

Radiation fields and sources including nuclear reactors, radioactive wastes, x-ray machines, and accelerators. Stopping of radiation (Charges particles, photons, and neutrons) by matter. Radiation transport methods. Radiation shielding design. Dose rate calculations. Biological effects of radiation. Regulatory guides (10CFR20). Prerequisite: Nuc Eng 3205.

**NUC ENG 4367 Radioactive Waste Management And Remediation** (LEC 3.0)

Sources and classes of radioactive waste, long-term decay, spent fuel storage, transport, disposal options, regulatory control, materials issues, site selection and geologic characterization, containment, design and monitoring requirements, domestic and foreign waste disposal programs, economic and environmental issues, history of disposal actions, and conduct of remedial actions and clean up. Prerequisite: Math 3304. (Co-listed with Geology 4421).

**NUC ENG 4370 Plasma Physics I** (LEC 3.0)

Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Aero Eng 5570, Mech Eng 5570, Physics 4543).

**NUC ENG 4428 Reactor Laboratory I** (LAB 1.0 and LEC 1.0)

Acquaints the student with neutron flux measurement, reactor operation, control rod calibration, reactor power measurement and neutron activation experiments. Experiments with the thermal column and neutron beam port are also demonstrated. Prerequisites: Nuc Eng 4312, 3205.

**NUC ENG 4438 Reactor Laboratory II** (LEC 1.0 and LAB 1.0)

A continuation of Nuclear Engineering 4428 with experiments of a more advanced nature. Prerequisite: Nuc Eng 4428.

**NUC ENG 4456 Reactor Operation II** (LAB 1.0)

The operation of the training reactor. The program is similar to that required for the NRC Reactor Operator's license. Students from other disciplines will also benefit from the course. Prerequisite: Nuc Eng 2105, 2406.

**NUC ENG 4496 Nuclear System Design I** (LEC 1.0)

A preliminary design of a nuclear system (e.g. a fission or fusion nuclear reactor plant, a space power system, a radioactive waste disposal system). Prerequisites: Nuc Eng 3223, 4203, 4229, preceded or accompanied by Nuc Eng 4241.

**NUC ENG 4497 Nuclear System Design II** (LEC 3.0)

A complete design of a nuclear system (e.g. a fission or fusion nuclear reactor plant, a space power system, a radioactive waste disposal system). Prerequisite: Nuc Eng 4496.

**NUC ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**NUC ENG 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**NUC ENG 5203 Reactor Physics I** (LEC 3.0)

Study of neutron interactions, fission, chain reactions, neutron diffusion and neutron slowing down; criticality of a bare thermal homogeneous reactor. Prerequisite: Nuc Eng 3205.

**NUC ENG 5207 Nuclear Fuel Cycle** (LEC 3.0)

Nuclear fuel reserves and resources; milling, conversion, and enrichment; fuel fabrication; in-and-out-of core fuel management; transportation, storage, and disposal of nuclear fuel; low level and high level waste management; economics of the nuclear fuel cycle. Prerequisite: Nuc Eng 3205.

**NUC ENG 5241 Nuclear Materials I** (LEC 3.0)

Fundamentals of materials selection for components in nuclear applications; design and fabrication of UO<sub>2</sub> fuel; reactor fuel element performance; mechanical properties of UO<sub>2</sub>; radiation damage and effects, including computer modeling; corrosion of materials in nuclear reactor systems. Prerequisites: Civ Eng 2210; Nuc Eng 3205; Nuc Eng 3223; Met Eng 2110. (Co-listed with Met Eng 5170).

**NUC ENG 5251 Reactor Kinetics** (LEC 3.0)

Derivation and solutions to elementary kinetics models. Application of the point kinetics model in fast and thermal reactor dynamics, internal and external feedback mechanisms, rigorous derivation and solutions of the space dependent kinetics model fission product and fuel isotope changes during reactor operation. Prerequisite: Nuc Eng 3205.

**NUC ENG 5257 Introduction to Nuclear Thermal Hydraulics** (LEC 3.0)

An introductory course in the application of thermal-hydraulic principles to energy systems, with emphasis on nuclear energy issues. Will include the development of constitutive models and applications to power systems, fluid mechanics, and heat transfer problems (including multiphase flows). Prerequisite: Graduate standing.

**NUC ENG 5281 Probabilistic Risk Assessment I** (LEC 3.0)

A study of the techniques for qualitative and quantitative assessment of reliability, safety and risk associated with complex systems such as those encountered in the nuclear power industry. Emphasis is placed on fault tree analysis. Prerequisite: Nuc Eng 3205.

**NUC ENG 5312 Nuclear Radiation Measurements and Spectroscopy** (LEC 2.0 and LAB 1.0)

Contemporary radiation detection theory and experiments with high resolution gamma-ray spectroscopy, solid state detectors, neutron detection and conventional gas filled detectors. Neutron activation analysis of unknown material, statistical aspects of nuclear measurements. Prerequisite: Nuc Eng 3205.

**NUC ENG 5347 Radiological Engineering** (LEC 3.0)

Radiation exposure pathways analysis. Modeling of radionuclides transport through atmosphere, surface and ground water. Human health impact. Transportation of nuclear waste. Nuclear Waste characterization. Regulatory structure and requirements. Scenario case studies and computer simulation of transport. Prerequisite: Nuc Eng 3205.

**NUC ENG 5350 Advanced Nuclear Medical Science** (LEC 3.0)

Advanced level of technologies involved in medical modalities, such as digital radiography, digital mammography, modern computed tomography, gamma camera, SPECT and PET will be covered. Prerequisites: Nuc Eng 4312 or equivalent.

**NUC ENG 5363 Applied Health Physics** (LEC 3.0)

Radiation sources; external and internal dosimetry; biological effects of radiation; radiation protection principles; regulatory guides; radioactive and nuclear materials management. Prerequisite: Nuc Eng 3103 or Physics 2305.

**NUC ENG 5365 Radiation Protection Engineering** (LEC 3.0)

Radiation fields and sources including nuclear reactors, radioactive wastes, x-ray machines, and accelerators. Stopping of radiation (Charges particles, photons, and neutrons) by matter. Radiation transport methods. Radiation shielding design. Dose rate calculations. Biological effects of radiation. Regulatory guides (10CFR20). Prerequisite: Nuc Eng 3205.

**NUC ENG 5367 Radioactive Waste Management And Remediation** (LEC 3.0)

Sources and classes of radioactive waste, long-term decay, spent fuel storage, transport, disposal options, regulatory control, materials issues, site selection and geologic characterization, containment, design and monitoring requirements, domestic and foreign waste disposal programs, economic and environmental issues, history of disposal actions, and conduct of remedial actions and clean up. Prerequisite: Math 3304. (Co-listed with Geology 4421).

**NUC ENG 5370 Plasma Physics I** (LEC 3.0)

Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Aero Eng 5570, Mech Eng 5570, Physics 4543).

**NUC ENG 5428 Reactor Laboratory I** (LEC 1.0 and LAB 1.0)

Acquaints the student with neutron flux measurement, reactor operation, control rod calibration, reactor power measurement and neutron activation experiments. Experiments with the thermal column and neutron beam port are also demonstrated. Prerequisites: Nuc Eng 4312, 3205.

**NUC ENG 5438 Reactor Laboratory II** (LEC 1.0 and LAB 1.0)

A continuation of Nuclear Engineering 304 with experiments of a more advanced nature. Prerequisite: Nuc Eng 4428.

**NUC ENG 5456 Reactor Operation II** (LAB 1.0)

The operation of the training reactor. The program is similar to that required for the NRC Reactor Operator's license. Students from other disciplines will also benefit from the course. Prerequisite: Nuc Eng 2105, 2406.

## Petroleum Engineering

Anyone with an interest in energy and a strong desire to get paid for traveling the globe might consider the possibility of a career as a petroleum engineer. Petroleum engineers seek out oil and gas reservoirs beneath the earth's surface. They develop the safest and most efficient methods of bringing those resources to the surface and to market.

Many petroleum engineers travel the world or live in foreign countries - wherever their explorations take them to find and recover valuable petroleum reserves. These travels can lead to the deserts, high seas, mountains, and arctic regions of the world in order to find untapped sources of energy for the world's population. Petroleum engineers also tend to quickly assume leadership roles, handling large projects with high levels of responsibility.

Because of the increasing demand for energy, there has been an accompanying increase in the demand for petroleum engineers

worldwide. In the United States, the oil industry workforce is aging, and numerous opportunities are expected as a result.

As a petroleum engineering student, you will study the technology of oil and gas drilling, production, reserves estimation, and the prediction of future production. You will also study various techniques for evaluating the characteristics of petroleum bearing formations and their fluid contents.

Petroleum Engineering is an independent degree program offered under the department of geological sciences and engineering

## Mission Statement

To educate engineers for the worldwide petroleum industry, and to perform meaningful research that advances oil and gas recovery. Students graduating from the petroleum engineering program shall be well prepared to serve the industry and themselves, through their technical knowledge, ethical considerations, participation in professional societies and desire for life long learning. The petroleum engineering program emphasizes the importance of geomechanics in petroleum development, through building mechanical earth models.

## Petroleum Engineering Educational Objectives

1. To produce a petroleum engineer who is capable of working as a drilling/completions, production, or reservoir engineer; or related fields of hydrogeology, petroleum transportation and storage, or oil and gas regulations.
2. To produce a petroleum engineer who understands the value of information in the exploitation of an oil or gas asset, and who can analyze and synthesize data to construct economic solutions to petroleum engineering problems.
3. To produce petroleum engineers who are recognized for their ability to integrate geology, geophysics, petrophysics and mechanical earth modeling to solve petroleum engineering problems within the framework of multidisciplinary teams.

## Educational Outcomes

The petroleum engineering program educational outcomes are based on ABET's outcomes 1 through 12 plus specific MEM related outcomes. The outcomes statements are as follows: Petroleum engineering seeks to graduate students who have:

1. The ability to apply knowledge of mathematics, science, and engineering.
2. The ability to design and conduct experiments, as well as to analyze and interpret data.
3. The ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. The ability to function on multidisciplinary teams.
5. The ability to identify, formulate, and solve engineering problems.
6. The understanding of professional and ethical responsibility.
7. The ability to communicate effectively.
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.



9. Recognition of the need for and an ability to engage in life-long learning.
10. Knowledge of contemporary issues.
11. The ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
12. The ability to use Mechanical Earth Modeling tools and techniques to solve problems associated with the production of oil and gas.

## Bachelor of Science Petroleum Engineering

Entering freshmen desiring to study Petroleum Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Petroleum Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering Program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major. A grade point average of 2.80 or higher is required to enter the Petroleum Engineering program from the Freshman Engineering Program.

For the Bachelor of Science degree in Petroleum Engineering a minimum of 129 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. A student must maintain at least two grade points per credit hour for all courses taken in Petroleum Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1. Six credit hours of English: All students are required to take ENGLISH 1120 and either ENGLISH 3560 (preferred) or ENGLISH 1160 or ENGLISH 1600.
2. Nine credit hours of basic humanities and social sciences: All students are required to take one history course, one economics course and one humanities course. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200. The humanities course must be selected from "The Approved List of Humanities and Social Science Courses for Engineering Degrees" maintained by the Office of Undergraduate Studies.
3. Three credit hours as a depth requirement. Three credit hours must be taken in humanities or social sciences at the 2000-level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 1180 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 4000-level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.
4. Three credit hours of elective humanities and social sciences from the approved list.
5. Special topics and special problems and honors seminars are allowed only by petition to and approval by the student's department chair.

The Petroleum Engineering program at Missouri S&T consists of a strong foundation in math, sciences and engineering fundamentals, plus strong content in the traditional Petroleum Engineering core areas of

drilling, production and reservoir engineering. Two unique features of the curriculum are a strong sequence of courses in Geology and Geophysics, plus a two course sequence in finite element analysis and mechanical earth modeling. S&T Petroleum Engineering students are prepared to solve today's problems and tomorrow's. Students learn theory, have ample hands-on experiences in laboratories, and they learn many modern software packages used by the petroleum industry.

Students planning on majoring in petroleum engineering should take the following courses.

Freshman Year			
First Semester	Credits	Second Semester	Credits
ENGLISH 1120	3	MATH 1215	4
FR ENG 1100	1	GEO ENG 1150 or GEOLOGY 1110	3
CHEM 1310	4	GEO ENG 1119	1
CHEM 1319	1	PHYSICS 1135	4
HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3	PET ENG 2510	3
MATH 1214	4	MECH ENG 1720	3
	16		18
Sophomore Year			
First Semester	Credits	Second Semester	Credits
MATH 2222	4	MATH 3304	3
PHYSICS 2135	4	PET ENG 3520	3
GEOLOGY 3310 (Geol 3319 lab optional)	3	MECH ENG 2350	2
CIV ENG 2200	3	CIV ENG 2210	3
PET ENG 3320	3	ECON 1100 or 1200	3
		GEOLOGY 3620	3
	17		17
Junior Year			
First Semester	Credits	Second Semester	Credits
GEOPHYS 4231	3	PET ENG 3330	3
CIV ENG 3330	3	PET ENG 4410	3
PET ENG Reservoir Engineering Elective <sup>4</sup>	3	PET ENG 4710	3
GEOLOGY 5513	3	PET ENG 4590	3
PET ENG 4210	3	Humanities/Social Sci Elective <sup>2</sup>	3
	15		15
Senior Year			
First Semester	Credits	Second Semester	Credits
MECH ENG 2527	3	PET ENG 4097	3
PET ENG 4010 <sup>3</sup>	1	GEO ENG 4115	3
PET ENG 4520	3	Hum/Soc Sci Elective <sup>2</sup>	3
PET ENG 4720	3	PET ENG Elective <sup>5</sup>	3
PET ENG Elective <sup>5</sup>	3	ENGLISH 3560 <sup>6</sup>	3
Humanities/Social Sci Elective <sup>2</sup>	3		
	16		15

Total Credits: 129

<sup>1</sup> All freshmen Petroleum Engineering students must enroll in CHEM 1100.

- <sup>2</sup> Humanities/Social Science electives are to be selected from a list of approved courses as published by the department. Petroleum Engineering students are especially encouraged to study foreign languages
- <sup>3</sup> All Petroleum Engineering students must take the Fundamentals of Engineering Examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree, however, it is the first step to becoming a registered professional engineer. This requirement is part of Missouri S&T assessment process as described in Assessment Requirements found elsewhere in this catalog. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.
- <sup>4</sup> This is a reservoir engineering elective. Students should choose from PET ENG 4511, PET ENG 4531, PET ENG 4611, PET ENG 4311, or PET ENG 4621.
- <sup>5</sup> Select Petroleum Engineering electives in accordance with interest area. Students interested in reservoir engineering select from topics in advanced reservoir engineering, simulation, natural gas engineering, and formation characterization. Students interested in drilling/completions and production select petroleum electives such as advanced drilling, well completions, stimulation. Other general interest petroleum electives may be selected as available.
- <sup>6</sup> Students may also select ENGLISH 1160 or ENGLISH 1600.

The total number of credit hours required for a degree in Petroleum Engineering is 129.

Petroleum Engineering students must earn the grade of "C" or better in all Petroleum Engineering courses to receive credit toward graduation.

## Minor Curriculum in Petroleum Engineering

The petroleum industry employs not only petroleum but also civil, electrical, chemical, geological, mechanical and other engineers. A petroleum engineering minor, therefore, enhances the academic credentials of a student and broadens their employment choices. A minor in petroleum engineering requires 15 hours of Missouri S&T credit to include the following:

PET ENG 3520	Petroleum Reservoir Engineering	3
PET ENG 4210	Drilling and Well Design	3
PET ENG 4410	Well Performance and Production Systems	3
Two elective courses*		6
Total Credits		15

\*The two elective courses are to be chosen from any petroleum engineering course and/or Petroleum Geology (GEOLOGY 5513) .

**Baojun Bai**, Associate Professor  
PHD New Mexico Institute of Mining

**Shari Dunn Norman**, Associate Professor  
PHD Heriot-Watt University

**Andreas Eckert**, Assistant Professor  
PHD University of Karlsruhe

**Ralph E Flori Jr**, Associate Professor  
PHD University of Missouri-Rolla

**Peyman Heidari**, Assistant Professor  
PHD The Pennsylvania State University

**Steven Hilgedick**, Assistant Teaching Professor  
PHD Missouri University of Science and Technology

**Mingzhen Wei**, Assistant Professor  
PHD New Mexico Tech

### **PET ENG 2000 Special Problems** (IND 1.0-3.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### **PET ENG 2001 Special Topics** (IND 1.0-3.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

### **PET ENG 2002 Cooperative Work Training** (IND 1.0-3.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation.

### **PET ENG 2510 Properties Of Hydrocarbon Fluids** (LEC 3.0)

Physical properties of petroleum fluids; chemical components of petroleum fluids. Elementary phase behavior; calculations of the physical properties of gases, liquids, and gas-liquid mixtures in equilibrium. Prerequisite: Chem 1310.

### **PET ENG 3000 Special Problems** (IND 1.0-3.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### **PET ENG 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

### **PET ENG 3320 Petrophysics** (LEC 2.0 and LAB 1.0)

Fundamental properties of petroleum reservoir rocks, including lithology, porosity, absolute permeability, pore surface area, relative and effective permeability, fluid saturations, rock wettability, capillary characteristics, acoustic properties, and electrical properties. Darcy's law for single phase linear horizontal and tilted flow and radial flow. Prerequisites: Preceded or accompanied by both Pet Eng 2510 and Physics 1135.

### **PET ENG 3330 Well Logging** (LAB 1.0 and LEC 2.0)

An introduction to the electrical, nuclear, and acoustic properties of rocks: theory and interpretation of conventional well logs. Prerequisites: Physics 2135 or 2111; Pet Eng 3520.

### **PET ENG 3520 Petroleum Reservoir Engineering** (LEC 3.0)

Properties of reservoir formations and fluids; reservoir volumetrics, reservoir statics, reservoir dynamics. Darcy's law and the mechanics of single and multiphase fluid flow through reservoir rock, capillary phenomena, material balance, reservoir drive mechanisms. Prerequisite: Accompanied or preceded by Pet Eng 2510.

### **PET ENG 3529 Petroleum Reservoir Laboratory** (LAB 1.0)

Core analysis determination of intensive properties of crude oil and its products; equipment and methods used to obtain petroleum reservoir information. Prerequisite: Accompanied or preceded by Pet Eng 3520.

### **PET ENG 4000 Special Problems Special Problems Special Problems** (IND 0.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PET ENG 4001 Special Topics** (LAB 1.0 and LEC 2.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PET ENG 4010 Ethics and Professionalism** (LEC 1.0)

Topics related to Ethics and Professionalism. Lifelong learning, teamwork and discussion of current events. (Course cannot be used for graduate credit). Prerequisite: Senior standing in Pet Eng.

**PET ENG 4097 Petroleum Engineering Design** (LEC 3.0)

Senior capstone design project(s) based on industry data. Application of reservoir engineering: drilling and production engineering principles to evaluate and solve an industry problem such as a new field development, evaluation of an existing reservoir asset, or analysis of field re-development. Prerequisites: Pet Eng 3520, Pet Eng 3410, and senior standing.

**PET ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**PET ENG 4109 Field Studies** (LAB 1.0)

Field trip, which studies different aspects of petroleum engineering like reservoirs, caprocks and traps, drilling rigs, petroleum production facilities, refineries and petroleum engineering research facilities. This course takes the students for one week to petroleum operations and geological outcrops in Oklahoma and Texas to expose students to field work.

**PET ENG 4111 Fundamental Digital Applications In Petroleum Engineering** (LEC 3.0)

Applications of Windows-based Visual Basic solutions to engineering problems including selected topics in fluid flow, PVT behavior, matrices in engineering solutions, translating curves to computer solutions, predictor-corrector material balance solutions, and graphical display of results. Prerequisite: Junior Standing.

**PET ENG 4210 Drilling and Well Design** (LAB 1.0 and LEC 2.0)

This course covers drilling fluids, including mixing and analysis of rheological properties; pressure loss calculations; casing design; well cementing; pore pressure and geomechanical considerations in drilling; completion equipment; and completion design. Prerequisite: Preceded or accompanied by Civ Eng 3330.

**PET ENG 4211 Advanced Drilling Technology** (LEC 3.0)

In-depth study of directional well planning and drilling. The course covers the bottom hole assemblies and operational techniques used in drill directional drilling as well as the limiting factors and hole problems related to horizontal wells. Prerequisites: Pet Eng 4210.

**PET ENG 4311 Reservoir Characterization** (LEC 3.0)

The integration and extrapolation of Geologic, Geophysical, and Petroleum Engineering data for flow model construction. Prerequisites: Pet Eng 3520 and Pet Eng 3310.

**PET ENG 4410 Well Performance and Production Systems** (LEC 2.0 and LAB 1.0)

Introduction to the producing wellbore system; inflow performance relationships, effect of formation damage on well flow, nodal systems analysis; perforating methods and their effect on inflow; stimulation treatments to enhance well performance. Introduction to well completions, diagnostics and well servicing. Overview of production systems. Prerequisite: Preceded or accompanied by Pet Eng 3520.

**PET ENG 4421 Artificial Lift** (LEC 3.0)

This course is a study of artificial lift methods used to produce liquids (oil/water) from wellbores. Methods covered include sucker rod (piston) pumps, electric submersible pumps, gas lift, hydraulic lift and plunger lift. Prerequisite: Pet Eng 4410.

**PET ENG 4431 Well Completion Design** (LEC 3.0)

An overview of the hardware, fluids and processes employed in completing oil and gas wells. Examination of types of well completions and considerations in their design. Introduction to downhole mechanics and tubing movement and stress calculations. Prerequisite: Pet Eng 3520.

**PET ENG 4441 Well Stimulation** (LEC 3.0)

This course reviews fundamentals of hydraulic fracturing and builds on the basic theory through the use of STIMPLAN software and hands on industry examples. The course teaches the methods used to plan, execute and evaluate hydraulic fracturing treatments. Students may not earn credit for both Pet Eng 4441 and Pet Eng 6441. Prerequisites: Pet Eng 3520 and Pet Eng 3330.

**PET ENG 4511 Applied Petroleum Reservoir Engineering** (LEC 3.0)

Quantitative study of oil production by natural forces, gas cap, water influx, solution gas, etc.; material balance equations, study of gas, non-retrograde gas condensate, and black oil reservoirs. Predictive calculations of oil recovery from different reservoir types. Prerequisites: Pet Eng 3520 and 3529.

**PET ENG 4520 Well Test Analysis** (LEC 2.0 and LAB 1.0)

Causes of low well productivity; analysis of pressure buildup tests, drawdown tests, multi-rate tests, injection well fall off tests, and open flow potential tests; design of well testing procedures. Prerequisite: Pet Eng 3520.

**PET ENG 4531 Natural Gas Engineering** (LEC 3.0)

Gas reserves estimation, deliverability, and future production performance prediction. Deliverability testing of gas wells including isochronal, flow after flow, drawdown and buildup. Gasfield development and underground storage. Gas production metering gauging and transmission. Prerequisite: Preceded or accompanied by Pet Eng 3520.

**PET ENG 4590 Petroleum Economics and Asset Valuation** (LEC 3.0)

Uncertainty in the estimation of oil and gas reserves; tangible and intangible investment costs; depreciation; evaluation of producing properties; federal income tax considerations; chance factor and risk determination. Petroleum economic evaluation software is introduced. Prerequisites: Pet Eng 3520, Econ 1100 or Econ 1200.

**PET ENG 4611 Secondary Recovery Of Petroleum** (LEC 3.0)

Oil recovery by water injection. Effects of wettability, capillary pressure, relative permeability, mobility ratio on displacement, sweep, and recovery efficiencies. Piston-like and Buckley-Leverett models. Fractional flow and frontal advance equation. Oil recovery prediction methods for linear and pattern waterfloods in single and multi-layered reservoirs. Prerequisites: Pet Eng 3520, Pet Eng 3529.

**PET ENG 4621 Fundamentals Of Petroleum Reservoir Simulation** (LEC 3.0)

An introduction to petroleum reservoir simulation. Fundamentals of finite difference approximation of the partial differential equations of flow through porous media. Discussion of various simulation schemes, data handling, boundary conditions. Use of a dry gas and black oil simulators. Prerequisite: Pet Eng 3520.

**PET ENG 4631 Applied Reservoir Simulation** (LEC 3.0)

Simulation of actual reservoir problems using both field and individual well models to determine well spacing, production effects of secondary and enhanced recovery processes, future rate predictions and recovery, coning effects, relative permeability adjustments and other history matching techniques. Prerequisite: Pet Eng 3520.

**PET ENG 4710 Finite Element Analysis with Applications in Petroleum Engineering** (LEC 2.0 and LAB 1.0)

This course introduces finite element analysis (FEA) methods and applications of FEA in subsurface engineering. The course is intended to provide a fundamental understanding of FEA software and experience in creating meshes for petroleum reservoirs or other subsurface features. Prerequisites: Pet Eng 3520, Geology 3310, and Math 3304.

**PET ENG 4720 Mechanical Earth Modeling** (LEC 3.0)

This course introduces the work process necessary to create the Mechanical Earth Model's principle components, formation in-situ stress and strength. 1-D modelign methods are reviewed and extended to 3-D; and the integration of MEM with well design is shown. An MEM model will be created and compared to actual field results. Prerequisites: Pet Eng 3310 and Geology 3310.

**PET ENG 4811 Offshore Petroleum Technology** (LEC 3.0)

An introduction to the development of oil and gas fields offshore, including offshore leasing, drilling, well completions, production facilities, pipelines, and servicing. Subsea systems, and deepwater developments are also included. This course is suitable for mechanical, electrical and civil engineering students interested in ultimately working offshore.

**PET ENG 4821 Environmental Petroleum Applications** (LEC 3.0)

This course is a study of environmental protection and regulatory compliance in the oil and gas industry. The impact of various environmental laws on drilling and production operations will be covered. Oilfield and related wastes and their handling are described. Federal, state and local regulatory agencies are introduced, and their role in permitting and compliance monitoring is presented. Legal and ethical responsibilities are discussed. Prerequisite: Chem 1310.

**PET ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects of projects in the department. Consent of instructor required.

**PET ENG 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PET ENG 5010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

**PET ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**PET ENG 5085 Internship** (IND 0.0-15)

Students working toward a doctor of engineering degree will select, with the advice of their committees, appropriate problems for preparation of a dissertation. The problem selected and internship plan must conform to the purpose of providing a high level engineering experience consistent with the intent of the doctor of engineering degree.

**PET ENG 5099 Research** (IND 0.0-12)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

## Philosophy

The philosophy program is offered in the department of arts, languages and philosophy.

The study of philosophy emphasizes the understanding of ideas, the capacity to identify assumptions, and the ability to gain insights into problems and puzzles. Central to philosophy is the application of rigorous thinking to the fundamental issues of reality, knowledge, and value.

Because rigorous thinking is not restricted to any one academic area, philosophical interests are wide ranging. All types of questions are considered: do we have freewill or are all our actions caused? Does God exist and have a determinable nature? How do we tell the difference between what's morally right and wrong? What is thinking and can animals or machines think? How does our nature influence our behavior and creative activity? What is the interrelationship between technological development and human values? etc.

Philosophy touches on nearly all fields of endeavor and a philosophical education is very flexible. With the help of advisors, students can design their curriculum to match their own special interests. Philosophy is also an excellent pre-professional degree.

## Bachelor of Science Philosophy

A minimum of 120 credit hours is required for a bachelor of science degree in philosophy, and a grade point average of 2.0 must be obtained. These requirements for the B.S. are in addition to credit received for basic ROTC.

The B.S. in philosophy degree requires the following:

1. ENGLISH 1120 (entering students will normally take ENGLISH 1120 within their first year of study.) (3 hours)
2. Sciences. A total of 24 hours in biological, physical (chemistry, geology, and physics), and mathematical (mathematics, statistics, computer science, and information science and technology) sciences is required. A course from each of the biological and physical sciences is required. Students have to take two math or statistics courses; both must be at the level of college algebra or higher. At least one hour of lab coursework is required. Students may count up to 12 hours of engineering courses, at the discretion of the major advisor. Also, students may count up to 3 hours from the following list, but which may not be used to satisfy another requirement: History of science and technology classes (HISTORY 2510, HISTORY 3510, and HISTORY 3530), PHILOS 4345, or PHILOS 3254 (24 hours)
3. Social Sciences. A total of 15 hours in social sciences is required. At least one course from two of the four areas must be taken: economics, sociology/anthropology, history/political science, and psychology. Six (6) hours from the biological, physical, and mathematical science, as well as engineering, not already used for the science requirement, may be substituted for 3 hours of social sciences; this substitution is only permitted once, unless allowed at the discretion of the major advisor. (15 hours)



4. Humanities. A total of 12 hours in humanities other than philosophy is required. Courses may be taken in literature, foreign/modern languages, speech and media studies, art, music, or theater. Three (3) hours from history not used for the social science requirement, and not HISTORY 1300 or HISTORY 1310, may be used to fulfill this requirement. (12 hours)

5. Two (2) Communication Intensive courses are required; waiving and substitutions are at the discretion of the student's advisor.

6. Minor: A minor will be selected from any discipline other than the major with approval of the major advisor. A total of at least 15 hours is required for the minor, but may include courses which also satisfy other requirements. At least nine hours must be beyond the introductory level.

7. Basic ROTC may be elected in the freshman and sophomore years, but is not creditable toward the B.S. in philosophy degree. Six credit hours of advanced ROTC may be credited toward this degree.

8. Elective Credits: In consultation with her/his advisor, each student will elect sufficient additional courses to complete a minimum of 120 credit hours which may include MATH 1120 or MATH 1140 and MATH 1160.

9. Philosophy: A total of at least 30 hours of philosophy courses is required. This is to include PHILOS 1105, PHILOS 1115, and at least 12 hours at the 4000-level, although substitutions may be permitted at the discretion of the major advisor. All philosophy work must accumulate to at least a 2.0 grade point average.

## Ethics Minor

To qualify, all students must take 15 hours of course work from the following list of which at least 6 hours are from the 4000-level:

PHILOS 1105	Introduction To Philosophy	3
PHILOS 1115	Introduction To Logic	3
PHILOS 1130	Introduction to Ethics	3
PHILOS 1175	Comparative Religious Philosophy	3
PHILOS 3223	Bioethics	3
PHILOS 3225	Engineering Ethics	3
PHILOS 3235	Business Ethics	3
PHILOS 4335	Philosophy Of Religion	3
PHILOS 4340	Social Ethics	3
PHILOS 4350	Environmental Ethics	3
PHILOS 4360	Foundations Of Political Conflict	3
PHILOS 4368	Law and Ethics in E-Commerce	3

## Philosophy Minor

- A student with a minor in philosophy must meet the following requirements:
  - Twelve hours in Philosophy course beyond PHILOS 1105 (PHILOS 1105 is a prerequisite to a minor in philosophy).
  - Six of the twelve hours must be completed in philosophy courses numbered 4000 or above.
- A student should declare his or her intention to minor in philosophy by his or her junior year.
- A member of the philosophy staff will act as the student's minor advisor. The student and his or her minor advisor will plan a course of study to meet the specific interests and needs of the student.

## Philosophy of Technology Minor

To qualify, all students must take 15 hours of course work in the following areas of philosophy, political science and history. Nine or more of these hours will need to be in philosophy.

### Mandatory:

PHILOS 1115	Introduction To Logic	3
-------------	-----------------------	---

### At least two of the following, one of which must be a philosophy class:

PHILOS 4345	Philosophy Of Science	3
PHILOS 4320	Minds And Machines	3
HISTORY 3550		3

### Additional courses from:

PHILOS 1105	Introduction To Philosophy	3
BIO SCI 1163	Biotechnology in Film	3
PHILOS 3223	Bioethics	3
HISTORY 2510	History of Technology	3
HISTORY 3510	Twentieth Century Technology And Society	3

**Joel P Dittmer**, Assistant Professor  
PHD University of Missouri

**Jonathan Andrew Finch**, Lecturer  
MA University of Miami

**Darin Finke**, Assistant Teaching Professor  
PHD University of Missouri

**Andrea Taylor**, Lecturer  
MA University of Oklahoma-Norman

### ***PHILOS 1105 Introduction To Philosophy*** (LEC 3.0)

An historical survey of the major approaches to philosophical problems, especially those of the nature of reality, human nature, and conduct. Prerequisite: Entrance requirements.

### ***PHILOS 1110 Practical Reasoning*** (LEC 3.0)

An introduction to the study of non-formal reasoning. The course examines the subtle ways that the form in which information is presented can color the way that information is understood. Prerequisite: Entrance requirements.

### ***PHILOS 1115 Introduction To Logic*** (LEC 3.0)

A study of the basic rules of both formal and symbolic logic, including types of argumentation, methods of reasoning, valid reasoning, inductive and deductive reasoning as used in the sciences and in communication in general. Prerequisite: Entrance requirements.

### ***PHILOS 1130 Introduction to Ethics*** (LEC 3.0)

A complex and rich tradition in philosophical thought, Ethics - from the Ancient Greeks up into contemporary thought philosophers - returns again and again to discuss theories in proper behavior. No previous exposure to philosophy is required.

### ***PHILOS 1175 Comparative Religious Philosophy*** (LEC 3.0)

A comparison of the philosophic ideas and foundations of the major Eastern and Western religions. Prerequisite: Entrance requirements.

### ***PHILOS 2000 Special Problems*** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### ***PHILOS 2001 Special Topics*** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHILOS 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PHILOS 3001 Special Topics** (LAB 1.0 and LEC 3.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHILOS 3204 Ancient Philosophy** (LEC 3.0)

A study of selected philosophical works from the pre-Socratics to William of Occam. Prerequisites: An introductory (below 2000) level Philosophy course.

**PHILOS 3205 Early Modern Philosophy** (LEC 3.0)

Principal figures in the development of rationalism, empiricism, and skepticism in early modern Europe, from Descartes through Hume. Prerequisites: A previous class in philosophy is recommended.

**PHILOS 3223 Bioethics** (LEC 3.0)

This course covers several areas of ethical interest in biotechnology, medicine, and medical care. Topics may include stem-cell research, cloning, genetic engineering, reproductive issues, pharmaceutical ethics, privacy, physician-assisted suicide, patient rights, human and animal experimentation, and resource allocation. Prerequisite: Sophomore standing or above.

**PHILOS 3225 Engineering Ethics** (LEC 3.0)

Engineering ethics, examines major ethical issues facing engineers in the practice of their profession: the problem of professionalism and a code of ethics; the process of ethical decision-making in different working environments; the rights, duties, and conflicting responsibilities of engineers. Prerequisite: Sophomore standing or above.

**PHILOS 3235 Business Ethics** (LEC 3.0)

Develop ethical concepts relevant to deciding the moral issues that arise in business. Topics include: Economic systems, government regulations, relations to external groups and environment, advertising, product safety and liability, worker safety and rights, rights and responsibilities of business professionals. Prerequisite: Sophomore standing or above.

**PHILOS 3254 Symbolic Logic in Argumentation** (LEC 3.0)

An introduction to sentential and predicate logic. Focuses on various techniques used to examine logical relationships within an artificial symbolic language, such as truth tables, derivations, and models. Includes metatheoretic discussions of syntax and semantics, and soundness and completeness. Prerequisites: Comp Eng 2210, or Comp Sci 1200, or any 1000-level or higher Philosophy course. Philosophy 1115 is recommended.

**PHILOS 3276 Thematics Studies in Film and Philosophy** (LEC 3.0)

A study of special topics at the intersection of film and philosophy. Topics vary but may include films on the nature of reality, films on the problem of evil, films on concepts of consciousness and the self, and more. Prerequisites: Art 1185 or one philosophy course, or junior standing. (Co-listed with Art 3276).

**PHILOS 3302 Medieval Philosophy** (LEC 3.0)

A critical study of the important philosophies of the period from Augustine to the Renaissance. Although there is no formal prerequisite, it is recommended that students have taken at least one other philosophy course. Prerequisites: A previous class in philosophy is recommended.

**PHILOS 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects of projects in the department. Consent of instructor required.

**PHILOS 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHILOS 4320 Minds And Machines** (LEC 3.0)

The course will be centered on the topic of artificial intelligence and the problems raised by contemporary attempts to simulate human thinking and perception in machines. Special emphasis will be placed on recent developments in psychology, physiology, cybernetics and computer technology. Prerequisite: Any philosophy course.

**PHILOS 4325 Epistemology: Knowledge and Justification** (LEC 3.0)

An introduction to the field of epistemology, the study of the scope, the limits, the sources, and the nature of knowledge and justified belief. Includes analyses of knowledge and justification, skepticism, scientific knowledge, and naturalism, among other topics. Prerequisite: Any 1000 or higher level philosophy course. Philosophy 1105 recommended.

**PHILOS 4333 American Philosophy** (LEC 3.0)

A study of American philosophical development with emphasis upon the "Classical Age of American Philosophy", i.e., Pierce, James, Dewey, Royce, Santayana and Whitehead. Prerequisite: An introductory (below 2000) level Philosophy course.

**PHILOS 4335 Philosophy Of Religion** (LEC 3.0)

A consideration of the major presuppositions of western theism, such as the existence of god and the cognitive meaningfulness of religious language. Prerequisite: Any introductory (below 2000) level philosophy course.

**PHILOS 4340 Social Ethics** (LEC 3.0)

This Communication Emphasized course discusses ethical issues confronting society and the arguments offered for alternative laws and public policies. Topics might include: freedom of speech/action, government regulation, welfare, capital punishment, euthanasia, abortion, the environment, affirmative action, just wars, foreign aid, world hunger. Prerequisite: Any philosophy course.

**PHILOS 4345 Philosophy Of Science** (LEC 3.0)

An examination of the fundamental methods and assumptions of the sciences, with emphasis on scientific reasoning and theories. Prerequisite: Any philosophy course.

**PHILOS 4350 Environmental Ethics** (LEC 3.0)

This Communication Emphasized course studies complex moral issues concerning our relationship to the environment and the ethical foundations of our environmental responsibilities. Discussion topics include: conservation, preservation, resource development, pollution, toxic substances, future generations, endangered species, regulation, zoning, and takings. Prerequisite: Any philosophy course.

**PHILOS 4354 Mathematical Logic I** (LEC 3.0)

A mathematical introduction to logic with some applications. Functional and relational languages, satisfaction, soundness and completeness theorems, compactness theorems. Examples from Mathematics, Philosophy, Computer Science, and/or Computer Engineering. Prerequisite: Philos 3254 or Math 5105 or Comp Sci 2500 or Comp Eng 2210. (Co-listed with Comp Eng 5803, Comp Sci 5203 and Math 5154).

**PHILOS 4360 Foundations Of Political Conflict** (LEC 3.0)

This course is designed as a survey of the philosophical foundation of major political systems. For example, communism, fascism, democracy. Materials will be drawn from relevant historical and/or contemporary sources. Prerequisite: Any philosophy course.

**PHILOS 4368 Law and Ethics in E-Commerce** (LEC 3.0)

Provides the ethical framework to analyze the ethical, legal, and social issues that arise for citizens and computer professionals regarding the computerization of society. Topics include: free speech, privacy, intellectual property, product liability, and professional responsibility. (Co-listed with IS&T 5168).

**PHILOS 4399 Topics in Philosophy** (LEC 3.0)

This communication intensive course is designed for students with a special interest in philosophy. The content of the course may vary and the course may be repeated for additional credit. Prerequisite: Any Philosophy course.

**PHILOS 5000 Special Problems** (IND 1.0-3.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PHILOS 5001 Special Topics** (IND 1.0-3.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

## Physical Education and Recreation

To enhance your academic education, you can take part in physical education and recreation courses on campus. There are courses in golf, racquetball, swimming fitness, elements of health education, and theory of sports officiating. The goal of the department is to provide recreational experiences and course work, which will contribute to your physical health and development, social adjustment, and emotional well being. The emphasis is on training you to gain the maximum benefit from leisure time both now and in the future.

The Multi-Purpose Building, Student Rec Center, and surrounding facilities provide an ideal place for you to participate in recreational activities. The building features an indoor swimming pool, indoor jogging track, basketball, volleyball, and badminton courts, weight rooms, aerobics/martial arts room, racquetball courts and a squash court. Multi-use intramural fields highlight the outdoor facilities.

**PHYS ED 1001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYS ED 1100 Weight Training** (LAB 1.0)

Course instruction emphasizes the cognitive aspects of weight lifting, covering such topics as motivation, common injuries, procedures for warm-up and cool down, and safety procedures.

**PHYS ED 1102 Fundamentals Of Golf** (LAB 1.0)

To give the student the theory and practical application of the golf swing while at the same time developing increasing skills, and an interest in the history, rules, and etiquette of the game of golf.

**PHYS ED 1103 Fundamentals Of Tennis** (LAB 1.0)

Lectures, demonstration, and supervised practice are designed to acquaint the student participants with theory and execution which govern the playing of sound and effective tennis.

**PHYS ED 1104 Beginning Aquatics** (LAB 1.0)

The course will provide the student with basic swimming, diving, and elementary life saving skills to prepare the student for additional work in the field of aquatics.

**PHYS ED 1105 Aerobics** (LAB 1.0)

The course intent is to improve the physical condition of the student through various mediums of exercise aimed at demanding more oxygen over an extended period of time to increase the efficiency of the cardiovascular system and improve muscle tone.

**PHYS ED 1108 Beginning Racquetball** (LAB 1.0)

Course instruction familiarizes the student with the rules, playing strategy, and court etiquette of racquetball. Actual playing experience allows the opportunity for skill development in this leisure activity.

**PHYS ED 1109 Basketball/Volleyball** (LAB 1.0)

The Basketball/Volleyball course will contribute to the mastery of fundamental skills in two of the world's leading participation sports. History, rules and strategy will be emphasized.

**PHYS ED 1110 Special Problems** (IND 0.0-6.0)

Problems of readings on specific subjects or projects in the department. Consent of instructor required.

**PHYS ED 1111 Swimming Fitness** (LAB 1.0)

The Swimming Fitness course will provide an environment which will be conducive for the student to improve physical skills and conditioning through training in the water. Benefits of exercise, training principles and safety precautions will be emphasized.

**PHYS ED 1120 Fundamentals And Theory Of Coaching Basketball** (LEC 2.0)

To make the student aware of skills, fundamentals, court situations, strategy, and administrative procedures for successful basketball coaching.

**PHYS ED 1130 Fundamentals And Theory Of Coaching Football** (LEC 2.0)

To present materials that will provide the student with a working knowledge of coaching, administration, and appreciation of football.

**PHYS ED 1500 Administration Of Interscholastic Athletics** (LEC 3.0)

To present materials that will provide the student with a working knowledge of the major administration and day to day problems that are associated with interscholastic athletics.

**PHYS ED 1510 Care And Prevention Of Athletic Injuries** (LEC 3.0)

Technique, principles, and theory underlying the prevention and care of athletic injuries.

**PHYS ED 1520 Elements Of Health Education** (LEC 2.0)

This course surveys various health topics and attempts to provide some answers related to them. Presents pertinent scientific and medical facts of current health concepts and their relation to the principles and theories of health education.

**PHYS ED 1530 Fundamentals And Theory Of Sports Officiating** (LEC 2.0)

To prepare students with knowledge and skills so that they may both officiate competently and adequately critique officiating by others.

**PHYS ED 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PHYS ED 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYS ED 2300 Methods In Physical Education K-4** (LEC 3.0)

The course will provide the opportunity to learn how to promote student fitness and skill development while building the foundation for a physically active life through specific activities aimed at the younger child. (Co-listed with Educ 2230).

**PHYS ED 2310 Methods In Physical Education 5-9** (LEC 3.0)

The course will provide the opportunity to learn how to promote student fitness and skill development while building the foundation for a physically active life through specific activities aimed at the student in transition from childhood to young adulthood (5-9). (Co-listed with Educ 2231).

## Physics

Physics is devoted to the discovery and exploration of the most basic physical laws governing our material universe. The working physicist attempts to express these laws in their most elegant mathematical form, so that they can be applied to predict the behavior of all forms of matter and energy, in physical systems that range from the subatomic level of quarks, gluons, nuclei, and atoms, all the way out to the astrophysical level of planets, stars, black holes, galaxies, and larger scale structures of the universe. The knowledge obtained in various experimental and theoretical investigations of physical phenomena forms the foundation for many modern technologies. For example there are lasers used in high-speed communications and micro-surgery, the plastic electronics used in modern computer displays, the magnetic behavior of the thin films used for computer hard drives, and the radiation detectors and optical elements used in the Hubble space telescope. The fundamental knowledge gained by physicists helps to shape and improve the quality of modern life.

The Missouri S&T physics department is dedicated to providing opportunities for undergraduates to participate in cutting-edge, nationally funded scientific research programs supervised by departmental faculty. Topics currently being investigated by Missouri S&T undergraduates include collisions between electrons, atoms, and ions; the magnetic properties of nanoscale thin films and other highly magnetic materials; transparent conducting oxides; photonic materials; quantum phase transitions; and atmospheric changes induced by manmade pollutants, such as those found in acid rain or in the exhaust generated by high altitude aircraft and space vehicle launches.

The department encourages its undergraduates to get involved in the many research projects available, and many students who participate in research go on to present their work at research competitions throughout the state and at national scientific meetings. Missouri S&T physics students regularly win prizes for their research accomplishments in the annual Fuller competitions.

After receiving a solid foundation in the basic physics governing the behavior of matter, energy, and radiation, the undergraduate physics major is able to choose among many advanced level courses to satisfy their particular interests in various fields of modern physics. Courses available to upper level physics majors include optics, astrophysics, subatomic physics, general relativity, solid state physics, laser physics, chaos, and computational physics. The curriculum also includes advanced laboratory courses where students design and participate in original research with other physics majors. Many additional technical courses are available to Physics majors in applied areas of other disciplines, such as computer science, electrical engineering, and the biological sciences.

Your undergraduate program will cover a range of fundamental topics and will include substantial laboratory training. In addition, the program is designed with many electives that allow physics majors to tailor their undergraduate education to their own particular interests. As a physics major you will have the flexibility to develop a program that best suits your interest and needs. There are 50 credit hours in physics, 23 in

mathematics, 9 in chemistry, and 3 in computer science. Also required are 24 credit hours in communication, humanities, and social sciences. The rest of the 128 required hours, 19 hours, are free electives that you select in consultation with your advisor.

Many physics majors choose to use their electives to study other technical areas, such as mathematics, computer science, or electrical engineering. Some students get dual bachelor's degrees, for example, with their second degree in computer science, chemistry, or mathematics. Because there is considerable overlap in degree requirements between physics and other technical and scientific disciplines, a dual degree usually requires no more than one extra semester of undergraduate study. The best curriculum for each student seeking a dual degree is determined in planning sessions with his or her advisor.

An undergraduate degree in physics provides opportunities for a wide range of careers. About two-thirds of our graduates go on to graduate school, many at some of the most prestigious first-tier schools in the country. In addition many of those who complete their physics education with a bachelor's degree have been very successful in finding exciting employment opportunities in today's high-tech industries. Missouri S&T physics graduates have gone on to lead and manage major research efforts at leading industrial companies, to be professors and chairmen at leading academic universities, and to work in areas ranging from law and medicine to ecophysics and astrophysics.

All interested or prospective students considering a career in physics are invited to visit the campus and tour our research laboratories and classrooms to obtain a better picture of the exciting opportunities available.

## Bachelor of Science Physics

A minimum of 128 credit hours is required for a bachelor of science degree in physics and an average of at least two grade points per credit hour must be obtained. These requirements for the B.S. degree are in addition to credit received for algebra, trigonometry, and basic ROTC.

The physics curriculum requires twelve semester hours in humanities, exclusive of foreign language, and must include ENGLISH 1160 or ENGLISH 3560. A minimum of nine semester hours is required in social sciences, including either HISTORY 1300, HISTORY 1310, HISTORY 1200, or POL SCI 1200. Specific requirements for the bachelor degree are outlined in the sample program listed below

Freshman Year			
First Semester	Credits	Second Semester	Credits
CHEM 1310	4	CHEM 1320	3
CHEM 1319	1	HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3
CHEM 1100	1	MATH 1221 <sup>6</sup>	5
ENGLISH 1120	3	PHYSICS 1111 & PHYSICS 1119 <sup>7</sup>	5
MATH 1208 <sup>5</sup>	5		
PHYSICS 1101	1		
	15		16
Sophomore Year			
First Semester	Credits	Second Semester	Credits
ENGLISH 1160	3	MATH 3304	3



MATH 2222	4	PHYSICS 2311	3
PHYSICS 2111 & PHYSICS 2119 <sup>8</sup>	5	PHYSICS 2129	3
COMP SCI 1570 & COMP SCI 1580 <sup>4</sup>	4	PHYSICS 2401	3
Elective <sup>1</sup>	3	Elective <sup>1</sup>	3
		19	15
<b>Junior Year</b>			
<b>First Semester</b>	<b>Credits</b>	<b>Second Semester</b>	<b>Credits</b>
PHYSICS 3201	3	PHYSICS 3211	3
PHYSICS 3119	3	PHYSICS 3129	3
PHYSICS 3311	3	Math/Stat Elective <sup>2</sup>	3
Math/Stat Elective <sup>2</sup>	3	Electives <sup>1</sup>	6
Electives <sup>1</sup>	6		
		18	15
<b>Senior Year</b>			
<b>First Semester</b>	<b>Credits</b>	<b>Second Semester</b>	<b>Credits</b>
PHYSICS 4211	3	PHYSICS 4311	3
PHYSICS 4301	3	Elective-Humanities (300 level) <sup>1</sup>	3
Physics Elective <sup>3</sup>	3	Physics Elective <sup>3</sup>	3
Electives <sup>1</sup>	6	Electives <sup>1</sup>	6
		15	15
Total Credits: 128			

**Note:** The minimum credit hours required for a bachelor of science in physics is 128 hours. No more than two of the required physics and mathematics courses with a grade of “D” may be used to meet graduation requirements. Upon petition to and approval by the physics faculty, three semester hours of advanced ROTC (military science or aerospace credit studies) credit can be counted as elective credit to meet requirements for graduation.

<sup>1</sup> Electives, in addition to the math/stat electives<sup>2</sup> and Physics electives<sup>3</sup>, shall include six hours of social studies and nine hours of humanities, at least three of which must be literature and at least three of which must be at the 3000 level or above not including Special Problems courses (PHILOS 4345 recommended). 19 hours of free electives may be used to develop an emphasis area. 18 hours of elective credit shall be in courses at the 3000 level or above.

<sup>2</sup> Six hours of mathematics or statistics beyond MATH 3304 are required. MATH 3108, MATH 5222, MATH 5325, or MATH 5351 are recommended.

<sup>3</sup> In addition to the specific physics courses listed (PHYSICS 3311, PHYSICS 3201, PHYSICS 4311, PHYSICS 4211, PHYSICS 3119, PHYSICS 3129, and PHYSICS 4301) two other physics 3000 level or higher courses are required.

<sup>4</sup> Alternatively COMP SCI 1971 and COMP SCI 1981; note that this will require one less credit hour than the option listed in the sample schedule.

<sup>5</sup> Alternatively students may substitute Math 1214 for Math 1208. Note that this is one less credit hour than Math 1208.

<sup>6</sup> Alternatively students may substitute Math 1215 for Math 1221. Note that this is one less credit hour than Math 1221.

<sup>7</sup> Alternatively students may substitute Physics 1135 for the combination of Physics 1111 and 1119. Note that this is one less credit hour than Physics 1111/1119.

<sup>8</sup> Alternatively students may substitute Physics 2135 for the combination of Physics 2111 and 2119. Note that this is one less credit hour than Physics 2111/2119.

Students may develop an emphasis area in secondary education by satisfying the requirements for a bachelor of science in physics and by completing the following additional requirements:

a. Take the education professional requirements courses:

EDUC 1040	Perspectives In Education	2
EDUC 1174	School Organization & Adm For Elementary & Secondary Teachers	2
EDUC 2216		3
EDUC 2251	Historical Foundation Of American Education	3
EDUC 3280	Teaching Methods And Skills In The Content Areas	6
EDUC 4298	Student Teaching Seminar	1
PSYCH 2300	Educational Psychology	3
PSYCH 3311	Psychological & Educational Development Of The Adolescent	3
PSYCH 4310	Psychology Of The Exceptional Child	3
Fifteen of these credit hours may be used to substitute for six hours of mathematics electives, six hours of physics electives, and three hours of computer science courses.		

b. Take the education clinical experience courses:

EDUC 1104	Teacher Field Experience	2
EDUC 1164	Aiding Elementary, Middle And Secondary Schools	2
EDUC 4299	Student Teaching	12

c. Take these additional courses:

SP&M S 1185	Principles Of Speech	3
POL SCI 1200	American Government	3
PSYCH 1101	General Psychology	3
BIO SCI 1113	General Biology	3
PHYSICS 1605	Environmental Physics I	3
HISTORY 3530	History of Science	3
A 3 hour Art/Music/Theater elective		3

d. Complete the requirements for teacher certification listed in this catalog.

## Physics Minor Curriculum

The minor in physics is a flexible program whose goal is to increase the breadth and competency of science and engineering students in modern or classical physics. Science students pursuing the physics minor will be interested in a deeper understanding of fundamental physical processes. Engineering students who intend to work in research or advanced development may use a physics minor to acquire a thorough knowledge of atomic, condensed matter, and environmental physics.

The physics minor consists of PHYSICS 2305 or PHYSICS 2311 and 12 additional hours of physics courses at the 2000-level or above. The program will be designed to conform to the individual's interests and needs.

**Daniel Fischer**, Assistant Professor  
PHD Heidelberg University

**Donald Edward Hagen**, Emeritus  
PHD Purdue University Main Campus

**Barbara N Hale**, Professor  
PHD Purdue University Main Campus

**Yew San Hor**, Associate Professor  
PHD Rutgers University

**Ulrich Jentschura**, Professor  
PHD Dresden University of Technology

**Cihan Kurter**, Assistant Professor  
PHD Illinois Institute of Technology

**David Edward Lay**, Lecturer  
MS University of Missouri-St. Louis

**Don H Madison**, Curators Professor  
PHD Florida State University

**Ioulia Y. Medvedeva**, Professor  
PHD Russian Academy of Science

**Paul E Parris**, Professor  
PHD University of Rochester

**Jerry L Peacher**, Professor  
PHD Indiana University Bloomington

**Michael Schulz**, Curators Professor  
PHD University of Heidelberg

**John G Story**, Associate Professor  
PHD University of Southern California

**Steffen Thomas Vojta**, Curators Distinguished Professor  
PHD Chemnitz University of Technology, Germany

**Agnes Vojta**, Associate Teaching Professor  
PHD Technical University Dresden

**George D Waddill**, Professor  
PHD Indiana University Bloomington

**Gerald Wilemski**, Professor  
PHD Yale University

**Alexey Georgiyevich Yamilov**, Associate Professor  
PHD The City University of New York

**PHYSICS 1001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYSICS 1101 Introduction To Physics** (LEC 1.0)  
An introduction to the study of physics and its intellectual and professional opportunities. The student will be acquainted with the various areas of physics and with departmental and campus facilities useful to their future studies. Required of all freshman majors.

**PHYSICS 1111 General Physics I** (LEC 4.0)  
An introduction to the fundamental ideas of physics, including mechanics, heat, and sound. Prerequisite: Preceded by Math 1208 or Math 1214.

**PHYSICS 1119 General Physics Laboratory** (LAB 1.0)  
Experiments related to topics studied in Physics 1111 and Physics 1145. Prerequisites: Preceded or accompanied by either Physics 1111 or Physics 1145.

**PHYSICS 1135 Engineering Physics I** (RSD 1.5 and LEC 1.5 and LAB 1.0)  
An introduction to mechanics, with an emphasis on topics needed by engineering students, including kinematics, dynamics, statics, and energetics. Prerequisite: Math 1208 or 1214.

**PHYSICS 1145 College Physics I** (LEC 3.0)  
An introduction to the ideas of physics, including mechanics, heat, and sound. Prerequisites: Math 1160 and either of Math 1120 or Math 1140.

**PHYSICS 1505 Introductory Astronomy** (LEC 3.0)  
An introductory course in basic astronomy designed primarily for students other than those in science and engineering. Topics include history, the sky, the solar system, stars, stellar evolution, galaxies and the origin and evolution of the universe. Credit will not be given for both Physics 1505 and Physics 1515.

**PHYSICS 1509 Astronomy Laboratory** (LAB 1.0)  
A science laboratory course in which the student analyzes and interprets astronomical data and makes observations with a telescope. Prerequisite: Preceded or accompanied by Physics 1505 or 1515.

**PHYSICS 1605 Environmental Physics I** (LEC 3.0)  
A course for non-science majors which will consider, without mathematics, the production of energy and the environmental consequences of its use, and the physical problems associated with pollution.

**PHYSICS 1609 Laboratory For Environmental Physics** (LAB 1.0)  
A laboratory course to accompany the Environmental Physics lecture course as an option. A set of experiments will be performed related to environmental impacts studied in Environmental Physics 1605. To be taken simultaneously with Environmental Physics 1605. Prerequisite: Corequisite Physics 1605.

**PHYSICS 2001 Special Topics** (IND 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYSICS 2111 General Physics II** (LEC 4.0)  
An introduction to the fundamental ideas of physics including electricity, magnetism, and light. Prerequisites: Preceded by Physics 1111 or Physics 1135 and preceded or accompanied by Math 1221 or Math 1215.

**PHYSICS 2119 General Physics Laboratory** (LAB 1.0)  
Experiments related to topics studied in Physics 2111 and Physics 2145. Prerequisite: Preceded or accompanied by either Physics 2111 or Physics 2145.

**PHYSICS 2129 Intermediate Physics Laboratory** (LAB 2.0 and LEC 1.0)  
A laboratory study of the principles of instrumentation used in all modern branches of physics. Analog and digital methods of data gathering are surveyed. Laboratory practice evolves from elementary operations to the design and assembly of a simple instrument.

**PHYSICS 2135 Engineering Physics II** (RSD 1.5 and LEC 1.5 and LAB 1.0)  
An introduction to electricity, magnetism, and light, with emphasis on topics needed by engineering students. Prerequisites: Physics 1135 or Physics 1111, Math 1221 or Math 1215.

**PHYSICS 2145 College Physics II** (LEC 3.0)  
An introduction to the ideas of physics, including electricity, magnetism, and light. Prerequisites: Math 1160, Physics 1145.

**PHYSICS 2305 Introduction To Modern Physics** (LEC 3.0)  
An elementary survey of the modern concepts in physics and their applications; relativity, quantum mechanics, atomic physics, solid state physics, nuclear and particle physics. Prerequisites: Math 2222 and Physics 2135 or 2111.

**PHYSICS 2311 Modern Physics I** (LEC 3.0)

An introduction to quantum mechanics, atomic physics, and solid state physics. Topics include historically important experiments and interpretations. Prerequisites: Physics 2135 or 2111, preceded or accompanied by Math 3304 or 3329.

**PHYSICS 2401 Introduction To Theoretical Physics** (LEC 3.0)

Fundamental physical concepts are elaborated in mathematical terms emphasizing the coherence and economy of Physics. Topics include elementary vector analysis, introduction to physical mechanics (motion of a point mass, conservation laws, relativity), Fourier series, and introduction to partial differential equations. Prerequisites: Math 3304 co-requisite; Physics 2135 or 2111.

**PHYSICS 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PHYSICS 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYSICS 3119 Advanced Physics Laboratory I** (LAB 3.0)

A laboratory study of the principles of basic experiments in all major branches of physics. The experiments stress design of apparatus, and procedures and analysis in projects involving electronic, optical, mechanical, and vacuum techniques. Prerequisite: Physics 2129.

**PHYSICS 3129 Advanced Physics Laboratory II** (LAB 3.0)

A senior laboratory involving experimental design. The student must specify his objectives, assemble apparatus, take measurements, analyze the results, form conclusions, write a report, and deliver an oral presentation of the results. Prerequisite: Physics 2129.

**PHYSICS 3201 Physical Mechanics** (LEC 3.0)

This course covers topics of rigid body motion in three dimensions, moving coordinate frames, two body collisions, conservation laws, small oscillations, generalized coordinates, and LaGrange's and Hamilton's equations. Prerequisite: Physics 2401.

**PHYSICS 3211 Electricity And Magnetism I** (LEC 3.0)

A study of electric and magnetic fields, leading to Maxwell's equations. Topics covered include the electrostatic field, the electric potential, and the electrostatic field in matter. Prerequisite: Physics 2401.

**PHYSICS 3311 Modern Physics II** (LEC 3.0)

A continuation of Physics 2311. An introduction to nuclear and particle physics. Topics include nuclear models, decays, and reactions, and elementary particles and fundamental forces. Prerequisites: Math 3304 or 3329, and either Physics 2305 with consent of instructor or Physics 2311.

**PHYSICS 4001 Special Topics** (LEC 3.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYSICS 4099 Undergraduate Research** (IND 0.0-6.0)

This course is designed for the undergraduate student who wishes to engage in research. It is not to be used for graduate credit nor for more than six credit hours of undergraduate credit. The subject and credit are to be arranged with the instructor.

**PHYSICS 4203 Introduction To General Relativity** (LEC 3.0)

An introduction to the theory of general relativity. Topics covered include the formalism of general relativity, Einstein's gravitational field equations, the Schwarzschild solution, black holes, and cosmological models of the universe. Prerequisite: Physics 2401.

**PHYSICS 4211 Electricity And Magnetism II** (LEC 3.0)

A continuation of Physics 3211. Topics covered include the magnetostatic field, the magnetic vector potential, the magnetostatic field in matter, electrodynamics, and electromagnetic waves. Prerequisite: Physics 3211.

**PHYSICS 4301 Introduction To Quantum Mechanics** (LEC 3.0)

The fundamental concepts, postulates and methods of quantum mechanics and their applications to physical systems. Topics include solutions of the Schrodinger equation for simple systems and operator methods. Prerequisites: Physics 2305 or 2311, 2401.

**PHYSICS 4311 Thermal Physics** (LEC 3.0)

A study of the equilibrium states of matter as governed by the first and second laws of thermodynamics. Emphasis is placed on the microscopic approach with an introduction to statistical mechanics. Topics include the kinetic theory of (uniform) gases, phase equilibria in pure systems, and an introduction to quantum statistics. Prerequisite: Physics 2305 or 2311.

**PHYSICS 4323 Elementary Solid State Physics** (LEC 3.0)

An introductory study of the structure and physical Properties of crystalline solids. Included are topics in crystal structure, x-ray diffraction, crystal binding, thermal properties of solids, free electron theory and elementary energy band theory. Prerequisites: Math 3304 and Physics 2305 or 2311.

**PHYSICS 4503 Classical Optics** (LEC 3.0)

Physical optics and advanced topics in geometrical optics. Topics include ray propagation, electromagnetic propagation, mirrors, lenses, interference, diffraction, polarization, imaging systems, and guided waves. Prerequisites: Math 2222 and Physics 2135 or 2111. (Co-listed with Elec Eng 5200).

**PHYSICS 4513 Laser Physics** (LEC 3.0)

The generation of coherent radiation by lasers and the interaction of laser radiation with matter. Topics include stimulated emission, population inversion, optical cavities, optical gain, properties of laser media and other applications. Prerequisite: Physics 2305 or 2311.

**PHYSICS 4523 Principles Of Engineering Materials** (LEC 3.0)

Examination of engineering materials with emphasis on selection and application of materials in industry. Particular attention is given to properties and applications of materials in extreme temperature and chemical environments. A discipline specific design project is required. (Not a technical elective for undergraduate metallurgy or ceramic majors) (Co-listed with Aero Eng 3877, Chem Eng 5300, Met Eng 5810, Cer Eng 5810).

**PHYSICS 4533 Transport in Nanostructures: An Introduction** (LEC 3.0)

The course overviews how wave interference, energy quantization and tunneling phenomena influence the wave (electron and light) transport in modern nanostructured materials and devices such as quantum dots, quantum wells, quantum wires, and photonic crystals. Prerequisite: Physics 2305 or 2311.

**PHYSICS 4543 Plasma Physics I** (LEC 3.0)

Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Aero Eng 5570, Mech Eng 5570, Nuc Eng 4370).

**PHYSICS 4553 Astrophysics** (LEC 3.0)

The structure, physical characteristics and evolution of stars, binary systems, nebulae and galaxies. Prerequisite: Physics 2305.

**PHYSICS 4563 Astrophysical Concepts** (LEC 3.0)

A comprehensive course in modern astrophysics. Topics include: Earth and sky, planetary science, stellar structure and evolution, galaxies, and structure and evolution of the universe. The course includes hands-on computer simulation and telescope use. (For secondary teachers or Master of Science for Teachers candidates.) Prerequisite: Math 2222 or admission to the MST program.

**PHYSICS 4605 Physics For Elementary School Teachers** (LEC 2.0 and LAB 1.0)

A nonmathematical review of the fundamental ideas of physics, including mechanics, matter, energy, sound, electricity, magnetism, astronomy, and light. Emphasis is placed on the development of hands-on activities. (For elementary school teachers or Master of Science for Teachers candidates only.).

**PHYSICS 4615 Physics For Secondary School Teachers** (LEC 3.0)

A review of the fundamental ideas of physics, including mechanics, matter, energy, sound, electricity, magnetism, and light with an emphasis on how mathematics can be used to help understand the underlying concepts. (For secondary teachers or Masters of Science Teachers candidates only.) Prerequisites: Math 2222 and admission to the MST program.

**PHYSICS 4625 Science Education and Quantitative Literacy for Middle School Teachers** (LEC 3.0)

An integrated science-mathematics course for middle school teachers. Course covers selected science/mathematics topics/skills specified in Missouri standards for grades 5-7. Inquiry based methods of teaching these topics in an integrated manner will be emphasized. Prerequisite: Current enrollment in a Teacher Education Program or a full or part-time teacher in a K-12 school. (Co-listed with Stat 5904).

**PHYSICS 4635 Physics, Energy, and the Environment** (LEC 3.0)

Applications of physics to the environment, including energy, its conservation and transformation, environmental consequences of energy use; world energy resources; atmospheric physics; sources of air, water, and land pollution, and the role physics plays in controlling those resources. May not be used as a 3000- or 4000-level elective for a B.S. in Physics. Prerequisite: Admissions to the Master of Science for Teachers program.

**PHYSICS 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PHYSICS 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYSICS 5201 Classical Mechanics I** (LEC 3.0)

Methods of Newton, Lagrange, and Hamilton applied to the motion of particles and rigid bodies. Introduction to canonical transformations and Poisson brackets. Classical scattering and small oscillations. Prerequisites: Math 3304, Physics 3201.

**PHYSICS 5211 Electrodynamics I** (LEC 3.0)

A rigorous development of the fundamentals of electromagnetic fields and waves. Electrostatics, magnetostatics, Maxwell's equations—Green's function, boundary value problems, multipoles, conservation laws. Prerequisites: Physics 4211.

**PHYSICS 5301 Quantum Mechanics I** (LEC 3.0)

Basic formalism applied to selected problems. Schrodinger equation and one dimensional problems, Dirac notation, matrix mechanics, harmonic oscillator, angular momentum, hydrogen atom, variational methods, introduction to spin. Prerequisite: Physics 4301 or equivalent.

**PHYSICS 5333 Subatomic Physics** (LEC 3.0)

An introduction to elementary particles. Topics include particle properties, nuclear forces, particle interactions, the Standard Model for quarks and leptons, fundamental forces in gauge field theory models, and the role of elementary particle interactions in cosmology. Prerequisite: Physics 3311.

**PHYSICS 5403 Computational Physics** (LEC 3.0 and LAB 1.0)

An introduction to modern computer simulations for solving physics problems. The course will be project-oriented with examples including planetary motion, chaotic dynamics, quantum scattering, structure of atoms and clusters, molecular dynamics, and Monte-Carlo simulations. Prerequisites: Physics 2305 or Physics 2311; Math 3304; programming experience.

**PHYSICS 5413 Chaos, Fractals, and Nonlinear Dynamics** (LEC 3.0)

An introduction into nonlinear dynamics, deterministic chaos, and fractals. Topics covered include phase plane analysis, iterated maps, routes to chaos, Lyapunov exponents, strange attractors and pattern formation with applications to chaotic vibrations, population dynamics, chemical oscillations and lasers. Prerequisites: Math 3304; Physics 2135 or Physics 2111.

**PHYSICS 5503 Fourier Optics** (LEC 3.0)

Applications of Fourier analysis and linear system theory to optics. Topics include scalar diffraction theory, Fourier transforming properties of lenses, optical information processing, and imaging systems. Prerequisites: Both ELEC ENG 3400 and 3600 or both PHYSICS 2401 and 4211. (Co-listed with ELEC ENG 5210).

**PHYSICS 5513 Fiber And Integrated Optics** (LEC 3.0)

Introduction to optical waveguides and their applications to communication and sensing. Topics include dielectric waveguide theory, optical fiber characteristics, integrated optic circuits, coupled-mode theory, optical communication systems, and photonic sensors. Prerequisite: Elec Eng 3600 or Physics 4211. (Co-listed with Elec Eng 5220).

**PHYSICS 5603 Advanced Physics Laboratory Teaching Methods** (LEC 3.0)

Objectives, methods and problems related to teaching of introductory physics, with an emphasis on laboratory instruction, the development of educational laboratory experiments and techniques, student learning styles, student assessment, student work groups, computer-based data acquisition, and communication techniques. Prerequisite: Graduate standing.

## Political Science

Political science explores the world of politics and the principles, techniques, and institutions through which we make collective decisions and resolve group conflicts. An understanding of politics is an especially useful skill for anyone entering a technical career, because so much of modern science and technology is embroiled in political controversy.

At Missouri S&T, courses are offered in American politics, comparative politics, international relations, and political theory. If you wish to pursue a specialized investigation of politics, a minor in political science is available.



## Political Science Minor Curriculum

The department of history and political science offers a minor degree in political science which must include 15 hours divided as follows: completion of POL SCI 1200, plus an approved sequence of 12 hours of upper level courses.

## Science, Technology and Humanity Minor

The science, technology and humanity (STH) minor is designed for students who want to explore the relationship between history, political science, and science and technology. The minor is particularly useful for technologically oriented students, because it provides insight into humanities and social science disciplines. It also shows how these disciplines interact with science and technology, thereby broadening their horizon of thought and action and preparing them for an increasingly technologically oriented future. To minor in STH the student must complete one of the following history survey courses: HISTORY 1100 or HISTORY 1200 or HISTORY 1300 or HISTORY 1310; and POL SCI 1200. The student then must take either HISTORY 2510 or HISTORY 3530. After completing the required six hours, the student will select nine additional hours from the list below.

### 15 credit hours total.

<b>Students must take one of the following:</b>		3
HISTORY 1100	Early Western Civilization	3
HISTORY 1200	Modern Western Civilization	3
HISTORY 1300	American History To 1877	3
HISTORY 1310	American History Since 1877	3
POL SCI 1200	American Government	3
<b>Students must take one of the following:</b>		3
HISTORY 2510	History of Technology	3
HISTORY 3530	History of Science	3
<b>Student must take three of the following as approved by minor advisor:</b>		9
BIO SCI 1163	Biotechnology in Film	3
BIO SCI 2263	Ecology	3
ECON 4540	Energy Economics	3
ECON 4820	Labor Economics	3
ENG MGT 4330/ PSYCH 4710	Human Factors	3
ENGLISH 2243	Science Fiction And Fantasy Literature	3
ENV ENG 5640	Environmental Law And Regulations	3
GEO ENG 1175	Geological Engineering in Popular Media	3
HISTORY 2510	History of Technology	3
HISTORY 3510	Twentieth Century Technology And Society	3
HISTORY 3530	History of Science	3
HISTORY 3443	The American Military Experience	3
HISTORY 4470	American Environmental History	3
HISTORY 4550	Architecture, Technology and Society; 1750 to Present	3
IS&T 5251	Technological Innovation Management and Leadership	3
IS&T 5885	Human-Computer Interaction	3
PHILOS 3223	Bioethics	3
PHILOS 3225	Engineering Ethics	3
PHILOS 4320	Minds And Machines	3
PHILOS 4345	Philosophy Of Science	3
PHILOS 4350	Environmental Ethics	3
POL SCI 3300	Principles Of Public Policy	3
PSYCH 4700	Industrial Psychology	3
PSYCH 4710	Human Factors	3
PSYCH 4720	Human-Computer Interaction	3
TCH COM 5610	History of Technical Communication	3

**Tseggai Isaac**, Associate Professor  
PHD University of Missouri-Columbia

**Michael E Meagher**, Associate Professor  
PHD Southern Illinois University Carbondale

**John Dalton Wiggins**, Lecturer  
JD University of Missouri-Columbia

### ***POL SCI 1100 Introduction to Political Science*** (LEC 3.0)

This course will introduce the student to the fundamental concepts and phenomena of political life and to the variety of political organizations characteristic of the modern age.

### ***POL SCI 1200 American Government*** (LEC 3.0)

National, state and local government in the United States with special emphasis on political behavior and the institutions that determine and execute public policy. Topics include basic structure of American government, (i.e., democracy, the Constitution, the branches of government), as well as citizenship, parties, pressure groups and American economic policy. The course views government in its relation to its people, its services and protection.

### ***POL SCI 2000 Special Problems*** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### ***POL SCI 2001 Special Topics*** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable credit.

### ***POL SCI 2400 Comparative Politics*** (LEC 3.0)

A comparative study of states, institutional structures, ideologies, political culture, political parties, interest groups and forms of government. How these social forces are organized to articulate national or parochial interests within the framework of participatory or centralized political systems will be studied. Prerequisite: Pol Sci 1200 or History 1300.

### ***POL SCI 2500 International Relations*** (LEC 3.0)

A general introduction to the theoretical framework, pattern and personalities of international relations with special emphasis upon American foreign policy making. Problems of international economic development, resources, and armaments will also be examined. Prerequisite: Pol Sci 1200 or History 1300 or 1310.

### ***POL SCI 3000 Special Problems*** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### ***POL SCI 3001 Special Topics*** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

### ***POL SCI 3010 Seminar*** (IND 0.0-6.0)

Discussion of current topics.

### ***POL SCI 3210 Constitutional Law: Government Powers and Civil Liberties*** (LEC 3.0)

This course will examine constitutional powers of American governmental institutions and leading Supreme Court decisions dealing with civil liberties including speech, religion, equal protection and the rights of the accused. The course will include study of current political issues and problems relating to these foundational civil liberties. Prerequisites: Pol Sci 1200, History 1200, 1300, or 1310.

**POL SCI 3211 American Political Parties** (LEC 3.0)

The origin and development of political parties in the United States, the two-party system, the functions, organizations and operation of parties. Prerequisite: Pol Sci 1200.

**POL SCI 3300 Principles Of Public Policy** (LEC 3.0)

This course presents a study of public policy in the United States. Students analyze the policy process, the resulting policy choices and the impact of the choices on the American people. Prerequisite: Pol Sci 1200.

**POL SCI 3310 Public Policy Analysis** (LEC 3.0)

An advanced study of major U.S. national policies. A wide range of public policies, including education, economics, and health and welfare will be studied. Students will be introduced to the methods of policy analysis. Emphasis will be placed on the use of tools used by policy analysts to determine program effectiveness and impact. Prerequisite: Pol Sci 1200.

**POL SCI 3760 The American Presidency** (LEC 3.0)

Historical development of the presidency; emphasis on the constitutional powers and limits of the office and the political contextual variables which influence presidential behavior. Prerequisite: Pol Sci 1200 or History 1310. (Co-listed with History 3760).

**POL SCI 3761 U.S. Diplomatic History to World War II** (LEC 3.0)

This course is a history of American foreign relations, broadly conceived, from the War for Independence to WWII. Among other things, it deals with the diplomacy of survival, of expansion and of economic and political hegemony. Prerequisites: History 1300, 1310 or Pol Sci 1200. (Co-listed with History 3761).

**POL SCI 3762 American Diplomatic History Since World War II** (LEC 3.0)

American Diplomatic History Since World War II will address the major issues in American foreign policy from WWII to the present. Its primary focus is on the Cold War and the post-Cold War problems the U.S. has faced. Prerequisite: History 1310 or Pol Sci 1200. (Co-listed with History 3762).

**POL SCI 3763 Contemporary Political Thought** (LEC 3.0)

This course will explore the impact of ideas on American politics and history, including the relationship between technological change and public policy; this will be pursued through the study of American political history, social institutions, and intellectual history. Prerequisite: History 1300 or History 1310 or Pol Sci 1200. (Co-listed with History 3763).

**POL SCI 4000 Special Problems And Readings** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**POL SCI 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**POL SCI 4010 Seminar** (RSD 0.0-6.0)

Discussion of current topics Prerequisite: Senior standing.

**POL SCI 4085 Political Science Internship** (IND 0.0-6.0)

Internship will involve students applying critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisite: Pol Sci 1200 or Pol Sci 1100.

**POL SCI 4510 The Politics of the Third World** (LEC 3.0)

This course explores the processes and problems of the developing nations of the world. It examines the internal political processes of third world nations, as well as the position of the third world in international affairs. Prerequisite: Pol Sci 1200 or History 1200 or History 1300 or History 1310.

## Prehealth Professions

Missouri S&T has several programs of study, which prepare students for success in the professional schools of human medicine, veterinary medicine, dentistry, and related areas of health-care. Degree programs in biological sciences, chemistry, and chemical and biochemical engineering offer all the coursework necessary for admission to health profession schools. Advising of students desiring a pre-health profession background is conducted by Missouri S&T Pre-Health Professions Advisory Committee in conjunction with the student's department advisors. Interested students may inquire with Dr. Katie Shannon, biological sciences department, who chairs the Pre-Health Professions Advisory Committee. Students interested in health professions are strongly encouraged to obtain shadowing and volunteer experience in their desired profession as early as possible.

## Premedicine Minor

It is recommended that students seeking the Pre-Medicine minor declare their intentions as soon as possible. Students completing the Pre-Medicine minor curriculum in addition to their BA/BS curriculum will have completed all requirements for admission to most Medical, Dental, Veterinary or other health profession programs. However, it is important to consult with a member of the Pre-Health Professions Advisory Committee to ensure you are completing the necessary coursework for your desired profession. The Pre-Medicine minor is not intended for a student majoring in Chemistry, Biological Sciences or Chemical and Biochemical Engineering which already offer a Pre-Medicine approved curriculum. Required courses for the Pre-Medicine minor are:

BIO SCI 1213 & BIO SCI 1219 or BIO SCI 1113 & BIO SCI 1219	Principles of Biology and General Biology Lab General Biology and General Biology Lab	5
BIO SCI 2213 & BIO SCI 2219	Cell Biology and Cell Biology Laboratory	4
CHEM 1310 & CHEM 1319 & CHEM 1320 & CHEM 1100	General Chemistry I and General Chemistry Laboratory and General Chemistry II and Introduction To Laboratory Safety & Hazardous Materials	9
CHEM 2210 & CHEM 2219 & CHEM 2220 & CHEM 2229	Organic Chemistry I and Organic Chemistry I Lab and Organic Chemistry II and Organic Chemistry II Lab	10
PHYSICS 1145 & PHYSICS 1119 or PHYSICS 1111 & PHYSICS 1119	College Physics I and General Physics Laboratory General Physics I and General Physics Laboratory	4-5
PHYSICS 2145 & PHYSICS 2119 or PHYSICS 2111 & PHYSICS 2119	College Physics II and General Physics Laboratory General Physics II and General Physics Laboratory	4-5
Mathematics two semesters to include:		
MATH 1208 or MATH 1214	Calculus With Analytic Geometry I Calculus For Engineers I	
One of the following courses (taking all three courses is highly recommended):		
BIO SCI 2223 BIO SCI 242	General Genetics	
CHEM 4610	General Biochemistry	

**Katie B Shannon**, Associate Teaching Professor  
PHD Harvard Medical School

**PREMED 1211 Introduction To Health Careers** (LEC 1.0)  
This course is for Pre-Medicine students or other interested in careers in the health care industry. Students will be introduced to different career options through invited speakers and independent research. Prerequisite: Admission Requirements.

**PREMED 3010 Communication Workshop for the Pre-Health Student** (RSD 1.0)  
This course is for Pre-Medicine students or others interested in careers in the health care industry or graduate studies. Students in this course will learn and develop writing and speaking skills necessary for success in health and science careers. Prerequisite: Junior Standing.

## Prelaw

The campus has a variety of programs of study to prepare students for admittance to a professional school of law. Dr. Michael Meagher, Department of History/Political Science, 120 Humanities/Social Sciences Building, is the pre-law advisor.

## Prelaw Minor

To qualify, students must complete a minimum of 18 hours of coursework in the following disciplines.

PHILOS 1115	Introduction To Logic	3
Select two of the following:		6
HISTORY 1300	American History To 1877	
HISTORY 1310	American History Since 1877	
POL SCI 1200	American Government	
PHILOS 1105	Introduction To Philosophy	
Select three of the following:		9
Two of the three courses must come from the humanities and social sciences disciplines of History, English, Etymology, Philosophy, or Political Science.		
COMP SCI 4700	Intellectual Property For Computer Scientists	
BUS 1210	Financial Accounting	
BUS 2910	Business Law	
ENGLISH 2410	Theory Of Written Communication	
ENGLISH 3101	Advanced Composition	
HISTORY 2510	History of Technology	
HISTORY 2530		
PHILOS 3235	Business Ethics	
PHILOS 4340	Social Ethics	
PHILOS 4345	Philosophy Of Science	
PHILOS 4350	Environmental Ethics	
PHILOS 4360	Foundations Of Political Conflict	
IS&T 5168/ PHILOS 4368	Law and Ethics in E-Commerce	
ECON 4430	Cost-Benefit Analysis	
ECON 4820	Labor Economics	
ECON 3830	History Of Economic Thought	
POL SCI 2760		
POL SCI 3300	Principles Of Public Policy	
POL SCI 3310	Public Policy Analysis	
ENG MGT 5514	Patent Law	
ENG MGT 5512	Legal Environment	
ETYM 4306	Introduction To Etymology	

## Psychology

Psychology is the scientific study of behavior and cognitive processes. Psychology is both a natural science, which stresses the cognitive and physiological causes of behavior, and a social science, which is directed at understanding how human behavior is affected by cultural and social

factors. As a psychology major at Missouri S&T, you will be exposed to the many diverse areas of psychology.

Perception, memory, thinking, personality, emotion, motivation, stress and adjustment, abnormal behavior, social relations, and group dynamics are among the basic areas of research in psychology. The discipline also represents the application of these basic research areas to people, their work, and their environment. Clinical, counseling, educational, industrial/organizational, and human factors psychologists are among the professionals who apply basic research to the solution of human problems. Our department provides a broad education to Missouri S&T students in both the basic and applied areas of psychology.

The statistics and research methods courses required of our majors prepare you to engage in undergraduate research as early as your sophomore year. By collaborating with a faculty member on a research project, you will gain valuable experience for subsequent graduate studies in psychology and related fields or for employment. Supervised internship experience in applied psychological settings, such as human service agencies, is also available for qualified students.

The department offers a choice of two degrees for majors. The Bachelor of Science degree provides a solid foundation in mathematics, biological sciences, physical sciences, and computer science. The bachelor of arts degree provides a broad liberal arts foundation, including courses in western civilization and foreign languages. Supporting courses in the humanities and social sciences are offered in both degrees and the psychology requirements are the same in both. In addition to the traditional B.A.-B.S. degrees in psychology, the department also offers specialized B.A.-B.S. degrees in psychology that prepare the student for secondary education teaching certification in Missouri.

The department also offers six minor programs: a general psychology minor, a minor in industrial/organizational psychology, a minor in the psychology of leadership, a minor in cognitive neuroscience, a minor in psychometrics, and a minor in multiculturalism and diversity. The general psychology minor allows students to select from a variety of courses tailored to their needs. The minor in industrial/organizational psychology requires specific courses of benefit to engineering and science majors. The minor in the psychology of leadership is geared for those individuals who would like to become leaders and managers. The cognitive neuroscience minor is designed to give students a broad understanding of neuroscience principles. The minor in psychometrics helps students better understand the application of statistical methods to the measurement of human characteristics and individual differences. The multicultural and diversity minor allows students to select courses across three of four departments, including psychological science, to increase their awareness of multiculturalism and diversity.

## Bachelor of Arts Psychology

A minimum of 120 credit hours is required for a bachelor of arts degree in psychology and an average of at least two grade points per credit hour must be obtained. The psychology B.A. curriculum requires 23 hours of basic skills and concepts. That is, 6 hours of English Composition, 6 hours of western civilization, and 11-16 hours of foreign language. 12 semester hours in humanities must be taken with at least one course taken in each of the three areas of literature (English and American), philosophy, and fine arts (art, music and theater), but not to include studio and performance offerings. A minimum of 12 semester hours is required in social sciences in at least two of the following three areas: economics, political science, and history. A minimum of 12 hours of

math and science are required and a minimum of 34 hours are required in psychology. Up to 12 credit hours of advanced ROTC may be credited toward the degree. Specific requirements for the bachelor of arts degree are outlined in the sample program listed below.

1. ENGLISH 1120 and one additional three hour composition course (6 hours).
2. Western civilization (HISTORY 1100 and HISTORY 1200 ) (6 hours).
3. Foreign languages for at least 3 semesters of basic study in French, German, Russian, Spanish or an approved substitute; or one year of basic study in a foreign language in either French, German, Russian, Spanish, or an approved substitute , and a humanities or social sciences course taught in a foreign country and employing the language of that country; or one year of basic study in each of two of the foreign languages of French, German, Russian or Spanish or an approved substitute (11-16 hours).
4. Sciences. At least one course taken in biological (biological sciences) and physical (chemistry, geology and geophysics, physics) sciences. At least one statistics course. A laboratory course is required (and a lab offered in engineering also may count at the discretion of the student's major advisor) toward the total requirement (12 hours).
5. Humanities and fine arts. Courses used to satisfy this requirement must include one course in each of the three areas of literature (English or American), philosophy, and fine arts (art, music or theater), but not to include studio and performance offerings (12 hours).
6. Social Sciences. At least two of the following social science areas are to be included: economics, political science, or history (12 hours).
7. Psychology Courses (34 hours)

**Required:\***

**General Skills Courses:**

PSYCH 1100	Introduction to Psychology	1
PSYCH 1101	General Psychology	3
PSYCH 2200	Research Methods	4
<b>Content Courses:</b>		
PSYCH 3310	Developmental Psychology	3
PSYCH 4400	Cognitive Psychology	3
PSYCH 4501	Abnormal Psychology	3
PSYCH 4600	Social Psychology	3

**And one of the following 2 courses:**

PSYCH 4410	Neuroscience	3
PSYCH 4411	Sensation and Perception	3

**Capstone Course:**

**Select three credit hours from the Capstone courses:**

PSYCH 3110	History Of Psychology	3
PSYCH 4010	Seminar	0-6
PSYCH 4099	Undergraduate Research	0-6
PSYCH 4200	Tests and Measurements	3
PSYCH 4590	Health Psychology	3
PSYCH 4994	Psychology in Media	3
PSYCH 4992	Cross-Cultural Psychology	3
PSYCH 4993	Psychology of Gender	3
PSYCH 4990	Internship	0-6

\*These required courses total 26 hours.

**Elective Courses:**

Select an additional 8 hours of psychology electives to complete the 34 hour degree requirement.

8. Major-field requirements: A cumulative grade point average of 2.0 must be earned in all course work taken in the major field. Upper-class (3000-4000-level) courses completed with grades of "D" may not be included in the course work for the major field without the

approval of the chair of the department. At least nine hours of upper-class work in the major field must be completed in residence at Missouri S&T.

9. Minor: A minor will be selected from any discipline other than the major with the approval of the student's advisor. A total of at least 15 hours is required for the minor, but may include courses which also satisfy other requirements. At least nine hours must be beyond the introductory level. A cumulative grade point average of 2.0 must be earned in all course work required in the minor field. At least six hours of work in the minor field must be completed in residence at Missouri S&T.
10. Basic ROTC may be elected in the freshman and sophomore years, but is not creditable toward a degree. Up to 12 credit hours of advanced ROTC may be credited toward a degree.
11. Elective Credits: In consultation with his/her advisor, each student will elect sufficient additional courses to complete a minimum of 120 credit hours.

## Emphasis Areas

Note: The following areas identify courses from which a student may opt to develop an emphasis area. It is not required that students obtain an emphasis specialty within psychology.

### Human Resources/Personnel

PSYCH 4700	Industrial Psychology	3
PSYCH 4600	Social Psychology	3
PSYCH 4601	Group Dynamics	3
PSYCH 4602	Organizational Psychology	3

### Human Services

PSYCH 3311	Psychological & Educational Development Of The Adolescent	3
or PSYCH 3310	Developmental Psychology	
PSYCH 4501	Abnormal Psychology	3
PSYCH 4500	Personality Theory	3
PSYCH 4510	Clinical Psychology	3

### Cognitive Neuroscience

PSYCH 4411	Sensation and Perception	3
PSYCH 3400	Theories Of Learning	3
or PSYCH 4501	Abnormal Psychology	
PSYCH 4400	Cognitive Psychology	3
PSYCH 4410	Neuroscience	3

### Usability of Technology

PSYCH 2300	Educational Psychology	3
PSYCH 3720	Web Design And Development	3
PSYCH 4710	Human Factors	3
PSYCH 4720	Human-Computer Interaction	3

### Psychology of Leadership

PSYCH 4600	Social Psychology	3
or PSYCH 4603	Social Influence: Science and Practice	
PSYCH 4610	Psychology of Leadership in Organizations	3
PSYCH 4993	Psychology of Gender	3
or PSYCH 4601	Group Dynamics	
PSYCH 4602	Organizational Psychology	3

## Bachelor of Arts Psychology (Secondary Education Emphasis Area)

You may earn a B.A. degree in psychology from Missouri S&T and certification to teach at the secondary level in the schools of Missouri with the secondary education emphasis area program. This program can



be completed in four academic years and student teaching is arranged with public schools within 30 miles of the Rolla campus.

Students interested in this emphasis area should consult with the advisor for the secondary education emphasis area in the department of psychological science.

In order to successfully complete this emphasis area, students must have at least 22 on the ACT, maintain a cumulative GPA of at least 2.5, and attain at least a 2.5 GPA in psychology courses taken. Current Missouri S&T or transfer students who wish to pursue this emphasis area must meet both of these GPA requirements to be accepted into the program. Students must also meet all requirements listed under the teacher education program in this catalog. Students who do not meet all the teacher certification requirements will not be eligible for the secondary education emphasis area, even if they have completed all course work.

A degree with this emphasis area requires 128 credit hours. The required courses are provided below.

<b>Communications Skills: 9 semester hours</b>		
ENGLISH 1120	Exposition And Argumentation	3
ENGLISH 1160	Writing And Research	3
SP&M S 1185	Principles Of Speech	3
<b>Humanities: 12 semester hours</b>		
Art, Music, or Theatre course		3
Philosophy course		3
Literature course		3
One additional humanities from the above course groups, Foreign Language, or Etymology		3
<b>Social Sciences: 18 semester hours</b>		
HISTORY 1300	American History To 1877	3
or HISTORY 1310	American History Since 1877	
POL SCI 1200	American Government	3
POL SCI 3211	American Political Parties	3
or POL SCI 3300	Principles Of Public Policy	
or POL SCI 3760	The American Presidency	
or POL SCI 3763	Contemporary Political Thought	
PSYCH 1101	General Psychology	3
ECON 1100	Principles Of Microeconomics	3
or ECON 1200	Principles Of Macroeconomics	
Geography		3
<b>Natural Science/Mathematics: 13 semester hours</b>		
One course in Physics, Chemistry or Geology		3-4
Mathematics		3
BIO SCI 1113	General Biology	3
STAT 1115	Statistics For The Social Sciences I	3
<b>Professional Requirements: 26 semester hours</b>		
EDUC 1040	Perspectives In Education	2
EDUC 1174	School Organization & Adm For Elementary & Secondary Teachers	2
EDUC 2251	Historical Foundation Of American Education	3
EDUC 3216	Teaching Reading in Content Area	3
EDUC 3280	Teaching Methods And Skills In The Content Areas	6
EDUC 4298	Student Teaching Seminar	1
PSYCH 2300	Educational Psychology	3
PSYCH 3311	Psychological & Educational Development Of The Adolescent	3
PSYCH 4310	Psychology Of The Exceptional Child	3
<b>Clinical Experience: 16 semester hours</b>		
EDUC 1104	Teacher Field Experience	2
EDUC 1164	Aiding Elementary, Middle And Secondary Schools	2
EDUC 4299	Student Teaching	12

<b>Psychology Degree Requirements: 17 semester hours</b>		
PSYCH 1100	Introduction to Psychology	1
PSYCH 2200	Research Methods	4
PSYCH 3400	Theories Of Learning	3
PSYCH 3310	Developmental Psychology	3
PSYCH 4501	Abnormal Psychology	3
or PSYCH 4500	Personality Theory	
PSYCH 4600	Social Psychology	3
<b>Certification: 17 semester hours</b>		
9 hours of American History from the following:		
HISTORY 3320	Colonial America	
HISTORY 3325	Revolutionary America, 1754-1789	
HISTORY 3340	Age Of Jefferson And Jackson	
HISTORY 3345	Civil War And Reconstruction	
HISTORY 3360	Recent United States History	
HISTORY 3425	History Of The Old South	
HISTORY 3426	History Of The Modern South	
HISTORY 3480	History Of Baseball	
HISTORY 3440	20th Century Americans In Combat	
HISTORY 3442	The United States In Vietnam	
HISTORY 3761	U.S. Diplomatic History to World War II	
HISTORY 4435	History of the American West	
8 hours of World History from the following:		
HISTORY 1100	Early Western Civilization	
HISTORY 1200	Modern Western Civilization	
HISTORY 2220	Making Of Modern Britain	
HISTORY 2222	The Making Of Modern France	
HISTORY 2224	Making Of Modern Russia	
HISTORY 2210	European Diplomatic History 1814 - Present	
HISTORY 3120	Ancient Greece	
HISTORY 3130	Medieval History I	
HISTORY 3135	Medieval History II	
HISTORY 3140	History Of Renaissance Thought	
HISTORY 3230	Europe In The Age Of The French Revolution And Napoleon	
HISTORY 3235	Foundations Of Contemporary Europe 1815-1914	
HISTORY 3240	Contemporary Europe	
HISTORY 3660	Modern East Asia	

## Bachelor of Science Psychology

A minimum of 124 credit hours is required for a bachelor of science degree in psychology and a cumulative grade point average of 2.0 must be obtained. These requirements for the B.S. degree are in addition to credit received for basic ROTC.

The psychology bachelor of science curriculum requires six hours of English composition; 23 hours of math, science and computer science; and twelve semester hours in humanities. Specific requirements for the bachelor degree are outlined in the sample program listed below.

1. ENGLISH 1120 and ENGLISH 1160 (entering students will normally take ENGLISH 1120 either semester of the first year.) (6 hours)
2. A total of 23 hours in biological, physical, (chemistry, geology and geophysics, and physics), and mathematical (mathematics/statistics and computer science or information science & technology) sciences, to include COMP SCI 1570 and COMP SCI 1580; or COMP SCI 1970 and COMP SCI 1980; or COMP SCI 1971 and COMP SCI 1981; or COMP SCI 1972 and COMP SCI 1982; or IS&T 1551 and at least one course taken in the biological and one in the physical sciences. Of the biological and physical science offerings, at least one must be a laboratory course. Engineering courses may, at the discretion of the

student's major advisor, also count toward this total requirement. (23 hours)

3. 12 hours in humanities and fine arts (literature, philosophy, art, music, or theater). Foreign language courses may count toward fulfilling this requirement. Courses used to satisfy this requirement must be taken in at least two humanities areas. (12 hours)
4. 12 hours in at least two social sciences fields outside the major area (economics or history or political science). A course in Modern Western Civilization (HISTORY 1200), American History To 1877 (HISTORY 1300) or American History Since 1877 (HISTORY 1310), or American Government (POL SCI 1200) must be taken to satisfy the requirement of the state of Missouri (the "Williams Law"), and this course may count toward fulfilling the social sciences requirement. (12 hours)
5. Minor: A minor will be selected from any discipline other than the major with the approval of the student's advisor. A total of at least 15 hours is required for the minor, but may include courses which also satisfy other requirements. At least nine hours must be beyond the introductory level.
6. Basic ROTC may be elected in the freshman and sophomore years, but is not creditable toward a degree. Six credit hours of advanced ROTC may be credited toward a degree.
7. Elective Credits: In consultation with his/her advisor, each student will elect sufficient additional courses to complete a minimum of 124 credit hours which may include MATH 1160 and one of MATH 1120 or MATH 1140 .
8. Psychology Courses (34 hours)

Required:*		
General Skills Courses:		
PSYCH 1100	Introduction to Psychology	1
PSYCH 1101	General Psychology	3
PSYCH 2200	Research Methods	4
Content Courses:		
PSYCH 3310	Developmental Psychology	3
PSYCH 4400	Cognitive Psychology	3
PSYCH 4501	Abnormal Psychology	3
PSYCH 4600	Social Psychology	3
And one of the following 2 courses:		
PSYCH 4410	Neuroscience	3
PSYCH 4411	Sensation and Perception	3
Capstone Course:		
Select three credit hours from the following Capstone courses:		
PSYCH 3110	History Of Psychology	3
PSYCH 4010	Seminar	0-6
PSYCH 4099	Undergraduate Research	0-6
PSYCH 4200	Tests and Measurements	3
PSYCH 4590	Health Psychology	3
PSYCH 4994	Psychology in Media	3
PSYCH 4992	Cross-Cultural Psychology	3
PSYCH 4993	Psychology of Gender	3
PSYCH 4990	Internship	0-6
*These required courses total 26 hours.		
Elective Courses:		
Select an additional 8 hours of psychology electives to complete the 34 hour degree requirement.		

9. A cumulative grade point average of 2.0 must be earned in all course work taken in the major field. Upper class (3000-level and above) courses completed with grades of "D" may not be included in the

course work for the major field without the approval of the advisor and the chair of the department concerned.

## Emphasis Areas

Note: The following areas identify courses from which a student may opt to develop an emphasis area. It is not required that students obtain an emphasis specialty within psychology.

<b>Human Resources/Personnel</b>		
PSYCH 4700	Industrial Psychology	3
PSYCH 4600	Social Psychology	3
PSYCH 4601	Group Dynamics	3
PSYCH 4602	Organizational Psychology	3
<b>Human Services</b>		
PSYCH 3311	Psychological & Educational Development Of The Adolescent	3
or PSYCH 3310	Developmental Psychology	
PSYCH 4501	Abnormal Psychology	3
PSYCH 4500	Personality Theory	3
PSYCH 4510	Clinical Psychology	3
<b>Cognitive Neuroscience</b>		
PSYCH 4411	Sensation and Perception	3
PSYCH 3400	Theories Of Learning	3
or PSYCH 4501	Abnormal Psychology	
PSYCH 4400	Cognitive Psychology	3
PSYCH 4410	Neuroscience	3
<b>Usability of Technology</b>		
PSYCH 2300	Educational Psychology	3
PSYCH 3720	Web Design And Development	3
PSYCH 4710	Human Factors	3
PSYCH 4720	Human-Computer Interaction	3
<b>Psychology of Leadership</b>		
PSYCH 4600	Social Psychology	3
or PSYCH 4603	Social Influence: Science and Practice	
PSYCH 4610	Psychology of Leadership in Organizations	3
PSYCH 4993	Psychology of Gender	3
or PSYCH 4601	Group Dynamics	
PSYCH 4602	Organizational Psychology	3

## Bachelor of Science Psychology (Secondary Education Emphasis Area)

You may earn a B.S. degree in psychology from Missouri S&T and certification to teach at the secondary level in the schools of Missouri with the secondary education emphasis area program. This program can be completed in four academic years and student teaching is arranged with public schools within 30 miles of the Rolla campus.

Students interested in this emphasis area should consult with the advisor for the secondary education emphasis area in the department of psychological science.

In order to successfully complete this emphasis area, students must have at least 22 on the ACT, maintain a cumulative GPA of at least 2.5, and attain at least a 2.5 GPA in psychology courses taken. Current Missouri S&T or transfer students who wish to pursue this emphasis area must meet both of these GPA requirements to be accepted into the program. Students must also meet all requirements listed under the teacher education program in this catalog. Students who do not meet all the teacher certification requirements will not be eligible for the secondary education emphasis area, even if they have completed all course work.

A degree in this emphasis area requires 136 credit hours. The required courses are provided below.

**Communications Skills: 9 semester hours**

ENGLISH 1120	Exposition And Argumentation	3
ENGLISH 1160	Writing And Research	3
SP&M S 1185	Principles Of Speech	3

**Humanities: 12 semester hours**

Art, Music, or Theatre course		3
Philosophy course		3
Literature course		3
One additional humanities from the above course groups, Foreign Language, or Etymology		3-4

**Social Sciences: 18 semester hours**

HISTORY 1300	American History To 1877	3
or HISTORY 1310	American History Since 1877	
POL SCI 1200	American Government	3
POL SCI 3211	American Political Parties	3
or POL SCI 3300	Principles Of Public Policy	
or POL SCI 3760	The American Presidency	
or POL SCI 3763	Contemporary Political Thought	
PSYCH 1101	General Psychology	3
ECON 1100	Principles Of Microeconomics	3
or ECON 1200	Principles Of Macroeconomics	
HISTORY 2110	World Regional Geography	3

**Natural Sciences/Mathematics: 21 semester hours**

One course in Physics, Chemistry or Geology		3-4
Mathematics		3
BIO SCI 1113	General Biology	3
STAT 1115	Statistics For The Social Sciences I	3
COMP SCI 1570 & COMP SCI 1580	Introduction To Programming and Introduction To Programming Laboratory	3-4
or COMP SCI 1970 & COMP SCI 1980	Basic Scientific Programming and Computer Programming Laboratory	
or COMP SCI 1971 & COMP SCI 1981	Introduction To Programming Methodology and Programming Methodology Laboratory	
or COMP SCI 1972 & COMP SCI 1982	Introduction to MATLAB Programming and MATLAB Programming Laboratory	
5-6 additional hours of Math &/or Science courses		5-6

**Professional Requirements: 26 semester hours**

EDUC 1040	Perspectives In Education	2
EDUC 1174	School Organization & Adm For Elementary & Secondary Teachers	2
EDUC 2251	Historical Foundation Of American Education	3
EDUC 3216	Teaching Reading in Content Area	3
EDUC 3280	Teaching Methods And Skills In The Content Areas	6
EDUC 4298	Student Teaching Seminar	1
PSYCH 2300	Educational Psychology	3
PSYCH 3311	Psychological & Educational Development Of The Adolescent	3
PSYCH 4310	Psychology Of The Exceptional Child	3

**Clinical Experience: 16 semester hours**

EDUC 1104	Teacher Field Experience	2
EDUC 1164	Aiding Elementary, Middle And Secondary Schools	2
EDUC 4299	Student Teaching	12

**Psychology Degree Requirements: 17 semester hours**

PSYCH 1100	Introduction to Psychology	1
PSYCH 2200	Research Methods	4
PSYCH 3400	Theories Of Learning	3
PSYCH 3310	Developmental Psychology	3
PSYCH 4501	Abnormal Psychology	3
or PSYCH 4500	Personality Theory	
PSYCH 4600	Social Psychology	3

**Certification: 17 semester hours**

9 hours of American History from the following:		
HISTORY 3320	Colonial America	
HISTORY 3325	Revolutionary America, 1754-1789	
HISTORY 3340	Age Of Jefferson And Jackson	
HISTORY 3345	Civil War And Reconstruction	
HISTORY 3360	Recent United States History	
HISTORY 3425	History Of The Old South	
HISTORY 3426	History Of The Modern South	
HISTORY 3480	History Of Baseball	
HISTORY 3440	20th Century Americans In Combat	
HISTORY 3442	The United States in Vietnam	
HISTORY 3761	U.S. Diplomatic History to World War II	
HISTORY 4435	History of the American West	

**8 hours of World History from the following:**

HISTORY 1100	Early Western Civilization	
HISTORY 1200	Modern Western Civilization	
HISTORY 2220	Making Of Modern Britain	
HISTORY 2222	The Making Of Modern France	
HISTORY 2224	Making Of Modern Russia	
HISTORY 2210	European Diplomatic History 1814 - Present	
HISTORY 3120	Ancient Greece	
HISTORY 3130	Medieval History I	
HISTORY 3135	Medieval History II	
HISTORY 3140	History Of Renaissance Thought	
HISTORY 3230	Europe In The Age Of The French Revolution And Napoleon	
HISTORY 3235	Foundations Of Contemporary Europe 1815-1914	
HISTORY 3240	Contemporary Europe	
HISTORY 3660	Modern East Asia	

The department of psychological science offers six minors: a general minor, industrial/organizational, psychology of leadership, cognitive neuroscience, psychometrics, and a minor in multiculturalism and diversity. Nine (9) hours of work in any of these minors in psychology must be completed in residence at Missouri S&T. A student may only receive one of the six minors.

## Psychology Minor

General psychology minor requires 15 hours of courses in psychology. At least nine of these hours must be at the 3000-level or above.

## Industrial/Organizational Psychology Minor

Requirements include:

PSYCH 1101	General Psychology	3
PSYCH 4700	Industrial Psychology	3
PSYCH 4600	Social Psychology	3
PSYCH 4710	Human Factors	3
PSYCH 4602	Organizational Psychology	3

## Psychology for Health Care Minor

Required Courses:

PSYCH 1101	General Psychology	3
PSYCH 4600	Social Psychology	3
Choose 3 of the Following Courses:		
PSYCH 4411	Sensation and Perception	3
PSYCH 4410	Neuroscience	3
PSYCH 4400	Cognitive Psychology	3
PSYCH 4501	Abnormal Psychology	3
PSYCH 4590	Health Psychology	3

## Psychology of Leadership

Requirements include general psychology and 4 of the following 5 courses:

PSYCH 4600	Social Psychology	3
PSYCH 4610	Psychology of Leadership in Organizations	3
PSYCH 4601	Group Dynamics	3
PSYCH 4602	Organizational Psychology	3
PSYCH 4603	Social Influence: Science and Practice	3

## Cognitive Neuroscience Minor

Requirements include:

PSYCH 1101	General Psychology	3
PSYCH 3400	Theories Of Learning	3
PSYCH 4400	Cognitive Psychology	3
PSYCH 4410	Neuroscience	3
PSYCH 4411	Sensation and Perception	3
or PSYCH 4412	Evolutionary Psychology	
or PSYCH 4501	Abnormal Psychology	

## Psychometric Minor

Requirements include the following courses:

PSYCH 1101	General Psychology	3
PSYCH 5201	Psychometrics	3
PSYCH 4700	Industrial Psychology	3
PSYCH 4200	Tests and Measurements	3
STAT 5346	Regression Analysis	3
or STAT 5353	Statistical Data Analysis	

## Multiculturalism & Diversity Minor

The Multiculturalism and Diversity Minor prepares students to function more effectively in a global society as well as enhances Missouri S&T graduates' employment options by providing knowledge, skills, and strategies for appreciating and understanding diverse cultural practices.

The minor requires 15 hours in a minimum of 3 of 4 humanities and social sciences (HSS) departments: the departments of arts, languages and philosophy; English and technical communication; history and political science; and psychological science. The academic home for this minor will be the arts, languages and philosophy department. Courses offered by these departments that can be included in the minor are listed below.

### Arts, Languages & Philosophy:

One language course at the third semester or above in a foreign language (German, Spanish, French, or Russian) *	
PHILOS 4340	Social Ethics
RUSSIAN 4360	Russian Civilization
SP&M S 3235	Intercultural Communication

### English and Technical Communication:

ENGLISH 1231	World Literature I: From The Beginnings To The Renaissance
ENGLISH 2242	Literature By Women
ENGLISH 2245	African American Literature
ENGLISH 3228	The American Experience

### History and Political Science:

HISTORY 3280	European Migrations and Nationalism Formation
HISTORY 3660	Modern East Asia
HISTORY 3665	History of Japan
POL SCI 2500	International Relations
POL SCI 4510	The Politics of the Third World

### Psychology:

PSYCH 4993	Psychology of Gender
------------	----------------------

PSYCH 4992	Cross-Cultural Psychology
------------	---------------------------

\* Language Courses at the 3rd Semester or above that qualify for the minor:

FRENCH 1180	Intermediate French
FRENCH 2110	Basic French Conversation
FRENCH 2170	Masterpieces Of French Literature
FRENCH 2180	Basic French Composition
FRENCH 4311	Advanced French Conversation
FRENCH 4320	French and Francophone Cinema
FRENCH 4360	French Culture And Civilization
FRENCH 4370	Survey Of French Literature I (Early Period)
FRENCH 4375	Survey Of French Literature II (Modern Period)
GERMAN 1180	Classical And Modern German Readings
GERMAN 2110	Basic German Conversation
GERMAN 2170	Masterpieces Of German Literature
RUSSIAN 1180	Readings In Science And Literature
RUSSIAN 2110	Basic Russian Conversation
RUSSIAN 2170	Masterpieces Of Russian Literature
RUSSIAN 4320	Russian Phonetics and Intonation
RUSSIAN 4330	Business Russian
RUSSIAN 4360	Russian Civilization
RUSSIAN 4370	Survey Of Russian Literature I (Early Period)
RUSSIAN 4375	Survey Of Russian Literature II (Modern Period)
SPANISH 1180	Intermediate Spanish
SPANISH 2110	Basic Spanish Conversation
SPANISH 2160	Hispanic Culture
SPANISH 2170	Masterpieces Of Hispanic Literature
SPANISH 2180	Intermediate Spanish Composition
SPANISH 4311	Advanced Spanish Conversation
SPANISH 4377	Spanish-American Novel And Short Story
SPANISH 4302	Phonetics and Phonology of Spanish

**Jessica L. Cundiff**, Assistant Professor  
PHD Pennsylvania State University

**Oshadee De Silva**, ANC  
MS Coventry University, UK

**Shihandi De Sylva**, ANC  
MS Northampton, Northamptonshire, UK

**Eugene James Gianladis**, Lecturer  
PHD Saint Louis University

**Amber M Henslee**, Assistant Professor  
PHD Auburn University Main Campus

**Anthe Ickx**, ANC, Adjunct Instructor  
MS University of Ghent, Belgium

**Ruzla Ismail**, ANC  
MS Christ University, Bangalore, India

**Brandi A Klein**, Assistant Professor  
PHD Bowling Green State University

**Melani Kodikar**, ANC  
MS University of Hertfordshire, UK

**Robert Lew Montgomery**, Emeritus Professor  
PHD Oklahoma State University Main

**Frances H Montgomery**, Chancellor's Professor  
PHD Florida State University



**Shanika Kushlani Munasinghe, ANC**  
MPhil University of Colombo, Sri Lanka

**Susan L Murray, Professor<sup>1</sup>**  
PHD Texas A&M University

**Chrishara Parनावithana, ANC**  
MPhil University of Colombo, Sri Lanka

**Mojgan Shadbash, ANC, Adjunct Instructor**  
PSY.D Institute of IVPM, Germany

**Donald J Sharpsteen, Associate Professor**  
PHD University of Denver

**Nancy J Stone, Professor**  
PHD Texas Tech University

**Nathan W Weidner, Assistant Professor**  
PHD Wayne State University

**Merilee Krueger Wilsdorf, Associate Teaching Professor**  
MA University of Nebraska Omaha

**PSYCH 1100 Introduction to Psychology** (LEC 1.0)  
An introduction to the study of psychology at S&T. Students will learn about personal and professional opportunities associated with the different areas of psychology and become acquainted with the psychology faculty and campus facilities.

**PSYCH 1101 General Psychology** (LEC 3.0)  
An introduction to the science of the human mind and behavior. Topics include brain structure and function, human development, learning and memory, motivation, emotion, personality and psychological health, psychological disorders and their treatment, and social cognition and human relationships.

**PSYCH 2000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PSYCH 2001 Special Topics** (LEC 0.0 and LAB 0.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**PSYCH 2200 Research Methods** (LAB 1.0 and LEC 3.0)  
An introduction to the content, models and methodologies of psychological research. This course covers the fundamental components of psychological research including the literature review, correlational and descriptive methods, experimental design, statistical analyses, interpretation, and ethics. Prerequisites: Psych 1101; Stat 1115, Stat 3113, or Stat 3115. Stat 1115 preferred.

**PSYCH 2300 Educational Psychology** (LEC 3.0)  
Principles of psychology relevant to the field of education. Course covers theoretical and applied information on such topics as human growth and development, and cognitive and behavioral views of learning and intelligence. The course also covers motivation, creation of learning environments, measurement and evaluation of learning. Prerequisite: Psych 1101. (Co-listed with Educ 2102).

**PSYCH 3000 Special Problems In Psychology** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PSYCH 3001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**PSYCH 3310 Developmental Psychology** (LEC 3.0)  
A study of human growth and development across the lifespan. The course emphasizes the interaction of physical, psychological, and social changes and their resulting impact on the developing person at all stages in life. Prerequisite: Psych 1101.

**PSYCH 3311 Psychological & Educational Development Of The Adolescent** (LEC 3.0)  
An examination of the biological, social, and cognitive transitions that occur during adolescence. Other topics include the role of families, the role of peers, the adolescent identity, sexuality, the impact of schools, the role of achievement, how adolescents spend their time (work, leisure), the role of the media, and problems encountered by the adolescent. Prerequisite: Psych 1101.

**PSYCH 3400 Theories Of Learning** (LEC 3.0)  
An examination of basic learning processes and the behavioral phenomena that arise from them. Topics include non-associative learning, classical conditioning, operant conditioning, and vicarious learning. Prerequisite: Psych 1101.

**PSYCH 4000 Special Problems And Readings In Psychology** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PSYCH 4001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**PSYCH 4010 Seminar** (RSD 0.0-6.0)  
Prerequisite: Senior Standing.

**PSYCH 4099 Undergraduate Research** (IND 0.0-6.0)  
Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Prerequisite: Instructor consent.

**PSYCH 4200 Tests and Measurements** (LEC 3.0)  
Theoretical and statistical basis of psychological testing and measurement; test development and validation; examination of standardized tests of intelligence, aptitude, interest, personality, attitudes, and psychopathology; use of test and test batteries for diagnostics and prediction of criteria. Prerequisite: Psych 1101.

**PSYCH 4310 Psychology Of The Exceptional Child** (LEC 3.0)  
Study of the psychology of children on both ends of the educational spectrum. The course presents the fundamentals of providing services as well as understanding the abilities and disabilities of children classified as exceptional. Includes coverage of various disabilities, and the implications of dealing with personal, family and classroom issues. Prerequisite: Psych 1101. (Co-listed with Educ 4310).

**PSYCH 4400 Cognitive Psychology** (LEC 3.0)  
This course covers basic cognitive processes and their application. Theory and research are presented on attention, perception, memory, problem solving, decision making and language. Prerequisite: Psych 1101.

**PSYCH 4410 Neuroscience** (LEC 3.0)  
The neurophysiological bases of behavior and cognition are examined. Topics covered include neuroanatomy, neurotransmission, neuropharmacology, brain systems, learning and memory, emotion, attention and consciousness, and neurologic/psychological disorders. Prerequisite: Psych 1101.

**PSYCH 4411 Sensation and Perception** (LEC 3.0)

An in-depth examination of the human senses, with special emphasis on vision and hearing. Topics include the anatomy and physiology of the eye and ear, neural transduction, the organization and interpretation of sensory signals by the brain, selective attention, and the neural basis of the perception of color, form, space, depth, motion, music, and language. Prerequisite: Psych 1101.

**PSYCH 4500 Personality Theory** (LEC 3.0)

An examination of the ways in which personality traits develop and the sources of differences among people in the traits they exhibit. The emphasis is on major theories of personality development, as well as recent research in the field. Prerequisite: Psych 1101.

**PSYCH 4501 Abnormal Psychology** (LEC 3.0)

An introductory study of various forms of personality and behavioral disorders. Consideration will be given to neurosis, psychosis, mental deficiency and other deviations, with emphasis on etiology and treatment. Prerequisite: Psych 1101.

**PSYCH 4510 Clinical Psychology** (LEC 3.0)

Comprehensive survey of the field of clinical psychology. Course will cover a variety of assessment and treatment procedures relevant to psychology and other professionals who treat human adjustment problems; techniques based on experimental outcome research and psychological testing will be emphasized. Prerequisites: Psych 1101 and Psych 4501.

**PSYCH 4590 Health Psychology** (LEC 3.0)

This course examines Health Psychology. Topics include basic behavioral pharmacology (involving alcohol and other drugs), illusions of invulnerability to risk, stress and coping, and the science of persuading people to protect their health. Students learn how to construct a public service announcement towards a societal problem as part of the course. Prerequisite: Psych 1101.

**PSYCH 4600 Social Psychology** (LEC 3.0)

An exploration of the phenomena involved in human social behavior and the theories that explain them. Topics typically include social thinking, attitudes and attitude change, conformity, persuasion, interpersonal attraction, and more. Prerequisite: Psych 1101.

**PSYCH 4601 Group Dynamics** (LEC 3.0)

A review of the concepts and theories related to group dynamics. Topics include group goals, communication within groups, group structure, norms, leadership, decision making, controversy, conflict resolution, power, diversity issues, and team development. Prerequisite: Psych 1101.

**PSYCH 4602 Organizational Psychology** (LEC 3.0)

Analysis, comprehension, and prediction of human behavior in organizational settings through the scientific study of individual processes, group processes, and organizational structure and function. Prerequisite: Psych 1101.

**PSYCH 4603 Social Influence: Science and Practice** (LEC 3.0)

Principles and procedures that affect the process of social influence, with consideration given to attitudinal, compliance inducing, and perceptual influences. Prerequisite: Psych 1101.

**PSYCH 4610 Psychology of Leadership in Organizations** (LEC 3.0)

Examination of conceptual and empirical research on determinants of effective vs. ineffective leadership. Topics include leadership measurement, traits, skills, leader-member exchange, charismatic and transformational leadership, change management, team leadership, and ethical leadership. Practical guidelines for developing leadership skills are discussed. Prerequisite: Psych 1101.

**PSYCH 4700 Industrial Psychology** (LEC 3.0)

An overview of the field of industrial psychology including topics such as criterion development, job analysis, selection, training, performance assessment, and some human factors concerns. Prerequisite: Psych 1101.

**PSYCH 4710 Human Factors** (LEC 3.0)

An examination of human-machine systems and the characteristics of people that affect system performance. Topics include applied research methods, systems analysis, and the perceptual, cognitive, physical and social strengths and limitations of human beings. The focus is on user-centered design of technology, particularly in manufacturing environments. Prerequisite: Psych 1101. (Co-listed with Eng Mgt 4330).

**PSYCH 4720 Human-Computer Interaction** (LEC 3.0)

Research, theory, and practice from psychology and other social science disciplines have implications for the effective design and use of computers in organizations. This course introduces students to the psychological issues in software engineering, technology in the workplace, and organizational design. Prerequisite: Psych 1101.

**PSYCH 4730 Environmental Psychology** (LEC 3.0)

An examination of the psychological effects of various environmental designs and ways to design environments effectively. Topics include: environmental attitudes, perception, and cognition; environmental influences, crowding, and the application of environmental design principles to living, educational, work, and recreational settings. Prerequisite: Psych 1101.

**PSYCH 4990 Internship** (IND 0.0-6.0)

Internship will involve students applying critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisite: Junior or Senior Psychology major; consent of instructor; must have completed 9 hours in major.

**PSYCH 4992 Cross-Cultural Psychology** (LEC 3.0)

Study of the impact of ethnic and national culture on psychological processes and behaviors. Topics include the effects of individualism and collectivism on patterns of socialization, personality, motivation, emotion and cognition; cultural differences in diagnosis and treatment of mental and physical health; and group and organizational behavior. Prerequisite: Psych 1101.

**PSYCH 4993 Psychology of Gender** (LEC 3.0)

Overview of current research and theory on the psychology of gender. The course explores gender as a psychological and social construct that influences women's and men's lives across a variety of contexts including work, family, relationships, self-perceptions, and health. Considers how gender intersects with other social categories to shape experience. Prerequisite: Psych 1101.

**PSYCH 4994 Psychology in Media** (LEC 3.0)

Examples drawn from the media (e.g., television, movies, newspapers) will be used as the basis for discussing a wide variety of psychological phenomena, principles, and theories, and their applicability to everyday life. Prerequisite: Psych 1101.

**PSYCH 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PSYCH 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new graduate level course. Variable title.

**PSYCH 5010 Introduction to Industrial / Organizational Psychology** (LEC 3.0)

Review of the most recent theoretical and applied research in advanced personnel and organizational psychology. Topics will include personnel selection, training and performance appraisal, job attitudes, motivation, work groups and teams, leadership, organizational culture, and organizational development. Prerequisite: Graduate standing.

**PSYCH 5012 Ethics and Professional Responsibilities** (LEC 1.0)

Case studies examining the ethical practice of psychology in organizations will be discussed. This will include covering both the legal and ethical standards surrounding the consulting and practice of I-O psychology and personnel management in organizations. Prerequisite: Graduate standing.

**PSYCH 5200 Theories and Practice of Psychological Measurement** (LEC 3.0)

An overview of psychological tests and batteries used in a variety of disciplines. An emphasis is placed on the proper development and use of these tests and test batteries. Tests examined will include tests of intelligence, aptitude, personality, and psychopathology. Prerequisite: Psych 4200 or graduate standing.

**PSYCH 5201 Psychometrics** (LEC 3.0)

An examination of statistical methods used to develop and refine measures of human performance, aptitudes, and personality. Topics include reliability and validity, data reduction, measuring inter-relationships among variables (e.g., factor analysis, multiple regression), and testing group differences. Prerequisite: Psych 5202.

**PSYCH 5202 Applied Psychological Data Analysis** (LEC 3.0)

This course will focus on those statistical methods most useful for advanced research in psychology. We will learn to use R, a powerful, open-source statistical programming platform, and work through examples with psychological data sets including such techniques as correlation, ANOVAs, regression, and chi-squared. Prerequisite: Graduate standing.

**PSYCH 5210 Advanced Research Methods** (LEC 3.0)

Research methods and techniques, with an emphasis on conducting psychological research in organizational settings. Topics discussed include: ethics, reliability and validity in measurement and application, proper uses of experimental, quasi-experimental, and survey methodologies, as well as advanced methodologies IRT, SEM, HLM, and Meta-Analyses. Prerequisite: Graduate standing.

**PSYCH 5600 Advanced Social Psychology** (LEC 3.0)

An advanced study of the behavior of individuals in interaction within groups. Consideration will also be given to the experimental literature dealing with the formal properties of groups, conformity and deviation, intergroup relations, and attitude formation and attitude change. Prerequisite: Psych 4600.

**PSYCH 5601 Small Group Dynamics** (LEC 3.0)

This course covers group perception, identification, leadership, structure, conflict, cohesion, commitment, performance, norms, roles, influence, and decisions, and groups' relations, networks, and work teams. Students consider both theory and applications to their lives and organizations through observational, research, team and applied assignments. Prerequisite: Psych 4601 or graduate standing.

**PSYCH 5602 Organizational Development** (LEC 3.0)

Examination of the field of organizational development theories and interventions. An emphasis is placed on research methods and application of practices related to individual processes, group processes, and organizational structures and functions that impact change and development strategies and interventions. Prerequisite: Psych 4602 or graduate standing.

**PSYCH 5603 Advanced Social Influence** (LEC 3.0)

An in-depth review of the principles and procedures that affect the process of social influence, with consideration given to attitudinal, compliance inducing, and perceptual influences. Students will consider the theoretical implications and practical applications of topics in social influence in the form of independent reading, research proposals and/or projects, and observational assignments. Prerequisite: Psych 4603 or graduate standing.

**PSYCH 5700 Job Analysis and Performance Management** (LEC 3.0)

A focus on the scientific measurement of job performance. An in-depth discussion of the science and methods of appropriate job and task analysis will be discussed. Additionally, students will focus on current issues in performance management and appraisal including scientific findings related to both objective and subjective measures of performance. Prerequisite: Psych 4700 or graduate standing.

**PSYCH 5710 Advanced Human Factors** (LEC 3.0)

An in-depth review of the foundations of human factors, focusing on the interaction of people with various forms of technology in a variety of environments. Topics include research and evaluation methods, displays (e.g., visual, auditory), attention and information processing, decision making, motor skills, anthropometry, and biomechanics. (Co-listed with ENG MGT 5330).

**PSYCH 5720 Advanced Human-Computer Interaction** (LEC 3.0)

This course examines the psychological research and theories that contribute to the field of human-computer interaction. An emphasis will be placed on engaging in critical evaluation of research and applying theoretical knowledge to effectively use computers in organizations. Prerequisite: Psych 4720 or graduate standing.

**PSYCH 5730 Environmental Psychology: Research and Practice** (LEC 3.0)

An in-depth review of the theoretical perspectives in environmental psychology and the psychological effects of various environments. An emphasis is placed on the review and integration of the research to explain the psychological issues related to various environments as well as to understand ways to effectively design living, educational, work, and recreational environments. Prerequisite: Psych 4730 or graduate standing.

## Russian

**Irina Ivliyeva**, Associate Professor  
PHD Russian Academy of Sciences

**RUSSIAN 1101 Elementary Russian I** (LEC 4.0)

Introduction to reading, conversation, and grammar. Prerequisite: Entrance requirements.

**RUSSIAN 1102 Elementary Russian II** (LEC 4.0)

Continuation of Russian 1101. Prerequisite: Russian 1101.

**RUSSIAN 1180 Readings In Science And Literature** (LEC 4.0)

Readings in scientific writings and literature for improving comprehension of Russian publications. Prerequisite: Russian 1102.

**RUSSIAN 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**RUSSIAN 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**RUSSIAN 2110 Basic Russian Conversation** (LEC 2.0)

Russian conversation and oral practice. Prerequisite: Russian 1102.

**RUSSIAN 2170 Masterpieces Of Russian Literature** (LEC 3.0)

Selected major works of Russian literature. Prerequisite: Russian 1180.

**RUSSIAN 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**RUSSIAN 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**RUSSIAN 3790 Scientific Russian** (LEC 3.0)

The course focuses on acquisition of Russian scientific vocabulary for STEM disciplines and development of practical skills in translating, discussing, and interpreting intermediate Russian scientific texts. Prerequisite: Russian 1180 or above.

**RUSSIAN 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**RUSSIAN 4001 Special Topics** (LAB 1.0 and LEC 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**RUSSIAN 4010 Seminar** (IND 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

**RUSSIAN 4320 Russian Phonetics and Intonation** (LEC 3.0)

This course focuses on pronunciation improvement, development of basic transcription skills, comprehension of Russian speech at fast tempo, interactions of intonation and syntax. Prerequisite: Russian 1102.

**RUSSIAN 4330 Business Russian** (LEC 3.0)

The course addresses practical language skills and strategies for conducting business in Russian-speaking countries. Students will improve their knowledge of contemporary Russian culture and business etiquette. Readings, lectures, and discussions are in Russian. Prerequisite: Russian 1180.

**RUSSIAN 4360 Russian Civilization** (LEC 3.0)

Introduction to Russian civilization and culture from the 9th to the 19th century exploring the interrelation between Russian society, its history and its cultural expression in painting, literature, music, visual arts and architecture over the past thousand years. Prerequisite: Any 1000 or higher level history course.

**RUSSIAN 4370 Survey Of Russian Literature I (Early Period)** (LEC 3.0)

A study of the history and development of 16th, 17th, 18th, and 19th century Russian literature. Prerequisite: Russian 2170.

**RUSSIAN 4375 Survey Of Russian Literature II (Modern Period)** (LEC 3.0)

20th Century Russian Literature. Prerequisite: Russian 2170.

**RUSSIAN 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**RUSSIAN 5790 Advanced Scientific Russian** (LEC 3.0)

The course focuses on acquisition of advanced Russian scientific vocabulary for STEM disciplines and development of practical skills in translating, discussion, and interpreting advanced Russian scientific texts. The final research project is required. Prerequisite: Russian 1180 or above.

## Spanish

**Jorge Porcel**, Associate Professor  
PHD University of Pittsburgh

**Lucy H Sutcliffe**, Lecturer

BA University of California, Santa Barbara

**SPANISH 1101 Elementary Spanish I** (LEC 4.0)

Introduction to Spanish. Oral drills, readings, grammar and composition. No previous knowledge of Spanish or no more than two years of Spanish in High School Prerequisites: Entrance requirements.

**SPANISH 1102 Elementary Spanish II** (LEC 4.0)

Continuation of Spanish 1101. Prerequisite: Spanish 1101.

**SPANISH 1180 Readings And Composition** (LEC 4.0)

Intermediate readings in Spanish. Prerequisite: Spanish 1102.

**SPANISH 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SPANISH 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**SPANISH 2110 Basic Spanish Conversation** (LEC 2.0)

Spanish conversation and oral practice. Prerequisites: SPANISH 1180.

**SPANISH 2160 Hispanic Culture** (LEC 3.0)

An interdisciplinary course that examines the culture of the Hispanic world (with an emphasis on Latin America). The presentation is in Spanish, and social science concepts and methods are stressed. Topics include: bilingualism, multiculturalism, economic development, and political stability. Prerequisite: Spanish 1180.

**SPANISH 2170 Masterpieces Of Hispanic Literature** (LEC 3.0)

A study of the major works in Spanish and Spanish American literature. Prerequisite: Spanish 1180.

**SPANISH 2180 Intermediate Spanish Composition** (LEC 3.0)

Practice in writing Spanish: compositions and written translations. Prerequisite: Spanish 1180.

**SPANISH 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SPANISH 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**SPANISH 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects of projects in the department. Consent of instructor required.

**SPANISH 4001 Special Topics** (LAB 1.0 and LEC 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**SPANISH 4010 Seminar** (IND 1.0-3.0)

Discussion of current topics.

**SPANISH 4302 Phonetics and Phonology of Spanish** (LEC 3.0)

Theoretical and practical approach to the phonetics and phonology of Spanish from the dual perspective of the mental representation of the sound system and pronunciation within syllables, words and phrases. Practice in listening comprehension, and sound discrimination with transcription exercises. Prerequisites: Any Spanish course at the 2000 or 3000 level.

**SPANISH 4311 Advanced Spanish Conversation** (LEC 2.0)

Advanced Spanish conversation and oral practice. Prerequisites: Any Spanish course at the 2000 or 3000 level.



**SPANISH 4370 Survey Of Spanish Literature** (LEC 3.0)  
Survey of Spanish literature from Medieval to Modern Times, including the Renaissance, Siglo De Oro, Enlightenment, Romanticism, and the 20th century.. Prerequisite: Spanish 2170 or native ability.

**SPANISH 4377 Spanish-American Novel And Short Story** (LEC 3.0)  
A study of the development of narrative prose in Spanish America. Prerequisite: Spanish 2170.

## Speech and Media Studies

Speech and media studies are the academic disciplines that seek to understand the processes by which human beings agree to cooperate in their endeavors. These processes are as old as human nature itself and are rooted in the original human condition of orality, but they continue to be modified as new media wax and old media wane. Understanding these processes is the basis for most of the coursework offered by this program, however, each course also seeks to develop the student's proficiency in the particular styles of communication engendered by media as they evolve.

The speech and media studies program offers two minors to Missouri S&T undergraduates: communication studies and leadership communication. Orality-based courses, including interpersonal, business, professional, intercultural, and mass communication, as well as courses in the social dynamics of leadership in groups and organizations may be incorporated into either minor to best meet students' individual needs.

Courses in speech and media studies serve students well in many aspects of their lives including not only school and vocation, but also family, society, and civic responsibility.

The speech and media studies program of the department of arts, languages and philosophy offers two minors in communication: communication studies and leadership communication. Each minor requires 15 hours of study.

### Communication Studies

Core Requirements:		3
SP&M S 2181	Communication Theory	
Elective requirements, select four of the following:		12
SP&M S 1185	Principles Of Speech	
SP&M S 2000	Special Problems	
SP&M S 2001	Special Topics	
SP&M S 3000	Special Problems	
SP&M S 3001	Special Topics	
SP&M S 3235	Intercultural Communication	
SP&M S 3250	Interpersonal Communication	
SP&M S 3255	Discussion And Conference Methods	
SP&M S 3275	Foundations of Media Communication	
SP&M S 3282		
Advisor or approved substitute for one of the above.		

### Leadership Communication

Core Requirement:		3
SP&M S 2181	Communication Theory	
Additional Requirements:		12
SP&M S 3235	Intercultural Communication	
SP&M S 3250	Interpersonal Communication	
SP&M S 3255	Discussion And Conference Methods	
SP&M S 5265		
SP&M S 3270	Leadership Practices	

Advisor or approved substitute for one of the above.

**Tracie Devault**, Lecturer  
MA Lindenwood University

**W Lance Haynes**, Professor  
PHD University of Minnesota

**Cheryl Lee Lillie**, Assistant Teaching Professor  
MA Southern Illinois University Edwardsville

**Terry Robertson**, Associate Teaching Professor  
PHD University of Oklahoma

**SP&M S 1185 Principles Of Speech** (LEC 3.0)  
A study of the arts of expression, oral communication, and listening (theory and practice); effective interaction of speech, speaker, listener, and occasion. Prerequisite: Entrance requirements.

**SP&M S 2000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SP&M S 2001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**SP&M S 2181 Communication Theory** (LEC 3.0)  
Deals with the concerns addressed by communication theory: language, cybernetics, visual arts, general semantics, information theory, and electronic communications. The university's fairly extensive media and communications resources are made use of, both for their content and for a study of the impact of their forms upon the transfer of information.

**SP&M S 3000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SP&M S 3001 Special Topics** (LEC 0.0 and LAB 0.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**SP&M S 3010 Seminar** (IND 0.0-6.0)  
Discussion of current topics.

**SP&M S 3221 Fundamentals in Photography** (LEC 3.0)  
In this course the student will learn the basics of photographic composition and the use of the digital camera. A brief history of photography will provide context for the student's own development. Prerequisite: Sp&M S 1185 or 2181 (required for Speech minor credit); Art 1180 or Art 1185 (required for Art minor credit). (Co-listed with Art 3221).

**SP&M S 3235 Intercultural Communication** (LEC 3.0)  
Examines the range of human differences as variables in the communication process; emphasis on broadening individual perspectives regarding the range of human experience. Particularly useful for students who will work and live in environments unlike those previously encountered. Prerequisite: Sp&M S 2181.

**SP&M S 3245 Voice, Diction and Interpretation** (LEC 3.0)  
Training the speaking voice; study of vocal mechanism, breathing, projection, articulation, enunciation; practical application of speaking principles in oral interpretation reading; mastering clarity and variation of speech through vocal exercises. Students will attend one on-campus play to review the speech of one of the actors (Co-listed with Theatre 3245).

**SP&M S 3250 Interpersonal Communication** (LEC 3.0)

Explores the theoretical and practical dimensions of human communication in significant one-on-one relationships. Emphasis on theoretical approaches to identify and achieve particular outcomes desired in professional and personal interactions. Prerequisite: Sp&M S 2181.

**SP&M S 3255 Discussion And Conference Methods** (LEC 3.0)

Explores the theoretical and practical dimensions of human communication in task-oriented small groups with emphasis on producing desired outcomes. Particularly useful for students who wish to improve their ability to work in small group environments. Prerequisite: Sp&M S 2181.

**SP&M S 3265 Leadership Communication** (LEC 3.0)

This course explores various approaches to leadership with emphasis on the communication theories and behaviors associated with leadership in modern corporate and public contexts. Prerequisites: Sp&M S 2181, 3250.

**SP&M S 3270 Leadership Practices** (LEC 3.0)

This course provides opportunities for students to do qualitative and quantitative research in leadership, small group, and organizational communication. Prerequisites: SP&M S 5265.

**SP&M S 3275 Foundations of Media Communication** (LEC 3.0)

The course explores the historical, social, and psychological impact of media through study and practice of academic and non-academic theories of effective media communication. The course supplies an integrated critical framework for application in student's day-to-day consumption of media. Prerequisite: Sp&M S 1185. (Co-listed with Art 3275).

**SP&M S 3283 Business And Professional Communication** (LEC 3.0)

Examines culture and communication in the workplace from theoretical and practical perspectives. Topics include: group communication, interviewing, networking, planning and presenting material to technical and general audiences interpersonal communication and leadership in the workplace context. Prerequisites: Sp&M S 1999, 2181 or permission of instructor.

**SP&M S 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects of projects in the department. Consent of instructor required.

**SP&M S 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**SP&M S 4010 Seminar** (IND 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

**SP&M S 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Prerequisite: Consent of instructor.

**SP&M S 5000 Special Problems** (IND 0.0-6.0)

Graduate level problems or readings on specific subjects of projects in the department. Consent of instructor required.

**SP&M S 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course with senior/graduate level emphasis. Variable title.

**SP&M S 5010 Seminar** (IND 0.0-6.0)

Advanced discussion of current topics.

## Statistics

(See Mathematics (p. 179) )

**Akim Mouhamadou Adekpedjou**, Associate Professor  
PHD University of South Carolina Columbia

**Gayla Renee Olbricht**, Assistant Professor  
PHD Purdue University

**Robert L Paige**, Professor  
PHD Colorado State University

**V A Samaranayake**, Curators' Distinguished Teaching Professor  
PHD Kansas State University

**Xuerong (Meggie) Wen**, Associate Professor  
PHD University of Minnesota

**STAT 1001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**STAT 1111 Business And Economic Statistics I** (LEC 3.0)

This is an introductory course in business and economic statistics. Our main objective is to familiarize the student with elementary statistical concepts within the context of numerous applications in Business and Economics. We will highlight the primary use of statistics, that is, to glean information from an available sample regarding the underlying population. Prerequisite: Math 1120 or Math 1140 with a grade of "C" or better. (Co-listed with Econ 1300).

**STAT 1115 Statistics For The Social Sciences I** (LEC 3.0)

A survey course in statistics for the social and behavioral sciences. Main emphasis is on inductive rather than traditional descriptive statistics. Attention given to the design of experiments, sampling procedures, basic probability distributions, tests of significance, linear regression and correlation, and analysis of variance. Not advised for engineering or science curricula.

**STAT 1116 Statistics For The Social Sciences II** (LEC 3.0)

A course on statistical methodology for the social and behavioral sciences. Regression, analysis of variance, forecasting, and use of statistical computer packages. Prerequisite: Stat 1115 with a grade of "C" or better.

**STAT 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**STAT 3111 Statistical Tools For Decision Making** (LAB 1.0 and LEC 2.0)

An introduction to statistical techniques commonly used in management decision making. Topics include statistical inference of population parameters, linear regression, basics of experimental design and analysis, analysis of categorical data, and the use of statistical software. Credit will be given for only one of Stat 3111, 3113, 3115 or 3117. Prerequisite: Math 1208 or 1212 or 1214 with a grade of "C" or better.

**STAT 3113 Applied Engineering Statistics** (LEC 3.0)

An introduction to applied statistical methods in engineering dealing with basic probability, estimation, tests of hypotheses, regression, design of experiments and control charts. Statistical computer packages will be used in connection with some of the material studies. Credit will be given for only one of Stat 3111, 3113, 3115 or 3117. Prerequisite: Math 1215 or 1221 with a grade of "C" or better.

**STAT 3115 Engineering Statistics** (LEC 3.0)

An introduction to statistical methods in engineering and the physical sciences dealing with basic probability, distribution theory, confidence intervals, significance tests, and sampling. Credit will be given for only one of Stat 3111, 3113, 3115 or 3117. Prerequisite: Math 1215 or 1221 with a grade of "C" or better.

**STAT 3117 Introduction To Probability And Statistics** (LEC 3.0)

Introduction to probability, distribution theory, statistical inference, with applications to physical and engineering sciences. Probability, probability and joint distributions, functions of random variables, system reliability, point and interval estimation, testing hypotheses, regression analysis. Credit will be given for only one of Stat 3111, 3113, 3115, or 3117. Prerequisite: Math 2222 with a grade of "C" or better.

**STAT 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**STAT 4001 Special Topics** (LEC 3.0 and LAB 1.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**STAT 4099 Undergraduate Research** (IND 0.0-6.0)

This course is designed for the undergraduate student who wishes to engage in research. It is not to be used for graduate credit nor for more than six credit hours of undergraduate credit. The subject and credit are to be arranged with the instructor. Prerequisite: Consent of instructor.

**STAT 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**STAT 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**STAT 5099 Graduate Research** (IND 0.0-6.0)

Investigation of an advanced nature leading to the preparation of a MS thesis or dissertation.

**STAT 5120 Statistical Methods** (LEC 3.0)

A continuation of Stat 3115 with emphasis on statistical methods. Topics would include further work on regression analysis, control charts, acceptance sampling, nonparametric statistics, goodness of fit tests, reliability and life-testing, analysis of experimental designs. Prerequisite: Stat 3115.

**STAT 5260 Statistical Data Analysis Using SAS** (LAB 1.0 and LEC 2.0)

This course will introduce the student to selected data analytic tools implemented in the Statistical Analysis System (SAS) and appropriate and effective use of these tools. Focus would be on both the use of SAS data analytic tools and the theoretical and methodological rationale that form the basis of such analyses. Prerequisite: One of Stat 3113 or 3115 or 3117 or 5643; and one of Stat 5346 or 5353 or 6841 or 6343 or 6344 or 6545.

**STAT 5346 Regression Analysis** (LEC 3.0)

Simple linear regression, multiple regression, regression diagnostics, multicollinearity, measures of influence and leverage, model selection techniques, polynomial models, regression with autocorrelated errors, introduction to non-linear regression. Prerequisites: Math 2222 and one of Stat 3111, 3113, 3115, 3117, or 5643. (Co-listed with Comp Sci 5204).

**STAT 5353 Statistical Data Analysis** (LEC 3.0)

Introduction to methods for analyzing statistical data from experiments and Introduction to methods for analyzing statistical data from experiments and surveys. Analysis of variance, correlation, introduction to regression techniques, contingency tables, non-parametric techniques and introduction to modern statistical software. Prerequisites: Math 2222 and one of Stat 1115, 3113, 3115 and 3117.

**STAT 5425 Introduction to Biostatistics** (LEC 3.0 and LAB 1.0)

Introduction to common biostatistical methods for designing research studies, collecting and analyzing data, with application to problems originating from the biological, environmental, and health sciences. Topics include randomization, means comparisons, ANOVA, regression, and analysis of count data. Prerequisites: A grade of "C" or better in Math 1120, Math 1140, Math 1208, Math 1212, or Math 1214.

**STAT 5643 Probability And Statistics** (LEC 3.0)

Introduction to the theory of probability and its applications, sample spaces, random variables, binomial, Poisson, normal distributions, derived distributions, and moment generating functions. Prerequisite: Math 2222.

**STAT 5644 Mathematical Statistics** (LEC 3.0)

A continuation of Stat 5643 with introduction to the theories of point estimation, hypothesis testing, and interval estimation. Includes sufficiency, completeness, likelihood and how they apply to the exponential family. Prerequisite: Stat 5643.

**STAT 5755 Statistical Models in Actuarial Science** (LEC 3.0)

This course covers the statistical foundation of actuarial models and their applications. Topics include survival and severity models, Kaplan-Meier and Nelson-Aalen estimators, aggregate and credibility models for insurance losses, discrete time Markov chains, ruin theory, and simulation. Prerequisite: Stat 5643 and either Stat 5644 or a 3000-level Stat course. (Co-listed with Econ 4350).

**STAT 5756 Statistical Models for Life Contingencies** (LEC 3.0)

The basic statistical theory of actuarial models for life uncertainties such as time of death. Multiple life and multiple decrement models, statistical models for life and contingent insurance; last survivor, disability, withdrawal, retirement and reserving models for life insurance. Prerequisite: Stat 5643.

**STAT 5814 Applied Time Series Analysis** (LEC 3.0)

Introduction to time series modeling of empirical data observed over time. Topics include stationary processes, autocovariance functions, moving average, autoregressive, ARIMA, and GARCH models, spectral analysis, confidence intervals, forecasting, and forecast error. Prerequisites: One of Stat 3113, 3115, 3117, 5643 and one of Math 3103, 3108, or 5108.

**STAT 5904 Science Education and Quantitative Literacy for Middle School Teachers** (LEC 3.0)

An integrated science-mathematics course for middle school teachers. Course covers selected science/mathematics topics/skills specified in Missouri standards for grades 5-7. Inquiry based methods of teaching these topics in an integrated manner will be emphasized. Prerequisite: Current enrollment in a Teacher Education Program or a full or part-time teacher in a K-12 school. (Co-listed with Physics 4625).

**STAT 5905 Making Sense Of Data For Elementary School Teachers** (LEC 3.0)

An activity based course that is intended to provide elementary school teachers with the skills necessary to implement the Probability & Statistics strand of the American Statistical Association of the National Council of Teachers of Mathematics (NCTM) joint. Prerequisite: Graduate Standing.

**STAT 5906 Making Sense Of Data For Middle School Teachers** (LEC 3.0)

An activity based course that is intended to provide middle school teachers with the skills necessary to implement the Probability & Statistics strand of the American Statistical Association of the National Council of Teachers of Mathematics (NCTM) joint.

**STAT 5907 Making Sense Of Data For High School Teachers** (LEC 3.0)

An activity based course that is intended to provide high school teachers with the skills necessary to implement the Probability & Statistics strand of the American Statistical Association of the National Council of Teachers of Mathematics (NCTM) joint.

## Sustainability

### Sustainability Minor

Sustainability is the minimal use of natural resources and the process of replacing used resources to meet the current needs of society without compromising the needs of future generations. Sustainability touches upon many fields of study, from social sciences to natural sciences to engineering to business. The concept has applications in the management of natural resources, such as energy and agriculture, and also in the development of business and engineering solutions. Given the interdisciplinary nature of the topic, Missouri S&T created a special sustainability minor program for students interested in this field of study.

Any undergraduate student at Missouri S&T can pursue a sustainability minor. The requirements for the minor include 15 hours of approved classes. One class, ENV ENG 5642/CIV ENG 5642 Sustainability, Population, Energy, Water, and Materials (3 hours), is required of all students. Students also take at least two approved classes from each of two general categories: social science classes and science/technical classes. Classes that meet the minor requirements in each category span many departments on campus, given the interdisciplinary nature of sustainability. At least 9 credit hours counting toward the minor must be from outside the student's home degree program.

The curricula criteria for the minor, including lists of approved courses in the two general categories, are maintained by the Sustainability Program Board and can be found on the sustainability minor homepage (<http://care.mst.edu/environmentalengineering/undergraduate/sustainabilityminor/>). Interested students can contact a Sustainability Program Board representative (listed on the website) to apply for the minor and to receive help with deciding which classes to take to meet the requirements.

## Systems Engineering

**Venkat Allada**, Professor

PHD University of Cincinnati

Sustainable produce development, product platform design, mass customization, product innovation, lean manufacturing, intelligent manufacturing systems, process planning supply chain management, systems engineering process and design.

**K Chandrashekhara**, Curators Professor

PHD Virginia Polytechnic Institute  
Structures and Composite Materials

**Steven M. Corns**, Associate Professor

PHD Iowa State University

Systems Engineering Research Focus Area: computational intelligence, modeling and simulation, risk modeling and assessment.

**Elizabeth Anne Fargher Cudney**, Associate Professor

PHD Missouri S&T

Quality, Six Sigma, Robust Engineering, and Lean Enterprise.

**Cihan H Dagli**, Professor

PHD University of Birmingham, UK

Systems Architecting and Engineering, Complex Adaptive Systems, Neural Networks, Fuzzy Logic, Evolutionary Programming, Nesting Problems. INCOSE Fellow, IIE Fellow

**David Enke**, Professor

PHD University of Missouri-Rolla

Investments, Derivatives, Options and Futures, Financial Forecasting, Trading Strategies, Hedge Funds, Endowment Investing, Financial Risk Management, Engineering Economy, Computational Finance, Computational Intelligence, Neural Networks.

**Abhijit Gosavi**, Associate Professor

PHD University of South Florida

Lean manufacturing, supply chain management, revenue management, simulation-optimization.

**Katie Grantham**, Associate Professor

PHD University of Missouri-Rolla

**Ivan Guardiola**, Associate Professor

PHD Texas Tech University

Simulation and modeling, risk modeling and assessment, systems engineering processes and design, network centric systems, wireless communications networks, stochastic and probability modeling, operations research, birth-death process modeling, speaker recognition and identification systems (pattern recognition), and rare event probability modeling.

**Sheryl Hodges**, Assistant Teaching Professor

DEng Louisiana Tech University

**Dincer Konur**, Assistant Professor

PHD University of Florida

Operations research, games theory, mathematical modeling, linear and non-linear optimization, supply chain management, logistics, transportation.

**Suzanna K. Long**, Professor

PHD University of Missouri-Rolla

Strategic management, change management, business logistics and marketing.

**Robert Marley**, Professor

PhD Wichita State University

Human System Integration, Ergonomics

**Susan L Murray**, Professor<sup>1</sup>

PHD Texas A&M University

Industrial engineering, human systems integration, human factors, and safety.

**Louis Pape II**, Assistant Adjunct Professor

PHD Missouri University of Science and Technology

The Boeing Company, Associate Technical Fellow



**Ruwen Qin**, Associate Professor  
 PHD Pennsylvania State University  
 Real options, financial engineering, and manufacturing and service operations.

**Stephen A Raper**, Associate Professor  
 PHD University of Missouri-Rolla  
 Packaging engineering, operations, productivity, total quality management, packaging systems design, environmental aspects of packaging and statistical process control.

**Jagannathan Sarangapani**, Professor  
 PHD University of Texas-Arlington  
 Adaptive Control, Wireless Networks

**Joan Barker Schuman**, Assistant Teaching Professor  
 PHD University of Southern Mississippi  
 Project Management and Engineering Economics.

**David G Spurlock**, Lecturer  
 PHD University of Illinois Urbana  
 General Management

**Zeyi Sun**, Assistant Professor  
 PHD University of Illinois at Chicago  
 Energy efficiency management of manufacturing systems, electricity demand response of manufacturing systems, system modeling of cellulosic biofuel manufacturing, energy modeling and control in additive manufacturing, intelligent maintenance of manufacturing systems.

**Donald C Wunsch II**, Professor<sup>1</sup>  
 PHD University of Washington  
 Adaptive critic designs, neural networks, fuzzy systems, surety, nonlinear adaptive control, intelligent agents, applications.

**Gonca Yildirim**, Adjunct Professor  
 PHD University of Florida  
 Cankaya University, Ankara, Turkey

**SYS ENG 5000 Special Problems** (IND 1.0-6.0)  
 Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SYS ENG 5001 Special Topics** (LEC 0.0 and LAB 0.0)  
 This course is designed to give the department an opportunity to test a new course. Variable title.

**SYS ENG 5040 Oral Examination** (IND 0.0)  
 After completion of all other program requirements, oral examination for on-campus MS/PhD students may be processed during intersession. Off-campus MS students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive exam (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**SYS ENG 5099 Research** (IND 1.0-15)  
 Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required. Prerequisite: Graduate standing.

### **SYS ENG 5101 System Engineering and Analysis** (LEC 3.0)

The concepts of Systems Engineering are introduced through a project. Students work in virtual teams. The topics covered are architecture development, basic system architectural design techniques, functional decomposition, design and technical review objectives, and initial specifications. Prerequisite: Graduate Standing.

### **SYS ENG 5211 Computational Intelligence** (LEC 3.0)

Introduction to Computational Intelligence (CI), Biological and Artificial Neuron, Neural Networks, Evolutionary Computing, Swarm Intelligence, Artificial Immune Systems, Fuzzy Systems, and Hybrid Systems. CI application case studies covered include digital systems, control, power systems, forecasting, and time-series predictions. Prerequisite: Graduate Standing. (Co-listed with Elec Eng 5310 and Comp Eng 5310).

### **SYS ENG 5212 Introduction to Neural Networks and Applications** (LEC 3.0)

The course provides an introduction to basic neural network architectures and their applications. Students learn to construct neural networks and train them to solve engineering problems, specifically pattern recognition and function approximation. Mathematical analysis of network architectures, training algorithms and practical applications of neural nets. Prerequisites: Graduate Standing. (Co-listed with Elec Eng 5370).

### **SYS ENG 5323 Wireless Networks** (LEC 2.0 and LAB 1.0)

Introduction to wireless communications and networking. Topics include transmission fundamentals, wireless channel, coding techniques and error control, satellite and cellular networks, cordless systems, mobile IP and management, multiple access techniques and wireless protocols, wireless LAN, IEEE 802.11, and adhoc and sensor networks. Prerequisites: Hardware competency, Elec Eng 3420 or Comp Eng 3150 and graduate standing. (Co-listed with Comp Eng 5430 and Elec Eng 5430).

## **Technical Communication**

At the undergraduate level, three technical communication programs are offered in the department of English and technical communication: a bachelor of science in technical communication, a minor in technical communication, and a certificate in technical writing.

The technical communication degree offers you an entry into a growing profession that communicates information about the purpose and operation of human tools. Technical communicators work at the interface of technical experts and product users. Consequently, technical communicators provide an essential service to national and global societies by facilitating technology transfer.

You should bring to the program a love of writing and a curiosity about technology. The interdisciplinary nature of the Missouri S&T degree enables you to acquire the qualifications you need to be competitive and flexible in an ever-changing technological environment. When you graduate, you will have a solid technical background in computer-enhanced information systems, an understanding of how organizations function, and strong communication skills. Areas employing technical communicators include computer manufacturing and software development, consumer electronics, banking and financial institutions, telecommunications, chemical and pharmaceuticals, hospitals and research labs, and academic institutions and libraries.

You will study both the theory and practice of communication in written, oral and visual forms. Specifically, you will study and practice the production of a variety of technical documents in print, electronic, and digital forms. You will have experience with the process of project

management in a user community and become adept in audience analysis, needs assessment, document design, and team building.

In Missouri S&T's unique environment, you will have opportunities to work alongside engineers and scientists in undergraduate research and design projects. Also, you are strongly encouraged to do summer internships or co-ops with companies before you graduate. At Missouri S&T, you will work with first-class faculty, associate with excellent students from around the country and the world and benefit from the world-class computer environment. Your theoretical and practical education will prepare you for full-time employment and lifelong learning.

## Bachelor of Science Technical Communication

The technical communication degree requires 33 credit hours of core courses: ENGLISH 2410, TCH COM 2540 (or ENGLISH 2540), TCH COM 2560 (or ENGLISH 2560), TCH COM 5620, TCH COM 3440, TCH COM 4410, and five additional courses from the following list: ENGLISH 3560, ENGLISH 3302, TCH COM 3001, TCH COM 3010, TCH COM 5510, TCH COM 4550, TCH COM 5610, TCH COM 4085, TCH COM 5530, TCH COM 5560, TCH COM 4520, TCH COM 4450. It also requires 42 hours of general education courses, 36 hours of interdisciplinary courses (see note below), and 15 hours of free electives, for a total of 126 hours. Specific requirements for the bachelor's degree are outlined in the sample program listed below.

Freshman Year			
First Semester	Credits	Second Semester	Credits
ENGLISH 1120	3	TCH COM 1600	3
MATH 1140	3	BIO SCI 1113, or 2223, or 2233, or 2263	3
PSYCH 1101	3	HISTORY 1300, or 1310, or 1100, or 1200	3
Interdisciplinary Course <sup>1</sup>	3	Interdisciplinary Course <sup>1</sup>	3
Humanities, Art, Music, Theater	3	ECON 1100	3
	15		15

Sophomore Year			
First Semester	Credits	Second Semester	Credits
SP&M S 1185	3	Humanities, Art, Music, Theater	3
English Literature	3	POL SCI 1200	3
TCH COM 2540	3	TCH COM 2560	3
ENGLISH 2410	3	TCH COM Elective	3
Interdisciplinary Course <sup>1</sup>	3	Chemistry, Geology, Physics	3
		Interdisciplinary Course <sup>1</sup>	3
	15		18

Junior Year			
First Semester	Credits	Second Semester	Credits
Math/Statistics	3	TCH COM 5620	3
TCH COM 3440	3	TCH COM Elective	3
Interdisciplinary Course <sup>1</sup>	3	TCH COM Elective	3
Interdisciplinary Course <sup>1</sup>	3	Interdisciplinary Course <sup>1</sup>	3
Interdisciplinary Course <sup>1</sup>	3	Interdisciplinary Course <sup>1</sup>	3
		Free Elective	3
	15		18

Senior Year			
First Semester	Credits	Second Semester	Credits
TCH COM Elective	3	TCH COM 4410	3
Interdisciplinary Course <sup>1</sup>	3	TCH COM Elective	3
Interdisciplinary Course <sup>1</sup>	3	Interdisciplinary Course <sup>1</sup>	3
Free Elective	3	Free Elective	3
Free Elective	3	Free Elective	3
	15		15

Total Credits: 126

- <sup>1</sup> In consultation with his or her advisor, the student will select 36 hours of interdisciplinary courses from only two of the areas listed below, with no fewer than 15 credit hours per area: biological sciences, business, chemistry, computer science, economics, education, engineering management, English, finance, one foreign language, geology, history, information science and technology, management and information systems, mathematics, philosophy, physics, political science, psychology, speech and media studies, statistics, any area of engineering. At least 12 of the 36 hours must come from courses numbered 2000-level or above. The student's course selections must be approved by the department of English and technical communication's technical communication committee.

## Minor in Technical Communication

To complete this minor students must take TCH COM 1600, TCH COM 2540 (or ENGLISH 2540), and TCH COM 2560 (or ENGLISH 2560) plus six additional hours elected from the 4000-level or above technical communication courses.

## Certificate in Technical Writing Admissions Requirements

A student must meet Missouri S&T regular undergraduate admission requirements.

## Certificate Requirements

- A student must have completed at least 60 undergraduate college-level transferable credit hours, 42 of which must meet Missouri S&T's general education credit policy, [https://ugs.mst.edu/media/administrative/ugs/documents/Missouri\\_ST\\_42GenEdCredit\\_Policy5.pdf](https://ugs.mst.edu/media/administrative/ugs/documents/Missouri_ST_42GenEdCredit_Policy5.pdf).
- A student must have completed the following courses totaling 12 credit hours:
 

TCH COM 1600	Introduction to Technical Communication *	3
or ENGLISH 1600	Introduction to Technical Communication	
ENGLISH 3560	Technical Writing **	3
TCH COM 2560	Technical Marketing Communication	3
or ENGLISH 2560	Technical Marketing Communication	
One 4000- or 5000-level course with the TCH COM designation, excluding 5000 and 4080 ***		3

\* This course should be taken first if possible.

\*\* The junior-standing prerequisite will be waived for a certificate student who has already taken TCH COM 1600 or ENGLISH 1600.

\*\*\* The ENGLISH 2540/TCH COM 2540 prerequisite will be waived for certificate students.

- Must have achieved at least a 2.5 average in the course work taken for the certificate

### Other Stipulations:

- A student pursuing the technical communication minor may count the same courses for the minor and the technical writing certificate.
- A student who already has a bachelor's degree from Missouri S&T may count relevant courses from that degree (e.g., TCH COM 1600) toward the technical writing certificate.
- The 12 credit hours of technical communication course work may not be counted toward the 60 credit hours of undergraduate college-level transferable course work.

**Ed A. Malone**, Professor  
PHD Southern Illinois University Carbondale

**Kathryn Michele Northcut**, Professor  
PHD Texas Tech University

**Elizabeth Roberson**, Assistant Teaching Professor  
MS Missouri University of Science and Technology

**Michael David Wright**, Associate Professor  
PHD Oklahoma State University Main

**TCH COM 1600 Introduction to Technical Communication** (LEC 3.0)  
Introduction to the role of the professional technical communicator in business and industry and practice in methods of developing technical documents. Prerequisite: English 1120. (Co-listed with English 1600).

**TCH COM 2540 Layout and Design** (LEC 3.0)  
Theory and practice of layout and design for print and electronic media. Prerequisite: TCH COM 1600 or English 1600. (Co-listed with English 2540).

**TCH COM 2560 Technical Marketing Communication** (LEC 3.0)  
An introduction to technical marketing communication with an emphasis on relevant genres such as (but not limited to) the data sheet, white paper, and technical demonstration. Prerequisites: English 1600 or Tch Com 1600 or English 1160. (Co-listed with ENGLISH 2560).

**TCH COM 3000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**TCH COM 3001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**TCH COM 3010 Seminar** (RSD 0.0-6.0)  
Discussion of current topics. Prerequisites: One semester of college composition or technical writing.

**TCH COM 3440 Theory of Visual Technical Communication** (LEC 3.0)  
A study of the relationships between visual and conceptual elements of technical communication. Prerequisites: TCH COM 1600 or ENGLISH 1600; TCH COM 2540 or ENGLISH 2540.

**TCH COM 3570 Writing in the Sciences** (LEC 3.0)  
This course is designed to teach students how to write effectively in the sciences. Writing assignments include short reports, proposals, and a major project such as a research or analytical report or a procedures/instructions manual. Emphasis is placed on clarity, conciseness, organization, format, style, and tone. Prerequisites: English 1120 or equivalent.

**TCH COM 4085 Internship** (IND 0.0-6.0)  
Internship will involve students applying critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisites: Must have completed 24 hours in the major core curriculum.

**TCH COM 4410 Theory and Practice of Technical Communication** (LEC 3.0)  
This capstone course enables the student to work on individual and group projects that put into play the theories and practices of technical communication. Students are expected to develop professional portfolios. Prerequisites: Tch Com 1600 or English 1600; Tch Com 2540 or English 2540.

**TCH COM 4450 International Dimensions of Technical Communication** (LEC 3.0)  
Examines complexity of communication of technical information worldwide. Includes topics such as graphics, icons, symbols; user interface design; intercultural communication. Students may not earn credit for both TCH COM 4450 and TCH COM 6450. Prerequisites: One semester of college composition or technical writing and undergraduate standing.

**TCH COM 4520 Help Authoring** (LEC 3.0)  
Students will acquire the technological and rhetorical skills necessary for creating effective online help systems, including context-sensitive help for computer applications. Prerequisites: One semester of college composition or technical writing, or graduate standing.

**TCH COM 4550 Proposal Writing** (LEC 3.0)  
Familiarizes students with many aspects of writing proposals for various purposes in academic, professional, and public spheres. Offers students opportunities to write documents to promote their academic, professional, or personal goals or those of their organization(s). Prerequisite: One semester of college composition or technical writing.

**TCH COM 5000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**TCH COM 5001 Special Topics** (LEC 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**TCH COM 5010 Seminar** (RSD 0.0-6.0)  
Discussion of current topics. Prerequisites: One semester of college composition or technical writing, or graduate standing.

**TCH COM 5040 Oral Examination** (IND 0.0)  
After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**TCH COM 5099 Research** (IND 0.0-15)  
Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**TCH COM 5510 Technical Editing** (LEC 3.0)

The principles and practices of technical editing, including usability, audience analysis, contextual editing, the conventions of scientific and technical communication, and the role of the editor in document development and publication. Students will also learn standard practices of copy editing and the use of style guides. Prerequisites: One semester of college composition or technical writing, or graduate standing.

**TCH COM 5530 Usability Studies** (LEC 3.0)

Students in this course will study and apply methods used by technical communicators to evaluate usability. Students will study methods used to evaluate human interaction with communication tools and how to make those products more suitable for human use. Prerequisites: One semester of college composition or technical writing, or graduate standing.

**TCH COM 5540 Advanced Layout and Design** (LEC 3.0)

Advanced theory and practice of layout and design for print and electronic media. Students who have taken TCH COM 2540 may not take this course for credit. Prerequisite: Graduate standing.

**TCH COM 5550 Advanced Proposal Writing** (LEC 3.0)

Familiarizes graduate students with many aspects of writing proposals for various purposes in academic, professional, and public spheres. Offers opportunities to write documents to promote their academic, professional, or personal goals or those of their organization(s). Credit will not be given for both TCH COM 4550 and TCH COM 5550. Prerequisites: Graduate standing.

**TCH COM 5560 Web-Based Communication** (LEC 3.0)

Covers such topics as advanced writing and editing for the web; the creation of rhetorically effective websites; the use of blogs, wikis, and other web genres to communicate technical information. Prerequisites: One semester of college composition or technical writing, or graduate standing.

**TCH COM 5610 History of Technical Communication** (LEC 3.0)

Introduction to the roles of the technical communicator and the technologies of communication from ancient cultures to the present. Prerequisites: One semester of college composition or technical writing, or graduate standing.

**TCH COM 5620 Research Methods in Technical Communication** (LEC 3.0)

Students learn essential research methods in technical communication, including audience analysis, interviewing techniques, working with subject matter experts, and experimental research design. Prerequisites: One semester of college composition or technical writing, or graduate standing.

## Theatre

Missouri S&T theatre program offers a theatre minor, up to five shows per year, and multiple ways to become involved. Every fall semester we hold an information meeting in Castleman 143 to welcome new students and announce the season. It is held the first day of classes for the fall semester at 6:00 pm. Here you can get to know folks and learn what is in store.

We are most proud of the fact that people can be involved as much or as little as they choose, depending on their course load, and everyone has an equal opportunity to be cast in or work on any of the shows.

It is considered by our 60+ students to be their safe place or second home. We offer independent studies and currently have a Special

Topics course: Voice, Diction and Interpretation (THEATRE 2001 and THEATRE 4000). Our courses count as humanities credits.

## Theatre Minor Curriculum

A minor in Theatre requires a minimum of 16 hours comprised of the following courses:

THEATRE 1190	Theatre via Video	3
THEATRE 2141	Acting I	3
THEATRE 1142	Stage Productions, Performers	1
or THEATRE 3220	Theatre Ensemble	
THEATRE 1143	Stage Productions, Technicians	1
THEATRE 2143	Stagecraft	3

In addition to the courses listed above, the student is required to choose a concentration and complete enough hours from one of the following concentration areas to meet the minimum 16 hours.

### Acting/Directing

THEATRE 3241	Acting II	3
THEATRE 4341	Directing	3
THEATRE 3242		3
or MUSIC 1111	Individual Music Instruction I	

### Technical Theatre

THEATRE 3242		3
THEATRE 3241	Acting II	3
or THEATRE 4341	Directing	

**THEATRE 1142 Stage Productions, Performers** (LAB 1.0)

Performers: The student must request permission from the theatre professor prior to taking this course. A skills course, not a humanities elective. Prerequisite: Participants selected by audition.

**THEATRE 1143 Stage Productions, Technicians** (LAB 1.0)

Technicians and production assistants; participants selected by interview. A skills course, not a humanities elective.

**THEATRE 1190 Theatre via Video** (LEC 3.0)

Provides knowledge and internal understanding of theatre. After watching plays on video through online resources on the student's own time and live productions, students will meet as a class weekly to discuss. Online journaling and field trip required. Approximately \$12 cost for online resources. \$5 for live performances.

**THEATRE 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**THEATRE 2001 Special Topics** (LAB 1.0 and LEC 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**THEATRE 2141 Acting I** (LEC 3.0)

Covers basic techniques for comprehension of theory and practice of acting. Explores inner/outer techniques to create a role. Follows working steps to create performance of a fully realized characterization. Designed as an introductory course.

**THEATRE 2143 Stagecraft** (LEC 1.0 and LAB 2.0)

Students will learn the fundamentals of theatrical construction, production, and organization.

**THEATRE 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.



**THEATRE 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**THEATRE 3220 Theatre Ensemble** (LAB 1.0)

This course offers the opportunity for a student to develop imagination and performance abilities through improvisation, clowning, readers theatre, exercises, mime; emphasis varies. Members selected by interview/audition. A skills course, not a humanities elective.

**THEATRE 3241 Acting II** (LAB 1.0 and LEC 2.0)

Continuation of Acting I, covering acting styles, more complicated, nuanced roles, and more detailed character analysis and performance—special emphasis on British and Classical performance. Prerequisite: Theatre 2141.

**THEATRE 3243 Entertainment Design** (LAB 2.0 and LEC 1.0)

Students will learn the fundamentals of design for live theatre, film, theme parks, clubs, concerts, and dance events.

**THEATRE 3245 Voice, Diction and Interpretation** (LEC 3.0)

Training the speaking voice; study of vocal mechanism, breathing, projection, articulation, enunciation; practical application of speaking principles in oral interpretation reading; mastering clarity and variation of speech through vocal exercises. (Co-listed with SP&M S 3245).

**THEATRE 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**THEATRE 4001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**THEATRE 4341 Directing** (LEC 3.0)

This course studies the theories, technique, and approaches of directing for the stage, culminating in the preparation, rehearsal, and presentation of directing scenes. Prerequisite: Theatre 2141.

# COURSE INFORMATION

---

## Course Numbers

This section has been prepared to give you a listing and description of the approved graduate level courses at the Missouri University of Science and Technology. Courses listed are those approved at the time this publication went to press. Changes are made at regular intervals. Electronic catalog descriptions, which are updated during the academic year, are available on the Web at: <http://catalog.mst.edu/> or on Joe'SS. This will enable you to keep abreast of new course additions. For current information on when courses are available, consult the campus schedule of classes available from the Registrar's Office, 103 Parker Hall.

**1000-1999** Freshmen-level courses. May not be used as any part of a graduate degree program.

**2000-2999** Sophomore-level courses. May not be used as any part of a graduate degree program.

**3000-3999** Junior-level courses.

**4000-4999** Senior-level courses.

**5000-5999** Entry and mid-level graduate courses (undergraduate enrollment allowed).

**6000-6999** Advanced graduate courses. Undergraduate and post-baccalaureate students are not normally eligible to enroll in 6000-level courses.

## Course Information

The number in parentheses following the name of the course indicates the number of credit hours given for successfully completing the course. It also reflects the section type; for example, (LEC 3.0) designates a lecture course of three hours credit; (LAB 1.0) designates a laboratory course of one-hour credit, (RSD 2.0) designates a recitation, seminar, discussion of two hours credit, and (IND 0.0-15.0) designates independent study or research with variable hours. A lecture credit hour is usually the credit granted for satisfactorily passing a course of approximately 15 classroom hours. A laboratory course of one-hour credit would normally meet three classroom hours per week for 15 weeks.

Three credit hour courses normally meet 50 minutes three times per week, or 75 minutes twice a week, for 15 weeks. The time in class is the same in each case. If you have two classes in succession, there should be at least 10 minutes between classes. Classes meeting Monday-Wednesday-Friday will normally begin on the hour. Classes meeting Tuesday-Thursday will normally alternate between the hour and half hour, beginning at 8:00 a.m.

Students must have completed the stated prerequisite(s) for the course for admission to the course or obtain the 'Consent of the Instructor' of the course.

# COURSE LIST

## Aerospace Engineering (AERO ENG)

### **AERO ENG 2001 Special Topics** (LAB 1.0 and LEC 1.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

### **AERO ENG 2360 Dynamics** (LEC 3.0)

The principles of mechanics are used to model engineering systems. Kinematics of particle motion, kinematics of plane- and three-dimensional motions of rigid bodies. Kinetics of particles and of rigid bodies. Energy and momentum methods. Prerequisite: Grade of "C" or better in each of Civ Eng 2200, Math 2222. (Co-listed with Mech Eng 2360).

### **AERO ENG 2780 Introduction to Aerospace Design** (LAB 1.0 and LEC 1.0)

Introduction to methodology of aerospace vehicle design and principles of layout to meet a given specification, mission objective, component sizing, design iteration and building & performance testing of models. Prerequisite: A grade of "C" or better in Aero Eng 2861.

### **AERO ENG 2790 Introduction to Spacecraft Design** (LAB 1.0 and LEC 1.0)

Intro. to basics of spacecraft design, including design requirements, subsystem definition, and vehicle design synthesis. Lab work includes design and fabrication of a small spacecraft payload that is flight tested on a high altitude balloon to 100,000 feet. Post-flight data reduction and analysis. Field trip will be required for balloon launch/retrieval. Prerequisite: A grade "C" or better in Aero Eng 2861.

### **AERO ENG 2861 Aerospace Vehicle Performance** (LEC 3.0)

Nature and theory of lift, drag, performance, and stability and control of aerospace vehicles. Prerequisite: "C" or better grade in both Math 1215 and Physics 1135.

### **AERO ENG 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### **AERO ENG 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

### **AERO ENG 3002 Cooperative Engineering Training** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry with credit arranged through departmental co-op adviser. Grade received depends on quality of reports submitted and work supervisor's evaluation.

### **AERO ENG 3010 Seminar in Aerospace Engineering** (RSD 1.0)

Discussion of current topics.

### **AERO ENG 3131 Aerodynamics I** (LEC 3.0)

A study of the fundamental concepts of fluid mechanics as applied to aerodynamic applications with both differential and control volume analysis. Theory and application of viscous and inviscid incompressible flow including boundary layer theory and two dimensional airfoil theory. Prerequisites: A grade of "C" or better in each of Aero Eng 2861, Math 1214, Math 1215, Math 2222 and Physics 1135.

### **AERO ENG 3171 Aerodynamics II** (LEC 3.0)

Three dimensional incompressible wing theory. Compressible one dimensional flow with normal and oblique shock waves, heat addition, and friction. Compressible transonic, and supersonic linearized flow theory. Supersonic wings and wing/fuselage configurations. Prerequisite: "C" or better in Aero Eng 3131 and Mech Eng 2519.

### **AERO ENG 3251 Aerospace Structures I** (LEC 3.0)

An introduction to various loads on aerospace vehicles. Basic theory and analysis of typical aerospace and related vehicle structures subjected to steady loading. An overview of various failure theories including yielding, buckling, fracture and fatigue. Design of thin walled structures. Introduction to advanced composite materials. Prerequisites: "C" or better in Math 1214 (or 1208), 1215 (or 1221), 2222, Physics 1135 and Civ Eng 2210.

### **AERO ENG 3361 Flight Dynamics and Control** (LEC 3.0)

Static stability and control of conventional aircraft and implications in aircraft design. Six degrees of freedom time dependent equations of motion and their linearized solutions. Consideration of stability vs maneuverability, and the dynamic modes of motion of the aircraft. Prerequisites: Aero Eng 3613, Aero Eng 3131, and accompanied or preceded by Aero Eng 2780.

### **AERO ENG 3613 Aerospace Mechanics I** (LEC 3.0)

Introduction to celestial mechanics and an analytical study of space flight. Emphasis is placed on satellite orbits and general theory of gyro dynamics. Prerequisites: Math 3304; a grade of "C" or better in each of Aero Eng 2360 (or Mech Eng 2360), Math 1214 (or 1208), 1215 (or 1221), 2222, and Physics 1135.

### **AERO ENG 3877 Principles of Engineering Materials** (LEC 3.0)

Examination of engineering materials with emphasis on selection and application of materials in industry. Particular attention is given to properties and applications of materials in extreme temperature and chemical environments. A discipline specific design project is required. (Not a technical elective for undergraduate metallurgy or ceramic majors) (Co-listed with Chem Eng 5300, Physics 4523, Met Eng 5810, Cer Eng 5810).

### **AERO ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### **AERO ENG 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

### **AERO ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

### **AERO ENG 4133 Introduction to Aerothermochemistry** (LEC 3.0)

Principles of thermochemistry in reacting flow including an introduction to fundamentals of quantum mechanics, statistical mechanics and statistical thermodynamics. Applications in flow through nozzles and shock waves, combustion, aerodynamic heating, ablation and propulsion. Prerequisites: Aero Eng 3131, Aero Eng 3171.

### **AERO ENG 4253 Aerospace Structures II** (LEC 3.0)

Introduction to the finite element method for static and dynamic analysis of aerospace structures. Analysis of beams, trusses and frames. Plane stress and plane strain analysis. Isoparametric elements and numerical integration. Free vibration and time dependent problems. Prerequisite: Aero Eng 3251.

**AERO ENG 4535 Aircraft and Space Vehicle Propulsion** (LEC 3.0)

Analysis of aircraft and missile propulsion systems; fundamentals of jet propulsion including air breathing and rocket engines. Introduction to advanced propulsion systems for space flights such as nuclear, thermonuclear, and plasma jets. Prerequisite: Mech Eng 3131, or Aero Eng 3171.

**AERO ENG 4780 Aerospace Systems Design I** (LEC 2.0)

Consideration of the creative design process with emphasis on aeronautical-aerospace systems. Short design problems to illustrate the process. Selection of design projects for Aero Eng 4781. Information gathering for the design projects which will be completed in Aerospace Systems Design II. Fall semester. Prerequisites: Aero Eng 3251, 3361, 3171.

**AERO ENG 4781 Aerospace Systems Design II** (LAB 3.0)

Preliminary design of aerospace systems. Project to integrate the knowledge of different aerospace engineering areas through synthesis and analysis. The creative design will include a consideration of such factors as performance reliability, cost, human factors, energy and ecology. Spring semester. Prerequisite: Aero Eng 4780.

**AERO ENG 4790 Spacecraft Design I** (LEC 3.0)

Fundamentals of spacecraft design. Systems engineering, subsystem analysis and design. Gantt charts, organizational charts. Oral presentations and technical documentation. Term project to involve design and development of actual flight hardware, continuing into Spacecraft Design II. Prerequisites: Aero Eng 3251, 3361, and 3171 for Aero Eng majors; consent of instructor for non-Aero Eng majors.

**AERO ENG 4791 Spacecraft Design II** (LAB 3.0)

As a continuation of Aero Eng 4790, detailed spacecraft design is performed, leading to procurement of components. As schedules permit, spacecraft fabrication and test commence. Development of labs to facilitate spacecraft test, operation, and data analysis continues. Prerequisites: Aero Eng 4790 for Aero Eng majors; consent of instructor for non-Aero Eng majors.

**AERO ENG 4882 Experimental Methods in Aerospace Engineering I** (LAB 2.0)

Introduction to experimental methods in low-speed aerodynamics, flight simulation, and aircraft structures. Measurements of drag, boundary layer flows, and aerodynamic forces and moments. Flight simulations, and structural testing of aircraft components. Statistical methods and probability distributions in data analysis and interpretation. Prerequisites: Aero Eng 3131 and Elec Eng 2800.

**AERO ENG 4883 Experimental Methods in Aerospace Engineering II** (LAB 2.0)

Laboratory investigations related to aerospace engineering. Investigations include high-speed aerodynamics, flow visualization measurements in turbulent flow, aircraft vibration and flutter, propeller acoustics, flight simulation, propulsion systems, flame measurements, and control experiments. Statistical error analysis. Prerequisites: Aero Eng 3251, 3361, 3171, & 4882.

**AERO ENG 4885 Assessment** (LEC 1.0)

This course is an overview and assessment of the required aerospace engineering courses that the students took. Prerequisites: Aero Eng 3171, Aero Eng 3361, Aero Eng 4535, Aero Eng 4253.

**AERO ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**AERO ENG 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title. (Co-listed with Mech Eng 5001).

**AERO ENG 5131 Intermediate Thermofluid Mechanics** (LEC 3.0)

Derivation of Navier-Stokes equations, analytical solutions of viscous flows; flow in pipes, flow networks; intermediate treatment of boundary layer theory; micro-fluidics and MEMS; introduction to numerical methods for solving fluid flows; and, preliminary treatise on turbulence. Prerequisite: Mech Eng 3131 or Aero Eng 3131. (Co-listed with Mech Eng 5131).

**AERO ENG 5139 Computational Fluid Dynamics** (LEC 3.0)

Introduction to the numerical solution of the Navier-Stokes equations, by finite difference methods, in both stream function-vorticity and primitive variable formulations. Course format emphasizes student development of complete computer programs utilizing a variety of solution methods. Prerequisites: Comp Sci 1570 or 1970 or 1971; one course in fluid mechanics. (Co-listed with Mech Eng 5139).

**AERO ENG 5169 Introduction to Hypersonic Flow** (LEC 3.0)

A study of the basic principles of hypersonic flow. Inviscid and viscous hypersonic flow. Application of numerical methods. High temperature flow. Consideration of real gas and rarefied flow. Applications in aerodynamic heating and atmospheric entry. Prerequisites: Aero Eng 3171.

**AERO ENG 5171 V/Stol Aerodynamics** (LEC 3.0)

Basic concepts of V/STOL flight. Take-off transition and landing performance, thrust vectoring. Propeller and helicopter aerodynamics. Unblown and blown flaps. Boundary layer control. Lift fans and ducted propellers. Wing-propeller interaction and thrust augmentation. Prerequisite: Aero Eng 3171.

**AERO ENG 5212 Introduction to Finite Element Analysis** (LEC 3.0)

Variational formulation of the governing equations. Finite element model, interpolation functions, numerical integration, assembly of elements and solution procedures. Applications to solid mechanics, fluid mechanics and heat transfer problems. Two-dimensional problems. Computer implementation and use of commercial finite element codes. Prerequisite: Mech Eng 3708 or Aero Eng 4253 or consent of instructor for majors that do not require either of these courses, or graduate standing. (Co-listed with Mech Eng 5212).

**AERO ENG 5220 Advanced Mechanics of Materials** (LEC 3.0)

Comprehensive insight into mechanics of materials. Topics to include: theories of failure, torsion of noncircular sections, shear flow and shear center, unsymmetric bending, bending of curved members, beams on elastic foundation and pressurization of thick walled cylinders. Prerequisites: Civ Eng 2210, Math 3304. (Co-listed with Mech Eng 5220).

**AERO ENG 5222 Introduction to Solid Mechanics** (LEC 3.0)

Review of basic concepts in continuum mechanics. Finite elasticity: some universal solutions for isotropic materials, application of special mechanical models. Linear elasticity: compatibility, stress functions, superposition, special examples such as extension, torsion, bending, and plane problems. Elements of plasticity. Prerequisite: Eng Mech 5211. (Co-listed with Mech Eng 5222).

**AERO ENG 5229 Smart Materials and Sensors** (LAB 1.0 and LEC 2.0)

Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multi-disciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior standing and Math 3304. (Co-listed with Mech Eng 5229, Elec Eng 5270 and Civ Eng 5118).



**AERO ENG 5234 Stability of Engineering Structures** (LEC 3.0)

Solution of stability problems with applications to columns, plates and shell structures. Torsional and lateral buckling of columns. Buckling under high temperatures. Effect of imperfections introduced by a technological process on stability. Design issues related to stability requirements. Prerequisites: Civ Eng 2210; Math 3304; and Mech Eng 2350 or Mech Eng 2360 or Aero Eng 2360. (Co-listed with Mech Eng 5234).

**AERO ENG 5236 Fracture Mechanics** (LEC 3.0)

Linear elastic and plastic mathematical models for stresses around cracks; concept of stress intensity; strain energy release rates; correlation of models with experiment; determination of plane stress and plane strain parameters; application to design. Prerequisite: Civ Eng 2210. (Co-listed with Mech Eng 5236).

**AERO ENG 5238 Fatigue Analysis** (LEC 3.0)

The mechanism of fatigue, fatigue strength of metals, fracture mechanics, influence of stress conditions on fatigue strength, stress concentrations, surface treatment effects, corrosion fatigue and fretting corrosion, fatigue of joints components and structures, design to prevent fatigue. Prerequisite: Civ Eng 2210. (Co-listed with Mech Eng 5238).

**AERO ENG 5282 Introduction to Composite Materials & Structures** (LEC 3.0)

Introduction to fiber-reinforced composite materials and structures with emphasis on analysis and design. Composite micromechanics, lamination theory and failure criteria. Design procedures for structures made of composite materials. An overview of fabrication and experimental characterization. Prerequisite: Civ Eng 2210. (Co-listed with Mech Eng 5282).

**AERO ENG 5307 Vibrations I** (LEC 3.0)

Equations of motion, free and forced vibration of single degree of freedom systems. Natural frequencies, resonance, modes of vibration and energy dissipation are studied. The vibration of continuous systems is introduced. Prerequisites: Mech Eng 3411 and 3313, or Aero Eng 3613 and Math 3304. (Co-listed with Mech Eng 5307).

**AERO ENG 5309 Engineering Acoustics I** (LEC 3.0)

Introduction to acoustical theory and measurement with emphasis on mechanical and aerospace engineering applications. Plane and spherical wave propagation, resonators and filters, absorption, room acoustics, human response to noise, noise legislation, noise control. Use of common instrumentation in several projects. Prerequisites: Mech Eng 3411 & 3313, or Aero Eng 3613 & Math 3304. (Co-listed with Mech Eng 5309).

**AERO ENG 5313 Intermediate Dynamics of Mechanical and Aerospace Systems** (LEC 3.0)

Principles of dynamics are applied to problems in the design of mechanical and aerospace systems; basic concepts in kinematics and dynamics; dynamics of systems of particles; dynamics of rigid bodies, three-dimensional effects in machine elements; dynamic stability, theory and applications; methods of analytical dynamics. Prerequisite: Mech Eng 3313 or Aero Eng 3613. (Co-listed with Mech Eng 5313).

**AERO ENG 5353 Aeroelasticity** (LEC 3.0)

Study of phenomena involving interactions among inertial, aerodynamic, and elastic forces and the influence of these interactions on aircraft and space vehicle design. Some aeroelastic phenomena are: divergence, control effectiveness, control reversal, flutter, buffeting, dynamic response to rapidly applied loads, aeroelastic effects on load distribution, and static and dynamic stability. Prerequisites: Aero Eng 3251 and 3171.

**AERO ENG 5361 Flight Dynamics-Stability And Control** (LEC 3.0)

Review of static stability, dynamic equations of motion, linearized solutions, classical control design and analysis techniques, introduction to modern control. Prerequisite: Aero Eng 3361.

**AERO ENG 5449 Robotic Manipulators and Mechanisms** (LEC 2.0 and LAB 1.0)

Overview of industrial applications, manipulator systems and geometry. Manipulator kinematics; hand location, velocity and acceleration. Basic formulation of manipulator dynamics and control. Introduction to machine vision. Projects include robot programming, vision-aided inspection and guidance, and system integration. Prerequisites: Mech Eng 3313; Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972 or Comp Sci 1570. (Co-listed with Mech Eng 5449).

**AERO ENG 5478 Mechatronics** (LEC 2.0 and LAB 1.0)

This course will introduce students to the basics of mechatronics (i.e., the integration of mechanical, electrical, computer, and control systems). Students will learn the fundamentals of sensors and actuators for mechanical systems, computer interfacing, microcontrollers, real-time software, and control. Prerequisite: Mech Eng 4479 or equivalent. (Co-listed with Mech Eng 5478, Elec Eng 5870 and Comp Eng 5820).

**AERO ENG 5481 Mechanical and Aerospace Control Systems** (LEC 3.0)

Synthesis of mechanical and aerospace systems to perform specific control functions. Response and stability are studied. Singular value analysis for stability margins is introduced. Prerequisite: Mech Eng 4479 or Aero Eng 3361. (Co-listed with Mech Eng 5481).

**AERO ENG 5519 Advanced Thermodynamics** (LEC 3.0)

After a short review of classical thermodynamics, the elements of chemical reactions, chemical equilibrium, statistical thermodynamics, and the basic concepts of kinetic theory are presented. Prerequisite: Mech Eng 2519. (Co-listed with Mech Eng 5519).

**AERO ENG 5525 Intermediate Heat Transfer** (LEC 3.0)

Analytical study of conduction; theory of thermal radiation and applications; energy and momentum equations in convective heat transfer and review of empirical relations. Current topics are included. Prerequisite: Mech Eng 3525. (Co-listed with Mech Eng 5525).

**AERO ENG 5527 Combustion Processes** (LEC 3.0)

Application of chemical, thermodynamic, and gas dynamic principles to the combustion of solid, liquid, and gaseous fuels. Includes stoichiometry, thermochemistry, reaction mechanism, reaction velocity, temperature levels, and combustion waves. Prerequisite: Mech Eng 3521. (Co-listed with Mech Eng 5527).

**AERO ENG 5535 Aerospace Propulsion Systems** (LEC 3.0)

Study of atmospheric and space propulsion systems with emphasis on topics of particular current interest. Mission analysis in space as it affects the propulsion system. Power generation in space including direct and indirect energy conversion schemes. Prerequisite: Aero Eng 4535.

**AERO ENG 5570 Plasma Physics I** (LEC 3.0)

Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Mech Eng 5570, Nuc Eng 4370, Physics 4543).

**AERO ENG 5614 Spaceflight Mechanics** (LEC 3.0)

Further topics in orbital mechanics. Time equations, Lambert's problem, patched-conic method, orbital maneuvers, orbit determination, orbit design, re-entry problem. Prerequisite: Aero Eng 3613.

**AERO ENG 5715 Concurrent Engineering** (LEC 3.0)

Students will be introduced to the concurrent engineering approach to product development. They will learn to set up quantitative requirements and then use a quantitative rating process to identify the critical requirements relating to the desired product. The interaction between design, manufacturing, assembly, cost, and supportability will be covered. The students will form teams and practice the concurrent engineering process for simple products. Prerequisites: Mech Eng 3313 or Aero Eng 3131 and Civ Eng 2210 (Co-listed with Mech Eng 5715).

**AERO ENG 5758 Integrated Product Development** (LAB 1.0 and LEC 2.0)

Students in design teams will simulate the industrial concurrent engineering development process. Areas covered will be design, manufacturing, assembly, cost, and product support. Using a 3-D solid modeling program, students will design, analyze, and send the data base to the automated machine shop where the parts will be manufactured. The parts will then be assembled, tested and analyzed for their performance. Prerequisites: Aero Eng 3251 or Mech Eng 3708 for Design; Mech Eng 3313 for Assembly; Accompanied or preceded by Mech Eng 5653 for Manufacturing; Eng Mgt 5711 or 5714 for Cost/Product Support.

**AERO ENG 5760 Probabilistic Engineering Design** (LEC 3.0)

The course deals with uncertainties in engineering analysis and design at three levels - uncertainty modeling, uncertainty analysis, and design under uncertainty. It covers physics-based reliability analysis and reliability-based design, robustness assessment and robust design, their integration with design simulations, and their engineering applications. Prerequisite: Mech Eng 3708 or Aero Eng 3361. (Co-listed with Mech Eng 5760).

**AERO ENG 5830 Applied Computational Methods** (LEC 3.0)

Detailed study of computational methods for efficient solution of selected fluids, structures, thermodynamics, and controls problems in aerospace and mechanical engineering. Besides basic numerical techniques, topics covered include gradient-based optimization and uncertainty quantification. Prerequisite: Comp Sci 1570 or 1970 or 1981; Math 3304. (Co-listed with Mech Eng 5830).

## Architectural Engineering (ARCH ENG)

**ARCH ENG 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ARCH ENG 2002 Cooperative Engineering Training** (IND 1.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation.

**ARCH ENG 2003 Engineering Communications and Computations** (LEC 2.0 and LAB 1.0)

Programming and software tools (including computer aided design and drafting, computer-based mathematics, word processing, spreadsheet, and presentation software) with application to and emphasis on written, graphical, and oral communication in professional civil and architectural engineering practice. (Co-listed with Civ Eng 2003).

**ARCH ENG 2103 Architectural Materials And Methods Of Construction** (LAB 1.0 and LEC 2.0)

A study of the origin and properties of construction materials, methods of construction, and installation. Materials include mineral based, wood, steel, concrete, masonry, asphalt, and gypsum as components of architectural engineering. Prerequisites: Chem 1310, Chem 1319 and Sophomore standing.

**ARCH ENG 2803 Architectural Design I** (LEC 1.0 and LAB 2.0)

Introduction to the interaction between architecture and the engineering disciplines. Theories of building and site design, technology as an integral component of design, plan and spatial organization, structural clarity, formal composition, and environmental context are considered as principle form determinants. Prerequisite: Sophomore standing.

**ARCH ENG 3000 Special Problems** (IND 1.0-6.0)

(Variable) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ARCH ENG 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ARCH ENG 3201 Structural Analysis I** (LAB 1.0 and LEC 2.0)

Loads on Structures. Analysis of statically determinate and indeterminate beams, frames and trusses. Influence lines and moving loads. Computation of deflections. Development and use of theorems of displacement methods including slope-deflection and moment distribution to analyze statically indeterminate structures. Computer solutions. Prerequisites: Civ Eng 2200, Civ Eng 2210 each with a grade of "C" or better. (Co-listed with Civ Eng 3201).

**ARCH ENG 3210 Structural Design in Metals** (LEC 2.0 and LAB 1.0)

The analysis and design of structural elements and connections for buildings, bridges and specialized structures utilizing structural metals. Both elastic and plastic designs are considered. Prerequisite: Arch Eng 3201 with grade of "C" or better. (Co-listed with Civ Eng 3210).

**ARCH ENG 3220 Reinforced Concrete Design** (LAB 1.0 and LEC 2.0)

The analysis and design of reinforced concrete beams, slabs, columns, retaining walls and footings by the elastic and ultimate strength methods including and introduction to the design of prestressed concrete. Introduction to use of computers as a design aid tool. Prerequisite: Arch Eng 3201 with grade of "C" or better. (Co-listed with Civ Eng 3220).

**ARCH ENG 3803 Building Electrical Systems** (LEC 3.0)

The design of interior and exterior building electrical systems, including power loads, branch circuits and switching. Work includes study of applicable NFPA 70 (NEC) and related building codes. Prerequisites: Math 3304 and Physics 2135.

**ARCH ENG 3804 Architectural Design II** (LAB 2.0 and LEC 1.0)

A continuation of Architectural Engineering Design I with an increased focus on problems and models associated with detail development, principles of acoustic design and building construction as a form determinant. Prerequisite: Art 3203.

**ARCH ENG 3805 Building Lighting Systems** (LEC 3.0)

Design and specifications for interior and exterior building illumination systems. Work includes study of applicable NFPA 70 (NEC) and related building codes. Prerequisites: Arch Eng 3803 and Arch Eng 3804.

**ARCH ENG 4010 Senior Seminar: Engineering In A Global Society** (RSD 1.0)

Discussion of contemporary issues: public safety, health, and welfare; the principles of sustainable development; lifelong learning; impact of engineering solutions in a global and societal and political context; relationships with owners, contractors, and the public; public service; the Code of Ethics; and the Missouri licensing Statutes and Board Rules. Prerequisite: Senior standing. (Co-listed with Civ Eng and Env Eng 4010).

**ARCH ENG 4097 Senior Design Project** (LEC 3.0)

Open-ended building design project involving one or more areas of engineering. Planning design projects, philosophy of design, and the application of engineering principles to design problems. Prerequisite: Arch Eng 4448 or Civ Eng 4448. (Co-listed with Civ Eng 4097 and Env Eng 4097).

**ARCH ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged by instructor.

**ARCH ENG 4447 Ethical, Legal and Professional Engineering Practice** (LEC 2.0)

Discussions of law concerning contracts, torts, agencies, real property, partnerships and corporations. The purposes and implications of the engineering registration law, the effect of legal, ethical and marketing considerations of the practice of Architectural Engineering. Prerequisite: Junior standing. (Co-listed with Civ Eng 4447).

**ARCH ENG 4448 Fundamentals Of Contracts And Construction Engineering** (LEC 3.0)

A study of the concepts and techniques used in large construction projects for the preparation of engineer service contracts, the development of a project manual, detailed and conceptual cost estimating, and construction scheduling analysis. Prerequisite: Senior Standing. (Co-listed with Civ Eng 4448).

**ARCH ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ARCH ENG 5001 Special Topics** (LAB 1.0 and LEC 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ARCH ENG 5203 Applied Mechanics In Structural Engineering** (LEC 3.0)

A study of basic relationships involved in the mechanics of structures. Topic include basic elasticity, failure criteria, fundamental theories of bending and buckling of plates and cylindrical shells for practical application in analysis and design of bridge building floors and shell roofs. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Civ Eng 5203).

**ARCH ENG 5205 Structural Analysis II** (LEC 3.0)

Classical displacement and force methods applied to structures of advanced design. Analysis of indeterminate structures such as continuous beams, arches, cables, and two and three dimensional frames, and trusses. Analysis of indeterminate structures involving temperature and support settlements effects. Prerequisites: Civ Eng 3201 or Arch Eng 3201. (Co-listed with Civ Eng 5205).

**ARCH ENG 5206 Low-Rise Building Analysis And Design** (LEC 3.0)

Characterization of various design loads, load combinations, general methodology of structural designs against lateral loads, code-oriented design procedures, distribution of lateral loads in structural systems, application of the International Building Code in design of loadbearing wall systems, building frame system and moment-resisting frame systems. Prerequisite: Preceded and/or accompanied by Civ -Arch Eng 3210 or Civ-Arch Eng 3220. (Co-listed with Civ Eng 5206).

**ARCH ENG 5207 Computer Methods of Structural Analysis** (LEC 3.0)

Force and displacement matrix methods and computer methods applied to structural analysis. Analysis of indeterminate structures such as continuous beams, and two and three dimensional frames and trusses. Analysis of indeterminate structures involving temperature and support settlements effects using computer methods formulation. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Civ Eng 5207).

**ARCH ENG 5208 Structural Dynamics** (LEC 3.0)

This course deals with fundamental concepts and structural responses under dynamic loads. Hand calculations and computer methods are developed. Specific topics include resonance, beating phenomenon, equation of motion, dynamic properties, frequencies and mode shapes, and modal and Ritz analyses. Prerequisites: Mech Eng 2350 or equivalent; Civ/Arch Eng 3201 or equivalent. (Co-listed with Civ Eng 5208).

**ARCH ENG 5210 Advanced Steel Structures Design** (LEC 3.0)

The design of structural steel systems into a final integrated structure. Plate girders, composite systems, stability, connections, rigid frames, single and multistory buildings, and similar type problems of interest to the student. Use of the computer as a tool aid in the design will be emphasized. Prerequisite: Arch Eng 3210 with a grade of "C" or better. (Co-listed with Civ Eng 5210).

**ARCH ENG 5220 Advanced Concrete Structures Design** (LEC 3.0)

The design of structural concrete systems into a final integrated structure. Two-way slabs, long columns, connections, and discontinuity regions, deflections and cracking of beams and slabs, ACI design criteria, and similar type problems of interest to the student. Use of the computer as a tool to aid in the design will be emphasized. Prerequisite: Arch Eng 3220 with a grade of "C" or better. (Co-listed with Civ Eng 5220).

**ARCH ENG 5222 Prestressed Concrete Design** (LEC 3.0)

Behavior of steel and concrete under sustained load. Analysis and design of pre-tensioned and post-tensioned reinforced concrete members and the combining of such members into an integral structure. Prerequisite: Arch Eng 3220 with a grade of "C" or better. (Co-listed with Civ Eng 5222).

**ARCH ENG 5231 Infrastructure Strengthening with Composites** (LEC 3.0)

The course presents composite materials and includes principles of reinforcing and strengthening for flexure, shear, and ductility enhancement in buildings and bridges. It covers the design of existing members strengthened with externally bonded laminates and near surface mounted composites. Case studies are discussed. Prerequisites: Arch Eng / Civ Eng 3201, Arch Eng / Civ Eng 3220. (Co-listed with Civ Eng 5231).

**ARCH ENG 5260 Analysis And Design Of Wood Structures** (LEC 3.0)

A critical review of theory and practice in design of modern wood structures. Effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design; development of design criteria and their application to plane and three dimensional structures. Prerequisite: Arch Eng 3201 with a grade of "C" or better. (Co-listed with Civ Eng 5260).

**ARCH ENG 5270 Structural Masonry Design** (LEC 3.0)

Review of the theory and practice of analyzing low-rise masonry structures, materials and assembly types, constructability considerations, structural masonry components, repair and strengthening, and model code requirements to ensure adequate load resisting buildings. Prerequisites: Arch Eng 3201 or Civ Eng 3201. (Co-listed with Civ Eng 5270).

**ARCH ENG 5442 Construction Planning and Scheduling Strategies** (LEC 3.0)

The goal of this course is to assist participants in gaining an understanding of schedule control techniques and the application of tools such as Primavera Software. Content areas to be addressed include: development of baseline schedules, progress monitoring and updating, recovery schedules, resource application and leveling. Prerequisite: Civ Eng or Arch Eng 4448. (Co-listed with Civ Eng 5442).

**ARCH ENG 5445 Construction Methods** (LEC 3.0)

Introduction to construction planning selection of equipment and familiarization with standard methods for horizontal and vertical construction. Application of network analysis and schedules to project control. Prerequisite: Arch Eng 4448 with a grade of "C" or better. (Co-listed with Civ Eng 5445).

**ARCH ENG 5446 Management Of Construction Costs** (LEC 3.0)

Management of construction projects from inception to completion: estimates, role of network preplanning, project monitoring and control. Prerequisite: Arch Eng 4448 with a grade of "C" or better. (Co-listed with Civ Eng 5446).

**ARCH ENG 5448 Green Engineering: Analysis of Constructed Facilities** (LEC 3.0)

Environmentally sound design and construction practices. Includes design issues, material selection and site issues that can reduce the impact on the environment caused by the construction process. LEED certification covered in depth. Prerequisites: Civ Eng 4448 or Arch Eng 4448; and Junior Standing. (Co-listed with Civ Eng 5448).

**ARCH ENG 5449 Engineering and Construction Contract Specifications** (LEC 3.0)

Legal and business aspects of contracts and contracting procedure in the construction industry. Topics include formulation of contracts in common law, engineering services contracts, and construction project contract documents and contract administration issues. Prerequisite: Arch Eng 4448 with a grade of "C" or better. (Co-listed with Civ Eng 5449).

**ARCH ENG 5642 Sustainability, Population, Energy, Water, and Materials** (LEC 3.0)

This course will examine the concepts regarding the continued advancement of humankind while maintaining our ecological niche on earth. Key topics include: population growth, poverty, and impacts of development; energy consumption, sources, storage, conservation and policy; water quality and quantity; materials and building; and policy implications. Prerequisite: Senior or graduate standing. (Co-listed with Env Eng 5642 and Civ Eng 5642).

**ARCH ENG 5665 Indoor Air Pollution** (LEC 3.0)

By developing a practical understanding of indoor air pollution sources, physics, chemistry and consequences, students will learn how radon, cigarette smoke, VOCs from furnishings, and so forth affect indoor air quality and apply engineering analyses to specify ventilation rates, choose furnishings and minimize occupant exposure to pollutants. Prerequisite: Civ Eng 2601 or Mech Eng 5571 or Graduate Status. (Co-listed with Civ Eng 5665 and Env Eng 5665).

**ARCH ENG 5729 Foundation Engineering II** (LEC 3.0)

Classical earth pressure theories. Analysis of shallow and deep foundations to include bearing capacity and settlement of footings, rafts, piles, and drilled piers. Analysis of stability and design of retaining walls and anchored bulkheads. Prerequisites: Civ Eng 4729 with a grade of "C" or better. (Co-listed with Civ Eng 5729).

**ARCH ENG 5850 Residential Renewable Energy Systems** (LAB 1.0 and LEC 2.0)

Applications of renewable energy systems for residential use will be covered, including system selection and sizing. Economic and life cycle analysis will be used to evaluate solar, geothermal and wind power systems. Prerequisites: Senior standing and consent of instructor, or Mech Eng 2527 or Civ Eng 3842.

**ARCH ENG 5872 Environmental Controls** (LEC 3.0)

Theory and applications of principles of heating, ventilating, and air conditioning equipment and systems; design problems. Physiological and psychological factors relating to environmental control. Prerequisites: Mech Eng 3521 and accompanied or preceded by Mech Eng 3525; or Mech Eng 2527 and Civ Eng 3330. (Co-listed with Mech Eng 5571).

## Art (ART)

**ART 1120 Drawing I** (LEC 3.0)

Principles of drawing: placement, proportion, perspective, chiaroscuro, values, line, form, texture, and techniques. Applied problems to develop perceptual observation.

**ART 1140 Painting I** (LEC 3.0)

Basic exploration of acrylic and water color painting techniques and methods. Still life, landscape and figure.

**ART 1164 Sculpture** (LEC 3.0)

Solving problems in shallow and BAS relief and small clay sculpture, study of contemporary and classical proportion, faux bronze and plaster casting.

**ART 1180 Art Appreciation** (LEC 3.0)

A basic introductory course designed to familiarize students who have little or no knowledge of the arts with fundamental knowledge necessary for intelligent approach to experiencing the visual arts; painting, sculpture, and architecture.

**ART 1185 Study Of Film** (LEC 2.0 and LAB 1.0)

A study of classic and contemporary films with emphasis on director's technique and philosophy. Films by Fellini, Antonioni plus Bergman, Chaplin, etc. will be viewed and discussed. \$30 lab fee required.

**ART 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ART 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ART 2130 Advanced Drawing** (LEC 3.0)

Advanced application of drawing principles: cast and life drawing. Exercises in representational rendering. Prerequisite: Art 1120.

**ART 2150 Advanced Painting** (LEC 3.0)

Advanced exploration of oil painting techniques and methods. Still life, landscape, and figure. Prerequisite: Art 1140.



**ART 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ART 3001 Special Topics** (LEC 1.5 and LAB 1.5)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ART 3100 Advanced Art Studio** (LAB 1.5 and LEC 1.5)

This course is for the advanced student in Sculpture, Painting or Drawing with similar topics in various chosen mediums. Prerequisites: Art 1120, Art 1140, or Art 1164.

**ART 3203 Architectural Design I** (LEC 1.0 and LAB 2.0)

Introduction to the interaction between architecture and art. A series focused on the history of architecture as it relates to styles and functions. Theories of building and site design, plan and spatial organization, formal composition, and environmental context are considered as principle form determinants. Prerequisite: Sophomore standing.

**ART 3219 Art For Elementary Teachers** (LEC 3.0)

Considers the vital role of art activities and creative experiences in the growth and development of children at their level. Prerequisite: Educ 1040. (Co-listed with Educ 2219).

**ART 3221 Fundamentals in Photography** (LEC 3.0)

In this course the student will learn the basics of photographic composition and the use of the digital camera. A brief history of photography will provide context for the student's own development. Prerequisite: Art 1180 or Art 1185 (required for Art minor credit) or Sp&M S 1185 or Sp&M S 2181 (required for Speech minor credit). (Co-listed with Sp&M S 3221).

**ART 3222 Revolution And Romanticism In The Arts 1785 - 1832** (LEC 3.0)

This course will investigate the great revolution of thought, perception, language, through art during the period between 1785 and 1832. Artists, writers, and musicians to be studied include: Blake, David, Wordsworth, and Beethoven. The role of art and artists to the French Revolution will be stressed. Prerequisite: Introductory level Art or History course.

**ART 3245 Thomas Hart Benton And The Tradition Of American Art** (LEC 3.0)

Missouri artist Tom Benton lived amidst controversy and acclaim from the 1920's to the 1970's. The American tradition from which Benton grew will be studied, then his own work and his subsequent influence. Prerequisite: Art 1185 or Art 1180.

**ART 3250 Thematic Studies In Film & Literature** (LEC 3.0)

Different thematic relationships between film & literature (e.g., Poe & Hitchcock, Shakespeare on Film, etc.) will be studied. Prerequisite: Art 1185.

**ART 3260 Exploring Digital Art** (LEC 1.5 and LAB 1.5)

An exploration of digital art as a medium for making art as well as understanding visual culture from the past, present, and ideas for the future. A multidisciplinary approach will combine digital arts with design thinking and humanities in a creative and scholarly atmosphere.

**ART 3275 Foundations of Media Communication** (LEC 3.0)

The course explores the historical, social, and psychological impact of media through study and practice of academic and non-academic theories of effective media communication. The course supplies an integrated critical framework for application in student's day-to-day consumption of media. Prerequisite: Sp&M S 1185. (Co-listed with Sp&M S 3275).

**ART 3276 Thematics Studies in Film and Philosophy** (LEC 3.0)

A study of special topics at the intersection of film and philosophy. Topics vary but may include films on the nature of reality, films on the problem of evil, films on concepts of consciousness and the self, and more. Prerequisites: Art 1185 or one philosophy course, or junior standing. (Co-listed with Philos 3276).

**ART 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ART 4001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ART 4320 French and Francophone Cinema** (LEC 3.0)

A survey of French and Francophone cinema. Prerequisites: French 2170 (Co-listed with French 4320).

## Biological Sciences (BIO SCI)

**BIO SCI 1001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**BIO SCI 1103 Microbes And Man -- Introductory Microbiology** (LEC 3.0)

An introduction to the study of microorganisms in nature, especially as they affect humans. Consideration of the involvement of microorganisms in disease, decomposition, nutrition, agriculture, food processing and preservation, industrial applications and waste treatment.

**BIO SCI 1113 General Biology** (LEC 3.0)

A comprehensive study of the general principles of the biology of plants, animals, and protists including population biology and regulation mechanisms. Prerequisite: Entrance requirements.

**BIO SCI 1163 Biotechnology in Film** (LEC 3.0)

Popular films that use biology-based plots influence society by disseminating facts and providing misinformation. Popular movies serve as the basis for discussing the biotechnology behind popular movie plots and examining the relationship between public perceptions and biotechnology.

**BIO SCI 1173 Introduction to Environmental Sciences** (LEC 3.0)

An introduction to environmental science, with an emphasis on biological aspects of current environmental problems. Topics range from chemical toxicity to global climate change. Environmental challenges facing local species and ecosystems will be emphasized.

**BIO SCI 1201 Biological Sciences Freshman Seminar** (RSD 1.0)

An introduction to the study of biology at Missouri S&T. Students will consider personal and professional opportunities within the various areas of biology and become acquainted with Biological Sciences faculty and departmental and campus facilities. Required of freshman Biological Sciences majors. Prerequisite: Biological Sciences majors only.

**BIO SCI 1213 Principles of Biology** (LEC 3.0)

A comprehensive study of the general principles of the biology of plants, animals, and protists including population biology and regulation mechanisms. An in-depth study of the fundamental principles governing all living organisms from the molecular to the population level. Required for Biological Sciences majors. Cannot also receive credit for Bio Sci 1113. Prerequisite: Biological Science majors only.

**BIO SCI 1219 General Biology Lab** (LEC 1.0 and LAB 1.0)

The laboratory work accompanying general biology consists of experiments designed to supplement and extend lectures in General Biology and Principles of Biology. Prerequisite: Preceded or accompanied by either Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 1223 Biodiversity** (LEC 3.0)

This course provides a survey of all life, but emphasizes diversity of eukaryotes including protists, fungi, plants, and animals. Emphasis is on form, function, ecology, and evolution of plants and animals and other organisms.

**BIO SCI 1229 Biodiversity Lab** (LAB 1.0)

This lab course is designed to accompany instruction in the Biodiversity class. Lab and field explorations of the varieties of life, with an emphasis is on form, function, ecology, and evolution of plants and animals and other organisms. Prerequisite: Preceded or accompanied by Biodiversity (Bio Sci 1223).

**BIO SCI 1943 Introduction to Human Anatomy and Physiology I** (LEC 3.0)

First semester of a two-semester sequence dealing with the structure and function of human organ systems. Includes the study of cells, tissues, and the integumentary, skeletal, muscular and nervous systems. Prerequisite: Any high school or college Biology course.

**BIO SCI 1953 Introduction to Human Anatomy and Physiology II** (LEC 3.0)

Second semester of a two-semester sequence of the study of the structure and function of human organ systems, including the endocrine, cardiovascular, lymphatic, respiratory, digestive, urinary and reproductive systems. Prerequisite: Bio Sci 1943.

**BIO SCI 1983 Introduction to Biological Design and Innovation** (LAB 3.0)

Students will identify problems in biomedical sciences, and then design and implement innovative solutions using advanced techniques. Students will present and defend their proposals and results. Prerequisite: Bio Sci 1993.

**BIO SCI 1993 Introduction to Biomedical Problems** (LEC 3.0)

Problem based learning approach to issues in medical science. Students will work in groups and individually to answer problems related to diagnostic testing and evaluation of diseases and other medical conditions. Prerequisite: Bio Sci 1953.

**BIO SCI 2001 Special Topics** (LEC 1.0 and LAB 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**BIO SCI 2213 Cell Biology** (LEC 3.0)

The structure and function of eukaryotic and prokaryotic cells. Emphasis on macromolecules, organelles, metabolic pathways, bioenergetics, cell signaling, the cell cycle, and gene expression. Prerequisites: Preceded or accompanied by CHEM 1320.

**BIO SCI 2219 Cell Biology Laboratory** (LAB 1.0)

Laboratory course to accompany Cell Biology (Bio Sci 2213). Laboratory work includes microscopy, biochemical assays, enzymology, and genetic analysis (PCR, mapping, electrophoresis, transfection, sequencing). Prerequisite: Preceded or accompanied by Bio Sci 2213.

**BIO SCI 2223 General Genetics** (LEC 3.0)

The study of the principles of heredity and reasons for variation in living organisms. Includes Mendelian principles, molecular, population, and evolutionary genetics with examples from a diverse array of species. Prerequisite: Bio Sci 1113 or 1213.

**BIO SCI 2233 Evolution** (LEC 3.0)

A survey of the genetic and environmental mechanisms associated with organic evolution.

**BIO SCI 2242 Cave Biology** (LAB 1.0 and LEC 1.0)

In Cave Biology, we will study cave organisms and cave ecosystems. We will cover such topics as growth of speleothems, caves as a natural laboratory, behavior of cave animals, and regressive characteristics of cave species. We will investigate the relationship between Karst topography (caves, springs, sinkholes) and underground water contamination. Prerequisites: Any Geology, Environmental Engineering, or Biological Sciences class except Bio Sci 1201.

**BIO SCI 2243 Sleep: Function and Dysfunction** (LEC 3.0)

Students will learn the genes, proteins, and anatomy that govern sleep regulation. The course will also cover how sleep deprivation changes the body and degrades health and performance as well as sleep disorders that may disrupt sleep. Prerequisite: Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 2252 Vegetation of the Ozarks** (LEC 1.0 and LAB 1.0)

The Vegetation of the Ozarks class is an intense, outdoor educational experience focusing on the plants and plant communities of the Missouri Ozarks. The five day long course teaches participants to identify much of the flora of the region and provides practice and instruction in the use of dichotomous keys for plant identification. Prerequisites: Bio Sci 1213 or Bio Sci 1113.

**BIO SCI 2263 Ecology** (LEC 3.0)

Relationships between organisms and the environment. Topics include the influence of environmental factors on individual organisms, population dynamics, interspecific associations, and entire ecosystems. Prerequisite: Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 2264 Field Ecology** (LEC 1.0 and LAB 1.0)

Field-based class designed to teach students applications of ecological research. Students will study distribution and abundance of organisms in aquatic and terrestrial systems in the Ozarks. Class includes lectures and field sampling in the Rolla area. Prerequisite: Any Bio Sci course.

**BIO SCI 2333 Nutrition** (LEC 3.0)

This introductory course provides an overview of the principles of nutritional science. Topics include the description and functions of nutrients, how nutrients are digested and absorbed, effects of nutrient imbalances, food sources, nutrient interactions, dietary guidelines, and the role of nutrition in weight management, health and disease. Prerequisites: Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 2353 Zoology** (LEC 3.0)

Survey class that explores the diversity of animal life. Emphasis on the morphology, physiology, development, ecology, and phylogeny of animals and protozoans.

**BIO SCI 2359 Zoology Laboratory** (LAB 1.0)

Bio Sci 2359 is designed to accompany Bio Sci 2353 and consists of laboratory and field explorations of the diversity of animal life. Prerequisite: Preceded or accompanied by Bio Sci 2353.

**BIO SCI 2372 Issues in Public Health** (LEC 3.0)

Issues in Public Health investigates chronic and infectious diseases and the impact of globalization on such diseases, environmental toxins, and controversies in public health. Students will develop an awareness of current public health issues and trends in order to make informed arguments and personal choices. Prerequisite: Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 2383 Plant Biology** (LEC 3.0)

An intermediate class covering plant form and function. Topics include the cellular structures unique to plants, their life cycles, and the mechanisms they use to survive, reproduce, and convert solar energy into a form usable by all other organisms. Prerequisite: Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 2389 Plant Biology Laboratory** (LAB 1.0)

Bio Sci 2389 is designed to accompany Bio Sci 2383 and consists of experiments that will supplement and extend the lectures in Bio Sci 2383. Among the topics to be covered are photosynthesis, diversity, respiration, anatomy and development, hormones, and transpiration. Prerequisites: Bio Sci 1219, preceded or accompanied by Bio Sci 2383.

**BIO SCI 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**BIO SCI 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**BIO SCI 3110 Introduction to Biomedical Engineering** (LEC 3.0)

This course will provide an introduction to the interdisciplinary field of biomedical engineering. The molecular, cellular, physiological and engineering principles that govern the field will be covered. Applications will include biomaterials, tissue engineering, biomechanics, bioimaging, bioinstrumentation, bio-nanotechnology and artificial organs. Prerequisite: Junior standing or above. (Co-listed with Cer Eng 3110 and Chem Eng 3210).

**BIO SCI 3313 Microbiology** (LEC 3.0)

General introduction to the culture and study of microorganisms, their physiology, structure, and contribution to biology. Prerequisite: Chem 1320.

**BIO SCI 3319 Microbiology Lab** (LAB 2.0)

General introduction to the techniques used for the culture and identification of microorganisms, their physiology, structure, and contribution to biology. Prerequisite: Preceded or accompanied by Bio Sci 3313.

**BIO SCI 3333 Human Anatomy and Physiology I** (LEC 3.0)

First semester of a two-semester sequence dealing with the structure and function of human organ systems. Includes the study of cells, tissues, and the integumentary, skeletal, muscular and nervous systems. Prerequisites: BIO SCI 1113 or BIO SCI 1213; BIO SCI 2213.

**BIO SCI 3339 Human Anatomy Physiology I Lab** (LAB 1.0)

Laboratory accompanying Human Anatomy and Physiology I (Bio Sci 3333). This course may be taken separately at a later date. Prerequisite: Preceded or accompanied by Bio Sci 3333.

**BIO SCI 3343 Human Anatomy and Physiology II** (LEC 3.0)

Second semester of a two-semester sequence of the study of the structure and function of human organ systems, including the endocrine, cardiovascular, lymphatic, respiratory, digestive, urinary and reproductive systems. Prerequisites: BIO SCI 1113 or BIO SCI 1213; BIO SCI 2213.

**BIO SCI 3349 Human Anatomy and Physiology II Laboratory** (LAB 1.0)

Laboratory accompanying Human Anatomy and Physiology II (Bio Sci 3343). This course may be taken separately at a later date. Prerequisite: Preceded or accompanied by Bio Sci 3343.

**BIO SCI 3483 Biomedical Problems** (LEC 3.0)

This course will use a problem-based learning approach to examine biological aspects of various medical conditions. Students will work in groups and individually to answer problems related to diagnostic testing and evaluation of diseases and other medical conditions. Prerequisites: Bio Sci 3333 or 3343.

**BIO SCI 3783 Biological Design and Innovation I** (LAB 3.0)

Students identify significant problems in biological/biomedical sciences, and then design and implement innovative solutions using advanced techniques. Students present and defend proposals and results. Prerequisite: At least two 2000 level or higher Biology courses.

**BIO SCI 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**BIO SCI 4010 Seminar** (RSD 1.0)

Students will work in groups to propose, research, develop, complete, and present service-learning projects that are related to the biological sciences. Prerequisites: Senior standing.

**BIO SCI 4099 Undergraduate Research** (IND 1.0-3.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours for graduation credit. Subject and credit to be arranged with the instructor. Prerequisite: Consent of instructor.

**BIO SCI 4313 Introduction to Environmental Microbiology** (LEC 3.0)

Environmental Microbiology is an interdisciplinary study of how microorganisms can impact humans and applied to solve problems such as water treatment and environmental cleanup of contaminants. This course differs from Bio Sci 6313 as no NSF-style report or presentation is required. Prerequisite: Bio Sci 3313.

**BIO SCI 4323 Molecular Genetics** (LEC 3.0)

A study of the properties and functions of DNA that make this macromolecule unique in the universe. Examples of replication, transcription, translation, repair, and regulation will be examined in viruses, prokaryotes, and eukaryotes. Prerequisites: Bio Sci 2223 and Bio Sci 2213.

**BIO SCI 4329 Molecular Genetics Laboratory** (LAB 2.0)

This course provides experience in the use of a variety of DNA manipulation techniques that are common to molecular studies. These include DNA extraction, restriction mapping, Southern blotting, recombinant plasmid construction, DNA sequencing and analysis, and polymerase chain reaction. Prerequisite: Preceded or accompanied by Bio Sci 4323.

**BIO SCI 4333 Exercise Physiology** (LEC 3.0)

Covers cardiovascular, pulmonary, and metabolic responses to aerobic and anaerobic muscular activities, work capacities, nutritional factors in performance, and role of exercise in health. Prerequisite: Bio Sci 1113 or Bio Sci 1213.

**BIO SCI 4343 Comparative Chordate Anatomy** (LEC 2.0 and LAB 2.0)

An integrated, comparative study of chordate structures and systems, with emphasis on evolution, development and function. Includes examination of gross anatomy and histology of selected forms. Prerequisites: Bio Sci 1223, Bio Sci 1229.

**BIO SCI 4353 Cancer Cell Biology** (LEC 3.0)

Advanced biology course examining cellular processes that go awry during tumorigenesis. We will discuss cell cycle controls, signal transduction pathways, DNA repair, telomerase, apoptosis, cell migration and adhesion that are altered in cancer cells. Prerequisite: Bio Sci 2213.

**BIO SCI 4363 Freshwater Ecology** (LEC 3.0)

The ecology of streams, lakes, and wetlands. The course will cover the physical and chemical characteristics of freshwater environments, the diversity of life in freshwaters, biogeochemical processes, and threats to freshwater systems. Prerequisite: Bio Sci 2263.

**BIO SCI 4383 Toxicology** (LEC 3.0)

A study of natural and man-made toxicants, various possible routes of exposure, absorption, distribution, biotransformation, specific target sites, and mechanisms involved in elicitation of toxic effects, as well as detoxification and excretion. Prerequisites: Bio Sci 2213, Bio Sci 2223, at least Junior standing.

**BIO SCI 4393 Immunology** (LEC 3.0)

A study of the principles of immunology, including biological and biochemical aspects of the immune response, immunochemistry, serology, immunoglobulin and T-cell mediated allergies, tumor and transplantation immunology, autoimmune diseases, and the role of immunity in host defense. Prerequisites: Chem 2220 or Chem 4620 and Bio Sci 2213.

**BIO SCI 4493 General Virology** (LEC 3.0)

An overview of the field of virology, including plant, animal, and bacterial viruses. Discussions will include morphology, classification, virus-host interactions, genetics, clinical and industrial aspects of viruses, and viruses as model systems for basic biological studies. Prerequisites: Bio Sci 1113 or 1213; Bio Sci 2213, 3313, Chem 1310, 1320, 2210.

**BIO SCI 4666 Nanobiotechnology** (LEC 3.0)

Nanotechnology has emerged to change human economy and society in many aspects. Applications of nanotechnology in life science is termed nanobiotechnology. This course describes recent development of nanobiotechnology in basic biological research as well as biomedical applications. Prerequisite: Bio Sci 2213 or Bio Sci 2223.

**BIO SCI 5000 Special Problems** (IND 0.0-6.0)

Graduate problems or readings on specific subjects or projects in the department. Prerequisite: Consent of the instructor.

**BIO SCI 5001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**BIO SCI 5010 Graduate Seminar** (RSD 0.0-6.0)

Presentation and discussion of current topics in Applied and Environmental Biology.

**BIO SCI 5040 Oral Examination** (IND 0.0)

(Variable) After completion of all other program requirements, oral examinations for on-campus M.S./PH.D students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**BIO SCI 5099 Graduate Research** (IND 0.0-15)

Investigation of an advanced nature leading to the preparation of a thesis or dissertation.

**BIO SCI 5210 Biomaterials I** (LEC 3.0)

This course will introduce senior undergraduate students to a broad array of topics in biomaterials, including ceramic, metallic, and polymeric biomaterials for in vivo use, basic concepts related to cells and tissues, host reactions to biomaterials, biomaterials-tissue compatibility, and degradation of biomaterials. Prerequisite: Senior undergraduate standing. (Co-listed with Chem Eng 5200, MS&E 5310).

**BIO SCI 5240 Tissue Engineering I** (LEC 3.0)

The course will introduce senior undergraduate students to the principles and clinical applications of tissue engineering including the use of biomaterials scaffolds, living cells and signaling factors to develop implantable parts for the restoration, maintenance, or replacement of biological tissues and organs. Prerequisite: Senior standing. (Co-listed with MS&E 5210).

**BIO SCI 5313 Pathogenic Microbiology** (LEC 3.0)

A study of medically important microorganisms. Students will learn about the properties that enable organisms to cause disease as well as the disease process within the host. Special emphasis will be placed on recent advances in the molecular genetics of host pathogen interaction. Prerequisite: Bio Sci 2213 or Civ Eng 2601.

**BIO SCI 5323 Bioinformatics** (LEC 3.0)

The course will familiarize students with the application of computational methods to biology, as viewed from both perspectives. It will introduce problems in molecular, structural, morphological, and biodiversity informatics, and will discuss principles, algorithms, and software to address them. Prerequisites: A grade of "C" or better in both one of Bio Sci 1113 or Bio Sci 1213 and one of Comp Sci 1570 and Comp Sci 1580 or Comp Sci 1971 and Comp Sci 1981. (Co-listed with COMP SCI 5700).

**BIO SCI 5333 Genomics** (LEC 3.0)

This course offers a general overview of the field of genomics. Topics covered include genome sequencing and annotation, transcriptomics, proteomics, metabolomics, genomic variation, and an overview of human, and several animal, plant, and microbial genome projects. Prerequisite: BIO SCI 4323.

**BIO SCI 5353 Developmental Biology** (LEC 3.0)

Study of the patterns of development of the vertebrate embryo, the molecular mechanisms of tissue induction, and interactions among developing tissues. Prerequisite: Bio Sci 2213.

**BIO SCI 5423 Advanced Biodiversity** (LEC 3.0)

This course focuses on the enhancement and reduction of biodiversity and modern techniques of measuring and monitoring it. Topics include biogeography, community structure, competition, predation, food webs, geology-biology relationships, environmental change, and human impact. Additional costs and a week-long field trip are required. Prerequisite: Bio Sci 2233 or Bio Sci 2263.

**BIO SCI 5433 Neurobiology** (LEC 3.0)

An intermediate course in cellular neurobiology. Emphasis will be placed on the unique properties of neurons and other excitable cells. Topics covered include the structure and biophysical properties of neurons, synaptic transmission, neurochemistry, signal transduction, neuropharmacology and neurodevelopment. Prerequisite: Bio Sci 2213.

**BIO SCI 5463 Global Ecology** (LEC 3.0)

This class covers ecological topics at large scales, emphasizing global scales. Topics include global energy balance, biogeochemical cycles of water, carbon, nitrogen, and other biologically important elements, and global biodiversity. Students will focus on primary literature related to global ecology. Prerequisite: Bio Sci 2263.

**BIO SCI 5533 Pharmacology** (LEC 3.0)

The basic principles of drug action, pharmacokinetics, pharmacodynamics and toxicity. We will emphasize the actions of drugs used to treat cardiovascular and nervous system disorders. Students will review the primary literature to prepare both written and oral reports on drug actions. Prerequisite: Bio Sci 2213.



## Business (BUS)

### **BUS 1000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### **BUS 1001 Special Topics** (IND 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

### **BUS 1110 Introduction to Management and Entrepreneurship** (LEC 3.0)

The course provides an introduction to the basic concepts of management and entrepreneurship to provide an awareness of what functions and challenges are faced by managers and entrepreneurs in today's global environment. Applications of the concepts to the organization, operations, and resources are discussed. Appropriate for all majors.

### **BUS 1210 Financial Accounting** (LEC 3.0)

This course is an introduction to financial accounting and its significant role in making sound business decisions. Emphasis is on what accounting information is, why it is important, and how it is used to make strategic economic decisions.

### **BUS 1810 Introduction to College Success** (LEC 1.0)

This course teaches essential skills for success in Business and Information Technology and a student's future career. The course creates a sense of community in the department and prepares the student for the business world.

### **BUS 1811 Introduction to College Success II** (LAB 0.50)

A continuation of BUS 10. Students learn essential skills for success in Business and Information Technology. The course creates a sense of community in the department and prepares the students for the business world.

### **BUS 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### **BUS 2001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

### **BUS 2002 Cooperative Training in Business** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry with credit arranged through departmental co-op advisor. Grade received depends on quality of reports submitted and work supervisors's evaluation. Prerequisite: Completed 30 hours toward degree.

### **BUS 2910 Business Law** (LEC 3.0)

This course is an introduction to the nature and meaning of law and the legal environment of business. Topics include the legal process, sources of law, and institutions.

### **BUS 3105 Management and Business Law Essentials** (LEC 1.5)

This course is an introduction to the essentials of management and business law for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Senior or Junior Standing; 3.0 GPA required.

### **BUS 3115 Introduction to Teambuilding and Leadership** (LEC 3.0)

This course covers an introduction to leadership styles, principles, models, issues, and applications through analytical and intellectual examination. Key components of teams are introduced, with opportunities to practice and develop both leadership and teambuilding skills.

### **BUS 3205 Accounting Essentials** (LEC 1.5)

This course is an introduction to the essentials of financial and managerial accounting for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Senior or Junior standing; 3.0 GPA required.

### **BUS 3220 Managerial Accounting** (LEC 3.0)

Emphasizes internal use of accounting information in establishing plans and objectives, controlling operations, and making decisions involved with management of an enterprise (the determination of costs relevant to a specific purpose such as inventory valuation, control of current operation, or special decisions). Prerequisites: Bus 1210 or Eng Mgt 2211.

### **BUS 3305 Operations Management Essentials** (LEC 1.5)

This course is an introduction to the essentials of operations management for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Senior or Junior Standing; 3.0 GPA required.

### **BUS 3705 Management Information Systems Essentials** (LEC 1.5)

This course is an introduction to the essentials of management information systems for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Senior or Junior Standing; 3.0 GPA required.

### **BUS 3805 Mathematics and Statistics Essentials** (LEC 1.5)

This course is an introduction to the essentials of mathematics and statistics for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Senior or Junior Standing; 3.0 GPA required.

### **BUS 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

### **BUS 4001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

### **BUS 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**BUS 4111 Business Negotiations** (LEC 3.0)

The purpose of this course is to understand the practices and processes of negotiation for negotiating successfully in a variety of settings. The course is designed to be relevant to the broad spectrum of negotiation problems faced by managers, consultants, etc. Because almost everyone negotiates all the time, this course is relevant to almost any student. Prerequisites: At least Junior status.

**BUS 4150 Customer Focus and Satisfaction** (LEC 3.0)

Major emphasis is given to the concept of customer focus, with coverage of techniques for obtaining customer needs, measuring customer satisfaction, developing products and services to satisfy customers, and maximizing the benefits of customer feedback. A semester long HoQ project will be done. Prerequisites: MKT 3110 or MKT 3105 or ENG MGT 3510. (Co-listed MKT 4150).

**BUS 4675 International Business** (LEC 3.0)

This survey course will deal with business concepts, analytical processes and philosophical bases for international business operations. Emphasis is on environmental dynamics, multinational business organizations, cultural and economic constraints, unique international business practices and international operations, strategy and policy.

**BUS 4970 Senior Business Design I** (LEC 1.0)

In this course, students will become familiar with the principles of entrepreneurship; learn about the basic purpose, content and structure of business plans; and develop business presentation skills through practice. At the end of the semester, student teams will give presentations to a bank in an attempt to secure a loan to run the business the following semester. Prerequisite: Senior Standing.

**BUS 4980 Senior Business Design II** (LEC 2.0)

In this course, students will be expected to carry out the business plans created in Bus 4970. Progress reports are submitted roughly every 3 weeks during the semester. At the end of the semester, students terminate the business organization and profits are donated to a non-profit organization in the team's name. Prerequisite: Bus 4970.

**BUS 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Prerequisite: Admission to the MBA program.

**BUS 5001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

**BUS 5040 Oral Examination** (IND 0.0)

After completion of all other requirements, oral examinations for on-campus M.B.A./Ph.D. students may be processed during intersession. Off-campus M.B.A. students must be enrolled in oral examination and must have paid an oral examination fee at the time defense/oral examination (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**BUS 5080 Practicum** (IND 0.0-6.0)

This course is similar to the Bus 5085 Internship course. The difference is that this course is intended for students who are already employed by an organization for whom they wish to continue working. Prerequisite: Bus Core.

**BUS 5085 Internship** (IND 0.0-6.0)

Students apply critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employer. Activities will vary depending on the student's background and the setting. Requires major report and formal presentation to sponsoring organization. Prerequisite: Graduate standing.

**BUS 5099 Research** (IND 0.0-9.0)

Research investigation of an advanced nature leading to a major report suitable for publication in a journal or in a conference proceedings. Prerequisite: Permission of the instructor.

**BUS 5105 Graduate Management and Business Law Essentials** (LEC 1.5)

This course is an introduction to the essentials of management and business law for running a business. It's designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit cannot be applied to any major or minor in Business, IS&T, or Economics. Additional case study or report required. Prerequisite: Bachelor Degree.

**BUS 5115 Teambuilding and Leadership in Business Settings** (LEC 3.0)

This course covers leadership styles, principles, models, issues, and applications through analytical and intellectual examination. Key components of teams are introduced, with opportunities to practice and develop both leadership and teambuilding skills. Case studies required.

**BUS 5205 Graduate Accounting Essentials** (LEC 1.5)

This course is an introduction to the essentials of financial and managerial accounting for running a business. It's designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit cannot be applied to any major or minor in Business, IS&T, or Economics. Additional case or report required. Prerequisite: Bachelor Degree.

**BUS 5230 Financial Statement Analysis** (LEC 3.0)

Analysis and interpretation of financial statements for profitability analysis, credit analysis, and other business analyses that rely on financial data. Introduces emerging roles of accounting analytics. Illustrates data analytics concepts and techniques to detect earning management, predict fraud, and to provide insights into other business strategies. Prerequisite: FINANCE 2150 or Graduate Standing.

**BUS 5305 Graduate Operations Management Essentials** (LEC 1.5)

This course is an introduction to the essentials of operations management for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit cannot be applied to any major or minor in Business, IS&T, or Economics. Additional case study or report required. Prerequisite: Bachelor Degree.

**BUS 5360 Business Operations** (LEC 3.0)

This course examines the concepts, processes, and institutions that are fundamental to an understanding of business operations within organizations. Emphasis is on the management and organization of manufacturing and service operations and the application of quantitative methods to the solution of strategic, tactical and operational problems. Prerequisites: BUS 1210 or ENG MGT 2211; at least Junior standing; and one of the following: STAT 1111, STAT 1115, STAT 1116, STAT 3111, STAT 3113, STAT 3115, or STAT 3117.

**BUS 5470 Human Resource Management** (LEC 3.0)

The course examines employee selection, performance appraisal, training and development, compensation, legal issues, and labor relations. Prerequisite: Bus 1110.

**BUS 5580 Strategic Management** (LEC 3.0)

Study of the formulation and implementation of corporate, business and functional strategies designed to achieve organizational objectives. Case studies and research reports may be used extensively. Prerequisites: MKT 3110 or Eng Mgt 3510; Finance 2150 or Eng Mgt 3200; Senior standing.

**BUS 5705 Graduate Management Information Systems Essentials** (LEC 1.5)

This course is an introduction to the essentials of management information systems for running a business. It is designed for students planning to enter the MBA program. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Additional case or report required. Prerequisite: Bachelor Degree.

**BUS 5805 Graduate Mathematics and Statistics Essentials** (LEC 1.5)

This course is an introduction to the essentials of mathematics and statistics for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit cannot be applied to any major or minor in Business, IS&T, or Economics. Additional case study or report required. Prerequisite: Bachelor Degree.

**BUS 5896 Project Research** (IND 0.0-9.0)

The research project will involve students applying research techniques and discipline specific knowledge working on a project designed by the advisor, often working with a business organization. Requires major report and formal presentation to sponsoring organization. Prerequisite: Permission of the instructor.

**BUS 5910 Privacy and Information Security Law** (LEC 3.0)

Explores issues concerning the use, disclosure, and protection of information (personal, organizational, health, and financial) from a legal perspective. A focus on understanding, planning, protecting, and responding to data breaches and other information risk and threats. Case studies based on litigation are reviewed and analyzed. Assumes MIS familiarity.

**BUS 5980 Business Models for Entrepreneurship and Innovation** (LEC 3.0)

This course uses problem based learning to expand student insight into the nature, development, and application of business models. It increases the practical skills and knowledge required to generate original models of value creation for both entrepreneurial start-ups and corporate innovation. Prerequisite: Senior or graduate standing.

## Ceramic Engineering (CER ENG)

**CER ENG 2002 Cooperative Training** (IND 1.0-3.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted at work supervisor's evaluation.

**CER ENG 2110 Atomic Structure Of Crystalline Ceramics** (LEC 3.0)

The crystal-chemical principles used to design and manufacture materials with specified properties are developed and applied to oxides, clays, silicates and other nonmetallic compounds.

**CER ENG 2120 Introduction To Glass Science And Technology** (LEC 3.0)

A study of the atomic-level structure of oxide glasses and the relationships between composition, properties and structure of glass-forming systems. Simple rate processes will be introduced to explain temperature-dependent properties. Prerequisite: "C" or better grade in Cer Eng 2110.

**CER ENG 2210 Ceramics In The Modern World** (LEC 2.0)

An introduction to traditional and modern applications of ceramics providing a broad overview of all aspects of current ceramic technology.

**CER ENG 2240 Applied Glass Forming** (LAB 1.0 and LEC 1.0)

Examines the properties and behavior of molten glass along with basic forming techniques, including off-hand shaping, molding and casting. Prerequisites: A grade of "C" or better in either Cer Eng 2210 or Met Eng 1210. Freshman standing or sophomore standing only.

**CER ENG 2315 Ceramic Materials Laboratory I-Characterization Of Materials** (LAB 2.0)

Laboratory experience in collection, beneficiation, and characterization of ceramic raw materials; granulation, compaction, and sintering of particulate materials; and characterization at an introductory level. Standard laboratory practice including safety, report writing, and error analysis are also emphasized. Prerequisite: Sophomore standing.

**CER ENG 2325 Ceramic Materials Laboratory II Glass And Ceramic Processing** (LAB 2.0)

Laboratory experience in design, processing, and characterization of glasses and ceramics. Glasses are formulated, melted and characterized to correlate composition and properties. Clay-based ceramics are formulated to meet performance specifications, prepared by slip casting/extrusion, and fired. Prerequisite: "C" or better grade in Cer Eng 2315.

**CER ENG 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable Title.

**CER ENG 3110 Introduction to Biomedical Engineering** (LEC 3.0)

This course will provide an introduction to the interdisciplinary field of biomedical engineering. The molecular, cellular, physiological and engineering principles that govern the field will be covered. Applications will include biomaterials, tissue engineering, biomechanics, bioimaging, bioinstrumentation, bio-nanotechnology and artificial organs. Prerequisite: Junior standing or above. (Co-listed with Bio Sci 3110 and Chem Eng 3210).

**CER ENG 3210 Thermal Processes In Ceramics** (LEC 3.0)

Considerations in rate controlled processes in the fabrication of ceramics, packing of powders, comminution and calcination, drying and firing of ceramic ware, polymorphic transformations, sintering, grain growth and hot pressing, relationships of fabrication techniques to physical properties.

**CER ENG 3220 Phase Equilibria** (LEC 3.0)

The study of unary, binary and ternary inorganic, phase equilibrium systems with examples for solving practical engineering problems. Prerequisite: "C" or better grade in Chem 1320 or Met Eng 1210.

**CER ENG 3230 Thermodynamics of Materials** (LEC 3.0)

Basic thermodynamic concepts are applied to materials. Calculations involving enthalpy, entropy, and Gibbs' free energy are studied. Inter-relationships among properties are emphasized. Fundamental concepts of phase equilibria are presented. Prerequisite: "C" or better grade in either Met Eng 1210 or Chem 1320.

**CER ENG 3315 Ceramic Processing Lab I** (LAB 2.0)

The first half of a two-semester sequence that gives students practical knowledge of the methods and techniques used in the fabrication of ceramics. Prerequisite: "C" or better grade in Cer Eng 2325.

**CER ENG 3325 Ceramic Processing Lab II** (LAB 2.0)

The second half of a two-semester sequence that gives students practical knowledge of the methods and techniques used in the fabrication of ceramics. Prerequisite: "C" or better grade in Cer Eng 3315.

**CER ENG 3410 Characterization Of Inorganic Solids** (LEC 3.0)

X-ray diffraction analysis is emphasized including lattice parameter determination, qualitative and quantitative analysis methods, and sources of error. In addition, the basic principles of other common characterization techniques including electron microscopy, thermal analysis, and energy dispersive spectroscopy are discussed. Prerequisite: "C" or better grade in either Cer Eng 2110 or Met Eng 2110 or a similar introductory course on structure of solids.

**CER ENG 3417 Characterization Of Inorganic Solids Laboratory** (LAB 1.0)

Practical aspects of x-ray diffraction analysis will be emphasized; students will gain hands-on experience in qualitative and quantitative analysis techniques, use of electronic databases, and operation of modern powder diffractometers. Prerequisite: Preceded or accompanied by Cer Eng 3410.

**CER ENG 3517 The Engineering Design Process** (LEC 2.0)

Introduction to elements of design process including strategic, planning, project, management, modelling, materials selection, engineering economics, safety, environmental issues and ethics. Prerequisite: Junior standing.

**CER ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CER ENG 4001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CER ENG 4096 Materials Senior Design I** (LEC 3.0)

Overview of the methods, approaches, and techniques required to execute materials related capstone senior design projects. Formation of teams, assignment of projects, review of department curriculum concepts and topics, and comprehensive project management skills needed to complete projects will be used as means to learn the design process. Prerequisites: Met Eng 3125 and Met Eng 2125, or Cer Eng 3315 with a "C" or better. (Co-listed with Met Eng 4096).

**CER ENG 4097 Materials Senior Design II** (LAB 3.0)

A continuation of the Materials Senior Design I. Students working in groups will complete a capstone design project including process and product simulation and/or fabrication, safety aspects, environmental impact and capital and operating economics. Prerequisite: "C" or better in either Cer Eng 4096 or Met Eng 4096. (Co-listed with Met Eng 4097).

**CER ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**CER ENG 4220 Mechanical Properties Of Ceramics** (LEC 3.0)

This course will treat the theory and testing practice related to design based on the mechanical properties of ceramics. The course also includes laboratory experiments for the characterization of the mechanical properties of ceramics. Prerequisite: A grade of "C" or better in Civ Eng 2210.

**CER ENG 4240 Electrical Properties Of Ceramics** (LEC 3.0)

The application of ceramic chemistry and physics to the development and evaluation of electronic, dielectric, magnetic, and optical properties. Emphasis is placed on the relationships between properties and crystal structure, defects, grain boundary nature, and microstructure. Prerequisite: "C" or better in Physics 2305.

**CER ENG 4250 Thermal Properties Of Ceramics** (LEC 3.0)

This course will teach the crystal physics underlying heat capacity, internal energy, phonon and photon conduction, and thermal expansion. These properties will be used to rationalize the behavior of a wide variety of ceramic materials in severe thermal environments. Prerequisite: Senior Standing.

**CER ENG 4310 Ceramic Processing** (LEC 3.0)

Powder, colloidal and sol-gel processing, forming methods, drying, sintering and grain growth. Relation of processing steps to densification and microstructure development. Prerequisite: Senior standing.

**CER ENG 4410 Introduction to Integrated Computational Materials Engineering** (LEC 2.0 and LAB 1.0)

This course will provide an introduction to different computational tools for studying materials at different length scales. Several atomistic, microscale, and continuum models will be introduced and bridging between different modeling scales will be discussed. This course has a computational laboratory to build models and run simulations. Prerequisites: A grade of "C" or better in both Cer Eng 3220 and Math 3304, and in either Cer Eng 2110 or Met Eng 2110.

**CER ENG 4510 International Engineering and Design** (LEC 3.0)

A multi-disciplinary engineering course focused on sustainable design and technology transfer to developing countries. Course includes elements of traditional capstone design classes. Experiential learning through competitions and/or field work is a major component of the class. Prerequisites: Senior standing, instructor approval, Geo Eng 5211, Geo Eng 5247. (Co-listed with Geo Eng 5092 and Met Eng 4510).

**CER ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CER ENG 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CER ENG 5002 Cooperative Training** (IND 1.0-3.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted at work supervisor's evaluation.

**CER ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**CER ENG 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**CER ENG 5115 X-Ray Diffraction Analysis** (LEC 2.0 and LAB 1.0)

Theory and practical aspects of x-ray diffraction analysis are covered including diffraction theory, qualitative and quantitative analysis techniques, electronic databases, and operation of modern powder diffractometers. Students cannot receive credit for both Cer Eng 3417 and Cer Eng 5115. Prerequisite: Preceded or accompanied by Cer Eng 3410.

**CER ENG 5220 Advanced Mechanical Properties of Ceramics** (LEC 3.0 and LAB 1.0)

An advanced course to treat the theory and testing practice related to design based on the mechanical properties of ceramics. The course also includes a laboratory consisting of experiments for the characterization of the mechanical properties of ceramics. Prerequisites: Graduate standing.



**CER ENG 5230 Glass Science And Engineering** (LEC 3.0)

The development, manufacturing methods, applications, and properties of flat, fiber, container, chemical, and special purpose glasses. Composition/property relationships for glasses and nucleation-crystallization processes for glass-ceramics are also covered. Prerequisite: "C" or better grade in Cer Eng 2120.

**CER ENG 5250 Refractories** (LEC 3.0)

The manufacture, properties, uses, performance, and testing of basic, neutral and acid refractories. Prerequisite: Cer Eng 3230.

**CER ENG 5260 Dielectric And Electrical Properties Of Oxides** (LEC 3.0)

The processes occurring in inorganic materials under the influence of an electric field are considered from basic principles. Emphasis is placed on application to real systems. Prerequisite: "C" or better grade in Cer Eng 4210.

**CER ENG 5310 Advanced Ceramic Processing** (LEC 3.0)

Materials, processing and design of microelectronic ceramics are covered. Introduction to devices, triaxial ceramics, high aluminas, tape fabrication, metallizations, thick film processing and glass-to-metal seals. Prerequisites: Cer Eng 3210 & 3325.

**CER ENG 5810 Principles Of Engineering Materials** (LEC 3.0)

Examination of engineering materials with emphasis on selection and application of materials in industry. Particular attention is given to properties and applications of materials in extreme temperature and chemical environments. A discipline specific design project is required. (Not a technical elective for undergraduate metallurgy or ceramic majors) (Co-listed with Aero Eng 3877, Chem Eng 5300, Physics 4523, Met Eng 5810).

## Chemical Engineering (CHEM ENG)

**CHEM ENG 1100 Computers And Chemical Engineering** (LAB 1.0 and LEC 2.0)

Introduction to chemical engineering, both its intellectual and professional opportunities. Students are introduced to computer programming and software packages while performing meaningful chemical engineering calculations.

**CHEM ENG 2001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course.

**CHEM ENG 2100 Chemical Engineering Material & Energy Balances** (LAB 1.0 and LEC 2.0)

The application of mathematics, physics and chemistry to industrial chemical processes. The use of equations of state, chemical reaction stoichiometry, and the conservation of mass and energy to solve chemical engineering problems. Prerequisites: Chem 1320 or Geology 3410; Math 1215 or Math 1221; preceded or accompanied by Physics 1135.

**CHEM ENG 2110 Chemical Engineering Thermodynamics I** (LEC 3.0)

Development and application of the laws and fundamental relationships of thermodynamics to industrial chemical processes. Emphasis is placed on the estimation of thermophysical property values for applications in chemical process engineering. Prerequisites: Preceded by Math 2222; Preceded or accompanied by Chem Eng 2100.

**CHEM ENG 2300 Chemical Process Materials** (LEC 3.0)

Fundamentals of the chemistry of materials. Classification, properties, selection, and processing of engineering materials. Introduction to polymers, electronic materials, biomaterials, and nanomaterials. Prerequisites: Physics 1135.

**CHEM ENG 2310 Professional Practice And Ethics** (LEC 1.0)

Preparation for post-graduate activities including resume writing and job searching. Professional attitudes, practice, licensure, and ethics in the chemical engineering profession. Discussions led by visiting industrialists and other invited speakers. Discussion of professional development including professional and graduate programs. Generally offered fall semester only. Prerequisite: At least sophomore standing.

**CHEM ENG 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CHEM ENG 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course.

**CHEM ENG 3002 Cooperative Engineering Training** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation.

**CHEM ENG 3100 Chemical Engineering Fluid Flow** (LEC 3.0)

Mass, energy, and momentum balance concepts in fluid flow are studied to provide a basis for study of flow measurement, fluid behavior, turbulent flow, dimensional analysis of fluid flows, and the study of some practical flow processes such as : filtration, fluidization, compressible flow, pipe networks. Prerequisites: Chem Eng 2100 and Math 3304; Chem Eng majors only.

**CHEM ENG 3101 Fundamentals of Transport in Chemical and Biochemical Engineering** (LEC 4.0)

This course covers the fundamentals of momentum, energy, and mass transport. Phenomenological mechanisms of molecular transport, fluid static, analysis of a fluid in motion laminar and turbulent flow are covered. The general differential equations for momentum, energy and mass transfer are presented and solved for a variety of chemical engineering problems. Prerequisites: Math 3304 and Chem Eng 2110. Admitted to the Chemical Engineering Program.

**CHEM ENG 3110 Chemical Engineering Heat Transfer** (LEC 2.0)

Process principles of heat transfer in the chemical process industry. Steady and unsteady state heat conduction and radiation heat transfer. Free and forced convection and condensation and boiling heat transfer. Practical heat exchanger design. Prerequisites: Math 2222 and preceded or accompanied by Chem Eng 3100. Chem Eng majors only.

**CHEM ENG 3111 Numerical Computing in Chemical and Biochemical Engineering** (LAB 1.0 and LEC 2.0)

The students are introduced to the concepts of engineering problem formulation, model building, and multi scale models. Matlab, spreadsheet and polymath computing are used to solve chemical engineering problems involving systems of linear and non linear algebraic equations, and ordinary and partial differential equations. Prerequisites: Math 3304 and either both Comp Sci 1971 and Comp Sci 1981 or both Comp Sci 1972 and Comp Sci 1982. Admitted to the Chemical Engineering Program.

**CHEM ENG 3120 Chemical Engineering Thermodynamics II** (LEC 3.0)

Physical, chemical and reaction equilibrium. Study of the thermophysical relationships of multicomponent, multiphase equilibrium. Application of equilibrium relationships to the design and operation of chemical mixers, separators and reactors. Prerequisites: Grade of "C" or better in Chem Eng 2100 and Chem Eng 2110; Chem Eng majors only.

**CHEM ENG 3130 Staged Mass Transfer** (LEC 3.0)

Principles of equilibrium stage operations applied to distillation, liquid-liquid extraction, absorption, and leaching. Methods for estimating pressure drop and stage efficiencies are also studied. Quantitative solutions to practical problems are stressed. Prerequisites: Chem Eng 3120, admitted to Chem Eng program.

**CHEM ENG 3131 Separations in Chemical and Biochemical Engineering** (LEC 3.0)

Flash and column distillation. McCabe-Thiele method, plate efficiencies. Azeotropes. Batch distillation. Absorption and stripping. Washing and leaching. Prerequisites: Chem Eng 3101, Chem Eng 3111, and Chem Eng 3120. Admitted to the Chemical Engineering Program.

**CHEM ENG 3140 Continuous Mass Transfer** (LEC 3.0)

Fundamentals of diffusion and mass transfer applied to absorption, extraction, humidification, drying and filtration. Design and rating of continuous chemical separators. Prerequisites: Preceded or accompanied by Chem Eng 3130. Chem Eng majors only.

**CHEM ENG 3141 Process Operations in Chemical and Biochemical Engineering** (LEC 2.0)

Design and selection of pumps, fans, compressors, valves, and ejectors. Design and selection of heat exchangers, condensers and reboilers. Design of mixing equipment, sterilizers, sedimentation vessels, centrifuges, and filtration and ultrafiltration units. Prerequisites: Chem Eng 3101 and Chem Eng 3120. Admitted to the Chemical Engineering Program.

**CHEM ENG 3150 Chemical Engineering Reactor Design** (LEC 3.0)

The study of chemical reaction kinetics and their application to the design and operation of chemical and catalytic reactors. Prerequisites: Preceded or accompanied by either Chem Eng 3140 or Chem Eng 3200 or preceded by both Chem Eng 3111 and Chem Eng 3101. Admitted to Chem Eng program.

**CHEM ENG 3160 Molecular Chemical Engineering** (LEC 3.0)

Introduction to the molecular aspects of chemical thermodynamics, transport processes, reaction dynamics, and statistical and quantum mechanics. Prerequisites: Chem Eng 3120, admitted to Chem Eng program.

**CHEM ENG 3200 Biochemical Separations** (LEC 3.0)

The fundamentals of mass transfer are introduced and applied to various unit operations employed in the separation of chemical and biochemical compounds. Prerequisites: Chem Eng 3120. Chem Eng majors only.

**CHEM ENG 3210 Introduction to Biomedical Engineering** (LEC 3.0)

This course will provide an introduction to the interdisciplinary field of biomedical engineering. The molecular, cellular, physiological and engineering principles that govern the field will be covered. Applications will include biomaterials, tissue engineering, biomechanics, bioimaging, bioinstrumentation, bio-nanotechnology and artificial organs. Prerequisite: Junior standing or above. (Co-listed with Cer Eng 3110 and Bio Sci 3110).

**CHEM ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CHEM ENG 4001 Special Topics** (LEC 3.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM ENG 4091 Chemical Process Design I** (LEC 1.0 and LAB 2.0)

Economic analysis of a chemical process including capital requirements, operating costs, earnings, and profits. The economic balance is applied to chemical engineering operations and processes. Optimization and scheduling techniques are applied to process evaluation. Preliminary process design and use of simulation software. Prerequisites: Either (Chem Eng 3150, Chem Eng 3131 and Chem Eng 3141) or (Chem Eng 3150 and preceded or accompanied by Chem Eng 5250).

**CHEM ENG 4096 Chemical Engineering Economics** (LEC 2.0)

Economic analysis of a chemical process including capital requirements, operating costs, earnings, and profits. The economic balance is applied to chemical engineering operations and processes. Optimization and scheduling techniques are applied to process evaluation. Prerequisite: Preceded or accompanied by Chem Eng 3130.

**CHEM ENG 4097 Chemical Process Design II** (LAB 2.0 and LEC 1.0)

Engineering principles involved in the design and layout of chemical process equipment. Material and energy balances, equipment selection and design, and preconstruction cost estimation are performed for a capstone design project. Communication emphasized course. Prerequisites: Chem Eng 3130 and Chem Eng 3150; preceded or accompanied by either Chem Eng 4091 or both Chem Eng 4110 and Chem Eng 4096.

**CHEM ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**CHEM ENG 4100 Chemical Engineering Laboratory I** (LAB 1.0 and LEC 1.0)

Experiments associated with unit operations involving fluid flow and heat transfer. Principles of data and uncertainty analysis are introduced with emphasis on model building. Communication skills are stressed. This is a communication emphasized course. Prerequisites: Chem Eng 3100 and Chem Eng 3110.

**CHEM ENG 4101 Chemical Engineering Laboratory I** (LEC 1.0 and LAB 2.0)

Experiments associated with unit operations involving fluid flow and heat transfer. Principles of data and uncertainty analysis are introduced with emphasis on model building. Communication skills are stressed. This is a communication emphasized course. Prerequisites: Chem Eng 3141.

**CHEM ENG 4110 Chemical Engineering Process Dynamics And Control** (LEC 3.0)

Study of the dynamics of chemical processes and the instruments and software used to measure and control temperature, pressure, liquid level, flow, and composition. Generally offered fall semester only. Prerequisites: Preceded or accompanied by any one of Chem Eng 4100 or Chem Eng 4130 or Chem Eng 4200; or preceded by Chem Eng 3150, Chem Eng 3131 and Chem Eng 3141; or preceded by Chem Eng 3150 and preceded or accompanied by Chem Eng 5250.

**CHEM ENG 4120 Process Dynamics And Control Laboratory** (LAB 1.0)

Application of concepts of industrial process dynamics and control using experiments that demonstrate different control and sensing devices and software. This is a communications emphasized course. Prerequisite: Preceded or accompanied by Chem Eng 4110.

**CHEM ENG 4130 Chemical Engineering Laboratory II** (LAB 2.0 and LEC 1.0)

Experiments illustrating the unit operations of continuous and staged separation. Experimental design methods are extended to include the principles of regression and model building. Communication skills are stressed. This is a communication emphasized course. Prerequisites: Chem Eng 3130 and Chem Eng 3140; or Chem Eng 3141 and Chem Eng 3131 and preceded or accompanied by Chem Eng 3150.

**CHEM ENG 4140 Chemical Process Safety** (LEC 3.0)

The identification and quantification of risks involved in the processing of hazardous and/or toxic materials are studied. Prerequisite: Preceded or accompanied by Chem Eng 3150.

**CHEM ENG 4150 Chemical Process Flowsheeting** (LEC 2.0 and LAB 1.0)

The development, implementation, and evaluation of methods for determining the mathematical model of a chemical process, ordering the equations in the mathematical model, and solving the model. Prerequisite: Math 3304 or graduate standing.

**CHEM ENG 4200 Biochemical Separations Laboratory** (LAB 2.0)

Introduction to the unit operations employed in the separation of chemicals and biochemicals. The experiments illustrate the staged and continuous separation systems that are involved. This is a communications emphasized course. Prerequisite: Chem Eng 3200.

**CHEM ENG 4201 Biochemical Separations and Control Laboratory** (LAB 2.0 and LEC 1.0)

Introduction to the unit operations employed in the separation of chemicals and biochemicals. The experiments illustrate the staged and continuous separation systems that are involved. Application of concepts of industrial process dynamics and control. Communications emphasized. Prerequisites: Chem Eng 5250.

**CHEM ENG 4210 Biochemical Reactors** (LEC 3.0)

Application of chemical engineering principles to biochemical reactors. Emphasis on cells as chemical reactors, enzyme catalysis and disposable technology. Prerequisite: Chem Eng 3150 or graduate standing.

**CHEM ENG 4220 Biochemical Reactor Laboratory** (LEC 1.0 and LAB 2.0)

Introduction to the unit operations involved with the production of biochemicals. The experiments emphasize the isolation of proteins and enzymes from tissue and bacteria cells. This is a communications emphasized course. Prerequisites: Chem Eng 3200 and preceded or accompanied by Chem Eng 4210; or preceded or accompanied by Chem Eng 5250 and Chem Eng 4210.

**CHEM ENG 4230 Bioprocess Safety** (LEC 1.0)

This course covers a risk assessment, biohazard containment and inactivation practices, and other biosafety issues relevant to industrial bioprocessing. Considerations relating to the release of genetically modified organisms are also discussed. Prerequisites: Preceded or accompanied by Chem Eng 4210.

**CHEM ENG 4241 Process Safety in the Chemical and Biochemical Industries** (LEC 3.0)

This course covers risk assessment, biohazard containment and inactivation practices, and other biosafety issues relevant to industrial bioprocessing. Considerations relating to the release of genetically modified organisms are also discussed. Prerequisites: Preceded or accompanied by Chem Eng 4210.

**CHEM ENG 4300 Patent Law** (LEC 3.0)

A presentation of the relationship between patent law and technology for students involved with developing and protecting new technology or pursuing a career in patent law. Course includes an intense study of patentability and preparation and prosecution of patent applications. Prerequisite: Senior or graduate standing. (Co-listed with Eng Mgt 5514).

**CHEM ENG 4310 Interdisciplinary Problems In Manufacturing Automation** (LAB 1.0 and LEC 2.0)

The course will cover material necessary to design a product and the fixtures required to manufacture the product. Participants will gain experience with CAD/CAM software while carrying out an actual manufacturing design project. (Co-listed with Mech Eng 5644, Eng Mgt 5315).

**CHEM ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CHEM ENG 5001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM ENG 5010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

**CHEM ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**CHEM ENG 5096 Industrial Chemical Processes** (LEC 3.0)

Detailed study of various industrial chemical manufacturing processes including underlying chemistry, reaction pathways and separation processes. Prerequisite: Chem Eng 3130 or Chem 2210, or graduate standing. (Co-listed with Chem 5250).

**CHEM ENG 5097 Intermediate Process Design** (LEC 3.0)

Study of newer unit operations, fluidization, chromatographic absorption, new developments in operations previously studied. Comparison of operations which might be selected for the same end result in an industrial process. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5100 Intermediate Transport Phenomena** (LEC 3.0)

The similarities of flow of momentum, heat and mass transfer and the applications of these underlying principles are stressed. Course is primarily for seniors and beginning graduate students. Prerequisite: Chem Eng 3140 or Chem Eng 3200 or graduate standing.

**CHEM ENG 5110 Intermediate Chemical Reactor Design** (LEC 3.0)

A study of homogeneous and heterogeneous catalyzed and noncatalyzed reaction kinetics for flow and batch chemical reactors. Application to reactor design is stressed. Prerequisite: Chem Eng 3150 or graduate standing.

**CHEM ENG 5120 Interfacial Phenomena In Chemical Engineering** (LEC 3.0)

The course deals with the effects of surfaces on transport phenomena and on the role of surface active agents. Topics include fundamentals of thermodynamics, momentum, heat and mass transfer at interfaces and of surfactants. Some applications are included. Prerequisite: Chem Eng 3140 or Chem Eng 3200 or graduate standing.

**CHEM ENG 5130 Risk Assessment and Reduction** (LEC 3.0)

Safe, secure manufacturing facilities protect the health of employees and the public, preserve the environment, and increase profitability. Methods for systematically identifying hazards and estimating risk improve the safety performance and security of manufacturing facilities. Prerequisite: Senior or Graduate Standing. (Co-listed with Eng Mgt 4312).

**CHEM ENG 5140 Intermediate Chemical Process Safety** (LEC 3.0)

The identification and quantification of risks involved in the processing of hazardous and/or toxic materials are studied. Methods to design safety systems or alter the chemical process to reduce or eliminate the risks are covered. Prerequisite: Graduate Standing.

**CHEM ENG 5150 Intermediate Chemical Process Flowsheeting** (LEC 2.0 and LAB 1.0)

The development, implementation, and evaluation of methods for determining the mathematical model of a chemical process, ordering the equations in the mathematical model, and solving the model. Projects on special topics and presentations related to the course materials will be included. Prerequisite: graduate standing.

**CHEM ENG 5160 Introduction to Molecular Modeling and Simulation** (LEC 3.0)

An introduction to the concepts of molecular-based modeling and simulations, their connections to other engineering approaches and their role in multiscale modeling. Major methodologies such as molecular dynamics and lattice and off-lattice Monte Carlo, and special case studies are discussed. Prerequisite: Chem Eng 3160.

**CHEM ENG 5161 Intermediate Molecular Engineering** (LEC 3.0)

Molecular aspects of chemical thermodynamics, transport processes, reaction dynamics, and statistical and quantum mechanics. Prerequisites: Chem Eng 3120 or graduate standing.

**CHEM ENG 5170 Physical Property Estimation** (LEC 3.0)

Study of techniques for estimating and correlating thermodynamic and transport properties of gases and liquids. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5180 Industrial Pollution Control** (LEC 3.0)

The study of water, air, and thermal pollution control methods and the application of these methods to the solution of pollution problems in the chemical industry. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5190 Plantwide Process Control** (LEC 3.0)

Synthesis of control schemes for continuous and batch chemical plants from concept to implementation. Multiloop control, RGA, SVD, constraint control, multivariable model predictive control, control sequence descriptions. Design project involving a moderately complicated multivariable control problem. Prerequisites: Chem Eng 4110 or Elec Eng 3320 or Elec Eng 3340 or graduate standing. (Co-listed with Elec Eng 5350).

**CHEM ENG 5200 Biomaterials I** (LEC 3.0)

This course will introduce senior undergraduate students to a broad array of topics in biomaterials, including ceramic, metallic, and polymeric biomaterials for in vivo use, basic concepts related to cells and tissues, host reactions to biomaterials, biomaterials-tissue compatibility, and degradation of biomaterials. Prerequisite: Senior undergraduate standing. (Co-listed with Bio Sci 5210, MS&E 5310).

**CHEM ENG 5210 Intermediate Biochemical Reactors** (LEC 3.0)

Application of chemical engineering principles to biochemical reactors. Emphasis on cells as chemical reactors, enzyme catalysis and production of monoclonal antibodies. Projects on special topics and presentations related to the course materials will be included. Prerequisite: Preceded or accompanied by Chem Eng 3150 or graduate standing.

**CHEM ENG 5220 Intermediate Engineering Thermodynamics** (LEC 3.0)

Review thermodynamic principles for pure fluids and mixtures. Emphasis on applications for the chemical industry and use of fundamental relations and equations of state. Prerequisite: Senior or graduate standing.

**CHEM ENG 5230 Bioprocess Safety** (LEC 1.0)

This course covers a risk assessment, biohazard containment and inactivation practices, and other biosafety issues relevant to industrial bioprocessing. Considerations relating to the release of genetically modified organisms are also discussed. Prerequisites: Graduate standing.

**CHEM ENG 5241 Intermediate Process Safety in the Chemical and Biochemical Industries** (LEC 3.0)

This course covers risk assessment, biohazard containment and inactivation practices, and other biosafety issues relevant to industrial bioprocessing. Considerations relating to the release of genetically modified organisms are also discussed. Prerequisites: Chem Eng 3150 or graduate standing.

**CHEM ENG 5250 Isolation and Purification of Biologicals** (LEC 3.0)

Isolation and purification of biologicals with emphasis on biopharmaceuticals. Principles and applications of chromatography, lyophilization, and product formulation. Use of ultrafiltration and diafiltration in the processing of protein products. Disposable technology. Prerequisites: Chem Eng 3131 and Chem Eng 3141.

**CHEM ENG 5300 Principles Of Engineering Materials** (LEC 3.0)

Examination of engineering materials with emphasis on selection and application of materials in industry. Particular attention is given to properties and applications of materials in extreme temperature and chemical environments. A discipline specific design project is required. (Not a technical elective for undergraduate metallurgy or ceramic majors) (Co-listed with Aero Eng 3877, Physics 4523, Met Eng 5810, Cer Eng 5810).

**CHEM ENG 5305 Hazardous Materials Management** (LAB 1.0 and LEC 2.0)

Major themes: hazard identification and characterization; safety, health and environmental management; and the protection of safety, health and environment. Students will have an understanding of work place and environmental hazards in order to be able to facilitate their management and control. The course will include an intensive 30 hour hands-on workshop. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5310 Structure And Properties Of Polymers** (LEC 3.0)

A study of the parameters affecting structure and properties of polymers. Syntheses, mechanisms, and kinetic factors are emphasized from the standpoint of structural properties. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5315 Corrosion And Its Prevention** (LEC 3.0)

A study of the theories of corrosion and its application to corrosion and its prevention. Prerequisite: A grade of "C" or better in either Chem Eng 3120 or Cer Eng 3230. (Co-listed with Met Eng 4230).

**CHEM ENG 5320 Introduction to Nanomaterials** (LEC 3.0)

Introduction to the fundamentals of nanomaterials and recent developments on nanomaterials. Topics include physical and chemical properties, synthesis, processing, and applications of nanomaterials. Example nanomaterials include nanoparticles, nanotubes, and nanowires. Prerequisite: Chem Eng 2300, or Met Eng 1210 or Chem 1320.

**CHEM ENG 5330 Alternative Fuels** (LEC 3.0)

Global energy outlook and available resources are discussed. Alternative energy options and their technologies are covered. Associated environmental concerns and technology are assessed. Special emphases are placed on renewable energies, transportation fuels, energy efficiencies, and clean technologies. Prerequisite: Chem Eng 3130 or senior or graduate standing.

**CHEM ENG 5340 Principles Of Environmental Monitoring** (LEC 3.0)

This course introduces the fundamentals of particle technology, including particle characterization, transport, sampling, and processing. In addition, students will learn about the basic design of some industrial particulate systems and environmental and safety issues related to particulate handling. Prerequisites: Chem Eng 3100 and Physics 2135, or graduate standing.



**CHEM ENG 5350 Environmental Chemodynamics** (LEC 3.0)

Interphase transport of chemicals and energy in the environment. Application of the process oriented aspects of chemical engineering and science to situations found in the environment. Prerequisite: Chem Eng 3140 or Chem Eng 3200 or graduate standing.

**CHEM ENG 5360 Pollution Prevention Via Process Engineering** (LEC 3.0)

To arrive at environmentally benign process design, each processing system will be considered as an inter-connection of elementary units. Systematic methods capitalizing on synergistic process integrations will be employed. Linear, nonlinear and integer optimization, mass/heat exchange networks, and reactor and reaction networks will be used. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5370 Intermediate Process Dynamics And Control** (LEC 3.0)

A study of the dynamic properties of engineering operations and the interrelationships which result when these operations are combined into processes. Formulation of equations to describe open-loop and closed-loop systems. Prerequisite: Chem Eng 3130 or graduate standing.

**CHEM ENG 5380 Intermediate Separation Processes** (LEC 3.0)

Fundamentals of separation operations such as extraction and distillation; rates of diffusion in equilibrium stages and continuous contactors; efficiencies; multistage contactors; performance of equipment; phase equilibrium data; multicomponent separation. Prerequisite: Chem Eng 3130 or graduate standing.

## Chemistry (CHEM)

**CHEM 1000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CHEM 1001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM 1100 Introduction To Laboratory Safety & Hazardous Materials** (LEC 1.0)

A systematic study of safe laboratory operations and pertinent regulations of state and federal agencies.

**CHEM 1110 Introduction To Chemistry** (LEC 1.0)

Introduction to chemistry, its intellectual and professional opportunities. Students will be acquainted with various areas of chemistry and with departmental and campus facilities useful to their future studies. Required of all freshman chemistry majors; encouraged for undergraduate transfer chemistry majors.

**CHEM 1111 Invitational Seminar** (LEC 1.0)

This invitational seminar will introduce the student to research in chemistry. A series of seminars will be presented by faculty and outside speakers on current topics in chemical research. Prerequisite: Chem 1310 or Chem 1351.

**CHEM 1301 General Chemistry For Non-Science Majors** (LEC 3.0)

A one semester introduction to chemistry designed to acquaint the student with the philosophy of the chemist's approach to problem solving and the contribution of chemistry to society. Prerequisite: Entrance requirements.

**CHEM 1310 General Chemistry I** (RSD 2.0 and LEC 2.0)

A comprehensive study of general chemistry concepts with focus on the atomic and molecular nature of matter. Fundamental scientific principles will be applied to solve chemistry problems and describe macroscopic physical properties. Prerequisite: Entrance requirements.

**CHEM 1319 General Chemistry Laboratory** (LAB 1.0)

The laboratory work accompanying general chemistry consists of experiments designed to supplement lectures in Chem 1310. Prerequisite: Preceded or accompanied by both Chem 1310 and Chem 1100.

**CHEM 1320 General Chemistry II** (LEC 3.0)

In-depth analysis of chemical reactions with an introduction to thermodynamics and kinetics including applications to electrochemistry and nuclear chemistry. Prerequisites: Chem 1310 with a grade of "C" or better and Chem 1319.

**CHEM 1351 Accelerated General Chemistry** (LEC 3.0 and RSD 1.0 and LAB 1.0)

An accelerated version of Chem 1310, Chem 1319, and Chem 1320. Four lectures and three laboratory hours per week. Students who do not meet these entrance requirements must take Chem 1310, 1319, & 1320. Prerequisite: Preceded or accompanied by Chem 1100 or an equivalent training program approved by S&T. A minimum score of 60 for the sum of the MMPT and the ACT N. SCI. test scores with neither score below 27.

**CHEM 1510 Qualitative Analysis** (LAB 2.0)

This course is to accompany the study of the metals in general chemistry and is devoted to the qualitative separation and detection of the metals. Prerequisite: Preceded or accompanied by both Chem 1320 and Chem 1100.

**CHEM 1550 Elementary Quantitative Chemical Analysis** (LEC 2.0)

A treatise of the fundamental principles of analytical chemistry and their application in analytical methods. Prerequisite: Preceded or accompanied by Chem 1320 or to be accompanied by Chem 1559.

**CHEM 1559 Elementary Quantitative Chemical Analysis** (LAB 2.0)

The application of the principles of analytical chemistry in gravimetric and volumetric determinations. Prerequisite: To be accompanied by Chem 1550 and preceded or accompanied by Chem 1100.

**CHEM 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CHEM 2001 Special Topics** (RSD 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM 2002 Cooperative Work Training** (IND 1.0-3.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental advisor. Grade received on quality of reports submitted and work supervisor's evaluation.

**CHEM 2010 Seminar** (IND 0.0-6.0)

Discussion of current topics.

**CHEM 2100 Master Student** (LEC 1.0)

Master Student is an orientation course for new and transfer students that addresses transition needs.

**CHEM 2210 Organic Chemistry I** (LEC 4.0)

This course consists of four parts: 1) Structure, bonding, and nomenclature; 2) hydrocarbons (alkanes, alkenes, and alkynes), conjugated systems, ultraviolet and visible spectroscopy, stereochemistry, resonance, and molecular orbital theory; 3) substitution and elimination reactions, and 4) identification of organic compounds via infrared and NMR spectroscopy. Prerequisites: Chem 1310, 1319, 1320; or Chem 1351.

**CHEM 2219 Organic Chemistry I Lab** (LAB 1.0)

Laboratory involves purification techniques, simple and multistep synthesis and spectroscopic identification of organic functional groups. Prerequisites: Preceded or accompanied by Chem 2210 and Chem 1100.

**CHEM 2220 Organic Chemistry II** (LEC 4.0)

This course consists of three parts. The first part will cover aromaticity and reactions of aromatic compounds, the second part will cover carbonyl compounds, amines and their reactions, and the third part will cover bioorganic compounds that include carbohydrates, aminoacids, peptides, proteins, lipids, nucleosides, nucleotides, and nucleic acids. Prerequisites: Grade of "C" or better in Chem 2210.

**CHEM 2229 Organic Chemistry II Lab** (LAB 1.0)

Continuation of Chem 2219. Prerequisites: Chem 2219 or Chem 2289, preceded or accompanied by both Chem 2220 and Chem 1100.

**CHEM 2289 Organic Chemistry Lab** (LAB 1.0)

The use of organic chemical laboratory procedures. For chemical engineering majors only. Prerequisites: Preceded or accompanied by both Chem 2210 and Chem 1100.

**CHEM 2310 Inorganic Chemistry I** (LEC 3.0)

A study of modern concepts of atomic structure, chemical bonding, thermodynamics and kinetics as related to the periodic relationship of the elements. Reference to topics of current interests as applied to the above areas.

**CHEM 2319 Inorganic Chemistry Laboratory** (LAB 1.0)

Synthesis and characterization of inorganic chemicals, high and low temperature syntheses, inert atmosphere and vacuum manipulations, electrochemistry, magnetochemistry, spectroscopy (NMR, IR, UV/VIS), superconductivity. Prerequisites: Preceded or accompanied by Chem 2310 and Chem 1100.

**CHEM 2320 Inorganic Chemistry II** (LEC 3.0)

A study of coordination chemistry, organometallics, bioinorganic and solid-state inorganic chemistry. Reference to topics of current interest as applied to the above areas. Prerequisites: CHEM 2310.

**CHEM 2510 Analytical Chemistry I** (LEC 3.0 and LAB 1.0)

A study of analytical chemistry including an introduction to experimental error, statistics, principles of gravimetric and combustion analysis, chemical equilibrium, acid-base titrations, and electro-analytical determinations. Prerequisites: Chem 1320 and preceded or accompanied by Chem 1100.

**CHEM 3100 Lab Safety and Environmental Safety** (LEC 1.0)

A systematic study of safe laboratory operations and pertinent regulations of state and federal agencies. This course is primarily intended for secondary education science teachers. Credit will not be given for both Chemistry 1100 and Chemistry 2100. Prerequisite: Entrance requirements for the MST program.

**CHEM 3319 MST General Chemistry Lab** (LAB 1.0)

The laboratory work accompanying the MST chemistry courses consists of experiments designed to supplement the lecture work in chemistry. This course is primarily intended for secondary education science teachers. Credit will not be given for both Chemistry 1319 and Chemistry 2319. Prerequisite: Entrance requirements for the MST program and preceded or accompanied by either Chem 1100 or Chem 2100.

**CHEM 3410 Chemical Thermodynamics I** (LEC 3.0)

A study of the laws of thermodynamics and their applications to the states of matter, solutions, and equilibria. Prerequisites: Physics 1111 or Physics 1135; accompanied or preceded by either Math 1215 or Math 1221.

**CHEM 3419 Physical Chemistry Laboratory I** (LAB 1.0)

Some typical operations of experimental physical chemistry. Prerequisites: Preceded or accompanied by both Chem 3410 and Chem 1100.

**CHEM 3420 Introduction To Quantum Chemistry** (LEC 3.0)

A study of molecular structures and spectroscopy, statistical thermodynamics, kinetic theory, chemical kinetics, crystals, and liquids. Prerequisites: Physics 2135 or Physics 2111; preceded or accompanied by Math 2222.

**CHEM 3429 Physical Chemistry Laboratory II** (LAB 1.0)

A continuation of Chem 3419. Prerequisites: Preceded or accompanied by both Chem 3420 and Chem 1100.

**CHEM 3430 Chemical Kinetics I** (LEC 3.0)

A study of kinetic theory, chemical kinetics, electromotive force and ionic equilibria. Prerequisite: Chem 3410.

**CHEM 3459 Accelerated Physical Chemistry Laboratory** (LAB 2.0)

A combined and accelerated version of Chem 3419 and Chem 3429 consisting of exploratory physical chemistry experiments. Prerequisites: Preceded or accompanied by both Chem 3420 and Chem 1100.

**CHEM 3510 Analytical Chemistry II** (LEC 3.0 and LAB 1.0)

A study of analytical chemistry including separation techniques for chemical and biochemical analysis, atomic-molecular mass spectrometry, atomic-molecular spectroscopy, surface analysis with electron spectroscopy, X-ray and mass spectrometry. Prerequisites: Chem 1100, Chem 2510, Chem 2220 and Chem 3410.

**CHEM 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Prerequisite: Preceded or accompanied by Chem 1100 or an equivalent training program approved by S&T. Consent of instructor required.

**CHEM 4001 Special Topics** (LEC 1.0 and LAB 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM 4010 Undergraduate Seminar** (RSD 1.0)

Written and oral presentations of current topics in chemistry. This course may serve as part of the capstone requirement for chemistry majors.

**CHEM 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Does not lead to the preparation of a thesis. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Preparation of a written, detailed report is required of the student. Prerequisite: Must meet departmental requirements for instruction in laboratory safety. Consent of instructor required.

**CHEM 4210 Intermediate Organic Chemistry I** (LEC 3.0)

An advanced course designed to give the student a mastery of the fundamentals of organic chemical reactions and theory. Prerequisite: Chem 2220.

**CHEM 4220 Intermediate Organic Chemistry II** (LEC 3.0)

A systematic study of organic reactions, their mechanisms and synthetic applications. Prerequisite: Chem 2220.

**CHEM 4297 Organic Synthesis And Spectroscopic Analysis** (LAB 2.0 and LEC 1.0)

Advanced methods for the multistep synthesis and characterization of organic compounds. Modern instrumental methods of identification of organic compounds. Prerequisites: Chem 1100, Chem 2220, Chem 2229.

**CHEM 4310 Selected Topics In Inorganic Chemistry** (LEC 3.0)

A study of inorganic chemistry with emphasis on physical methods. General subjects covered include: molecular structure, bonding, complexes, spectroscopy, and reaction rates.

**CHEM 4410 Chemical Thermodynamics II** (LEC 3.0)

A study of the laws of thermodynamics with application to chemical systems. Emphasis is placed on partial molal functions. Prerequisites: Chem 3420.

**CHEM 4420 Chemical Kinetics II** (LEC 3.0)

Advanced treatments of topics in physical chemistry including statistical mechanics and kinetics. Prerequisites: Chem 3420.

**CHEM 4510 Instrumental Methods Of Chemical Analysis** (LEC 3.0 and LAB 1.0)

Principles and analytical applications of molecular spectroscopy, chromatographic separations, mass spectrometry, and radiochemistry. A brief overview of instrument electronics, signal generation and processing, and automated analysis is also provided. Prerequisites: Chem 3510 and Chem 3430.

**CHEM 4610 General Biochemistry** (LEC 3.0)

A resume of the important aspects of quantitative and physical chemistry in biochemical processes. General subjects covered include: proteins, nucleic acids, enzymes, carbohydrates and lipids. Prerequisite: Chem 2220.

**CHEM 4619 General Biochemistry Laboratory** (LAB 2.0)

Experiments are integrated with the lectures and cover the chemical and physical properties of proteins, enzymes, nucleic acids, carbohydrates and lipids. Prerequisites: Preceded or accompanied by both Chem 4610 and Chem 1100.

**CHEM 4620 Metabolism** (LEC 3.0)

A continuation of Chem 4610. Catabolism and anabolism of carbohydrates, lipids, proteins, and nucleic acids. Photosynthesis, oxidative phosphorylation and membranes. Prerequisite: Chem 4610.

**CHEM 4630 Introduction to Bio-Nanotechnology** (LEC 3.0)

This course will educate on the interdisciplinary areas of bio-nanotechnology. Goal is for students to understand how biomacromolecules such as nucleic acids, proteins, and lipids self-assemble to form the functional units of an intact cell. Emphasis will be on current application in DNA/protein nanotechnology, drug delivery and environmental biosensors. Prerequisite: At least junior standing.

**CHEM 4710 Principles Of Environmental Monitoring** (LEC 3.0)

This course provides an overview of environmental monitoring methodologies. Discussion covers thermodynamic and kinetic processes that affect chemical transport and fate in the environment. Federal environmental regulations and remediation technologies are also covered with specific examples. Prerequisites: Chem 2210; Physics 1111 or Physics 1135.

**CHEM 4810 Chemistry And Inherent Properties Of Polymers** (LEC 3.0)

A basic study of the organic chemistry of natural and synthetic high polymers, their inherent properties and their uses in plastic, fiber, rubber, resin, food, paper and soap industries. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with MS&E 4810).

**CHEM 4819 Polymer Science Laboratory** (LEC 1.0 and LAB 2.0)

Lectures and laboratory experiments dealing with polymerization reactions, solution properties and bulk or solid properties will be presented. Each student will prepare polymers and carry out all characterization experiments on actual samples. Prerequisite: Chem 4810 or MS&E 4810 and preceded or accompanied by Chem 1100. (Co-listed with MS&E 4819).

**CHEM 4850 Fundamentals Of Protective Coating I** (LEC 3.0)

Study of the basic principles of protective coatings with particular reference to the paint and varnish industry. Classifications, manufacture, properties and uses of protective coatings. Prerequisite: Chem 1320. (Co-listed with MS&E 4850).

**CHEM 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Prerequisite: Preceded or accompanied by Chem 1100 or an equivalent training program approved by S&T. Consent of instructor required.

**CHEM 5001 Special Topics** (LEC 1.0 and LAB 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM 5099 Master Research** (IND 0.0-6.0)

Master level research with the intent to lead to the preparation of a master degree thesis. Not more than six (6) credit hours allowed for graduate credit. Subject and credit to be arranged with the instructor. Preparation of a written, detailed report culminating in a thesis is required of the student. Prerequisite: Must meet departmental training requirements for laboratory safety. Consent of instructor required.

**CHEM 5100 Laboratory Safety & Hazardous Materials** (LEC 1.0)

A systematic study of safe laboratory operations and pertinent regulations of state and federal agencies. Prerequisites: Graduate standing.

**CHEM 5210 Fundamentals of Organic Reactions** (LEC 3.0)

An advanced course designed to give the student a mastery of the fundamentals of organic chemical reactions and theory. Graduate students are required to demonstrate a higher level of learning on assessments. Prerequisite: Chem 2220.

**CHEM 5220 Synthetic Organic Chemistry** (LEC 3.0)

A systematic study of organic reactions, their mechanisms and synthetic applications. Graduate students are expected to demonstrate a higher level of proficiency during assessments. Prerequisite: Chem 2220.

**CHEM 5250 Industrial Chemical Processes** (LEC 3.0)

Detailed study of various industrial chemical manufacturing processes including underlying chemistry, reaction pathways and separation processes. Prerequisite: Chem Eng 3130 or Chem 2210, or graduate standing. (Co-listed with Chem Eng 5096).

**CHEM 5310 Introduction to Inorganic Chemistry** (LEC 3.0)

A study of inorganic chemistry with emphasis on physical methods. General subjects covered include: molecular structure, bonding, complexes, spectroscopy, and reaction rates. Graduate students are required to demonstrate a higher level of proficiency during assessments.

**CHEM 5410 Advanced Chemical Thermodynamics** (LEC 3.0)

A study of the laws of thermodynamics with application to chemical systems. Emphasis is placed on partial molal functions. Credit will not be given for both Chem 5410 and Chem 4410. Prerequisites: Chem 3420.

**CHEM 5420 Elemental Quantum Chemistry** (LEC 3.0)

A study of molecular structures and spectroscopy, statistical thermodynamics, kinetic theory, chemical kinetics, crystals, and liquids. Prerequisites: Math 2222; Physics 2135 or Physics 2111.

**CHEM 5430 Advanced Chemical Kinetics** (LEC 3.0)

Introductory graduate treatment of special topics of physical chemistry including statistical mechanics and kinetics. Prerequisites: Chem 3430.

**CHEM 5510 Introduction to Chemical Analysis** (LEC 3.0 and LAB 1.0)

Principles and analytical applications of molecular spectroscopy, chromatographic separations, mass spectrometry, and radiochemistry. A brief overview of instrument electronics, signal generation and processing, and automated analysis is also provided. Graduate students are expected to achieve a higher level of proficiency on application and assessments compared to Chem 4510 students. Prerequisites: Chem 1100, Chem 2510, Chem 2220, Chem 3430.

**CHEM 5610 Biochemistry** (LEC 3.0)

A resume of the important aspects of quantitative and physical chemistry in biochemical processes. General subjects covered include: proteins, nucleic acids, enzymes, carbohydrates and lipids. Credit may not be given for both Chem 5610 and Chem 4610. Prerequisite: Chem 2220.

**CHEM 5619 Biochemistry Laboratory** (LAB 2.0)

Experiments are integrated with the lectures and cover the chemical and physical properties of proteins, enzymes, nucleic acids, carbohydrates and lipids. Credit may not be given for both Chem 5619 and Chem 4619. Prerequisites: Preceded or accompanied by Chem 5610 and Chem 1100 or an equivalent training program approved by S&T.

**CHEM 5620 Biochemical Metabolism** (LEC 3.0)

A continuation of Chem 5610. Catabolism and anabolism of carbohydrates, lipids, proteins, and nucleic acids. Photosynthesis, oxidative phosphorylation and membranes. Credit may not be given for both Chem 5620 and Chem 4620. Prerequisite: Chem 4610 or 5610.

**CHEM 5630 Biochemical Nanotechnology** (LEC 3.0)

This course will educate on the interdisciplinary areas of bio-nanotechnology. Student will investigate the potential of nanoscience in advanced applications including DNA/protein nanotechnology, drug delivery, environmental biosensor and emerging biotechnology industries. Credit may not be given for both Chem 5630 and Chem 4630. Prerequisite: At least junior standing.

**CHEM 5710 Environmental Monitoring** (LEC 3.0)

This course provides an overview of environmental monitoring methodologies. Discussion covers thermodynamic and kinetic processes that affect chemical transport and fate in the environment. Federal environmental regulations and remediation technologies are also covered with specific examples. Credit may not be given for both Chem 5710 and Chem 4710. Prerequisites: Chem 2210, Physics 2111.

**CHEM 5810 Introduction to Polymeric Materials** (LEC 3.0)

A basic study of the organic chemistry of natural and synthetic high polymers, their inherent properties and their uses in plastic, fiber, rubber, resin, food, paper and soap industries. Credit may not be given for both Chem 5810 and Chem 4810. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with MS&E 5810).

**CHEM 5819 Polymer Synthesis and Characterization Lab** (LAB 2.0 and LEC 1.0)

Laboratory experiments dealing with polymerization syntheses and solution, bulk and solid properties will be presented. Each student will prepare polymers and carry out all characterization experiments on actual samples. Credit may not be given for both Chem 5819 and Chem 4819. Prerequisite: Chem 4810 or MS&E 4810 or Chem 5810 or MS&E 5810 or Chem Eng 5310, preceded or accompanied by Chem 1100 or Chem 5100 or an equivalent training program approved by S&T. (Co-listed with MS&E 5819).

**CHEM 5850 Introduction to Coating Chemistry** (LEC 3.0)

Study of the basic principles of protective coatings with particular reference to the paint and varnish industry. Classifications, manufacture, properties and uses of protective coatings. Credit may not be given for both Chem 5850 and Chem 4850. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with MS&E 5850).

## Civil Engineering (CIV ENG)

**CIV ENG 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CIV ENG 2002 Cooperative Engineering Training** (IND 1.0-3.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation.

**CIV ENG 2003 Engineering Communications and Computations** (LAB 1.0 and LEC 2.0)

Programming and software tools (including computer aided design and drafting, computer-based mathematics, word processing, spreadsheet, and presentation software) with application to and emphasis on written, graphical, and oral communication in professional civil and architectural engineering practice. (Co-listed with Arch Eng 2003).

**CIV ENG 2200 Statics** (LEC 3.0)

Application of the principles of mechanics to engineering problems of equilibrium. Topics include resultants, equilibrium, friction, trusses, center of gravity and moment of inertia. Prerequisites: Physics 1135 or Physics 1111 with a grade of "C" or better; Math 1215 or Math 1221 with a grade of "C" or better; preceded or accompanied by Math 2222.

**CIV ENG 2210 Mechanics Of Materials** (LEC 3.0)

Application of the principles of mechanics to engineering problems of strength and stiffness. Topics include stress, strain, thin cylinders, torsion, beams, and combined stresses at a point. Prerequisite: Civ Eng 2200 with grade of "C" or better.

**CIV ENG 2211 Materials Testing** (LAB 1.0)

Designed to assist in the teaching of mechanics of materials. Topics include strain measurement, testing machines and properties of materials. Prerequisite: Preceded or accompanied by Civ Eng 2210.

**CIV ENG 2401 Fundamentals Of Surveying** (LAB 1.0 and LEC 2.0)

Surveying fundamentals: leveling, directions, angles, distances, errors, traverse calculations and basic adjustments. Fundamentals of horizontal curves. Lab exercises include leveling, traversing, horizontal circular curve layout and building layout. Prerequisite: Preceded or accompanied by Math 1214 (or 1208).

**CIV ENG 2601 Fundamentals Of Environmental Engineering And Science** (LAB 1.0 and LEC 2.0)

Course discusses fundamental chemical, physical, and biological principles in environmental engineering and science. Topics include environmental phenomena, aquatic pollution and control, solid waste management, air pollution and control, water and wastewater treatment systems, sustainability and life cycle analyses. Prerequisites: Chem 1310, Chem 1301, or Chem 1351; Math 1214, Math 1212, or Math 1208. (Co-listed with Env Eng 2601).



**CIV ENG 2602 Biological Fundamentals Of Environmental Engineering** (LEC 3.0)

Introduction to the function of organisms related to environmental engineering. The course focuses on both the application of organisms to removing contaminants and the effects of contaminants on organisms. Prerequisites: Bio Sci 1113 and preceded or accompanied by Civ/Env Eng 2601. (Co-listed with Env Eng 2602).

**CIV ENG 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CIV ENG 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CIV ENG 3116 Construction Materials, Properties And Testing** (LAB 1.0 and LEC 2.0)

A study of the origin, production, uses and general properties of construction materials accompanied by selected laboratory tests and demonstrations. Prerequisites: Civ Eng 2211 or Min Eng 3812; Civ Eng 3715 or both Geo Eng 1150 and Min Eng 3412.

**CIV ENG 3201 Structural Analysis I** (LAB 1.0 and LEC 2.0)

Loads on Structures. Analysis of statically determinate and indeterminate beams, frames and trusses. Influence lines and moving loads. Computation of deflections. Development and use of theorems of displacement methods including slope-deflection and moment distribution to analyze statically indeterminate structures. Computer solutions. Prerequisites: Civ Eng 2200, 2210 each with a grade of "C" or better. (Co-listed with Arch Eng 3201).

**CIV ENG 3210 Structural Design in Metals** (LEC 2.0 and LAB 1.0)

The analysis and design of structural elements and connections for buildings, bridges and specialized structures utilizing structural metals. Both elastic and plastic designs are considered. Prerequisite: Civ Eng 3201 with a grade of "C" or better. (Co-listed with Arch Eng 3210).

**CIV ENG 3220 Reinforced Concrete Design** (LAB 1.0 and LEC 2.0)

The analysis and design of reinforced concrete beams, slabs, columns, retaining walls and footings by the elastic and ultimate strength methods, including an introduction to the design of prestressed concrete. Introduction to use of computers as a design aid tool. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 3220).

**CIV ENG 3330 Engineering Fluid Mechanics** (LEC 3.0)

Study of fluids at rest and in motion. Topics include fluid properties, statics of fluids, and the control volume approach to conservation of mass, momentum and energy. Applications include flow in pipes, pipe systems, external flow, and fluid flow measurements. Prerequisites: Mech Eng 2350 or Mech Eng 2340, and MATH 3304, each with a grade of "C" or better.

**CIV ENG 3333 Engineering Hydrology** (LAB 1.0 and LEC 2.0)

A study of hydrologic processes as they relate to design of structures for control and management of water. Emphasizes characterization of precipitation processes, development of design hydrographs, rainfall/runoff frequency analysis, ground-water and wells. Prerequisites: Civ Eng 3330 with grade of "C" or better.

**CIV ENG 3334 Water Resources Engineering** (LEC 3.0 and LAB 1.0)

An introduction to the engineering of water resources; flow in closed conduits, pumps, flow in open channels, surface water hydrology, rainfall analysis, hydrograph analysis, flow routing; and ground-water hydrology. Prerequisites: Civ Eng 3330 and Stat 3113 with grades of "C" or better.

**CIV ENG 3335 Hydraulic Engineering** (LAB 1.0 and LEC 2.0)

A study of applied hydraulics to design of systems used for collection or distribution of water. Emphasis on open channel flow, hydraulic machinery, design of supply systems, drainage systems, and hydraulic transients. Prerequisites: Civ Eng 3330 with grade of "C" or better.

**CIV ENG 3500 Transportation Engineering** (LAB 1.0 and LEC 2.0)

A study of operating characteristics of transportation modes including highways, railways, inland waterways, airways, and pipelines. Consideration of traffic control devices, safety, system capacity, design of routes, planning of urban transportation systems, and economic evaluation of transportation alternatives. Prerequisites: Civ Eng 2401 and Civ Eng 2003.

**CIV ENG 3615 Water And Wastewater Engineering** (LEC 3.0)

A study of the engineering design principles dealing with the quantity, quality and treatment of water, and the quantity, characteristics, treatment and disposal of wastewater. Prerequisites: Civ Eng 2601 and at least junior standing. (Co-listed with Env Eng 3615).

**CIV ENG 3715 Fundamentals of Geotechnical Engineering** (LAB 1.0 and LEC 2.0)

Analysis of geotechnical systems including soil classification, index properties, permeability, compressibility and shear strength. Basic geotechnical engineering design principles as they apply to civil constructed facilities, such as analysis of foundations and earth structures. Laboratory determination of the basic properties of soils. Prerequisite: Geo Eng 1150 or Arch Eng 2103; Civ Eng 2210; and preceded or accompanied by Civ Eng 3330.

**CIV ENG 3842 Fundamentals of Building Systems** (LEC 3.0)

An examination of building life support systems and technology of interest to civil engineers in the planning, operation, and maintenance of buildings. Topics include human comfort, electrical, mechanical, water and waste, transportation, lighting, and other systems necessary for building utilization. Prerequisites: Physics 2135, Math 2222, and Junior Standing.

**CIV ENG 4010 Senior Seminar: Engineering In A Global Society** (RSD 1.0)

Discussion of contemporary issues: public safety, health, and welfare; the principles of sustainable development; lifelong learning; impact of engineering solutions in a global and societal and political context; relationships with owners, contractors, and the public; public service; the Code of Ethics; and the Missouri licensing Statutes and Board Rules. Prerequisite: Senior standing. (Co-listed with Arch Eng and Env Eng 4010).

**CIV ENG 4097 Senior Design Project** (LEC 3.0)

Open-ended design projects involving one or more areas of engineering. Planning design projects, philosophy of design, and application of engineering principles to design problems. Prerequisite: Civ Eng 4448 or Arch Eng 4448. (Co-listed with Arch Eng 4097 and Env Eng 4097).

**CIV ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**CIV ENG 4447 Ethical, Legal and Professional Engineering Practice** (LEC 2.0)

Discussions of laws concerning contracts, torts, agencies, real property, partnerships, and corporations. The purposes and implications of the engineering registration law, the effect of legal, ethical and marketing considerations of the practice of Civil Engineering. Prerequisite: Junior standing. (Co-listed with Arch Eng 4447).

**CIV ENG 4448 Fundamentals Of Contracts And Construction Engineering** (LEC 3.0)

A study of the concepts and techniques used in large construction projects for the preparation of engineer service contracts, the development of a project manual, detailed and conceptual cost estimating, and construction scheduling analysis. Prerequisite: Senior Standing. (Co-listed with Arch Eng 4448).

**CIV ENG 4729 Foundation Engineering** (LEC 3.0)

The effect of subsoil conditions on the behavior and choice of foundations. Topics include geotechnical explorations and the design of foundations, which includes the selection of foundation types, the analysis of bearing capacity and settlement of shallow/deep foundations, and retaining walls. Prerequisite: Civ Eng 3715.

**CIV ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CIV ENG 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**CIV ENG 5010 Seminar** (LEC 1.0)

Discussion of current topics. Prerequisite: Senior standing.

**CIV ENG 5070 Teaching Engineering** (LEC 3.0)

Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mgt 5070, Env Eng 5070, Comp Eng 5070, Elec Eng 5070).

**CIV ENG 5112 Bituminous Materials** (LEC 2.0 and LAB 1.0)

Properties, types, and grades of bituminous materials are presented. Emphasis is placed on usage, distress, surface treatment design, and asphalt concrete mix properties, behavior, design manufacture, and construction. Prerequisite: Preceded or accompanied by Civ Eng 3116.

**CIV ENG 5113 Composition And Properties Of Concrete** (LEC 3.0)

Properties of plastic and hardened concrete and the influence of cements, aggregates, water and admixtures upon these properties. The microstructure of cement gel and other factors are related to the behavior of hardened concrete under various types of loading and environments, drying shrinkage, creep and relaxation, fatigue, fracture, and durability. Introduction to statistical quality control of concrete production. Prerequisite: Civ Eng 3116 with a grade of "C" or better.

**CIV ENG 5117 Asphalt Pavement Design** (LEC 3.0)

Structural design of flexible pavements including loading characteristics, properties of pavement components, stress distribution, and the effects of climatic variables on design criteria. Prerequisite: Civ Eng 3116 with a grade of "C" or better.

**CIV ENG 5118 Smart Materials And Sensors** (LEC 2.0 and LAB 1.0)

Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multidisciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior Standing and Math 3304. (Co-listed with Aero Eng 5229, Mech Eng 5229 and Elec Eng 5270).

**CIV ENG 5156 Concrete Pavement Design** (LEC 3.0)

Design of rigid pavements including loading characteristics, properties of pavement components, stress distribution, and the effects of climatic variables on design criteria. Prerequisite: Civ Eng 3116 with a grade of "C" or better.

**CIV ENG 5203 Applied Mechanics In Structural Engineering** (LEC 3.0)

A study of the basic relationships involved in the mechanics of structures. Topics include basic elasticity, failure criteria, fundamental theories of bending and buckling of plates and cylindrical shells for practical application in analysis and design of bridge, building floors, and shell roofs. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 5203).

**CIV ENG 5205 Structural Analysis II** (LEC 3.0)

Classical displacement and force methods applied to structures of advanced design. Analysis of indeterminate structures such as continuous beams, arches, cables, and two and three dimensional frames, and trusses. Analysis of indeterminate structures involving temperature and support settlements effects. Prerequisites: Civ Eng 3201 or Arch Eng 3201. (Co-listed with Arch Eng 5205).

**CIV ENG 5206 Low-Rise Building Analysis and Design** (LEC 3.0)

Characterization of various design loads, load combinations, general methodology of structural designs against lateral loads, code-oriented design procedures, distribution of lateral loads in structural systems, application of the International Building Code in design of loadbearing wall systems, building frame system and moment-resisting frame systems. Prerequisite: Preceded and/or accompanied by Civ -Arch Eng 3210 or Civ-Arch Eng 3220. (Co-listed with Arch Eng 5206).

**CIV ENG 5207 Computer Methods of Structural Analysis** (LEC 3.0)

Force and displacement matrix methods and computer methods applied to structural analysis. Analysis of indeterminate structures such as continuous beams, and two and three dimensional frames and trusses. Analysis of indeterminate structures involving temperature and support settlements effects using computer methods formulation. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 5207).

**CIV ENG 5208 Structural Dynamics** (LEC 3.0)

This course deals with fundamental concepts and structural responses under dynamic loads. Hand calculations and computer methods are developed. Specific topics include resonance, beating phenomenon, equation of motion, dynamic properties, frequencies and mode shapes, and modal and Ritz analyses. Prerequisites: Mech Eng 2350 or equivalent; Civ/Arch Eng 3201 or equivalent. (Co-listed with Arch Eng 5208).

**CIV ENG 5210 Advanced Steel Structures Design** (LEC 3.0)

The design of structural steel systems into a final integrated structure. Plate girders, composite systems, stability, connections, rigid frames, single and multistory buildings, and similar type problems of interest to the student. Use of the computer as a tool to aid in the design will be emphasized. Prerequisite: Civ Eng 3210 with a grade of "C" or better. (Co-listed with Arch Eng 5210).

**CIV ENG 5220 Advanced Concrete Structures Design** (LEC 3.0)

The design of structural concrete systems into a final integrated structure. Two-way slabs, long columns, connections, and discontinuity regions, deflections and cracking of beams and slabs, ACI design criteria, and similar type problems of interest to the student. Use of the computer as a tool to aid in the design will be emphasized. Prerequisite: Civ Eng 3220 with a grade of "C" or better. (Co-listed with Arch Eng 5220).

**CIV ENG 5222 Prestressed Concrete Design** (LEC 3.0)

Behavior of steel and concrete under sustained load. Analysis and design of pre-tensioned and post-tensioned reinforced concrete members and the combining of such members into an integral structure. Prerequisite: Civ Eng 3220 with a grade of "C" or better. (Co-listed with Arch Eng 5222).

**CIV ENG 5231 Infrastructure Strengthening with Composites** (LEC 3.0)

The course presents composite materials and includes principles of reinforcing and strengthening for flexure, shear, and ductility enhancement in buildings and bridges. It covers the design of existing members strengthened with externally bonded laminates and near surface mounted composites. Case studies are discussed. Prerequisites: Civ Eng / Arch Eng 3201, Civ Eng / Arch Eng 3220. (Co-listed with Arch Eng 5231).

**CIV ENG 5250 Air Transportation** (LEC 2.0 and LAB 1.0)

Runway configuration, airfield capacity, geometrics and terminal layout and design. Aircraft performance; navigation and air traffic control; airport planning and design; airline operations; aviation systems planning. Prerequisite: Civ Eng 3500 with a grade of "C" or better.

**CIV ENG 5260 Analysis And Design Of Wood Structures** (LEC 3.0)

A critical review of theory and practice in design of modern wood structures. Effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design; development of design criteria and their application to plane and three dimensional structures. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 5260).

**CIV ENG 5270 Structural Masonry Design** (LEC 3.0)

Review of the theory and practice of analyzing low-rise masonry structures, materials and assembly types, constructability considerations, structural masonry components, repair and strengthening, and model code requirements to ensure adequate load resisting buildings. Prerequisites: Arch Eng 3201 or Civ Eng 3201. (Co-listed with Arch Eng 5270).

**CIV ENG 5330 Unsteady Flow Hydraulics** (LEC 3.0)

The study of unsteady flow and its effect on closed water systems and in open channels. Prerequisites: Civ Eng 3330 with a grade of "C" or better.

**CIV ENG 5331 Hydraulics Of Open Channels** (LEC 3.0)

The phenomena accompanying the flow of water in open channels, such as uniform and varied flow, critical conditions, backwater curves, hydraulic jump, hydraulic drop and applications are studied in detail. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

**CIV ENG 5332 Transport Processes in Environmental Flows** (LEC 3.0)

Dynamics, mixing and contaminant transport in surface water bodies, including rivers and lakes. Buoyancy modifications to the mixing and dynamics of pollutant discharges and surface water bodies. Transport of sediments. Exchange processes at the air/water and sediment/water interfaces. Prerequisite: At least a "C" in Civ Eng 3330.

**CIV ENG 5333 Intermediate Hydraulic Engineering** (LEC 3.0)

Application of fluid mechanics principles to the design. Kinematics of fluid motion, conservation of mass, linear and angular momentum, and energy. Requirements for similarity of fluid flow. Introduction to dynamics of fluid flows and viscous incompressible flows. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

**CIV ENG 5335 Water Infrastructure Engineering** (LAB 1.0 and LEC 2.0)

Fundamental principles underlying comprehensive water infrastructure development; sanitary sewers, sanitary treatment facilities, stormwater sewers, stormwater detention, water power development, and hydraulic structures. The student is responsible for the planning and design of a water infrastructure development project. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

**CIV ENG 5337 River Mechanics And Sediment Transport** (LEC 3.0)

Formation of rivers and the laws governing river regulation and improvements, including navigation and flood protection. Principles governing sediment transport. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

**CIV ENG 5338 Hydrologic Engineering** (LEC 3.0)

A study of current up-to-date hydrologic techniques involving design of hydrologic input for bridges, culverts, reservoirs. Techniques involve extreme value statistics, model hydrographs, routing, etc. Prerequisite: Civ Eng 3334 with a grade of "C" or better.

**CIV ENG 5360 Water Resources And Wastewater Engineering** (LEC 3.0)

Application of engineering principles to the planning and design of multipurpose projects involving water resources development and wastewater collection/treatment/disposal/systems. Latest concepts in engineering analysis are applied to evaluation of alternative solutions. Prerequisites: Civ Eng 3333, 3335, 3615. (Co-listed with Env Eng 5360).

**CIV ENG 5404 Legal Aspects Of Boundary Surveying** (LEC 3.0)

The U.S. Public Land Survey System (USPLSS): original GLO survey instructions and procedures. Resurveys on the USPLSS law, standards, procedures with emphasis on Missouri. Rights in real property; statute, case and administrative law applied to boundaries. Simultaneous and sequence conveyances. Unwritten rights in real property. Riparian boundaries. Writing and interpreting boundary descriptions. Land surveyor duties and responsibilities. Prerequisite: Civ Eng 2401 with grade of "C" or better.

**CIV ENG 5406 Surveying Systems** (LEC 3.0)

Celestial observations for azimuths. Introduction to State Plane Coordinate systems. Theory and calculations. Route surveying and geometrics, horizontal, spiral and vertical curves. Surveying aspects of residential and commercial subdivision design: lot layout, rights of way, easements, setbacks, platting, planning and zoning constraints, application of surveying software. Instrumentation: total stations, electronic levels, instrument calibrations. Prerequisite: Civ Eng 2401 with grade of "C" or better.

**CIV ENG 5441 Professional Aspects Of Engineering Practice** (LEC 3.0)

A study of engineering registration laws, regulations, rules of professional responsibility and standards of practice. Review of causative factors of selected failures and their relationship to professional responsibility. Prerequisite: Senior standing.

**CIV ENG 5442 Construction Planning and Scheduling Strategies** (LEC 3.0)

The goal of this course is to assist participants in gaining an understanding of schedule control techniques and the application of tools such as Primavera Software. Content areas to be addressed include: development of baseline schedules, progress monitoring and updating, recovery schedules, resource application and leveling. Prerequisite: Civ Eng or Arch Eng 4448. (Co-listed with Arch Eng 5442).

**CIV ENG 5445 Construction Methods** (LEC 3.0)

Introduction to construction planning, selection of equipment and familiarization with standard methods for horizontal and vertical construction. Application of network analysis and schedules to project control. Prerequisite: Civ Eng 4448 with a grade of "C" or better. (Co-listed with Arch Eng 5445).

**CIV ENG 5446 Management Of Construction Costs** (LEC 3.0)

Management of construction projects from inception to completion: estimates, role of network preplanning, project monitoring and control. Prerequisites: Civ Eng 4448 with a grade of "C" or better. (Co-listed with Arch Eng 5446).

**CIV ENG 5448 Green Engineering: Analysis of Constructed Facilities** (LEC 3.0)

Environmentally sound design and construction practices. Includes design issues, material selection and site issues that can reduce the impact on the environment caused by the construction process. LEED certification covered in depth. Prerequisites: Civ Eng 4448 or Arch Eng 4448; and Junior Standing. (Co-listed with Arch Eng 5448).

**CIV ENG 5449 Engineering and Construction Contract Specifications** (LEC 3.0)

Legal and business aspects of contracts and contracting procedure in the construction industry. Topics include formulation of contracts in common law, engineering services contracts, and construction project contract documents and contract administration issues. Prerequisite: Civ Eng 4448 with a grade of "C" or better. (Co-listed with Arch Eng 5449).

**CIV ENG 5510 Geometric Design Of Highways** (LEC 2.0 and LAB 1.0)

Development and applications of concepts of geometric design for rural and urban highways. Design controls and criteria; elements of design, including sight distance, horizontal and vertical alignment; cross-section elements; highway types; intersection design elements; types of interchanges and interchange design elements; grade separations and clearance; development of visual elements. Prerequisite: Civ Eng 3500 with grade of "C" or better.

**CIV ENG 5513 Traffic Engineering** (LEC 3.0)

Driver, vehicle, and roadway characteristics; traffic control devices; traffic studies; intersection capacity, intersection design, traffic safety, and evaluation of traffic improvements. Traffic laws and ordinances, traffic engineering, traffic circulation, parking design, and forecasting traffic impacts. Prerequisite: Civ Eng 3500 with a grade of "C" or better.

**CIV ENG 5515 Advanced Traffic Signal Operations** (LEC 3.0)

This course will discuss the role and function of traffic signal components: the signal controller, conflict monitor, vehicle detectors, etc. The course also covers the layout of traffic signal hardware at an intersection and will discuss the phasing/timing of traffic signals in detail. Prerequisite: CIV ENG 5513.

**CIV ENG 5605 Environmental Systems Modeling** (LEC 3.0)

Introductory course in modeling environmental systems. Course will focus on contaminant fate and transport in the environment. Models will be developed that will include physical, chemical and biological reactions and processes that impact this fate. Prerequisites: Env Eng/Civ Eng 2601, Env Eng/Civ Eng 2602 and Env Eng/ Civ Eng 3603; or Graduate standing. (Co-listed with Env Eng 5605).

**CIV ENG 5619 Environmental Engineering Design** (LAB 1.0 and LEC 2.0)

Functional design of water and wastewater facilities and other environmental cleanup systems. Prerequisite: Civ Eng 3615 or Env Eng 3615. (Co-listed with Env Eng 5619).

**CIV ENG 5630 Remediation of Contaminated Groundwater and Soil** (LAB 1.0 and LEC 2.0)

Course covers current in-situ and ex-situ remediation technologies. Current literature and case studies are utilized to provide the focus for class discussions and projects. Prerequisites: Civ Eng 3615, Geo Eng 5237 or Graduate Standing. (Co-listed with Env Eng 5630).

**CIV ENG 5640 Environmental Law And Regulations** (LEC 3.0)

This course provides comprehensive coverage of environmental laws and regulations dealing with air, water, wastewater, and other media. The primary focus is permitting, reporting, and compliance protocols. The course topics include U.S. and international legal systems and judicial processes, liability, enforcement, Clean Air Act, Clean Water Act (NPDES permitting), Safe Drinking Water Act, OSGA, TSCA, RCRA, AND CERCLA. Case studies will be emphasized. (Co-listed with Env Eng 5640).

**CIV ENG 5642 Sustainability, Population, Energy, Water, and Materials** (LEC 3.0)

This course will examine the concepts regarding the continued advancement of humankind while maintaining our ecological niche on earth. Key topics include: population growth, poverty, and impacts of development; energy consumption, sources, storage, conservation and policy; water quality and quantity; materials and building; and policy implications. Prerequisite: Senior or graduate standing. (Co-listed with Env Eng 5642 and Arch Eng 5642).

**CIV ENG 5650 Public Health Engineering** (LEC 3.0)

A comprehensive course dealing with the environmental aspects of public health. Prerequisite: Civ Eng 2601 with a grade of "C" or better. (Co-listed with Env Eng 5650).

**CIV ENG 5660 Introduction To Air Pollution** (LEC 3.0)

Introduction to the field of air pollution dealing with sources, effects, federal legislation, transport and dispersion and principles of engineering control. Prerequisite: Civ Eng 3330; or graduate standing. (Co-listed with Env Eng 5660).

**CIV ENG 5662 Air Pollution Control Methods** (LEC 3.0)

Study of the design principles and application of the state-of-the-art control techniques to gaseous and particulate emissions from fossil fuel combustion, industrial and transportation sources. Prerequisite: Civ Eng 3330; or graduate standing. (Co-listed with Env Eng 5662).

**CIV ENG 5665 Indoor Air Pollution** (LEC 3.0)

By developing a practical understanding of indoor air pollution sources, physics, chemistry and consequences, students will learn how radon, cigarette smoke, VOCs from furnishings, and so forth affect indoor air quality and apply engineering analyses to specify ventilation rates, choose furnishings and minimize occupant exposure to pollutants. Prerequisite: Civ Eng 2601 or Mech Eng 5571 or Graduate Status. (Co-listed with Env Eng 5665 and Arch Eng 5665).

**CIV ENG 5670 Solid Waste Management** (LEC 3.0)

A systematic study of the sources, amounts and characteristics of solid wastes and methods used for their collection, reclamation, and ultimate disposal. Prerequisite: Civ Eng 2601 with grade of "C" or better; or graduate standing. (Co-listed with Env Eng 5670).



**CIV ENG 5702 Geomatics** (LEC 3.0)

Horizontal and vertical geodetic datums and networks. Theory, calculations and applications of State Plane Coordinate Systems. Introduction to Geographic and Land Information Systems: hardware and software issues; data quality and accuracy; resource, environmental, cadastral and governmental applications; databases; GIS/LIS trends. Introduction to Global Positioning Systems (GPS): Project planning, data collection, data processing and network adjustment applications, Kinematic and RealTime GPS applications, hardware and software options and costs. Prerequisite: Civ Eng 2401 with grade of "C" or better.

**CIV ENG 5715 Intermediate Soil Mechanics** (LEC 3.0)

General principles of soil mechanics and their applications, including mineralogy, soil structure, flow through porous media, shear strength, slope stability and consolidation. Prerequisites: Civ Eng 3715 with grade of "C" or better.

**CIV ENG 5716 Geotechnical Earthquake Engineering** (LEC 3.0)

Geotechnical earthquake hazards and mitigations, damage to structures, plate tectonics, seismicity, wave propagation, characterization of ground motions, theory of vibrations (1-DOF), effect of local soil conditions on ground response, development of design ground motions, liquefaction, dynamic lateral earth pressures and slope stability/deformation. Prerequisites: Civ Eng 3715 with a grade of "C" or better.

**CIV ENG 5729 Foundation Engineering II** (LEC 3.0)

Classical earth pressure theories. Analysis of shallow and deep foundations to include bearing capacity and settlement of footings, rafts, piles, and drilled piers. Analysis of stability and design of retaining walls and anchored bulkheads. Prerequisites: Civ Eng 4729 with a grade of "C" or better. (Co-listed with Arch Eng 5729).

**CIV ENG 5744 Geosynthetics in Engineering** (LEC 3.0)

Geotechnical principles are applied to design of geosynthetic systems for foundation support, earth retention, drainage, and disposal of hazardous conventional wastes. Geosynthetic testing and identification. Emphasis is on design of geosynthetic earth reinforcement, roadway stabilization, filters, and waste containment systems. Prerequisite: Civ Eng 3715 with grade of "C" or better.

**CIV ENG 5750 Transportation Applications of Geophysics** (LAB 1.0 and LEC 2.0)

Overview of geophysical and non-destructive test methods that are commonly used to investigate transportation structures and their foundations. Emphasis is placed on bridge system substructure, bridge system superstructure, pavement, roadway subsidence, subsurface characterization and vibration measurements. Prerequisite: Junior level standing or higher. (Co-listed with Geo Eng 5761 and Geophys 5761).

## Computer Engineering (COMP ENG)

**COMP ENG 1200 Introduction to Digital Electronics** (LEC 3.0)

Introduction to electronics and digital circuit design including combinational logic and sequential circuits using circuit design tools, logic gates, integrated circuits and field programmable gate arrays. This course provides S&T equivalent credit for the Project Lead The Way Digital Electronics course.

**COMP ENG 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP ENG 2210 Introduction to Digital Logic** (LEC 3.0)

Binary arithmetic, Boolean algebra, logic and memory elements, computer organization. Prerequisite: Sophomore standing. Comp Eng 2211 is also a co-requisite for Comp Eng and Elec Eng majors.

**COMP ENG 2211 Computer Engineering Laboratory** (LAB 1.0)

Introduction to digital design techniques, logic gates, Medium Scale Integration (MSI) parts and flipflops, Timing analysis, Programming and use of Programmable Logic Devices (PLD). Prerequisite: Preceded or accompanied by Comp Eng 2210.

**COMP ENG 3000 Special Problems** (IND 1.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**COMP ENG 3001 Special Topics** (LEC 1.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP ENG 3002 Cooperative Engineering Training** (IND 1.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation. Pass-fail grading option only. Prerequisite: Consent of the Electrical and Computer Engineering Department required.

**COMP ENG 3110 Computer Organization and Design** (LEC 3.0)

Introduction to basic concepts of computer organization and design: metrics for computer performance, computer arithmetic, Von Neumann architecture, instruction implementation, control unit, pipelining, memory systems hierarchy, cache memories and basic I/O controllers. Prerequisites: COMP ENG 2210; preceded or accompanied by COMP ENG 3150.

**COMP ENG 3150 Introduction to Microcontrollers and Embedded System Design** (LEC 3.0)

Microcontroller-based digital system design methodology and techniques. Topics include basic machine organization, interface design, and C and assembly language programming for real-time embedded systems. Prerequisites: COMP ENG 2210 and COMP SCI 1570 (or programming equivalent) each with grade of "C" or better.

**COMP ENG 3151 Digital Engineering Lab II** (LAB 1.0)

Advanced digital design techniques, Microcontroller based design, hardware and software codesign. Prerequisites: Comp Eng 2210, Comp Eng 2211, and Comp Sci 1570 (or programming equivalent) each with grade of "C" or better. Preceded or accompanied by Comp Eng 3150.

**COMP ENG 4000 Special Problems** (IND 1.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**COMP ENG 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP ENG 4096 Computer Engineering Senior Project I** (LAB 0.50 and RSD 0.50)

A complete design cycle. Working in small teams, students will design, document, analyze, implement, and test a product. Topics include: Iteration in design, prototyping, group dynamics, design reviews, making effective presentations, concurrent design, designing for test, ethics and standards, testing and evaluation. Prerequisites: Comp Eng 2210, either Econ 1100 or Econ 1200, either English 3560 or English 1160, Comp Eng 3150, Comp Eng 3151, Comp Eng 3110, and Elec Eng 2200.

**COMP ENG 4097 Computer Engineering Senior Project II** (LAB 3.0)

A continuation of Comp Eng 4096. Prerequisites: Comp Eng 4096 with a grade of "C" or better, Stat 3117 or Stat 3115 or Stat 5643, and Sp&M S 1185.

**COMP ENG 4099 Undergraduate Research** (IND 1.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**COMP ENG 5000 Special Problems** (IND 1.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**COMP ENG 5001 Special Topics** (LEC 1.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**COMP ENG 5070 Teaching Engineering** (LEC 3.0)

Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mgt 5070, Env Eng 5070, Elec Eng 5070, Civ Eng 5070).

**COMP ENG 5099 Special Research And Thesis** (IND 1.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Prerequisite: Consent of the instructor required.

**COMP ENG 5110 Principles of Computer Architecture** (LEC 3.0)

Principles of performance measurement and instruction set design; advanced issues in pipelining; instruction level parallelism (dynamic scheduling, branch prediction, multi-issue processors); memory hierarchies for superscalar processors; multiprocessors; multi-threading; storage systems; and interconnection networks. Prerequisite: Comp Eng 3110.

**COMP ENG 5120 Digital Computer Design** (LEC 3.0)

Organization of modern digital computers; design of processors, memory systems and I/O units, hardware-software tradeoffs in different levels of computer system design. Prerequisites: COMP ENG 3150 and COMP ENG 3151.

**COMP ENG 5130 Advanced Microcomputer System Design** (LEC 3.0)

The design of digital systems based on advanced microprocessors. Introduction to microcomputer logic development systems. I/O interfaces. Assembly and high level language tradeoffs. Hardware and software laboratory projects required. Prerequisites: COMP ENG 5110.

**COMP ENG 5151 Digital Systems Design Laboratory** (LAB 1.0 and LEC 2.0)

Experimental studies of problems with high speed digital signals in circuits. Student designs, wires, tests, and programs a microprocessor based single board computer project. A FPGA design is programmed and tested. Prerequisites: COMP ENG 3150 or 5110.

**COMP ENG 5160 Embedded Processor System Design** (LEC 3.0)

Development of hardware and software for embedded systems, including real-time operating systems, advanced programming, communication schemes, hardware peripherals and sensors, control methodologies, printed-circuit board design, interrupts, microcontrollers, and hardware-software co-design. One or more team design projects. Prerequisites: COMP ENG 3150 or equivalent or 80x51 processor experience.

**COMP ENG 5170 Real-Time Systems** (LEC 3.0)

Introduction to real-time (R-T) systems and R-T kernels, also known as R-T operating systems, with an emphasis on scheduling algorithms. The course also includes specification, analysis, design and validation techniques for R-T systems. Course includes a team project to design an appropriate R-T operating system. Prerequisites: COMP ENG 3150 or COMP SCI 3800.

**COMP ENG 5210 Introduction To VLSI Design** (LEC 3.0)

An introduction to the design and analysis of digital integrated circuits (ICs). Topics include basic manufacturing techniques, transistor-level design and analysis of logic and memory circuits, logic timing, and parasitics. Computer aided design tools are used to develop circuits in the lab. Prerequisites: Elec Eng 2200 and Comp Eng 2210.

**COMP ENG 5220 Digital System Modeling** (LEC 3.0)

Digital system modeling for simulation, synthesis, and rapid system prototyping. Structural and behavioral models, concurrent and sequential language elements, resolved signals, generics, configuration, test benches, processes and case studies. Prerequisite: Comp Eng 2210 with a grade of "C" or better.

**COMP ENG 5230 Optical Computing** (LEC 3.0)

Introduction to the principles, subsystems, and architectures of optical computing. Topics include characteristics of optical devices; optical implementations of memory, logic elements, and processors; and computational structures. Prerequisite: Comp Eng 2210 or equivalent. (Co-listed with Elec Eng 5250).

**COMP ENG 5310 Computational Intelligence** (LEC 3.0)

Introduction to Computational Intelligence (CI), Biological and Artificial Neuron, Neural Networks, Evolutionary Computing, Swarm Intelligence, Artificial Immune Systems, Fuzzy Systems, and Hybrid Systems. CI application case studies covered include digital systems, control, power systems, forecasting, and time-series predictions. Prerequisite: Graduate Standing. (Co-listed with Elec Eng 5310 and Sys Eng 5211).

**COMP ENG 5410 Introduction to Computer Communication Networks** (LEC 3.0)

Design of computer networks with emphasis on network architecture, protocols and standards, performance considerations, and network technologies. Topics include: LAN, MAN, WAN, congestion/flow/error control, routing, addressing, broadcasting, multicasting, switching, and internetworking. A modeling tool is used for network design and simulation. Prerequisites: Comp Eng 3150 or computer hardware competency and Stat 3117 or Stat 3115 or Stat 5643 or equivalent.

**COMP ENG 5420 Introduction to Network Security** (LEC 3.0)

This course examines basic issues in network management, testing, and security; it also discusses key encryption, key management, authentication, intrusion detection, malicious attack, and insider threats. Security of electronic mail and electronic commerce systems is also presented. Prerequisite: Comp Eng 5410 or Comp Sci 5600.

**COMP ENG 5430 Wireless Networks** (LEC 2.0 and LAB 1.0)

Introduction to wireless communications and networking. Topics include transmission fundamentals, wireless channel, coding techniques and error control, satellite and cellular networks, cordless systems, mobile IP and management, multiple access techniques and wireless protocols, wireless LAN, IEEE 802.11, and adhoc and sensor networks. Prerequisites: Hardware competency, Elec Eng 3420 or Comp Eng 3150 and graduate standing. (Co-listed with Elec Eng 5430 and Sys Eng 5323.).

**COMP ENG 5450 Digital Image Processing** (LEC 3.0)

Fundamentals of human perception, sampling and quantization, image transforms, enhancement, restoration, channel and source coding. Prerequisites: At least one of the following: Elec Eng 3400, Elec Eng 3410, Elec Eng 3420, or prior exposure to Fourier Transforms and consent of the instructor. (Co-listed with Elec Eng 5450).

**COMP ENG 5460 Machine Vision** (LEC 3.0)

Image information, image filtering, template matching, histogram transformations, edge detection, boundary detection, region growing and pattern recognition. Complementary laboratory exercises are required. Prerequisites: At least one of the following: Elec Eng 3400, Elec Eng 3410, Elec Eng 3420, or prior exposure to Fourier Transforms and consent of the instructor. (Co-listed with Elec Eng 5460).

**COMP ENG 5510 Fault-Tolerant Digital Systems** (LEC 3.0)

Design and analysis of fault-tolerant digital systems. Fault models, hardware redundancy, information redundancy, evaluation techniques, system design procedures. Prerequisites: Comp Eng 2210 and Comp Eng 2211.

**COMP ENG 5610 Real-Time Digital Signal Processing** (LEC 2.0 and LAB 1.0)

Introduction to the use of programmable DSP chips. Includes real-time data acquisition, signal generation, interrupt-driven programs, high-level language, and assembly level routines. Applications to real-time systems are also presented. Prerequisite: Elec Eng 3400 or Elec Eng 3410.

**COMP ENG 5620 Signal Integrity in High-Speed Digital & Mixed Signal Design** (LEC 3.0)

Signal integrity ensures signals transmitted over a propagation path maintain sufficient fidelity for proper receiver operation. Compromised signal integrity is often associated with parasitics (e.g. unintentional inductance, capacitance). Theory and CAD tools used for signal integrity analysis of functioning designs. Prerequisites: Elec Eng 3600 or Comp Eng 3150, and Senior standing. (Co-listed with Elec Eng 5620).

**COMP ENG 5803 Mathematical Logic I** (LEC 3.0)

A mathematical introduction to logic with some applications. Functional and relational languages, satisfaction, soundness and completeness theorems, compactness theorems. Examples from Mathematics, Philosophy, Computer Science, and/or Computer Engineering. Prerequisite: Philos 3254 or Math 5105 or Comp Sci 2500 or Comp Eng 2210. (Co-listed with Comp Sci 5203, Philos 4354 and Math 5154).

**COMP ENG 5820 Mechatronics** (LEC 2.0 and LAB 1.0)

This course will introduce students to the basics of mechatronics (i.e., the integration of mechanical, electrical, computer, and control systems). Students will learn the fundamentals of sensors and actuators for mechanical systems, computer interfacing, microcontrollers, real-time software, and control. Prerequisite: Mech Eng 4479 or equivalent. (Co-listed with Mech Eng 5478, Aero Eng 5478 and Elec Eng 5870).

**COMP ENG 5880 Introduction to Robotics** (LEC 3.0)

This course provides an introduction to robotics, covering robot hardware, fundamental kinematics, trajectories, differential motion, robotic decision making, and an overview of current topics in robotics. Prerequisite: A "C" or better in both Math 3108 and Comp Sci 1510. (Co-listed with Comp Sci 5403 and Elec Eng 5880).

## Computer Science (COMP SCI)

**COMP SCI 1001 Special Topics** (LAB 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP SCI 1010 Introduction To Computer Science** (LEC 1.0)

This course is devoted to an introduction of various areas of Computer Science, the faculty members, and lab equipment. Computer ethics will be discussed in several lectures.

**COMP SCI 1200 Discrete Mathematics For Computer Science** (LEC 3.0)

A rigorous treatment of topics from discrete mathematics which are essential to computer science. Principal topics include: formal logic (propositional & predicate), proof techniques, mathematical induction, program correctness, sets, combinatorics, probability, relations, functions, matrices, graph theory and graph algorithms. Prerequisite: A "C" or better grade in Comp Sci 1570.

**COMP SCI 1570 Introduction To Programming** (LEC 3.0)

Programming design and development using C++. Emphasis placed on problem solving methods using good programming practices and algorithm design and development. Topics included are syntax/ semantics, logical, relational and arithmetic operators, decision branching, loops, functions, file I/O, arrays, output formatting, C-strings, and an introduction to Object-Oriented Programming including the development and use of classes. Prerequisite: Accompanied by Comp Sci 1580.

**COMP SCI 1575 Data Structures** (LEC 3.0)

A continuation of Object-Oriented Programming, with emphasis on the efficient organization of data through Abstract Data Types and Data Structures. Topics include Linked Lists, Vectors, Stacks, Queues, Trees, Hash Tables, Graphs and their use in a variety of algorithms. Recursive programming techniques are also covered. This course is programming intensive. Prerequisite: Grade of "C" or better in Comp Sci 1570.

**COMP SCI 1580 Introduction To Programming Laboratory** (LAB 1.0)

Practical applications of concepts learned in Computer Science 1570. Hands-on instruction in C++ developing, debugging, and testing programming projects. Prerequisite: Accompanied by Comp Sci 1570.

**COMP SCI 1585 Data Structures Laboratory** (LAB 1.0)

Hands-on instruction in programming development tools such as version control systems, integrated development environments, debuggers, profilers, and event-based programming environments. Exercises will complement the concepts presented in Comp Sci 1575. Prerequisite: Preceded or accompanied by Comp Sci 1575.

**COMP SCI 1970 Basic Scientific Programming** (LEC 2.0)

Introduction to the structure of programs and programming techniques in Fortran to solve science and engineering problems. Topics include data representation, basic solutions of numerical problems and the debugging and verification of programs. Prerequisite: Entrance requirements.



**COMP SCI 1971 Introduction To Programming Methodology** (LEC 2.0)

Basic structured programming and problem solving techniques using C+. Development, debugging, and testing of programs, data representation. Topics to include syntax/semantics, operators, loops, decision branching, arrays, file I/O. This course is a terminal course for non-majors and is not sufficient for entry into Computer Science 1510.

**COMP SCI 1972 Introduction to MATLAB Programming** (LEC 2.0)

Programming design and development using MATLAB for non-CS majors. Strong emphasis placed on algorithmic problem solving methods using good programming practices. Introduction to built-in functions including plotting, as well as logical/relational/arithmetic operators, decision branching, loops, functions, file I/O, datastructures, and output formatting. Prerequisite: Accompanied by Comp Sci 1982 and a "C" or better grade in either Math 1208 or Math 1214.

**COMP SCI 1980 Computer Programming Laboratory** (LAB 1.0)

A laboratory to accompany Comp Sci 1970 which emphasizes the designing, writing and debugging of programs in Fortran. Prerequisite: Accompanied by Comp Sci 1970.

**COMP SCI 1981 Programming Methodology Laboratory** (LAB 1.0)

A hands-on introduction to structured programming in C++. Development, coding, debugging, and execution of programming concepts discussed in Computer Science 1971. Prerequisite: Accompanied by Computer Science 1971.

**COMP SCI 1982 MATLAB Programming Laboratory** (LAB 1.0)

Practical application of concepts learned in Comp Sci 1972. Hands-on instruction in MATLAB developing, debugging and testing programming projects. Prerequisite: Accompanied by Comp Sci 1972.

**COMP SCI 2001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP SCI 2002 Cooperative Work Training** (IND 1.0-5.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation. Not more than 9 hours may be applied to the B.S. degree.

**COMP SCI 2200 Theory of Computer Science** (LEC 3.0)

This course will cover the theoretical underpinnings of computer science. In particular, this course will cover the following topics: basic computability and formal language concepts, regular languages, context free languages, recursively-enumerable languages, and classes P, NP, and NP-completeness. Prerequisite: A "C" or better grade in both Comp Sci 1200 and Comp Sci 1510.

**COMP SCI 2300 File Structures And Introduction To Database Systems** (LEC 3.0)

Course covers major topics in file structures and database systems including techniques for disk access and organization, record and file structures, index structures, sequential file, dense/sparse and secondary indexes, B-trees, range queries, insertion/deletion, hash tables, fundamentals of database systems, the ER model, relational model, algebra and SQL. Prerequisite: A "C" or better grade in Comp Sci 1510.

**COMP SCI 2500 Algorithms** (LEC 3.0)

Students will solve recurrence relations, analyze algorithms for correctness and time/space complexity, apply these analysis techniques to fundamental dynamic programming, greedy, shortest-path, minimal spanning trees, and maximum flow algorithms and validate these analyses through programming. Prerequisite: A "C" or better grade in both Comp Sci 1200 and Comp Sci 1510; preceded by "C" or better grade in either Math 1208 or Math 1214, or accompanied by either Math 1208 or Math 1214.

**COMP SCI 2501 Java and Object Oriented Design** (LEC 3.0)

This course will cover Basic Java, Applets, Application, Classes, interfaces, Strings, Arrays, Generics, inheritance, Polymorphism, Algorithm and Object Oriented Design, Software Testing, Exception Handling, File I/O. The use of Graphical User Interfaces in program design and introduction to Software Life Cycle. Project included. Prerequisite: A "C" or better grade in Comp Sci 1570.

**COMP SCI 2889 Introduction To Computer Organization And Assembly** (LEC 3.0)

A detailed study designed to teach the building blocks of a computer system, assembly language programming and the basic computer organization concepts. Subjects include digital logic, performance issues, machine & assembly language, binary arithmetic, and the structure of an ALU. Prerequisites: Comp Sci 1510 and Comp Sci 1200.

**COMP SCI 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP SCI 3010 Seminar** (IND 0.0-6.0)

Discussion of current topics.

**COMP SCI 3100 Software Engineering I** (LEC 3.0)

Development of methodologies useful in the software engineering classical life cycle. This includes: requirements, design, implementation, and testing phases. These methodologies are reinforced through utilization of a CASE tool and a group project. Prerequisite: A "C" or better grade in Comp Sci 2500 and at least Junior standing.

**COMP SCI 3200 Introduction To Numerical Methods** (LEC 3.0)

Finite difference interpolation, numerical differentiation and integration, linear systems of equations, solution of nonlinear equations, numerical solution of ordinary differential equations, computational techniques and the programming of a large number of problems on digital computers. Prerequisites: Program competency and a "C" or better grade in either Math 1215 or Math 1221.

**COMP SCI 3500 Programming Languages And Translators** (LEC 3.0)

Covers basic design of programming languages, compilers and interpreters. The concepts of syntax, variables, expressions, types, scope, functions, procedures, statements, I/O, exception handling and concurrency are introduced. The manner in which various programming languages handle these concepts is discussed. Prerequisite: A "C" or better grade in Comp Sci 2200.

**COMP SCI 3600 Introduction to Computer Security** (LEC 3.0)

This course encompasses threats and vulnerabilities, trust and security policies, and enforcement. Specific topics include access control, risk management, systems and applications life cycle, physical security, key management, transmission security, and cryptography. Prerequisite: A "C" or better grade in Comp Sci 2500.



**COMP SCI 3601 Digital Forensics** (LEC 3.0)

Planning/managing incidents and response related to digital forensics; identifying, collecting, and preserving digital evidence; live/dead approaches covering systems as a whole emphasizing file system forensics; analysis and interpretation of artifacts culminating in a final project consisting of a collection, analysis, and report; legal and ethical issues. Prerequisites: A "C" or better grade in both COMP SCI 3600 and COMP SCI 3800.

**COMP SCI 3800 Introduction To Operating Systems** (LEC 3.0)

This course teaches the concepts, structure, and mechanisms of Operating Systems. Topics include process management, concurrency, synchronization, deadlock, multithreading, memory management, scheduling, and internetworking. Special emphasis is given to Unix and its modern-day derivatives. Prerequisites: A "C" or better grade in all of Comp Sci 1510, Comp Sci 1200, and Comp Eng 3150.

**COMP SCI 3803 Computer Organization** (LEC 3.0)

A detailed study of computer organization concepts and the components of a computer system including control unit, microprogramming, pipelining, memory hierarchy, cache design, virtual memory, I/O devices, and a brief introduction to parallel processors. Prerequisites: A "C" or better in both Comp Eng 2210 and Comp Sci 1510.

**COMP SCI 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**COMP SCI 4001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP SCI 4010 Seminar** (IND 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

**COMP SCI 4096 Software Systems Development I** (LEC 3.0)

Class members will work in small teams to develop a complete software system beginning with end-user interviews and concluding with end-user training. Prerequisites: 100 credit hours completed and a grade of "C" or better in both Comp Sci 3100 and one of Phil 3225, Phil 3235, Phil 4340, or Phil 4368.

**COMP SCI 4097 Software Systems Development II** (LEC 3.0)

This course is an optional continuation of Comp Sci 397. Those interested in project management should take this course since participants become officers or group leaders in the class "corporation." This course is especially important for those going straight into industry upon graduation. Students with coop experience may find this course redundant. Prerequisite: A "C" or better grade in Comp Sci 4096.

**COMP SCI 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Does not lead to the preparation of a thesis. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the faculty supervisor.

**COMP SCI 4489 Multimedia Systems** (LEC 3.0)

This course introduces the concepts and components of Multimedia information systems. Topics include: Introduction to Multimedia Data, Multimedia Data Compression, Techniques and Standards, Indexing and Retrieval, Data Storage Organization, Communication and Synchronization, Applications-Media-OnDemand Systems, Video Conferencing, Digital Libraries. Prerequisite: A "C" or better grade in Comp Sci 1510.

**COMP SCI 4600 Computer Communications And Networks** (LEC 3.0)

Network architecture model including physical protocols for data transmission and error detection/correction, data link concepts, LAN protocols, internetworking, reliable end to end service, security, and application services. Students will implement course concepts on an actual computer network. Prerequisite: A "C" or better grade in Comp Sci 3800.

**COMP SCI 4601 Computer Network Concepts And Technology** (LEC 3.0)

This course will introduce computer network concepts and will survey the current and evolving technology for the construction, operation, and management of those networks. Both hardware and software issues will be addressed with a focus on local area networks. Prerequisite: A "C" or better grade in Comp Sci 3800.

**COMP SCI 4700 Intellectual Property For Computer Scientists** (LEC 3.0)

A presentation of the relationship between the law of intellectual property and computer science. Topics include the application of copyright principles to computer programs, protection of computer programs through patents and trade secret law, and the effect of various agreements which are frequently encountered by the computer scientist. Prerequisite: Senior or graduate standing.

**COMP SCI 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**COMP SCI 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**COMP SCI 5099 Research** (IND 0.0-16)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**COMP SCI 5100 Agile Software Development** (LEC 3.0)

Understand principles of agile software development and contrast them with prescriptive processes. Specifically: Eliciting, organizing, and prioritizing requirements; Design processes; Understand how a particular process promotes quality; Estimate costs and measure project progress and productivity. Prerequisite: A "C" or better grade in Comp Sci 3100.

**COMP SCI 5101 Software Testing And Quality Assurance** (LEC 3.0)

It covers unit testing, subsystem testing, system testing, object-oriented testing, testing specification, test case management, software quality factors and criteria, software quality requirement analysis and specification, software process improvement, and software total quality management. Prerequisite: A "C" or better grade in Comp Sci 2500.

**COMP SCI 5102 Object-Oriented Analysis And Design** (LEC 3.0)

This course will explore principles, mechanisms, and methodologies in object-oriented analysis and design. An object-oriented programming language will be used as the vehicle for the exploration. Prerequisite: A "C" or better grade in Comp Sci 2500.

**COMP SCI 5200 Analysis Of Algorithms** (LEC 3.0)

The purpose of this course is to teach the techniques needed to analyze algorithms. The focus of the presentation is on the practical application of these techniques to such as sorting, backtracking, and graph algorithms. Prerequisite: A "C" or better grade in Comp Sci 2500.

**COMP SCI 5201 Object-Oriented Numerical Modeling I** (LEC 3.0)

A study of object-oriented modeling of the scientific domain. Techniques and methodologies will be developed enabling the student to build a class library of reusable software appropriate for scientific application. Applications will be drawn from mechanics, finance, and engineering. Prerequisites: A "C" or better grade in both Comp Sci 3200 and Comp Sci 1510; a "C" or better grade in one of Math 3108, 3103, 3329.

**COMP SCI 5202 Object-Oriented Numerical Modeling II** (LEC 3.0)

A continued study of object-oriented modeling of the scientific domain. Advanced applications include models posed as balance laws, integral equations, and stochastic simulations. Prerequisite: A "C" or better grade in Comp Sci 5201.

**COMP SCI 5203 Mathematical Logic I** (LEC 3.0)

A mathematical introduction to logic with some applications. Functional and relational languages, satisfaction, soundness and completeness theorems, compactness theorems. Examples from Mathematics, Philosophy, Computer Science, and/or Computer Engineering. Prerequisite: Philos 3254 or Math 5105 or Comp Sci 2500 or Comp Eng 2210. (Co-listed with Math 5154, Philos 4354 and Comp Eng 5803.).

**COMP SCI 5204 Regression Analysis** (LEC 3.0)

Simple linear regression, multiple regression, regression diagnostics, multicollinearity, measures of influence and leverage, model selection techniques, polynomial models, regression with autocorrelated errors, introduction to non-linear regression. Prerequisites: Math 2222 and one of Stat 3111, 3113, 3115, 3117, or 5643. (Co-listed with Stat 5346).

**COMP SCI 5300 Database Systems** (LEC 3.0)

This course introduces the advanced database concepts of normalization and functional dependencies, transaction models, concurrency and locking, timestamping, serializability, recovery techniques, and query planning and optimization. Students will participate in programming projects. Prerequisite: A "C" or better grade in both Comp Sci 1200 and Comp Sci 2300.

**COMP SCI 5400 Introduction To Artificial Intelligence** (LEC 3.0)

A modern introduction to AI, covering important topics of current interest such as search algorithms, heuristics, game trees, knowledge representation, reasoning, computational intelligence, and machine learning. Students will implement course concepts covering selected AI topics. Prerequisite: A "C" or better grade in Comp Sci 2500.

**COMP SCI 5401 Evolutionary Computing** (LEC 3.0)

Introduces evolutionary algorithms, a class of stochastic, population-based algorithms inspired by natural evolution theory (e.g., genetic algorithms), capable of solving complex problems for which other techniques fail. Students will implement course concepts, tackling science, engineering and/or business problems. Prerequisite: A "C" or better grade in both Comp Sci 2500 and in a Statistics course.

**COMP SCI 5402 Data Mining & Machine Learning** (LEC 3.0)

Classical and modern data mining and machine learning algorithms; data preprocessing/warehousing, mining association rules, classification/prediction methods, clustering techniques, Bayesian networks; unsupervised/supervised/reinforcement learning, learning decision trees, artificial neural networks, support vector machines, and ensemble learning. Prerequisites: A "C" or better in both Comp Sci 2300 and one of Stat 3111, Stat 3113, Stat 3115, Stat 3117.

**COMP SCI 5403 Introduction to Robotics** (LEC 3.0)

This course provides an introduction to robotics, covering robot hardware, fundamental kinematics, trajectories, differential motion, robotic decision making, and an overview of current topics in robotics. Prerequisite: A "C" or better in both Math 3108 and Comp Sci 1510. (Co-listed with Comp Eng 5880 and Elec Eng 5880).

**COMP SCI 5404 Introduction to Computer Vision** (LEC 3.0)

This course introduces foundational theories and analysis methods in computer vision. Topics will include camera model and geometry, description of visual features, shape analysis, stereo reconstruction, motion and video processing, and visual object recognition. Prerequisite: A "C" or better grade in both Math 3108 and Comp Sci 2500.

**COMP SCI 5405 Java Gui & Visualization** (LEC 3.0)

Fundamentals of Java Swing Foundation Classes, Java System Language Specifics, Graphical User Interfaces, Images, Audio, Animation, Networking, and Threading. Visualization of Algorithms. GUI Elements include Event Driven Programming, Interaction with Mouse and KeyBoard, Window Managers, Frames, Panels, Dialog Boxes, Borders. Prerequisite: A "C" or better grade in Comp Sci 2500 or equivalent.

**COMP SCI 5406 Interactive Computer Graphics** (LEC 3.0)

Applications and functional capabilities of current computer graphics systems. Interactive graphics programming including windowing, clipping, segmentation, mathematical modeling, two and three dimensional transformations, data structures, perspective views, antialiasing and software design. Prerequisite: A "C" or better grade in both Comp Sci 3200 and Comp Sci 2500.

**COMP SCI 5500 The Structure of a Compiler** (LEC 3.0)

Review of Backus normal form language descriptors and basic parsing concepts. Polish and matrix notation as intermediate forms, and target code representation. Introduction to the basic building blocks of a compiler: syntax scanning, expression translation, symbol table manipulation, code generation, local optimization, and storage allocation. Prerequisite: A "C" or better grade in both Comp Sci 3500 and Comp Sci 2500.

**COMP SCI 5600 Computer Networks** (LEC 3.0)

This course focuses on the Internet and the general principles of computer networking. It covers the TCP/IP model from the application layer to the link layer in a top-down approach. It also exposes students to multimedia networking, network security, wireless and mobile networks. It is a networking class targeted for entry-level graduate students. This course has additional requirements beyond CS4600 on network performance modeling and analysis, development and implementation of complex communication protocols. Credit will not be given if previously have taken CS4600 or CpE 4410/5410. Prerequisite: A "C" or better grade in Comp Sci 3800.

**COMP SCI 5601 Security Operations & Program Management** (LEC 3.0)

An overview of information security operations, access control, risk management, systems and application life cycle management, physical security, business continuity planning, telecommunications security, disaster recovery, software piracy, investigations, ethics and more. There will be extensive reporting, planning and policy writing. Prerequisite: A "C" or better grade in all of: operating systems, computer networking, and a writing emphasized course.

**COMP SCI 5700 Bioinformatics** (LEC 3.0)

The course will familiarize students with the application of computational methods to biology, as viewed from both perspectives. It will introduce problems in molecular, structural, morphological, and biodiversity informatics, and will discuss principles, algorithms, and software to address them. Prerequisites: A grade of "C" or better in both one of Bio Sci 1113 or Bio Sci 1213 and one of Comp Sci 1570 and Comp Sci 1580 or Comp Sci 1971 and Comp Sci 1981. (Co-listed with Bio Sci 5323).

**COMP SCI 5800 Distributed Computing** (LEC 3.0)

This is an introduction to the fundamentals of distributed computing. Topics include a review of communication between distributed processes, causality, distributed state maintenance, failure detection, reconfiguration and recovery, distributed mutual exclusion, clock synchronization, and leader election. Students will implement select course concepts. Prerequisites: A grade of "C" or better in both Comp Sci 3800 and Comp Sci 2500.

**COMP SCI 5801 The Structure Of Operating Systems** (LEC 3.0)

The hardware and software requirements for operating systems for uniprogramming, multiprogramming, multiprocessing, time sharing, real time and virtual systems. The concepts of supervisors, interrupt handlers, input/output control systems, and memory mapping are discussed in detail. Prerequisite: A "C" or better grade in Comp Sci 3800.

**COMP SCI 5802 Introduction to Parallel Programming and Algorithms** (LEC 3.0)

Parallel and pipelined algorithms, architectures, network topologies, message passing, process scheduling and synchronization. Parallel programming on clusters. Cost, speedup and efficiency analysis. Prerequisite: A "C" or better grade in both Comp Sci 3800 and Comp Sci 2500.

**COMP SCI 5803 Introduction to High Performance Computer Architecture** (LEC 3.0)

Overviews high performance architecture of computing systems and covers various architectural/hardware and software/algorithmic means that enhance performance. Uniprocessor and concurrent systems are investigated. Various computational models are studied and linked to commercial systems. Prerequisite: A "C" or better grade in both Comp Eng 3150 and Comp Sci 2500.

## Economics (ECON)

**ECON 1000 Special Problems** (IND 1.0-6.0)

Problems or readings on specific subjects or projects in the department. Prerequisite: Consent of instructor required.

**ECON 1001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ECON 1100 Principles Of Microeconomics** (LEC 3.0)

An examination of how resources and products are priced and how income is distributed within various types of market structures.

**ECON 1200 Principles Of Macroeconomics** (LEC 3.0)

A study of alternative strategies for managing the U.S. economy within a global environment, to attain the goals of full employment, stability and growth.

**ECON 1300 Business And Economic Statistics I** (LEC 3.0)

This is an introductory course in business and economic statistics. Our main objective is to familiarize the student with elementary statistical concepts within the context of numerous applications in Business and Economics. We will highlight the primary use of statistics, that is, to glean information from an available sample regarding the underlying population. Prerequisite: Math 1120 or Math 1140 with a grade of "C" or better. (Co-listed with Stat 1111).

**ECON 2000 Special Problems** (IND 1.0-6.0)

Problems or readings on specific subjects or projects in the department. Prerequisite: Consent of instructor required.

**ECON 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ECON 2100 Intermediate Microeconomic Theory** (LEC 3.0)

Analysis of demand and supply in various market environments using the theories of production, resource pricing, and distribution of income. Emphasis on efficiency attainment and the rationale for market intervention. Prerequisites: Econ 1100 and 1200.

**ECON 2114 Managerial Economics** (LEC 3.0)

Focuses on micro- and macroeconomic contributions to managerial decision-making, business analysis and strategy. The roles of information, economic incentives, efficient markets, profits and decision-making under risk and uncertainty will be explored in both domestic and global settings. Prerequisites: Econ 1100 & 1200.

**ECON 2200 Intermediate Macroeconomic Theory** (LEC 3.0)

Examines the theoretical framework of national income and product generation, and the use of this theory to construct approaches such as, monetary and fiscal policy to attain economic, political and social goals. Prerequisites: Econ 1100 and 1200.

**ECON 2300 Economic and Business Applications** (LAB 1.0 and LEC 2.0)

Introduction and application of basic econometric and statistical techniques to solve real business and economics problems. Practical, hands-on use of Excel and SPSS will be introduced in the course. Prerequisites: Econ 1100 or 1200; Math 1140 or higher; Stat 1115 or 3111 or 3113 or 3115 or 3117 or 5643.

**ECON 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ECON 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ECON 3512 Mining Industry Economics** (LEC 3.0)

Importance of the mineral industry to national economy, uses, distribution, and trade of economic minerals, time value of money, mineral taxation, economic evaluation utilizing depreciation, depletion, and discounted cashflow concepts, social and economical significance of mineral resources. Prerequisite: Econ 1100 or 1200. (Co-listed with Min Eng 3512).

**ECON 3810 Law And Economics** (LEC 3.0)

Study of application of economics analysis to legal concepts, issues and reasoning. Emphasizes the use of microeconomic theory to examine questions of efficacy and efficiency of decisions emanating from three major areas of common law -property rights, contracts and torts. Prerequisite: Econ 1100 or equivalent.

**ECON 3830 History Of Economic Thought** (LEC 3.0)

Contributions of the classical and modern economists to the development of economic thought. Course aims at establishing a synthesis of evolving doctrines which have become the basis of currently accepted economic theory. Prerequisites: Econ 1100 and 1200.

**ECON 3880 Introduction to Sports Economics** (LEC 3.0)

The course uses economics to analyze the business of sports. The course is designed for students with both an introductory or broader economics background, but who have not studied the economics of sports. Topics include labor relations, stadium financing, league structure, competitive balance, amateurism, sports gambling and in-game strategy. Prerequisite: Econ 1100 or Econ 1200.

**ECON 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ECON 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ECON 4010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

**ECON 4085 Internship** (IND 0.0-6.0)

Internship will involve students applying critical thinking skills and discipline-specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisite: Senior status; must have completed 24 hours in major.

**ECON 4120 Micro and Macro Economics Essentials** (LEC 1.5)

This course is an introduction to the essentials of micro and macro economics for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Senior or Junior standing and 3.0 GPA required.

**ECON 4130 Network Economy** (LEC 3.0)

Emerging Network/Internet economy, using traditional economic tools. Topics: production and reproduction cost of information, information as an "experience good," versions of products, switching cost, lock-in effects, market adoption dynamics, first-mover advantage, intellectual property rights. Prerequisite: Econ 1100 or Econ 1200. (Co-listed with IS&T 4257).

**ECON 4230 Money And Banking** (LEC 3.0)

Study of the origin, principles, and functions of money, emphasizing the role of banks in the effectuation of monetary policies geared to achieve various economic and political goals. Prerequisite: Econ 2200.

**ECON 4310 Mathematical Economics** (LEC 3.0)

Marginal analysis, calculus, and linear algebraic systems are applied in selected advanced topics in economics such as price theory, general equilibrium theory, input-output analysis, activity analysis, and game theory. Prerequisite: Econ 2100, 2200, and Math 1208.

**ECON 4350 Statistical Models in Actuarial Science** (LEC 3.0)

This course covers the statistical foundation of actuarial models and their applications. Topics include survival and severity models, Kaplan-Meier and Nelson-Aalen estimators, aggregate and credibility models for insurance losses, discrete time Markov chains, ruin theory, and simulation. Prerequisite: Stat 5643 and either Stat 5644 or a 3000-level Stat course. (Co-listed with Stat 5755).

**ECON 4410 Public Finance** (LEC 3.0)

Study of government expenditures and sources of revenue. Particular emphasis is given to governmental decision making—how these decisions affect the economy and the behavior of individuals, firms, and families within the economy; and how these decisions may be evaluated. Prerequisite: Econ 2100.

**ECON 4430 Cost-Benefit Analysis** (LEC 3.0)

Investigates the rationale for cost-benefit analysis within a free enterprise setting. Discussion of market efficiency and failure; determination of social costs and benefits; applications of cost-benefit analysis; and, problems remaining in theory and practice. Prerequisite: Econ 2100.

**ECON 4440 Environmental And Natural Resource Economics** (LEC 3.0)

Optimum use of replenishable and non-replenishable resources, public goods and common resources, externalities, private vs. public costs, and quality of the environment; emphasis on public policy related to environmental and natural resource economics. Prerequisite: Econ 2100. (Co-listed with Min Eng 4523).

**ECON 4512 Mine Management** (LEC 3.0)

Theory and practice of mine management, including basic managerial functions, management theories, communication skills, motivation, leadership, organization, maintenance management, managerial decision making, cost control, labor relations, government relations, ethics and risks management with emphasis in presentation skills. Prerequisite: Completion of 50 credits toward Mining Engineering degree. (Co-listed with MIN ENG 4512).

**ECON 4540 Energy Economics** (LEC 3.0)

Market structure. World resource development. Supply and demand analysis on energy production and consumption within domestic and global settings. Prerequisite: Econ 2100. (Co-listed with Min Eng 4524).

**ECON 4641 Foundations of Sustainability** (LEC 3.0)

This interdisciplinary course is designed as an introduction to sustainability in commerce. It examines the concept of environmental, social, and economic issues in an organizational context. Principles, processes, and practices of sustainability will be explored.

**ECON 4642 Introduction to Global Eco- and Social-preneurship and Innovation** (LEC 3.0)

This interdisciplinary course applies an entrepreneurial mindset to the environmental and social opportunities and challenges facing the global community. Topics are examined from multiple perspectives: nonprofit, hybrid, and for-profit organizations.

**ECON 4643 Ethical Problems in a Global Environment** (LEC 3.0)

Focuses on the international dimension of ethics including corporate responsibility from economic, social, and environmental perspectives. It addresses the ethical challenges of decision making, stakeholder engagement, and governance at micro- (personal), meso- (org), and macro- (system) levels.

**ECON 4710 International Trade** (LEC 3.0)

Analysis of gains from trade; the effects of factor mobility; effects of trade restrictions on trade flow and income distribution; arguments for restricting trade; and effects of trade on economic development, employment and human capital development. Prerequisite: Econ 2100.

**ECON 4720 International Finance** (LEC 3.0)

Examination of the international monetary system, the Balance of Payments, the foreign exchange market, futures and options markets; foreign exchange and other risk management for firms, financing from a global perspective and direct foreign investment. Prerequisite: Econ 2200.

**ECON 4730 Economic Development** (LEC 3.0)

Theoretical analysis of the problem of economic development of the "poor" countries, where two-thirds of the world's population lives. Treatment of basic problem areas leading to a synthesis of theoretical approaches for the achievement of development. Prerequisite: Econ 2100 or 2200.

**ECON 4820 Labor Economics** (LEC 3.0)

Labor as a factor of production, collective bargaining, trade unionism, labor legislation, from the viewpoint of public policy. Prerequisite: Econ 2100 or Econ 2200.

**ECON 4860 Problems In Economic Policy** (LEC 3.0)

Advanced course designed for students majoring within the department. Appraisal and analysis of major problems of economic policy. Research and reports. Topics covered vary from year to year. Offered jointly by members of the department. Prerequisite: Seniors with 24 or more hours in Econ.



**ECON 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ECON 5001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course.

**ECON 5010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

**ECON 5120 Advanced Micro and Macro Economics Essentials** (LEC 1.5)

An introduction to the essentials of micro and macro economics for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Additional case or report required. Prerequisite: Bachelor Degree.

**ECON 5310 Advanced Mathematical Economics** (LEC 3.0)

Marginal analysis, calculus, and linear algebraic systems are applied in selected advanced topics in economics such as price theory, general equilibrium theory, input-output analysis, activity analysis, and game theory. This course is an advanced version of Econ 4310, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4310 and Econ 5310. Prerequisites: Econ 2100, 2200 and Math 1208, Math 3103.

**ECON 5330 Econometric Methods** (LEC 2.0 and LAB 1.0)

A survey of econometric topics and methods illustrated through real world applications. Includes least squares estimation, generalized least squares, two-stage least squares, simultaneous equations models, panel data and qualitative choice models. Students will use modern statistical software packages (STATA, R) to perform hands-on quantitative analysis. Prerequisites: Econ 2100 and Econ 2200, Stat 3111 or Stat 3113 or Stat 3115 or Stat 3117 or Stat 5643.

**ECON 5337 Financial Mathematics** (LEC 3.0)

The course objective is to provide an understanding of the fundamental concepts of financial mathematics. Topics include pricing, assets-liability management, capital budgeting, valuing cash flow, bonds, futures, swaps, options. Preparation for the financial mathematics actuarial exam will be provided. Prerequisites: Math 1215 or Math 1221, Econ 2100 or Econ 2200 or Finance 2150 or Econ 5160, Stat 3111 or Stat 3113 or Stat 3115 or Stat 3117 or Stat 5643. (Co-listed with Math 5737).

**ECON 5342 Advanced Finance** (LEC 3.0)

This course provides a rigorous and consistent presentation of the theory of financial decisions. Capital markets are analyzed under assumptions of risk aversion and uncertainty. Models of modern portfolio theory are discussed including the CAPM and the Modigliani-Miller analysis. This course is an advanced version of Econ 321, and will include additional research and project assignments. Credit cannot be obtained for both Econ 5160 and Econ 5342. Prerequisite: Econ 2100 or Econ 2200.

**ECON 5430 Advanced Cost-Benefit Analysis** (LEC 3.0)

Investigates the rationale for cost-benefit analysis within a free enterprise setting. Discussion of market efficiency and failure; determination of social costs and benefits; applications of cost-benefit analysis; and, problems remaining in theory and practice. This course is an advanced version of Econ 4430, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4430 and Econ 5430. Prerequisite: Econ 2100.

**ECON 5440 Advanced Environmental And Natural Resource Economics** (LEC 3.0)

Optimum use of replenishable and non-replenishable resources, public goods and common resources, externalities, private vs. public costs, and quality of the environment; emphasis on public policy related to environmental and natural resource economics. This course is an advanced version of Econ 4440, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4440 and Econ 5440. Prerequisite: Econ 2100.

**ECON 5532 Advanced Mining Economics** (LEC 3.0)

Mining industry & national economics. Social & economics significance of mined commodities. Marketing of mined commodities. Innovation approaches to mine financing, project loans, and leasing. Mining feasibility studies, government influence & policy, mining industry foreign investment, investment strategies, mining taxation, cost predictions. Case Studies. (Co-listed with MIN ENG 5532).

**ECON 5540 Advanced Energy Economics** (LEC 3.0)

Market structures. World resource development. Supply and demand analysis on energy production and consumption within domestic and global settings. This course is an advanced version of Econ 4540, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4540 and Econ 5540. Prerequisite: Econ 2100.

**ECON 5644 Creativity, Innovation, and Sustainability** (LEC 3.0)

This interdisciplinary course examines the use of innovation as a competitive technological strategy with a sustainability perspective. It explores ways in which individuals, groups, and organizations can become more creative and how leadership and a culture of change can be implemented.

**ECON 5710 Advanced International Trade** (LEC 3.0)

Analysis of gains from trade; the effects of factor mobility; effects of trade restrictions on trade flow and income distribution; arguments for restricting trade; and effects of trade on economic development, employment and human capital development. This course is an advanced version of Econ 4710+D1194, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4710 and Econ 5710. Prerequisite: Econ 2100.

**ECON 5720 Advanced International Finance** (LEC 3.0)

Examination of the international monetary system, the Balance of Payments, the foreign exchange market, futures and options markets; foreign exchange and other risk management for firms, financing from a global perspective and direct foreign investment. This course is an advanced version of Econ 4720, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4720 and Econ 5720. Prerequisite: Econ 2200.

**ECON 5820 Advanced Labor Economics** (LEC 3.0)

Labor as a factor of production, collective bargaining, trade unionism, labor legislation, from the viewpoint of public policy. This course is an advanced version of Econ 4820, and will include additional research and project assignments. Credit cannot be obtained for both Econ 4820 and Econ 5820. Prerequisite: Econ 2100 or Econ 2200.

## Education (EDUC)

**EDUC 1000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**EDUC 1001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**EDUC 1040 Perspectives In Education** (LEC 2.0)

This course is an introduction course which will assist students planning to enter the teacher-education program in assessing their personal and professional characteristics required for the teaching profession. It is an overview of the teacher education profession for elementary, middle and secondary.

**EDUC 1104 Teacher Field Experience** (LAB 2.0)

Observation and analysis of instructional techniques and duties in the classroom and school environment by discipline. Student will spend at least 30 contact hours per credit hours in classroom. In addition, library and field experience reports will be made. In addition, Action Research and Seminars will be required. Prerequisite: Educ 1040.

**EDUC 1164 Aiding Elementary, Middle And Secondary Schools** (LAB 2.0)

Instructionally-related clinical/administrative and monitorial duties in the classroom during semesters and summer. Student works 30 hours for each credit, with instructor supervising. Also, Action Research and Seminars are required. Prerequisites: Educ 1040 and Educ 1104.

**EDUC 1174 School Organization & Adm For Elementary & Secondary Teachers** (LEC 2.0)

Required for certification of elementary and secondary teachers. Course content relates to methods of organization and management in the elementary and secondary schools. Prerequisites: Educ 1040 and Educ 1104.

**EDUC 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**EDUC 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**EDUC 2002 Problems Of Teaching Social Studies** (LEC 2.0)

A study of current methodologies for teaching in area of specialization.

**EDUC 2102 Educational Psychology** (LEC 3.0)

Principles of psychology relevant to the field of education. Course covers theoretical and applied information on such topics as human growth and development, and cognitive and behavioral views of learning and intelligence. The course also covers motivation, creation of learning environments, measurement and evaluation of learning. Prerequisite: Psych 1101. (Co-listed with Psych 2300).

**EDUC 2203 Problems Of Teaching Mathematics** (LEC 3.0)

A study of current methodologies for teaching in area of specialization.

**EDUC 2205 Problems Of Teaching Science/Chemistry** (LEC 2.0)

A study of current methodologies for teaching in area of specialization.

**EDUC 2206 Problems Of Teaching Science/Physics** (LEC 2.0)

A study of current methodologies for teaching in area of specialization.

**EDUC 2207 Problems Of Teaching English** (LEC 2.0)

A study of current methodologies for teaching in area of specialization.

**EDUC 2219 Art For Elementary Teachers** (LEC 3.0)

Considers the vital role of art activities and creative experiences in the growth and development of children at their level. Prerequisite: Educ 1040. (Co-listed with Art 3219).

**EDUC 2230 Methods In Physical Education K-4** (LEC 3.0)

The course will provide the opportunity to learn how to promote student fitness and skill development while building the foundation for a physically active life through specific activities aimed at the younger child. (Co-listed with Phy Ed 2300).

**EDUC 2231 Methods In Physical Education 5-9** (LEC 3.0)

The course will provide the opportunity to learn how to promote student fitness and skill development while building the foundation for a physically active life through specific activities aimed at the student in transition from childhood to young adulthood (5-9). (Co-listed with Phy Ed 2310).

**EDUC 2251 Historical Foundation Of American Education** (LEC 3.0)

Development of American educational institutions and ideas, and of social forces that have influenced them. Prerequisites: Educ 1040 and History 1300 or 1310.

**EDUC 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**EDUC 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**EDUC 3211 Child Psychology** (LEC 3.0)

The psychological, intellectual, social, and physical development of children with emphasis on the cognitive and affective processes. The theory, research and application will be studied. Prerequisite: Educ 1040 or Psych 1101.

**EDUC 3215 Teaching of Reading in Elementary and Middle School** (LEC 3.0)

Current materials, methods and teaching techniques in teaching reading in elementary and middle school grades. Emphasis on assessing elementary and middle students needs, individualizing programs based on needs, reading in the content areas, study skills and recreational reading as a lifetime habit. Prerequisite: Educ 1040.

**EDUC 3216 Teaching Reading in Content Area** (LEC 3.0)

For elementary, middle and secondary school teachers. Specific ways teachers can help students improve reading skills in content areas and ways reading can be taught in reading classes.

**EDUC 3217 Analysis and Correction of Reading Difficulties** (LEC 3.0)

Procedures for diagnosing and correcting reading problems within the classroom. Acquaint preservice teachers preparing for elementary education with commercially prepared informal diagnostic instruments, attitude and interest inventories, prescriptive measures, anecdotal records and strategies for corrective reading instruction within the regular classroom. Prerequisite: Educ 3215.

**EDUC 3218 Language Arts for Elementary Teachers** (LEC 3.0)

Procedures used in teaching integrated language arts in elementary grades. The strategies would be the development of written and oral communication for use in elementary grades. Prerequisite: Educ 1040.

**EDUC 3221 Teaching Math in Elementary and Middle Schools** (LEC 3.0)

The course presents an overview of how children learn mathematics, various techniques in teaching mathematics, and examples of applying these techniques to specific mathematical concepts (such as geometry, measurement, basic operations, statistics and probability, etc.). Prerequisite: Math 1120 or Math 1140. (Co-listed with Math 3921).

**EDUC 3222 Geometric Concepts for Elementary Teachers** (LEC 3.0)

The course covers methods of teaching the study of points, lines, polygons, similarity, congruence, constructions, and proof in Euclidean Plane Geometry. Transformational geometry and trigonometry are introduced to elementary teachers. Prerequisites: Math 1120 or Math 1140. (Co-listed with Math 3922).

**EDUC 3280 Teaching Methods And Skills In The Content Areas** (LEC 6.0)

Series of weekly experiences, demonstrations, observations, micro teaching, small group discussions to develop concepts of and skills in a variety of basic teaching tasks. Also, demonstration and lecture exercises in the preparation and use of audio visual materials for teaching. Prerequisites: Educ 1040 and 1104.

**EDUC 3305 Philosophy And Administration Of The Middle School** (LEC 3.0)

This course will acquaint students with aspects of education that are unique to the middle school. Attention will be given to the philosophy underlying the middle school. Finally, leadership theories most appropriate to the middle school will be studied.

**EDUC 3311 Psychological & Educational Development Of The Adolescent** (LEC 3.0)

A theoretical and empirical examination of the psychological and educational development of the adolescent.

**EDUC 3320 Professional Development** (LEC 1.0)

This online course focuses on the responsibilities of the professional development committee, state requirements, and components of effective programs that positively impact student performance. Students will examine the relationships among the district's Comprehensive School Improvement Plan, MSIP and the PD Plan. Prerequisite: Graduate standing.

**EDUC 3325 Novell Netware 4.1 / 4.11** (LEC 3.0)

A practical, hands-on course for Novell network administration including NDS planning, mapping and documentation; system power up/down; security, resource service management; user management from creation to user and workstation maintenance; application software installation and management, and Novell Server installation.

**EDUC 3335 Curriculum And Instruction Of The Middle School** (LEC 3.0)

This course advances teachers' understanding of middle school curriculum and instruction. It utilizes knowledge about the nature and needs of young adolescents in developing interdisciplinary learning units, and fosters applications appropriate to experienced teachers' professional assignments. Prerequisite: Graduate standing.

**EDUC 3339 Current Issues In Educ: Performance Based Assessment, Beginning** (LAB 2.0 and LEC 1.0)

This course is intended to provide an understanding of the principles of sound classroom assessment, the five different types of learning outcomes that need to be assessed and the choice of an assessment that best evaluates the achievement targets. Prerequisite: Practicing educator.

**EDUC 3340 Current Issues In Educ: Performance Based Assessment, Intermediate** (LEC 3.0)

This course will provide participants with an understanding of performance-based assessments, how to construct performance tasks and how to construct scoring guides.

**EDUC 3341 Current Issues In Educ: Performance Based Assessment, Advanced** (LEC 1.0 and LAB 2.0)

This course is intended to provide an understanding of balanced classroom assessment. Students will learn to create multiple types of assessment measures for the purpose of evaluating a wide variety of achievement targets. Prerequisite: Practicing educator.

**EDUC 3345 Introducing Educators To Computers** (LEC 1.0)

A basic introduction to computers for K-12 educators. Includes identification and use of hardware components, as well as the fundamentals of using the operating system and basic computer software. Actual software taught will reflect current usage. Prerequisite: Post Bac/practicing teacher.

**EDUC 3350 Social Studies In The Elementary School** (LEC 3.0)

Problems in preparation, teaching of social studies units with suitable materials, techniques for elementary teachers. Prerequisite: Instructor's approval.

**EDUC 4298 Student Teaching Seminar** (LEC 1.0)

Weekly seminars will be required for all students enrolled in student teaching. Contemporary educational topics, trends, reflective decision making and other pertinent topics will be covered. Reflection of topics and experiences will be exhibited in papers, portfolios and journal writings. Prerequisites: Meet all requirements for student teaching and concurrently be enrolled in student teaching.

**EDUC 4299 Student Teaching** (LEC 12)

Student teaching will be supervised participation, on the level of certification in an assigned Public School. Student teaching is based on 16 weeks (8 weeks in two schools and requires the student teacher to demonstrate his/her ability to be effective decision making teacher and an inquiry learner. Prerequisites: Professional standing and arrangements made previous semester.

**EDUC 4310 Psychology Of The Exceptional Child** (LEC 3.0)

Study of the psychology of children on both ends of the educational spectrum. The course presents the fundamentals of providing services as well as understanding the abilities and disabilities of children classified as exceptional. Includes coverage of various disabilities, and the implications of dealing with personal, family and classroom issues. Prerequisite: Psych 1101. (Co-listed with Psych 4310).

**EDUC 4315 Advanced Adolescent Development** (LEC 3.0)

This course is an advanced examination of the intellectual and social development of the adolescent. Theories of adolescent development and their implications for the educative process are covered and debated.

**EDUC 4370 Teachers Academy: Effective Instructional Strategies** (LEC 3.0)

Participants will develop an understanding of research-based instruction and the ability to implement the instructional strategies in their classrooms. In addition to effective instructional practices, the teachers' academy will focus on leadership, empowerment, collaboration and renewal. Prerequisite: Graduate standing.

## Electrical Engineering (ELEC ENG)

**ELEC ENG 1010 Transfer Student Seminar** (LEC 0.50)

Discussion of current topics. Prerequisite: First semester transfer student.

**ELEC ENG 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ELEC ENG 2100 Circuits I** (LEC 3.0)

Circuit elements, signals, Kirchhoff's laws, network theorems, mesh and nodal analysis, transient and complete response of RL, RC, and RLC circuits. Prerequisites: Math 1215 (or 1221) with a grade of "C" or better. Students should enroll in Elec Eng 2100 and Elec Eng 2101 simultaneously.

**ELEC ENG 2101 Circuit Analysis Laboratory I** (LAB 1.0)

Safety, basic measurements and meters, oscilloscopes, resistor networks, measurement of capacitors and inductors, RLC circuit response. Prerequisite: Preceded or accompanied by Elec Eng 2100. A student who drops Elec Eng 2100 must also drop Elec Eng 2101.

**ELEC ENG 2120 Circuits II** (LEC 3.0)

Analysis of steady state AC circuits, phasor notation, polyphase circuits, complex frequency and frequency response, magnetically coupled circuits. Prerequisites: Elec Eng 2100 and Math 2222 each with grade of "C" or better; passing the Elec Eng Advancement Exam I.

**ELEC ENG 2200 Introduction to Electronic Devices** (LEC 3.0)

Materials and device structures for applications in analog and digital electronics. Topics include characteristics and basic circuits for diodes, field-effect transistors, bipolar junction transistors, and operational amplifiers. Prerequisites: Elec Eng 2100, Elec Eng 2101, and Physics 2135 each with grade of "C" or better; passing the Elec Eng Advancement Exam I. Students should enroll in Elec Eng 2200 and Elec Eng 2201 simultaneously.

**ELEC ENG 2201 Electronic Devices Laboratory** (LAB 1.0)

Laboratory tools and measurement techniques for basic electronic circuits using diodes, field-effect transistors, bipolar junction transistors, and operational amplifiers. Topics include DC biasing and applications in analog and digital electronics. Prerequisites: Elec Eng 2100, Elec Eng 2101, and Physics 2135 each with grade of "C" or better; passing the Elec Eng Advancement Exam I. Preceded or accompanied by Elec Eng 2200.

**ELEC ENG 2800 Electrical Circuits** (LEC 3.0)

Taught primarily as an alternating current (AC) circuits course with direct current (DC) circuits as a special case. Current, voltage, and power relations; complex algebra; voltage and power relations in polyphase circuits with an emphasis on Transformers and Induction Machines. Not for electrical engineering majors. Prerequisites: Math 3304 or 3329; Physics 2135.

**ELEC ENG 3000 Special Problems** (IND 1.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ELEC ENG 3001 Special Topics** (LAB 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ELEC ENG 3002 Cooperative Engineering Training** (IND 1.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation. Pass-fail grading option only. Prerequisite: Consent of the Electrical and Computer Engineering Department required.

**ELEC ENG 3100 Electronics I** (LEC 3.0)

Diode and transistor circuits, small signal analysis, amplifier design, differential and operational amplifiers, flipflop circuits and waveshaping. Prerequisites: Elec Eng 2120, Elec Eng 2200, Elec Eng 2201, and Comp Eng 2210 each with a grade of "C" or better. Passing grade on Elec Eng Advancement Exam II and III. Elec Eng 3101 is a corequisite.

**ELEC ENG 3101 Electronics I Laboratory** (LAB 1.0)

Experiments in design with diodes, transistors, differential and operational amplifiers, and logic components. Prerequisites: Elec Eng 2120, Elec Eng 2200, Elec Eng 2201, and Comp Eng 2210 each with a grade of "C" or better. Passing grade on Elec Eng Advancement Exam II and III. Elec Eng 3100 is a corequisite.

**ELEC ENG 3120 Electronics II** (LEC 3.0)

Continuation of Elec Eng 3100. Diode and transistor circuits, small signal analysis, amplifier design, differential and operational amplifiers, flipflop circuits and waveshaping. Prerequisites: Elec Eng 3100 and Elec Eng 3101 each with a grade of "C" or better. Elec Eng 3121 is optional, but recommended.

**ELEC ENG 3121 Electronics II Laboratory** (LAB 1.0)

Experiments in design with diodes, power transistors, integrated circuits, advanced bipolar and FET logic gates, flipflops and registers. Prerequisites: Elec Eng 3100 and Elec Eng 3101 each with a grade of "C" or better. Elec Eng 3120 is a corequisite.

**ELEC ENG 3250 Electronic And Photonic Devices** (LEC 3.0)

Semiconductor materials and devices for electronic and photonic applications. Topics include crystal physics, electron and photon behavior, pn junctions, heterojunctions, junction diodes, optoelectronic devices, and ohmic and rectifying contacts. Prerequisite: Elec Eng 2200 and Elec Eng 2120 each with grade of "C" or better; passing the Elec Eng Advancement Exams II and III.

**ELEC ENG 3320 Control Systems** (LEC 3.0)

Laplace transforms, formulation of the control problem, system equations and models, time and frequency domain analysis, stability, and design of linear control systems. Prerequisites: ELEC ENG 2120 and MATH 3304 each with a grade of "C" or better; passing the ELEC ENG Advancement Exam II; accompanied by ELEC ENG 3321.

**ELEC ENG 3321 Control Systems Laboratory** (LAB 1.0)

Software tools for control systems analysis. Prerequisites: ELEC ENG 2120 and MATH 3304 with a grade of "C" or better; passing the ELEC ENG Advancement Exam II; preceded or accompanied by ELEC ENG 3320.

**ELEC ENG 3340 Controllers For Factory Automation** (LEC 2.0 and LAB 1.0)

Introduction to programmable automation, programmable logic controller (PLC) hardware, programming languages and techniques, closed-loop strategies using PLC's, sensors, transducers. Case studies. Laboratory experiments. Prerequisites: Elec Eng 2120 and Comp Eng 2210 each with a grade of "C" or better.

**ELEC ENG 3410 Digital Signal Processing** (LEC 3.0)

Analysis methods for discrete-time signals and systems in the time and frequency-domains including signal models and Fourier techniques. Continuous-time concepts are included as introductory material. Prerequisites: ELEC ENG 2120 with a grade of "C" or better; passing the ELEC ENG Advancement Exam II.

**ELEC ENG 3411 Discrete Linear Systems Laboratory** (LAB 1.0)

Software tools for signal and system representation and for time and frequency-domain systems analysis. Prerequisites: Elec Eng 2120 with a grade of "C" or better; passing the Elec Eng Advancement Exam II. Preceded or accompanied by Elec Eng 3410.

**ELEC ENG 3430 Digital Communications I** (LEC 3.0)

Signals and systems for digital communications. Topics include signals and their spectra, source formatting and source coding, digital baseband data communication, and digital pass-band modulation and demodulation. Prerequisites: ELEC ENG 2120 with a grade of "C" or better; passing the ELEC ENG Advancement Exam II; accompanied by ELEC ENG 3431.

**ELEC ENG 3431 Digital Communication Laboratory** (LAB 1.0)

Laboratory and software tools for the analysis of communications and for linear and non-linear signals and systems. Topics include spectral analysis, transforms, and applications. Prerequisites: ELEC ENG 2120 and ELEC ENG 2101 with a grade of "C" or better; passing the ELEC ENG Advancement Exam II; preceded or accompanied by ELEC ENG 3430.

**ELEC ENG 3440 Digital Communications II** (LEC 3.0)

Continuation of Elec Eng 3430. Signals and their spectra with application to digital communication systems. Prerequisites: ELEC ENG 3430 with a grade of "C" or better.



**ELEC ENG 3500 Electromechanics** (LEC 3.0)

Magnetics and magnetically coupled circuits, electromechanical energy conversion, rotating magnetic fields, stepper motors, DC machines, induction machines, synchronous machines, and brushless DC machines. Prerequisites: Physics 2135 with a grade of "C" or better; Elec Eng 2120 with a grade of "C" or better; passing grade on the Elec Eng Advancement Exam II.

**ELEC ENG 3501 Electromechanics Laboratory** (LAB 1.0)

Experiments with power measurement, transformers, magnetically coupled circuits, rotating magnetic fields, stepper motors, DC machines, induction machines, synchronous machines, and brushless DC machines. Credit will only be given for one of Elec Eng 3501 or Elec Eng 3541. Prerequisites: Elec Eng 2120 with a grade of "C" or better; passing grade on the Elec Eng Advancement Exam II. Preceded or accompanied by Elec Eng 3500.

**ELEC ENG 3540 Power System Design And Analysis** (LEC 3.0)

Power system components and transmission lines, three phase balanced power system theory, analysis and design including economic and reliability considerations, and fault analysis. A power system design project using a graphical power flow program is included. Prerequisites: Elec Eng 2120 with a grade of "C" or better; passing grade on the Elec Eng Advancement Exam II.

**ELEC ENG 3541 Power System Design And Analysis Laboratory** (LAB 1.0)

Computer-aided analysis of voltage regulation, power flow, compensation, and economic analysis. Individual projects are required. Credit will only be given for one of Elec Eng 3501 or Elec Eng 3541. Prerequisites: Elec Eng 2120 with a grade of "C" or better; passing grade on the Elec Eng Advancement Exam II. Preceded or accompanied by Elec Eng 3540.

**ELEC ENG 3600 Electromagnetics** (LEC 4.0)

Static electric and magnetic fields using vector analysis and time-varying electromagnetic fields using Maxwell's equations. Topics include Coulomb's law, Gauss's law, Ampere's law, dielectric and magnetic materials, plane waves, and transmission lines. Prerequisites: Elec Eng 2120, Elec Eng 2101, Physics 2135, and Math 3304 each with a grade of "C" or better. Passing grade on Elec Eng Advancement Exam II.

**ELEC ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ELEC ENG 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ELEC ENG 4010 Senior Seminar** (RSD 0.50)

Discussion of current topics. Prerequisite: Next to last semester senior.

**ELEC ENG 4096 Electrical Engineering Senior Project I** (LAB 0.50 and RSD 0.50)

A complete design cycle. Working in small teams, students will design, document, analyze, implement and test a product. Topics include: Iteration in design, prototyping, group dynamics, design reviews, making effective presentations, concurrent design, designing for test, ethics and standards, testing and evaluation. Prerequisites: Comp Eng 2210, Econ 1100 or 1200, English 3560, at least 3 of the following: Elec Eng 3500, Elec Eng 3540, Elec Eng 3320, Elec Eng 3420, Elec Eng 3600, Elec Eng 3100.

**ELEC ENG 4097 Electrical Engineering Senior Project II** (LAB 3.0)

A continuation of EI Eng 4096. Prerequisite: Elec Eng 4096 with a grade of "C" or better, Stat 3117, Sp&M S 1185.

**ELEC ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**ELEC ENG 4380 Practicum in Automation Engineering** (LAB 3.0)

Students on an approved internship or cooperative education assignment with industry will complete a project designed by the advisor and employer. The project selected must be related to topics in one or more of the other courses in the Automation Engineering Minor program. The same work period cannot receive credit for both Elec Eng 3002 and Elec Eng 4380. Prerequisites: Elec Eng 3340.

**ELEC ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ELEC ENG 5001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ELEC ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/ comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**ELEC ENG 5070 Teaching Engineering** (LEC 3.0)

Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mgt 5070, Env Eng 5070, Comp Eng 5070, Civ Eng 5070).

**ELEC ENG 5099 Special Research And Thesis** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**ELEC ENG 5100 Advanced Electronic Circuits** (LEC 3.0)

Application of feedback theory, oscillators and frequency standards, precision analog techniques, low-power circuit design, interfacing sensors, designing for high reliability, electronics for harsh environments. Prerequisite: Elec Eng 3120.

**ELEC ENG 5120 Communication Circuits** (LEC 3.0)

Analysis and design of circuits used in communication systems. Topics include RF semiconductor devices, low-noise amplifiers, mixers, modulators, crystal oscillators, AGC circuits, highpower RF amplifiers, phase-locked loops, impedance matching, and frequency-selective networks and transformers. Prerequisites: Elec Eng 3120, preceded or accompanied by Elec Eng 3420.

**ELEC ENG 5140 High-Frequency Amplifiers** (LEC 3.0)

Analysis and design of high frequency amplifiers. Topics include parameter conversions, activity and passivity, stability criteria, device operating conditions, Smith chart usage, matching networks, microstrip, scattering parameters, and practical applications. Prerequisites: Elec Eng 3120, 3600.

**ELEC ENG 5150 Photovoltaic Systems Engineering** (LEC 3.0)

Physics and characteristics of photovoltaic (solar) cell technologies, electronic control of alternative energy sources, site selection, array design, energy storage methods, electrical code compliance, stand-alone systems, grid-intertie systems, legal and economic considerations. Prerequisite: Senior or graduate standing in Science or Engineering.

**ELEC ENG 5160 Computer-Aided Network Design** (LEC 3.0)

Analysis and design of active and passive electric networks. Theory and computer application, including methods for automatic formulation of network state equations, network tolerance, network optimization, and device modeling. Prerequisites: Elec Eng 3100.

**ELEC ENG 5170 Introduction To Circuit Synthesis** (LEC 3.0)

Fundamentals of linear circuit theory. Matrix formulation, and topological methods as applied to circuit analysis. Properties of network functions and introductory network synthesis. Prerequisites: Elec Eng 3400.

**ELEC ENG 5200 Classical Optics** (LEC 3.0)

Physical optics and advanced topics in geometrical optics. Topics include ray propagation, electromagnetic propagation, mirrors, lenses, interference, diffraction, polarization, imaging systems, and guided waves. Prerequisites: Math 2222 and Physics 2135 or 2111. (Co-listed with Physics 4503).

**ELEC ENG 5210 Fourier Optics** (LEC 3.0)

Applications of Fourier analysis and linear systems theory to optics. Topics include scalar diffraction theory, Fourier transforming properties of lenses, optical information processing, and imaging systems. Prerequisites: Both ELEC ENG 3400 and 3600 or both PHYSICS 2401 and 4211. (Co-listed with PHYSICS 5503).

**ELEC ENG 5220 Fiber And Integrated Optics** (LEC 3.0)

Introduction to optical waveguides and their applications to communication and sensing. Topics include dielectric waveguide theory, optical fiber characteristics, integrated optic circuits, coupled-mode theory, optical communication systems, and photonic sensors. Prerequisite: Elec Eng 3600 or Physics 4211. (Co-listed with Physics 5513).

**ELEC ENG 5250 Optical Computing** (LEC 3.0)

Introduction to the principles, subsystems, and architectures of optical computing. Topics include characteristics of optical devices; optical implementations of memory, logic elements, and processors; and computational structures. Prerequisite: Comp Eng 2210 or equivalent. (Co-listed with Comp Eng 5230).

**ELEC ENG 5270 Smart Materials And Sensors** (LEC 2.0 and LAB 1.0)

Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multidisciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior standing and Math 3304. (Co-listed with Aero Eng 5529, Mech Eng 5229 and Civ Eng 5118).

**ELEC ENG 5300 Digital Control** (LEC 3.0)

Analysis and design of digital control systems. Review of ztransforms; root locus and frequency response methods; state space analysis and design techniques; controllability, observability and estimation. Examination of digital control algorithms. Prerequisite: Elec Eng 3320.

**ELEC ENG 5310 Computational Intelligence** (LEC 3.0)

Introduction to Computational Intelligence (CI), Biological and Artificial Neuron, Neural Networks, Evolutionary Computing, Swarm Intelligence, Artificial Immune Systems, Fuzzy Systems, and Hybrid Systems. CI application case studies covered include digital systems, control, power systems, forecasting, and time-series predictions. Prerequisite: Graduate Standing. (Co-listed with Comp Eng 5310 and Sys Eng 5211).

**ELEC ENG 5320 Neural Networks Control and Applications** (LEC 3.0)

Introduction to artificial neural networks and various supervised and unsupervised learning techniques. Detailed analysis of some of the neural networks that are used in control and identification of dynamical systems. Applications of neural networks in the area of Control. Case studies and a term project. Prerequisites: Elec Eng 3320.

**ELEC ENG 5330 Fuzzy Logic Control** (LEC 3.0)

A mathematical introduction to the analysis, synthesis, and design of control systems using fuzzy sets and fuzzy logic. A study of the fundamentals of fuzzy sets, operations on these sets, and their geometrical interpretations. Methodologies to design fuzzy models and feedback controllers for dynamical systems. Various applications and case studies. Prerequisite: Elec Eng 3320.

**ELEC ENG 5340 Advanced PLC** (LEC 2.0 and LAB 1.0)

Advanced programmable logic controller (PLC) programming, function block, structured text, function chart, sequencer. Factory communications, system simulation, human-machine interface (HMI) programming. Advanced PID control. Network security and reliability. Class-wide project. Prerequisite: Elec Eng 3340.

**ELEC ENG 5345 PLC Motion Control** (LAB 1.0 and LEC 2.0)

Factory automation motion control integrated with programmable logic controllers, servo control, variable-speed drive control, PackML state model, sizing motors and drives, machine safety, and experience with commercial hardware/software. Laboratory exercises on small-scale standard applications such as coordinated motion of multiple axes and camming. Prerequisite: Elec Eng 3340.

**ELEC ENG 5350 Plantwide Process Control** (LEC 3.0)

Synthesis of control schemes for continuous and batch chemical plants from concept to implementation. Multiloop control, RGA, SVD, constraint control, multivariable model predictive control, control sequence descriptions. Design project involving a moderately complicated multivariable control problem. Prerequisites: Chem Eng 4110 or Elec Eng 3320 or Elec Eng 3340 or graduate standing. (Co-listed with Chem Eng 5190).

**ELEC ENG 5360 System Simulation And Identification** (LEC 3.0)

Computationally efficient methods of digital simulation of linear systems. Non-parametric identification. Parametric identification with least squares and recursive least squares algorithms. Algorithms programmed using MATLAB. Prerequisite: Elec Eng 3320.

**ELEC ENG 5370 Introduction to Neural Networks and Applications** (LEC 3.0)

The course provides an introduction to basic neural network architectures and their applications. Students learn to construct neural networks and train them to solve engineering problems, specifically pattern recognition and function approximation. Mathematical analysis of network architectures, training algorithms and practical applications of neural nets. Prerequisites: Graduate Standing. (Co-listed with Sys Eng 5212).

**ELEC ENG 5380 Autonomous Mobile Robots** (LEC 3.0)

This course will provide an introduction to mobile robots and current approaches to robot autonomy. Topics include mobile robot systems, modeling and control, sensors and estimation, localization and mapping, and motion planning. Prerequisites: Elec Eng 3320 or equivalent and Stat 3117 or equivalent.

**ELEC ENG 5400 Digital Signal Processing II** (LEC 3.0)

Spectral representations, sampling, quantization, z-transforms, digital filters and discrete transforms including the Fast Fourier transform. Prerequisites: Elec Eng 3410 or Elec Eng 3420.

**ELEC ENG 5420 Communications Systems II** (LEC 3.0)

Random signals and their characterization; noise performance of amplitude, angle and pulse modulation systems; digital data transmission; use of coding for error control. Prerequisite: Elec Eng 3420.

**ELEC ENG 5430 Wireless Networks** (LAB 1.0 and LEC 2.0)

Introduction to wireless communications and networking. Topics include transmission fundamentals, wireless channel, coding techniques and error control, satellite and cellular networks, cordless systems, mobile IP and management, multiple access techniques and wireless protocols, wireless LAN, IEEE 802.11, and adhoc and sensor networks. Prerequisites: Hardware competency, Elec Eng 3420 or Comp Eng 3150 and graduate standing. (Co-listed with Comp Eng 5430 and Sys Eng 5323).

**ELEC ENG 5440 Stochastic Signal Analysis I** (LEC 3.0)

Introduction to the application of probabilistic models to typical electrical engineering problems. Topics include: methods for describing random voltages, random digital signals, correlation, linear mean-square estimation, linear transformation of random digital signals, and bit-error rate calculation for communication systems. Prerequisites: Math 3304 and Elec Eng 2120.

**ELEC ENG 5450 Digital Image Processing** (LEC 3.0)

Fundamentals of human perception, sampling and quantization, image transforms, enhancement, restoration, channel and source coding. Prerequisites: At least one of the following: Elec Eng 3400, Elec Eng 3410, Elec Eng 3420, or prior exposure to Fourier Transforms and consent of the instructor. (Co-listed with Comp Eng 5450).

**ELEC ENG 5460 Machine Vision** (LEC 3.0)

Image information, image filtering, template matching, histogram transformations, edge detection, boundary detection, region growing and pattern recognition. Complementary laboratory exercises are required. Prerequisites: At least one of the following: Elec Eng 3400, Elec Eng 3410, Elec Eng 3420, or prior exposure to Fourier Transforms and consent of the instructor. (Co-listed with Comp Eng 5460).

**ELEC ENG 5500 Electric Drive Systems** (LEC 3.0)

Course content is roughly 1/3 power electronics, 1/3 applied control and 1/3 electric machinery and focuses on analysis, simulation, and control design of electric drive based speed, torque, and position control systems. Prerequisites: Elec Eng 3500 and Elec Eng 3320.

**ELEC ENG 5510 Electric-Drive Vehicles** (LEC 3.0)

Course covers introductory topics related to understanding/analysis of electric, hybrid/plug-in hybrid power trains. Classification of hybrid drivetrains, driving cycles, energy storage systems, mechanical coupling devices, automotive applications of fuel cells and introduction to power converters. Prerequisite: Senior standing and Physics 2135.

**ELEC ENG 5520 Power Electronics** (LEC 3.0)

Analysis, design, modeling, and control of switching mode power converter circuits for ac-dc, dc-dc, dc-ac, and ac-ac conversion. Power semiconductor devices, passive components, and non-ideal sources and loads. Applications to industry, consumer goods, electric vehicles, and alternative energy. Prerequisite: Elec Eng 3100.

**ELEC ENG 5521 Power Electronics Laboratory** (LAB 2.0)

An introduction to power electronic circuits is presented. Students will construct several dc/dc, dc/ac and ac/dc converters. Various switching algorithms, including pulse width modulation, delta modulation, and hysteresis control will be developed to regulate and control the respective circuits. Prerequisite: Co-requisite Elec Eng 5520.

**ELEC ENG 5540 Power Systems Engineering** (LEC 3.0)

Network analysis applied to power systems; the load flow concept; economic operation of power systems; synchronous machine reactances and transient stability; symmetrical components and asymmetrical faults; protective relaying. Prerequisite: Elec Eng 3540.

**ELEC ENG 5550 Electric Power Quality** (LEC 3.0)

Definitions of power quality, types of power quality problems; sources of sags, transient overvoltages and harmonics; distribution overcurrent protection methods and their effect on power quality and reliability; harmonic analysis, principles of controlling harmonics, devices for filtering harmonics; power quality improvement methods. Prerequisite: Elec Eng 3500 or Elec Eng 3540.

**ELEC ENG 5570 Extra High Voltage Engineering** (LEC 2.0 and LAB 1.0)

The physical phenomena associated with high voltage dielectric breakdown are presented. Methods of generating and measuring high voltages and currents are explained. Demonstration of design and performance. Field trips to companies for laboratory testing of high voltage according to industry standards will serve as the lab part of the course. Prerequisite: Senior standing.

**ELEC ENG 5600 Interference Control in Electronic Systems** (LEC 3.0)

Principles of high frequency effects in PCBs and components, generation of unwanted radio-frequency (RF) signals by ICs, RF radiation mechanisms, shielding, and immunity against electrostatic discharge and RF signals. Prerequisites: Elec Eng 3400 and 3600.

**ELEC ENG 5620 Signal Integrity in High-Speed Digital & Mixed Signal Design** (LEC 3.0)

Signal integrity ensures signals transmitted over a propagation path maintain sufficient fidelity for proper receiver operation. Compromised signal integrity is often associated with parasitics (e.g. unintentional inductance, capacitance). Theory and CAD tools used for signal integrity analysis of functioning designs. Prerequisites: Elec Eng 3600 or Comp Eng 3150, and Senior standing. (Co-listed with Comp Eng 5620).

**ELEC ENG 5630 Wave Propagation and Transmission Lines** (LEC 3.0)

The materials in this course are intended to provide a) follow up electromagnetics related courses, b) electromagnetics related career including RF design and c) a graduate degree in electromagnetic related fields an in-depth understanding of the basics of wave propagation and transmission lines. Prerequisite: Elec Eng 3600.

**ELEC ENG 5640 Antennas and Propagation** (LEC 3.0)

Propagated fields of elemental dipole, directivity and gain, radiation resistance, the half-wave dipole, wire antennas, arrays, broadband antennas, aperture antennas, horn antennas, and antenna temperature. Prerequisite: Elec Eng 3600.

**ELEC ENG 5650 Microwave and Millimeter Wave Engineering and Design** (LEC 3.0)

Introduce senior and graduate students to the concept of microwave and millimeter wave engineering and passive component design such as waveguide, cavities, couplers, detectors, mixers, etc., including network theory and scattering matrix. Finally, their specific application in the design of various microwave circuits will be discussed. Prerequisites: Elec Eng 3600.

**ELEC ENG 5660 Microwave Principles For Mixed-Signal Design** (LEC 3.0)

Transmission lines; coupled transmission lines; microwave network analysis; impedance matching and tuning; design of microwave amplifiers and oscillators. Prerequisite: Elec Eng 3600.

**ELEC ENG 5670 Nondestructive Testing** (LEC 3.0)

Principles and applications of various means of non-destructive testing of metallic materials. Radiological inspection methods, ultrasonic testing, magnetic methods, electrical and eddy current methods and others. Prerequisite: Physics 2135 or 2111. (Co-listed with Met Eng 5510).

**ELEC ENG 5870 Mechatronics** (LAB 1.0 and LEC 2.0)

This course will introduce students to the basics of mechatronics (i.e., the integration of mechanical, electrical, computer, and control systems). Students will learn the fundamentals of sensors and actuators for mechanical systems, computer interfacing, microcontrollers, real-time software, and control. Prerequisite: Mech Eng 4479 or equivalent. (Co-listed with Mech Eng 5478, Aero Eng 5478 and Comp Eng 5820).

**ELEC ENG 5880 Introduction to Robotics** (LEC 3.0)

This course provides an introduction to robotics, covering robot hardware, fundamental kinematics, trajectories, differential motion, robotic decision making, and an overview of current topics in robotics. Prerequisite: A "C" or better in both Math 3108 and Comp Sci 1510. (Co-listed with Comp Sci 5403 and Comp Eng 5880).

## Engineering Management (ENG MGT)

**ENG MGT 1001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENG MGT 1100 Practical Concepts for Technical Managers** (LEC 1.0)

This course introduces topics relevant to the technical manager in the 21st Century. Topics covered include management practices, leadership, communications, project management, working in the global environment, risk management, systems engineering, product development, and quality management.

**ENG MGT 1210 Economic Analysis of Engineering Projects** (LEC 2.0)

Engineering project analysis from an engineering economics perspective. Topics include: interest, equivalent worth, comparing alternatives, rate of return methods, depreciation and taxes, inflation and price changes, benefit-cost analysis and risk analysis. Prerequisites: Math 1214.

**ENG MGT 2001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENG MGT 2002 Cooperative Engineering Training** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation.

**ENG MGT 2011 Competition Team Leadership** (LEC 1.0)

Students will participate in open lecture on team based management and leadership as it pertains to ongoing project activities. Project activity reports will be generated using real project data and assessed at the end of the semester through a project master plan and oral presentation. Prerequisite: Sophomore (or greater) standing and leadership role in an experiential learning design team or nomination by an experiential learning team advisor.

**ENG MGT 2012 Competition Team Communication** (LEC 0.50 and LAB 0.50)

Communication skills, both technical and promotional, will be covered. Students will practice both communication skills in written, oral and media-based modes. Specific activities will include writing a proposal for funding, developing a promotional media piece and speaking to external groups about a SDEL team. Assessment will be made on each of the deliverables. Prerequisite: Sophomore (or greater) standing and membership in an experiential learning design team.

**ENG MGT 2013 Competition Team Design** (LAB 1.0)

Students will participate in a significant design activity as part of one of the experiential learning design team projects. Design activity will be reported and assessed at the end of the semester through a design report and oral presentation. Prerequisite: Sophomore (or greater) standing and membership in an experiential learning design team.

**ENG MGT 2110 Managing Engineering And Technology** (LEC 3.0)

Introduces the management functions of planning, organizing, motivating, and controlling. Analyzes the application of these functions in research, design, production, technical marketing, and project management. Studies evolution of the engineering career and the transition to engineering management. Prerequisite: A grade of "C" or better is required in this course to meet Engineering Management degree requirements.

**ENG MGT 2211 Engineering Accounting and Finance** (LEC 3.0)

This course is designed to introduce the fundamentals of accounting and finance and provide the student with tools used in making financial decisions within a technically based enterprise. Prerequisite: Eng Mgt 1210, or understanding of engineering economic principles.

**ENG MGT 2310 Introduction to System Engineering** (LEC 3.0)

Provide an understanding of systems engineering and tools to manage system design, construction, and operation. Topics include systems thinking, modeling and simulation of systems, uncertainty in engineering, risk, and decision making in certain and uncertain environments. Prerequisites: Math 1208 or Math 1214.

**ENG MGT 3310 Operations and Production Management** (LEC 3.0)

Concepts of operations and production management are presented at an introductory level. Qualitative and quantitative tools and techniques used for the optimization of the operations component of the total enterprise are explored in the context of improved productivity and strategic competitiveness. Prerequisites: Eng Mgt 2110.

**ENG MGT 3320 Introduction to Project Management** (LEC 3.0)

This course covers the fundamentals of project management including project definition, project selection, project planning, estimating, scheduling, resource allocation and project control. Prerequisites: Junior or above standing.

**ENG MGT 3510 Marketing Management** (LEC 3.0)

Study of basic functions of marketing in the technological enterprise, including product selection and development, market research, market development, selection of distribution channels and advertising, marketing strategy. Prerequisites: Preceded or accompanied by Eng Mgt 2110.



**ENG MGT 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ENG MGT 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENG MGT 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Consent of instructor required.

**ENG MGT 4110 General Management-Design and Integration** (LEC 3.0)

Integrating and executing marketing, production, finance, and engineering policies and strategies for the benefit of an enterprise. Analysis, forecasting, and design methods using case studies and management simulation. Prerequisites: Eng Mgt 2210, 2211; preceded or accompanied by Eng Mgt 3310, 3320, 4710, and senior standing.

**ENG MGT 4310 Materials Handling and Plant Layout** (LAB 1.0 and LEC 2.0)

The design and objectives of materials handling equipment including diversity of application in industry from the viewpoint of efficient movement of materials and products from the receiving areas to the shipping areas. The layout of a plant to include materials handling equipment is considered throughout. Cost comparison of various systems will be made. Prerequisites: Junior standing.

**ENG MGT 4312 Risk Assessment and Reduction** (LEC 3.0)

Safe, secure manufacturing facilities protect the health of employees and the public, preserve the environment, and increase profitability. Methods for systematically identifying hazards and estimating risk improve the safety performance and security of manufacturing facilities. Prerequisite: Senior or Graduate Standing. (Co-listed with Chem Eng 5130).

**ENG MGT 4330 Human Factors** (LEC 3.0)

An examination of human-machine systems and the characteristics of people that affect system performance. Topics include applied research methods, systems analysis, and the perceptual, cognitive, physical and social strengths and limitations of human beings. The focus is on user-centered design technology, particularly in manufacturing environments. Prerequisite: Psych 1101. (Co-listed with Psych 4710).

**ENG MGT 4710 Quality** (LEC 3.0)

This course will provide an overview of quality tools and methodologies and how they apply to engineering management. Quality management methodologies will be explored as well as current and relevant tools and techniques used in the successful application of quality into various environments. Prerequisites: Stat 3115 or Stat 3117.

**ENG MGT 4907 Engineering Management Senior Design** (LEC 3.0)

Open-ended design projects will be addressed with small teams. The emphasis will be on solving industry-based projects that are broad in nature and which will require the students to incorporate the knowledge and skills acquired in earlier course work in the solution of the problems. Prerequisites: Preceded or accompanied by Eng Mgt 4110.

**ENG MGT 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ENG MGT 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENG MGT 5070 Teaching Engineering** (LEC 3.0)

Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Env Eng 5070, Comp Eng 5070, Elec Eng 5070, Civ Eng 5070).

**ENG MGT 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**ENG MGT 5110 Managerial Decision Making** (LEC 3.0)

Individual and group decision making processes and principles for engineers and technical managers with emphasis on the limitations of human rationality and the roles of social influence and organizational contexts; principles and skills of negotiation. Prerequisite: Senior or graduate standing.

**ENG MGT 5111 Management for Engineers and Scientists** (LEC 3.0)

The transition of the engineer or scientist to manager; study of management roles and theory, organizational systems and behavior, managing and motivating technical personnel, leadership, communication, processes, and customer focus. Prerequisite: Graduate standing.

**ENG MGT 5210 Economic Decision Analysis** (LEC 3.0)

Comprehensive treatment of engineering economy including effects of taxation and inflation; sensitivity analysis; decisions with risk and uncertainty; decision trees and expected value, normally includes solutions on personal computer and student problem report. Prerequisite: Graduate students without previous course in engineering economy because of partial overlap.

**ENG MGT 5212 Intelligent Investing** (LEC 3.0)

An overview of the essential elements of intelligent investing. Coverage includes stocks, bonds, exchange traded funds, mutual funds, stock screening, fundamental and technical analysis, valuation, market and industry analysis, macroeconomic indicators, investing strategies, and portfolio construction. Prerequisites: Senior or Graduate Standing.

**ENG MGT 5312 Advanced Risk Assessment and Reduction** (LEC 3.0)

Safe, secure manufacturing facilities protect the health of employees and the public, preserve the environment, and increase profitability. Methods for systematically identifying hazards and estimating risk improve the safety performance and security of manufacturing facilities. Prerequisite: Senior or Graduate Standing.

**ENG MGT 5313 Packaging Management** (LEC 3.0)

Provides a comprehensive background in the field of packaging and its place in productive systems. Emphasizes the design or economics of the system. Analyzes the management of the packaging function and interrelationship with other functions of an enterprise.

**ENG MGT 5314 Computer Integrated Manufacturing Systems** (LEC 2.0 and LAB 1.0)

Study of the design and use of computer-based integrated manufacturing management systems in the allocation and control of plant, equipment, manpower, and materials. Prerequisite: Eng Mgt 3310.

**ENG MGT 5315 Interdisciplinary Problems In Manufacturing Automation** (LEC 1.0 and LAB 2.0)

Introduction to basic techniques and skills for concurrent engineering, manufacturing strategies, product design, process planning, manufacturing data management and communication are the topics covered. Students experiment the design process through team projects and structured manufacturing laboratory work. (Co-listed with Mech Eng 5644, Chem Eng 4310).

**ENG MGT 5316 Safety Engineering Management** (LEC 3.0)

This course is an introduction to the principles of safety engineering applied to industrial situations. Job safety analysis, reduction of accident rates, protective equipment, safety rules and regulations, environmental hazards, health hazards, and ergonomic hazards are covered. Prerequisite: Senior or graduate standing.

**ENG MGT 5320 Project Management** (LEC 3.0)

Organization structure and staffing; motivation, authority and influence; conflict management; project planning; network systems; pricing, estimating, and cost control; proposal preparation; project information systems; international project management. Prerequisite: Graduate Standing.

**ENG MGT 5330 Advanced Human Factors** (LEC 3.0)

An in-depth review of the foundations of human factors, focusing on the interaction of people with various forms of technology in a variety of environments. Topics include research and evaluation methods, displays (e.g., visual, auditory), attention and information processing, decision making, motor skills, anthropometry, and biomechanics. (Co-listed with PSYCH 5710).

**ENG MGT 5410 Industrial System Simulation** (LEC 3.0)

Simulation modeling of manufacturing and service operations through the use of computer software for operational analysis and decision making. Prerequisite: Stat 3115 or Stat 3117.

**ENG MGT 5411 Engineering Design Optimization** (LEC 3.0)

This course is an introduction to the theory and practice of optimal design as an element of the engineering design process. The use of optimization as a tool in the various stages of product realization and management of engineering and manufacturing activities is stressed. The course stresses the application of nonlinear programming methods. Prerequisite: Math 3304 or 3329.

**ENG MGT 5412 Operations Management Science** (LEC 3.0)

Application of management science with an emphasis on supporting managerial decision-making. Design and operations of systems are modeled and analyzed using quantitative and qualitative techniques implemented using modern technology. Specific approaches include mathematical modeling and optimization, probabilistic/statistical analysis, and simulation. Prerequisites: Graduate standing.

**ENG MGT 5413 Introduction To Intelligent Systems** (LEC 3.0)

Introduction to the design of intelligent systems. Topics include: definitions of intelligence, rule-based expert systems, uncertainty management, fuzzy logic, fuzzy expert systems, artificial neural networks, genetic algorithms and evolutionary computation, hybrid systems, and data mining. Prerequisite: Graduate or senior standing.

**ENG MGT 5414 Introduction To Operations Research** (LEC 3.0)

Mathematical methods for modeling and analyzing industrial systems, topics including linear programming, transportation models, and network models. Prerequisite: Stat 3115 or Stat 3117.

**ENG MGT 5510 Industrial Marketing Systems Analysis** (LEC 3.0)

An analysis of the factors of engineered products, customers, communication, promotion, personal selling, persuasion and management within a dynamic industrial sales environment. Prerequisites: Senior or graduate standing.

**ENG MGT 5511 Technical Entrepreneurship** (LEC 3.0)

Student teams develop a complete business plan for a company to develop, manufacture and distribute real technical/product service. Lectures & business fundamentals, patents, market/ technical forecasting, legal and tax aspects, venture capital, etc., by instructor and successful technical entrepreneurs. Prerequisite: Senior or graduate standing.

**ENG MGT 5512 Legal Environment** (LEC 3.0)

Study of the effect of the legal environment on the decisions which the engineering manager must make. The course investigates the social forces that produced this environment and the responsibilities incumbent upon the engineer. Prerequisites: Senior or graduate standing.

**ENG MGT 5513 Energy and Sustainability Management Engineering** (LEC 3.0)

This course explores strategic processes and partnership required for the management of sustainable energy infrastructures and innovation in energy systems. Topics relate to renewable energy, energy efficiencies, energy conversion, energy technology, and economic efficiency of energy sources. Prerequisite: Senior or Graduate Standing.

**ENG MGT 5514 Patent Law** (LEC 3.0)

A presentation of the relationship between patent law and technology for students involved with developing and protecting new technology or pursuing a career in patent law. Course includes an intense study of patentability and preparation and prosecution of patent applications. Prerequisite: Senior or graduate standing. (Co-listed with Chem Eng 4300).

**ENG MGT 5515 Integrated Product And Process Design** (LEC 3.0)

Emphasize design policies of concurrent engineering and teamwork, and documenting of design process knowledge. Integration of product realization activities covering important aspects of a product life cycle such as "customer" needs analysis, concept generation, concept selection, product modeling, process development, and end of product life options. Prerequisites: Junior or above standing. (Co-listed with MECH ENG 5757).

**ENG MGT 5516 Integrated Product Development** (LAB 2.0 and LEC 1.0)

Students in design teams will simulate the industrial concurrent engineering development process. Areas covered will be design, manufacturing, assembly, process quality, cost, supply chain management, and product support. Students will produce a final engineering product at the end of the project. Prerequisite: Eng Mgt 5515 or Mech Eng 5757 or Mech Eng 3653 or Mech Eng 5708. (Co-listed with Mech Eng 5758).

**ENG MGT 5610 Advanced Facilities Planning & Design** (LAB 1.0 and LEC 2.0)

An integrated approach to the planning and design of facilities; examination of advanced techniques and tools for facility location, space allocation, facility layout materials handling system design, work place design; e.g. mathematical programming and simulation modeling. Prerequisites: Graduate standing.

**ENG MGT 5613 Value Analysis** (LEC 3.0)

An organized effort at analyzing the function of goods or services for the purpose of achieving the basic functions at the lowest overall cost, consistent with achieving the essential characteristics. Covers the basic philosophy, function analysis, FAST diagramming, creativity techniques, evaluation of alternatives, criteria analysis, and value stream mapping. Prerequisite: Senior or graduate standing.

**ENG MGT 5614 Supply Chain Management Systems** (LEC 3.0)

This course focuses on the development of logistics management skills related to global supply chains. Particular attention will be given to supply chain systems management as part of the firm's strategic positioning, cultural interactions and transportation sourcing decisions. Prerequisite: Stat 3115 or Stat 3117.

**ENG MGT 5615 Production Planning And Scheduling** (LEC 3.0)

Introduction to basic techniques of scheduling, manufacturing planning and control, just-in-time systems, capacity management, master production scheduling, single machine processing, constructive Algorithms for flow-shops, scheduling heuristics, intelligent scheduling systems are the topics covered. Prerequisite: Eng Mgt 3310.

**ENG MGT 5710 Six Sigma** (LEC 3.0)

This course is an introduction to the principles of implementing the Six Sigma philosophy and methodology. Topics include tools and methods including process flow diagrams, cause and effect diagrams, failure mode and effects analysis, gage R&R, capability studies, design of experiments and strategy for organizing six sigma techniques in industry. Prerequisite: Graduate standing.

**ENG MGT 5711 Total Quality Management** (LEC 3.0)

Examination of various quality assurance concepts and their integration into a comprehensive quality management system: statistical techniques, FMEA's, design reviews, reliability, vendor qualification, quality audits, customer relations, information systems, organizational relationships, motivation. Prerequisite: Senior or graduate standing.

**ENG MGT 5712 Introduction To Quality Engineering** (LEC 3.0)

This course is an introduction to the theory and practice of quality engineering with particular emphasis on the work of Genichi Taguchi. The application of the quality loss function, signal to noise ratio and orthogonal arrays is considered in-depth for generic technology development; system, product and tolerance design; and manufacturing process design. The emphasis of the course is off-line quality control. Other contributions in the field are also considered. Prerequisite: Eng Mgt 5711.

**ENG MGT 5713 Management And Methods In Reliability** (LEC 3.0)

Study of basic concepts in reliability as they apply to the efficient operation of industrial systems. Prerequisite: Stat 3115, 3117, or 5643.

**ENG MGT 5714 Statistical Process Control** (LEC 3.0)

The theoretical basis of statistical process control procedures is studied. Quantitative aspects of SPC implementation are introduced in context along with a review of Deming's principles of quality improvement and a brief introduction to sampling inspection. Prerequisite: Stat 3115, or Stat 3117.

## English (ENGLISH)

**ENGLISH 1000 Special Problems And Readings** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ENGLISH 1001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENGLISH 1110 English As A Second Language-I** (IND 0.0-6.0)

Elementary English for non-English speakers. Conversation and reading. A study of English recommended for international students during their first semester in the United States.

**ENGLISH 1120 Exposition And Argumentation** (LEC 3.0)

Practice in college level essay writing.

**ENGLISH 1160 Writing And Research** (LEC 3.0)

Practice in techniques of analytical writing and in methods of research. Prerequisite: English 1120.

**ENGLISH 1170 Creative Writing** (LEC 3.0)

Practice in forms and techniques of poetry and prose fiction, with special attention to narrative development. Prerequisite: English 1120.

**ENGLISH 1211 British Literature I: The Beginnings To 1800** (LEC 3.0)

A survey of works and authors that explores the way these works represent the chronological period and express the individual concerns and techniques of those authors.

**ENGLISH 1212 British Literature II 1800 To Present** (LEC 3.0)

A survey of works and authors that explores the way these works represent the chronological period and express the individual concerns and techniques of those authors.

**ENGLISH 1221 American Literature: 1600 To 1865** (LEC 3.0)

A chronological survey that explores the ways the literature represents the concerns of individual authors as well as the history of literature.

**ENGLISH 1222 American Literature: 1865 To Present** (LEC 3.0)

A chronological survey that explores the ways the literature represents the concerns of individual authors as well as the history of literature.

**ENGLISH 1223 Introduction To American Studies** (LEC 3.0)

Introduces the core subjects as well as the methods and theories that constitute the field of American Studies.

**ENGLISH 1231 World Literature I: From The Beginnings To The Renaissance** (LEC 3.0)

A survey of representative works and authors from the world's cultures. (Excludes British and American works).

**ENGLISH 1600 Introduction to Technical Communication** (LEC 3.0)

Introduction to the role of the professional technical communicator in business and industry and practice in methods of developing technical documents. Prerequisite: English 1120. (Co-listed with TCH COM 1600).

**ENGLISH 2000 Special Problems And Readings** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ENGLISH 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENGLISH 2002 Critical Approaches To Literature** (LEC 3.0)

Study and application of the terminology and critical approaches used in understanding literary forms and genres.

**ENGLISH 2010 Seminar** (IND 0.0-6.0)

Discussion of current topics. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2171 Fiction Writing** (LEC 3.0)

This course introduces students to concepts of craft in fiction writing and the critical tools writers bring to revision. Students will write and present their own fully-developed stories and examine the stories of others in a workshop format. Prerequisite: English 1120 or equivalent.

**ENGLISH 2172 Creative Nonfiction Writing** (LEC 3.0)

Students will write creative nonfiction essays about their experiences and the experiences of others. The course will emphasize the revision process, focusing on both sentence-level and global issues. Additionally, this course will introduce students to published writers rhetorical choices. Prerequisite: English 1120 or equivalent.

**ENGLISH 2230 Literature And Film** (LEC 3.0)

This course will examine intertextual connections between literature and film, in terms of such things as adaptations, narrative technique and theory, genre, theme, and ideological movements. Prerequisite: English 1120.

**ENGLISH 2240 Children's Literature** (LEC 3.0)

Introduction to the study of children's literature. Emphasis on historical developments, multicultural issues and works. Prerequisites: English 1120.

**ENGLISH 2241 Literature For Adolescents** (LEC 3.0)

Primarily intended for teacher certification students. Selection and organization of materials for teaching literature to adolescents. Emphasizes literature written for adolescents and includes a unit of literature of American ethnic groups. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2242 Literature By Women** (LEC 3.0)

A study of writings by women, emphasizing major writers and the development of a female literary tradition. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2243 Science Fiction And Fantasy Literature** (LEC 3.0)

A study of short stories, poems, or novels which represent the development and the techniques of the science fiction-fantasy genre. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2244 Fantasy Literature** (LEC 3.0)

A study of the development of fantasy literature in the nineteenth and twentieth centuries. The primary focus will be on novels, especially the work of J.R.R. Tolkien. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2245 African American Literature** (LEC 3.0)

The history and development of African American literature, with special emphasis upon contemporary achievements. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2246 The Bible As Literature** (LEC 3.0)

Deals with the Old Testament, the Apocryphal/Deuterocanonical books, and the New Testament. Class lectures and discussions focus on literary forms and patterns, use of symbolism, narrative methods, and characterization. The basic approach is literary rather than theological or historical. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2247 American Crime And Detective Fiction** (LEC 3.0)

An introduction survey of American crime literature emphasizing the works of Hammett, Chandler, and James M. Cain to the more recent "true crime" tradition beginning with Capote's *In Cold Blood*. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2248 Thematic Studies in Literature and Film** (LEC 3.0)

Topics examine different thematic relationships between literature and film (e.g. Poe and Hitchcock, Shakespeare on film, etc.) announced at time of registration. Prerequisites: English 1120 and semester of college literature.

**ENGLISH 2250 American Short Story** (LEC 3.0)

This course follows the development of the short story genre from its early nineteenth-century beginnings up to and including stories written by contemporary American authors. Prerequisite: English 1120.

**ENGLISH 2410 Theory Of Written Communication** (LEC 3.0)

Major critical and conceptual approaches to written communication theory; includes semantics, history of print media, visible language, grammars, discourse theory, socio-linguistics reception theory, stylistics. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 2540 Layout And Design** (LEC 3.0)

Theory and practice of layout and design for print and electronic media. Prerequisite: English 1600 or TCH COM 1600. (Co-listed with TCH COM 2540).

**ENGLISH 2560 Technical Marketing Communication** (LEC 3.0)

An introduction to technical marketing communication with an emphasis on relevant genres such as (but not limited to) the data sheet, white paper, and technical demonstration. Prerequisites: English 1600 or Tch Com 1600 or English 1160. (Co-listed with TCH COM 2560).

**ENGLISH 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ENGLISH 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENGLISH 3010 Seminar** (RSD 3.0)

Discussion of current topics. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3085 Internship** (IND 0.0-6.0)

Internship will involve students applying critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisite: Senior status; must have completed 24 hours in the major.

**ENGLISH 3101 Advanced Composition** (LEC 3.0)

Instruction and practice in writing expository essays of substantial content and skill, with particular emphasis on the rhetorical applications of recent findings in language research. Papers required will include critical analyses of literary works, and library research. Prerequisite: English 1160 or 3560.

**ENGLISH 3170 Teaching And Supervising Reading and Writing** (LEC 3.0)

Students will study contemporary and traditional approaches to reading and writing instruction. The course will give students practice in applying literacy and composition theory and research to development of teaching methods, including course syllabi and assignments. Prerequisite: 6 hours of college level writing courses.

**ENGLISH 3210 Survey Of Old And Middle English Literature** (LEC 3.0)

Survey of Old English poetry in translation and Middle English literature (excluding Chaucer) through Malory. Special emphasis on culture and language with some attention given to modern reinterpretation of medieval works. Prerequisites: English 1120 and a semester of college literature.



**ENGLISH 3211 Chaucer** (LEC 3.0)

A study of Chaucer as a narrative poet by an intensive examination of The Canterbury Tales and Troilus and Criseyde. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3212 Sixteenth Century English Literature** (LEC 3.0)

A survey of the poetry and prose of England from 1500 to 1600. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3213 Seventeenth Century English Literature** (LEC 3.0)

A study of major authors (excluding Milton) of prose and poetry in England from 1600 to 1660. Special attention will be paid to John Donne and the metaphysical poets, to Ben Jonson and the Cavalier poets, and to major prose writers such as Francis Bacon, Sir Thomas Browne, and others. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3214 The Plays Of William Shakespeare** (LEC 3.0)

Selected comedies, tragedies, histories, and romances from early middle, and late periods of William Shakespeare's life. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3215 The Restoration & Eighteenth Century** (LEC 3.0)

The history, development, and cultural contexts of British literature from 1660 to 1798. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3216 British Romantic Literature** (LEC 3.0)

A study of the prose and poetry of the British Romantic period, 1775 to 1832. Prerequisite: English 1120 and a semester of college literature.

**ENGLISH 3217 Victorian Literature** (LEC 3.0)

A study of British prose and poetry from 1832 to 1900. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3218 The British Novel I** (LEC 3.0)

The history, development, and cultural contexts of the British novel from the late seventeenth to the early nineteenth century. Prerequisite: English 1120 and a semester college literature.

**ENGLISH 3219 The British Novel II** (LEC 3.0)

A study of the development of the novel with major attention given to the Victorian and 20th century novelists. Prerequisites: ENGLISH 1120 and a semester of college literature.

**ENGLISH 3220 Early American Literature** (LEC 3.0)

This course will follow the development of American literature from its Colonial beginnings (1614) to the rise of Romanticism (1836). The course will pay particular attention to how American writers used literature in defining and even creating the New World. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3221 American Poetry I** (LEC 3.0)

A study of significant selected poets of, primarily, the 19th century, with special attention to theme, diction, and form, and to poetry as a compressed image of the human condition. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3222 The American Renaissance** (LEC 3.0)

A study of American literature from Poe to Whitman. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3223 American Poetry II** (LEC 3.0)

A study of significant selected poets of the 20th century, with special attention to theme, diction, and form, and poetry as a compressed image of the human condition. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3224 Southern Culture** (LEC 3.0)

Introduction to major issues in the history and culture of the recent American South. Non-fiction, fiction, memoir, autobiography, journalism and film explore the social, economic, and political transformations of the region in the last half-century. Prerequisite: English 1120 and one semester of literature.

**ENGLISH 3225 The American Novel I** (LEC 3.0)

A study of selected, representative novels in chronological sequence from the beginning to the major realists. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3226 The American Novel II** (LEC 3.0)

A study of selected, representative novels in chronological sequence from the major realists to the present. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3227 American Gothic** (LEC 3.0)

This course follows the development of gothic/horror literature in the United States for its earliest expression in Phillip Freneau's 18th century works through Brockden Brown's late 18c. Gothic novels, to Hawthorne, Melville, and Poe's dark fiction, and finally to modern and contemporary works by Faulkner, O'Connor, Stephen King and others. Prerequisite: English 1120 and a previous literature course.

**ENGLISH 3228 The American Experience** (LEC 3.0)

Examines one or more of the subjects of the American experience such as race, gender, class, ethnicity, region, technology, religion, as it is expressed in the culture. Prerequisite: English 1223.

**ENGLISH 3232 Contemporary American Literature** (LEC 3.0)

Studies in American prose (fiction and non-fiction), drama, poetry, and screen plays published within the last fifteen years. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3233 Contemporary British Literature** (LEC 3.0)

Studies in British prose (fiction and non-fiction), drama, poetry, and screen plays published within the last fifteen years. Prerequisites: English 1120 and a semester of college literature.

**ENGLISH 3234 Myth & Folklore** (LEC 3.0)

This course traces the development of myth and folklore from Ancient Mesopotamia through nineteenth century Europe. Students will be challenged with three questions along the way: What do myth and folklore do? Why were they important to earlier societies? Is myth alive today? Prerequisites: English 1120 and one semester of college literature.

**ENGLISH 3301 A Linguistic Study Of Modern English** (LEC 3.0)

A descriptive analysis of Modern English--its phonology, grammar, and vocabulary. Prerequisite: English 1120.

**ENGLISH 3302 History And Structure Of The English Language** (LEC 3.0)

An introduction to the study of the English language and its history through Old English, Middle English, and Modern English. Prerequisite: English 1120.

**ENGLISH 3560 Technical Writing** (LEC 3.0)

The theory and practice of writing technical papers and reports in the professions. Prerequisites: English 1120 and second-semester junior standing.

**ENGLISH 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Consent of instructor required.

**ENGLISH 4290 Texts And Contexts** (LEC 3.0)

Examines the relationships between selected texts written or published in a given year and the context of events of that time. Also explores current critical approaches to such texts and contexts. Writing intensive and Computer intensive. Prerequisites: English 1120 and a semester of college literature; junior standing.

**ENGLISH 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ENGLISH 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENGLISH 5100 Readings In Rhetoric And Composition** (LEC 3.0)

Directed readings and writing on selected topics and areas in Rhetoric and Composition. Credit will only be given for one of English 5210, 5220, 5230, or 5100 toward the Coop MA with UMSL. Prerequisites: Graduate standing and consent of instructor.

**ENGLISH 5210 Readings In British Literature** (LEC 3.0)

Directed readings and writing on selected topics and areas in British literature. Credit will only be given for one of English 5210, 5220, 5230, or 5100 toward the Coop MA with UMSL. Prerequisites: Graduate standing and consent of instructor.

**ENGLISH 5220 Readings In American Literature** (LEC 3.0)

Directed readings and writing on selected topics and areas in American literature. Credit will only be given for one of English 402, 403, 404, or 405 toward the Coop MA with UMSL. Prerequisites: Graduate standing and consent of instructor.

**ENGLISH 5230 Readings In Literature And Theory** (LEC 3.0)

Directed readings and writing on selected topics and areas in Literature and Theory. Credit will only be given for one of English 5210, 5220, 5230, or 5100 toward the Coop MA with UMSL. Prerequisites: Graduate standing and consent of instructor.

**ENGLISH 5571 Advanced Writing For Science & Engineering** (LEC 3.0)

Focus on writing applications specifically for students in scientific or engineering fields. Primary emphases will be on producing effective and readable professional writing. Prerequisites: English 3560 and 2560, or graduate standing.

**ENGLISH 5572 Advanced Writing For Science And Engineering II** (LEC 2.0)

This course -- second in a series -- focuses on writing for publication, from the initial proposal and query to the final product. Students will work on the materials they have underway with their advisers and/or research colleagues. Prerequisites: English 3560 and 2560, or graduate standing.

## Enterprise Resource Planning (ERP)

**ERP 2110 Introduction to Enterprise Resource Planning** (LEC 3.0)

Fundamentals of enterprise resource planning (ERP) systems concepts, and the importance of integrated information systems in an organization. The focus of this course is on illustrating procurement, production, and sales business processes using ERP software. Use of SAP as an example ERP system. Prerequisite: IS&T 1750.

**ERP 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ERP 4220 Introduction to Enterprise Decision Dashboard Prototyping** (LEC 3.0)

Study design and implementation principles for enterprise decision dashboards utilizing data warehouse and databases to support visual analytics. SAP HANA & BW, Business Objects Dashboards, IBM Watson Analytics, SAS Visual Analytics, or similar tools are used for practical assignments. Prerequisites: (ERP 2110 or ERP 5110) and one of ERP 5410, ERP 6444, or IS&T 6444.

**ERP 4610 Customer Relationship Management in ERP Environment** (LEC 3.0)

The course emphasizes identification (targeting), acquisition, retention, and development (expansion) of (profitable) customers, as well as effective and efficient management of customers, using information technology. SAP CRM, SAS BI tools, and Sybase mobile application development are used. Prerequisite: ERP 2110 or preceded or accompanied by ERP 5110.

**ERP 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**ERP 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ERP 5110 Enterprise Resource Planning Systems Design and Implementation** (LEC 3.0)

This course provides a technical overview of Enterprise Resource Planning Systems and their impact on organizations. SAP is introduced to illustrate the concepts, fundamentals, framework, general information technology context, technological infrastructure, and integration of business enterprise-wide applications. Prerequisites: Preceded or accompanied by ERP 2110; or Graduate Standing and computer programming knowledge.

**ERP 5130 ERP in Small & Mid-Size Enterprises** (LEC 3.0)

Provides an overview of enterprise applications for small and midsize companies. A leading platform such as Microsoft Dynamics AX or SAP Business One is introduced to illustrate theories and practical enterprise-wide applications for entrepreneurs, who manage business functions across sales, operation, and financials, all in a single integrated system. Prerequisites: ERP 5110 or ERP 2110.

**ERP 5210 Performance Dashboard, Scorecard and Data Visualization** (LEC 3.0)

This course will study different performance management systems including dashboards, management cockpit, scorecards, and strategy maps in an organization. SAP's BW, Business Objects Xcelsius, Crystal Reports, Sybase Unwired Platform will be used to develop the applications.. Prerequisite: ERP 2110 or preceded or accompanied by ERP 5110.

**ERP 5240 Enterprise Application Development and Software Security** (LEC 3.0)

This course provides a conceptual foundation and hands on experience in web and mobile based (HTML5) applications development deployed through an enterprise platform. Enterprise development tools, such as SAP HANA Cloud Platform, will be used to build these apps. The course also covers software cybersecurity from a web and mobile perspective. Prerequisites: Programming knowledge and either ERP 2110 or preceded or accompanied by ERP 5110.

**ERP 5310 Supply Chain Management Systems in an ERP Environment** (LEC 3.0)

The course studies the need for supply chain integration and the challenges of managing complex interfaces using the systems approach for the planning, analysis, design, development, and evaluation of supply chain. SAP's ERP ECC, SCM, BW, and Sybase Unwired Platform are used to deploy SCM apps. Prerequisite: ERP 2110 or preceded or accompanied by ERP 5110.

**ERP 5410 Use of Business Intelligence** (LEC 3.0)

This course introduces data-oriented techniques for business intelligence. Topics include Business Intelligence architecture, Business Analytics, and Enterprise Reporting. SAP Business Information Warehouse, Business Objects, or similar tools will be used to access and present data, generate reports, and perform analysis. Prerequisites: IS&T 3423 or equivalent; ERP 2110 or preceded or accompanied by ERP 5110.

**ERP 5510 ERP System Administration** (LEC 3.0)

System administration and performance monitoring practices for an Enterprise Resource Planning (ERP) system will be studied. Students will install an instance of an ERP system and establish user management attributes and system security. Prerequisite: ERP 5110.

## Environmental Engineering (ENV ENG)

**ENV ENG 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENV ENG 2601 Fundamentals Of Environmental Engineering and Science** (LEC 2.0 and LAB 1.0)

Course discusses fundamental chemical, physical, and biological principles in environmental engineering and science. Topics include environmental phenomena, aquatic pollution and control, solid waste management, air pollution and control, water and wastewater treatment systems, sustainability and life cycle analyses. Prerequisites: Chem 1310, Chem 1301, or Chem 1351; Math 1214, Math 1212, or Math 1208. (Co-listed with Civ Eng 2601).

**ENV ENG 2602 Biological Fundamentals Of Environmental Engineering** (LEC 3.0)

Introduction to the function of organisms related to environmental engineering. The course focuses on both the application of organisms to removing contaminants and the effects of contaminants on organisms. Prerequisites: Bio Sci 1113 and preceded or accompanied by Civ/Env Eng 2601. (Co-listed with Civ Eng 2602).

**ENV ENG 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENV ENG 3603 Chemical Fundamentals Of Environmental Engineering** (LEC 2.0 and LAB 1.0)

Introduction to the key chemical and physical concepts integral to environmental systems and processes. This course provides a fundamental background in those chemical and environmental engineering principles that are common to all environmental engineering disciplines. Prerequisites: Chem 1320 or Geology 3410; Physics 1135, Math 2222.

**ENV ENG 3615 Water And Wastewater Engineering** (LEC 3.0)

A study of the engineering design principles dealing with the quantity, quality and treatment of water, and the quantity, characteristics, treatment and disposal of wastewater. Prerequisites: Civ Eng 2601 and at least junior standing. (Co-listed with Civ Eng 3615).

**ENV ENG 4010 Senior Seminar: Engineering In A Global Society** (RSD 1.0)

Discussion of contemporary issues: public safety, health, and welfare; the principles of sustainable development; lifelong learning; impact of engineering solutions in a global and societal and political context; relationships with owners, contractors, and the public; public service; the Code of Ethics; and the Missouri licensing Statutes and Board Rules. Prerequisite: Senior standing. (Co-listed with Civ Eng and Arch Eng 4010).

**ENV ENG 4097 Senior Design Project** (LEC 3.0)

Open-ended design projects involving one or more areas of engineering. Planning design projects, philosophy of design, and application of engineering principles to design problems. Prerequisite: Civ Eng 4448 or Arch Eng 4448. (Co-listed with Arch Eng 4097 and Civ Eng 4097).

**ENV ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**ENV ENG 4609 Research in Environmental Engineering** (LEC 1.0)

Students will investigate cutting edge research in the environmental engineering field including experimental studies, current environmental policy changes, and international environmental issues. Investigation to include live research seminars, reading current literature, and/or laboratory experimentation. Prerequisite: Senior standing.

**ENV ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department.

**ENV ENG 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**ENV ENG 5070 Teaching Engineering** (LEC 3.0)

Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mgt 5070, Comp Eng 5070, Elec Eng 5070, Civ Eng 5070).

**ENV ENG 5360 Water Resources And Wastewater Engineering** (LEC 3.0)

Application of engineering principles to the planning and design of multipurpose projects involving water resources development and wastewater collection/treatment/disposal systems. Latest concepts in engineering analysis are applied to evaluation of alternative solutions. Prerequisites: Civ Eng 3333, 3335, 3615. (Co-listed with Civ Eng 5360).

**ENV ENG 5605 Environmental Systems Modeling** (LEC 3.0)

Introductory course in modeling environmental systems. Course will focus on contaminant fate and transport in the environment. Models will be developed that will include physical, chemical and biological reactions and processes that impact this fate. Prerequisites: Env Eng/Civ Eng 2601, Env Eng/Civ Eng 2602 and Env Eng/ Civ Eng 3603; or Graduate standing. (Co-listed with Civ Eng 5605).

**ENV ENG 5619 Environmental Engineering Design** (LEC 2.0 and LAB 1.0)

Functional design of water and wastewater facilities and other environmental cleanup systems. Prerequisite: Civ Eng 3615 or Env Eng 3615. (Co-listed with Civ Eng 5619).



**ENV ENG 5630 Remediation of Contaminated Groundwater And Soil** (LEC 2.0 and LAB 1.0)

Course covers current in-situ and ex-situ remediation technologies. Current literature and case studies are utilized to provide the focus for class discussions and projects. Prerequisites: Civ Eng 3615, Geo Eng 5237 or Graduate Standing. (Co-listed with Civ Eng 5630).

**ENV ENG 5635 Phytoremediation and Natural Treatment Systems: Science and Design** (LEC 3.0)

Students learn the scientific basics of chemical transport in soil and groundwater and learn fundamental plant physiology and processes. Students then learn how these processes are utilized in design of phytoremediation and natural treatment systems, including the most up to date literature and design guidance available. Prerequisite: Env Eng 3615 or Civ Eng 3615 or graduate standing.

**ENV ENG 5640 Environmental Law And Regulations** (LEC 3.0)

This course provides comprehensive coverage of environmental laws and regulations dealing with air, water, wastewater, and other media. The primary focus is permitting, reporting, and compliance protocols. The course topics include U.S. and international legal systems and judicial processes, liability, enforcement, Clean Air Act, Clean Water Act (NPDES permitting), Safe Drinking Water Act, OSGA, TSCA, RCRA, and CERCLA. Case studies will be emphasized. (Co-listed with Civ Eng 5640).

**ENV ENG 5642 Sustainability, Population, Energy, Water, and Materials** (LEC 3.0)

This course will examine the concepts regarding the continued advancement of humankind while maintaining our ecological niche on earth. Key topics include: population growth, poverty, and impacts of development; energy consumption, sources, storage, conservation and policy; water quality and quantity; materials and building; and policy implications. Prerequisite: Senior or graduate standing. (Co-listed with Civ Eng 5642 and Arch Eng 5642).

**ENV ENG 5650 Public Health Engineering** (LEC 3.0)

A comprehensive course dealing with the environmental aspects of public health. Prerequisite: Civ Eng 2601 with grade of "C" or better. (Co-listed with Civ Eng 5650).

**ENV ENG 5660 Introduction To Air Pollution** (LEC 3.0)

Introduction to the field of air pollution dealing with sources, effects, federal legislation, transport and dispersion and principles of engineering control. Prerequisite: Civ Eng 3330 or equivalent; or graduate standing. (Co-listed with Civ Eng 5660).

**ENV ENG 5662 Air Pollution Control Methods** (LEC 3.0)

Study of the design principles and application of the state-of-the-art control techniques to gaseous and particulate emissions from fossil fuel combustion, industrial and transportation sources. Prerequisite: Civ Eng 3330 or equivalent; or graduate standing. (Co-listed with Civ Eng 5662).

**ENV ENG 5665 Indoor Air Pollution** (LEC 3.0)

By developing a practical understanding of indoor air pollution sources, physics, chemistry and consequences, students will learn how radon, cigarette smoke, VOCs from furnishings, and so forth affect indoor air quality and apply engineering analyses to specify ventilation rates, choose furnishings and minimize occupant exposure to pollutants. Prerequisite: Civ Eng 2601 or Mech Eng 5571 or Graduate Status. (Co-listed with Civ Eng 5665 and Arch Eng 5665).

**ENV ENG 5670 Solid Waste Management** (LEC 3.0)

A systematic study of the sources, amounts and characteristics of solid wastes and methods used for their collection, reclamation, and ultimate disposal. Prerequisite: Civ Eng 2601 with grade of "C" or better; or graduate standing. (Co-listed with Civ Eng 5670).

## Etymology (ETYM)

**ETYM 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Prerequisite: Consent of instructor.

**ETYM 4306 Introduction To Etymology** (LEC 3.0)

Introduction to etymology in its broadest sense: origin of words, idioms, writing systems, etc. Prerequisite: Any foreign language course or English 1120.

## Explosives Engineering (EXP ENG)

**EXP ENG 5000 Special Problems** (IND 1.0-3.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**EXP ENG 5001 Special Topics** (LEC 1.0 and LAB 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**EXP ENG 5112 Explosives Handling and Safety** (LEC 3.0)

Basic handling & safety for explosives, explosive devices and ordnance related to laboratory handling, testing, manufacturing & storage, for both civil and defense applications. Classroom instruction only. Prerequisite: Junior Standing or above.

**EXP ENG 5512 Commercial Pyrotechnics Operations** (LAB 1.0 and LEC 2.0)

Provide participants with training preparing for Missouri Licensed Display Operator (Outdoor) License and advanced lead pyrotechnic operator training. Class work will be complemented by practical training in laboratory sessions, culminating in a full pyrotechnic show, from start to finish. Prerequisites: Both Chem 1310 and Chem 1319 or their equivalent; US Citizen or permanent resident, Successful background check, resident enrollment at Missouri S&T.

**EXP ENG 5513 Stage Pyrotechnics and Special Effects** (LAB 2.0 and LEC 1.0)

Use of energetic materials in close proximity to audiences. Provide participants with training preparing for Missouri Pyrotechnics Display Operators License. Covers: close proximity indoor and outdoor pyrotechnics and special effects. Working with stage crews and talent, safety and permitting. Prerequisites: Both Chem 1310 and Chem 1319 or their equivalent; US Citizen or permanent resident, Successful background check, resident enrollment at Missouri S&T.

**EXP ENG 5514 Display Fireworks Manufacturing** (LAB 2.0 and LEC 1.0)

Theory and practice of manufacturing display fireworks. Focusing on safety, chemical interaction, color development, basic theory, state and federal law. The lab will include hands on building of ball and canister shells and other pyrotechnic effects. Prerequisites: Chem 1310, Chem 1319, Chem 1100; one of Econ 1100, Econ 1200, Eng Mgt 1210; Successful background check.

**EXP ENG 5555 Computer Fired Pyrotechnic Show Design and Firing System Operation** (LAB 2.0 and LEC 1.0)

Students will learn to use music editing, electronic firing system operation and Fire One pyrotechnic choreography and simulation software to design their own pyromusical show programs. Creation of a musical sound track, selecting the fireworks and choreographing to the musical score. Create, setup, diagnose and fire a pyrotechnic show. Prerequisites: Exp Eng 5512 or Exp Eng 5513 and successful background check.



**EXP ENG 5612 Principles of Explosives Engineering** (LAB 1.0 and LEC 2.0)

Theory and application of explosives in the mining industry; explosives, initiating systems, characteristics of explosive reactions and rock breakage, fundamentals of blast design, drilling and blasting, regulatory and safety considerations. Prerequisites: Min Eng 2126; successful background check. (Co-listed with Min Eng 5612).

**EXP ENG 5622 Blasting Design And Technology** (LAB 1.0 and LEC 2.0)

Advanced theory and application of explosives in excavation; detailed underground blast design; specialized blasting including blast casting, construction and pre-splitting. Introduction to blasting research. Examination of field applications. Prerequisites: Min Eng 5612. Student must be at least 21 years of age. Successful background check. (Co-listed with Min Eng 5622).

**EXP ENG 5711 Explosives in Industry** (LEC 3.0)

Overview of how explosives are applied in various industrial settings. Focus is placed on the general application, identification, and necessity of explosives in industry. Topics include explosive use in surface and underground mining, road development, construction, utility placement, demolition, oil, gas, and underwater.

**EXP ENG 5713 Demolition of Buildings and Structures** (LAB 1.0 and LEC 2.0)

Provide participants with basics and solid grounding in the equipment, techniques and processes required for the demolition and remediation of mine plant and processing equipment sites and non-mining structures such as buildings, factories, bridges, etc. Field trip required. Prerequisites: Preceded or accompanied by Civ Eng 2200 or Mech Eng 2340; US citizen or permanent resident; Successful background check.

**EXP ENG 5721 Specialty Uses of Energetic Materials** (LEC 3.0)

Overview of special, less common uses of energetic materials and how they can be applied as a functional tool. Topics include the use of energetics in aerospace, explosive ordnance, oil field development, welding, pyrotechnics, theatrics, and cinematic special effects.

**EXP ENG 5914 Explosives Manufacturing** (LEC 3.0)

History of industrial explosives from discovery to what is used today. Manufacturing processes for packaged and bulk explosives are explored along with specialty explosives such as detonating cord, cast boosters, detonators, shaped charges, and commercial fireworks. Field manufacturing of explosives by mixing or gassing is also covered.

**EXP ENG 5922 Advanced Tunneling & Underground Construction Techniques** (LAB 1.0 and LEC 2.0)

Advanced topics in mechanical and conventional excavation techniques in underground tunneling and construction. Topics include tunneling layouts design, equipment and performance modeling, ground control systems including support, drainage, and structural integrity. Construction specifications, advance rate and contractual and cost estimation. Prerequisite: Consent of Instructor (Co-listed with Min Eng 5922).

## Finance (FINANCE)

**FINANCE 2000 Special Problems** (IND 0.0-6.0)

(Variable) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**FINANCE 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**FINANCE 2150 Corporate Finance I** (LEC 3.0)

This course studies the need for funds in business and the techniques of analysis used to determine how effectively these funds are invested within the firm. Topics include the institutions, instruments, and markets concerned with raising funds. Prerequisites: Bus 1210 or Eng Mgt 2211.

**FINANCE 3000 Special Problems** (IND 0.0-6.0)

(Variable) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**FINANCE 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**FINANCE 3205 Finance Essentials** (LEC 1.5)

This course is an introduction to the essentials of corporate finance for running a business. This course is designed for students planning to enter the MBA program. Credit in this course cannot be applied to any major or minor in Business, Information Sciences and Technology. Prerequisites: Senior or Junior Standing; 3.0 GPA required.

**FINANCE 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed towards graduation credit. Subject and credit to be arranged with the instructor.

**FINANCE 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in finance. Prerequisite: Admission to the MBA program and permission of the instructor.

**FINANCE 5001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title. Prerequisite: Admission to the MBA program.

**FINANCE 5099 Research** (IND 0.0-9.0)

Research investigation of an advanced nature leading to a major report suitable for publication in a journal or in a conference proceedings. Prerequisite: Permission of the instructor.

**FINANCE 5160 Corporate Finance II** (LEC 3.0)

This course provides a rigorous and consistent presentation of the theory of financial decisions. Capital markets are analyzed under assumptions of risk aversion and uncertainty. Models of modern portfolio theory are discussed including the CAPM and the Modigliani-Miller analysis. Prerequisite: Finance 2150.

**FINANCE 5205 Graduate Finance Essentials** (LEC 1.5)

This course is an introduction to the essentials of corporate finance for running a business. This course is designed for students planning to enter the MBA program. Credit in this course cannot be applied to any major or minor in Business, Information Sciences and Technology. Additional case or report required. Prerequisite: Bachelor Degree.

**FINANCE 5260 Investments I** (LEC 3.0)

Introduction to fundamental elements of investment analysis. Students learn financial tools and gain necessary knowledge to select among alternative financial assets. Real world experience includes stock analysis, portfolio simulations and interactions with professionals in the securities industry. Prerequisites: Finance 2150.

## French (FRENCH)

**FRENCH 1101 Elementary French I** (LEC 4.0)

Introduction to reading, conversation, and grammar. Prerequisite: Entrance requirements.

**FRENCH 1102 Elementary French II** (LEC 4.0)

A continuation of French 1101. Prerequisite: French 1101.

**FRENCH 1180 Intermediate French** (LEC 4.0)

Focuses on intermediate reading, writing, speaking, & listening skills in French. Prerequisite: French 1102.

**FRENCH 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**FRENCH 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**FRENCH 2110 Basic French Conversation** (LEC 3.0)

French conversation and oral practice. Prerequisite: French 1102.

**FRENCH 2170 Masterpieces Of French Literature** (LEC 3.0)

Selected major works and movements in French literature. Prerequisite: French 1180.

**FRENCH 2180 Basic French Composition** (LEC 3.0)

Composition and translations from English. Prerequisite: French 1102.

**FRENCH 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**FRENCH 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**FRENCH 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**FRENCH 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**FRENCH 4010 Seminar** (IND 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

**FRENCH 4311 Advanced French Conversation** (LEC 3.0)

Advanced conversation and oral practice. Prerequisite: French 2170.

**FRENCH 4320 French and Francophone Cinema** (LEC 3.0)

A survey of French and Francophone cinema. Prerequisite: French 2170.

**FRENCH 4330 Business French** (LEC 3.0)

This course addresses practical reading, speaking, listening, and writing strategies for conducting business in French-speaking countries. Students will also improve their knowledge of the contemporary Francophone world. Readings, lectures, and discussions are in French. Prerequisite: French 2170.

**FRENCH 4360 French Culture And Civilization** (LEC 3.0)

A survey of French culture and civilization of the past 2,000 years, including art, architecture, music, literature, geography and politics. Prerequisite: French 2170.

**FRENCH 4370 Survey Of French Literature I (Early Period)** (LEC 3.0)

The history and development of French literature from Les Chansons De Geste through the important philosophers of the 18th century to Beaumarchais. Assigned readings are in French, and lectures are largely in French. Prerequisite: French 2170.

**FRENCH 4375 Survey Of French Literature II (Modern Period)** (LEC 3.0)

19th and 20th century French literature. Prerequisite: French 2170.

## Freshman Engineering (FR ENG)

**FR ENG 1100 Study And Careers In Engineering** (LEC 1.0)

Examination of engineering degree programs available at Missouri S&T and career opportunities in engineering. Introduction to non-engineering majors and minors at Missouri S&T. Academic, professional and ethical expectations of the student and engineering professional. Introduction to campus facilities and resources for assisting in student success.

## Geological Engineering (GEO ENG)

**GEO ENG 1001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEO ENG 1119 Physical and Environmental Geology Laboratory** (LAB 1.0)

Geology 1119 is designed to accompany Geology 1110 and consists of laboratory explorations of the study of common rocks and minerals, air photographs, maps, and case studies of geological problems related to management of Earth resources, hazards, and environmental challenges. Prerequisite: Preceded or accompanied by Geology 1110. (Co-listed with Geology 1119).

**GEO ENG 1150 Physical and Environmental Geology** (LEC 3.0)

Materials, structure, and surface features of the Earth and planets are studied in the context of the processes that continuously transform the Earth and affect management of Earth resources, hazards, engineering problems, and environmental challenges. Prerequisite: Entrance requirements. (Co-listed with Geology 1110).

**GEO ENG 1175 Geological Engineering in Popular Media** (LAB 2.0 and LEC 1.0)

Examination of the issues and topics related to geological engineering as presented in movies, television programs, and other communications media.

**GEO ENG 1605 Mathematical Concepts for Military Engineers** (LEC 2.0)

Review of fundamental concepts in Algebra, Trigonometry and Calculus for students in Geological Engineering. Designed as a bridging course for Military Reserve officers enrolled in the On-Line Certificate in Military Geological Engineering. Prerequisite: Permission of instructor. This course was designed for military officers registered in either the GE DL MS Degree Program or the GE FLW MS Degree Program.

**GEO ENG 1810 Humanitarian Engineering and Science Colloquium** (RSD 0.50)

Course introduces Humanitarian Engineering & Science Minor students to topics such as impact of Western interventions on developing cultures, ethics and engineering, frugal engineering, the role of civic engagement in corporate culture, responsible behavior in outreach programs, and others. Cannot be used for credit towards Geological Engineering B.S. Prerequisites: Open to undergraduate students pursuing the Humanitarian Engineering and Science Minor.

**GEO ENG 1880 Civic Engagement** (IND 0.50)

Course provides a formal independent study framework so that Humanitarian Engineering & Science Minor students and other students have the opportunity to achieve formal recognition of experiential service learning that may occur during participation in extracurricular programs. Cannot be used for credit towards Geological Engineering B.S. Prerequisites: Open to undergraduate students pursuing the Humanitarian Engineering and Science Minor.

**GEO ENG 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GEO ENG 2001 Special Topics** (LEC 1.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEO ENG 2002 Cooperative Work Training** (IND 1.0-3.0)

On the job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation.

**GEO ENG 2110 Principles Of Geological Engineering** (LEC 1.0)

Introduce GE students to the GE program. Topics include career paths, professional development, licensure, life long learning, engineering ethics, societal issues, engineering law, international engineering, and GE program outcomes and objectives. Discussion of the teaching and research of the faculty. Prerequisite: Sophomore standing in the GE program.

**GEO ENG 2407 Geology and Engineering of Ancient and Modern Peru** (LEC 1.0)

A study of the geological engineering of the Cuzco-Machu Picchu corridor, including the interrelations of geology, climate, archeology, and history. A technical report and a week-long field trip to Peru during Spring Break are required.

**GEO ENG 2536 Basic Weather** (LAB 1.0 and LEC 2.0)

A course to study basic concepts of atmospheric science such as air masses, frontal weather patterns and weather forecasting. The course also will include topics on climate and severe weather. Prerequisites: Physics 1135, Geo Eng 1150.

**GEO ENG 2605 Statics and Mechanics of Geologic Materials** (LEC 3.0)

Fundamental statics of rigid bodies and mechanics of deformable bodies for entering graduate students, focusing on behavior of rock and soil in engineering situations. Not for students intending to register as professional engineers. Designed for military officers registered in GE DL MS Degree Program or GE FLW MS Degree Program. Prerequisite: Permission of instructor.

**GEO ENG 3148 Fundamentals Of Geographic Information Systems** (LAB 1.0 and LEC 2.0)

Introduction to the fundamental concepts and components of Geographic Information Systems. Techniques for acquiring, manipulating and analyzing digital terrain data for geological and geotechnical applications. (Co-listed with Geology 3811).

**GEO ENG 3175 Geomorphology And Terrain Analysis** (LAB 1.0 and LEC 2.0)

Study of geomorphic processes, landform development, and surficial materials. Stresses evaluation of the engineering properties of terrain for site selection and design of engineered structures. Prerequisite: Geo Eng 1150.

**GEO ENG 3249 Fundamentals Of Computer Applications In Geological Engineering** (LAB 1.0 and LEC 2.0)

Applications of existing and available software packages utilizing a variety of hardware systems for geological engineering purposes. Emphasis on practical utilization of personal computers and network operations for graphical analysis of geologic data, mapping of surface and subsurface configurations and modeling of geologic processes. Prerequisites: Geo Eng 1150, Comp Sci 1970, 1980.

**GEO ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GEO ENG 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEO ENG 4010 Current Topics and Professionalism** (RSD 0.50)

Discussion of current topics, professionalism, and ethics. Required for two semesters during senior year. (Course cannot be used for graduate credit). Prerequisite: Senior standing.

**GEO ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**GEO ENG 4115 Statistical Methods in Geology and Engineering** (LEC 3.0)

Statistical methods in engineering and geological applications including site investigations and environmental data analyses. Introduction to spatial correlation analysis and geostatistical techniques such as kriging for resource evaluation and estimation.

**GEO ENG 4276 Environmental Aspects Of Mining** (LEC 3.0)

Permitting: the legal environment of reclamation and environmental impact assessment; post-mining land-use selection and mine planning for optimum reclamation of all mines: metal, nonmetal, and coal; unit operations of reclamation; drainage, backfill, soil replacement, revegetation, maintenance, etc. Prerequisites: Co-requisites: MIN ENG 4933 or GEO ENG 5441 or ENV ENG 5619. (Co-listed with MIN ENG 4742).

**GEO ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor is required.

**GEO ENG 5001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEO ENG 5085 Internship** (IND 0.0-15)

Students working toward a doctor of engineering degree will select, with the advice of their committees, appropriate problems for preparation of a dissertation. The problem selected and internship plan must conform to the purpose of providing a high level engineering experience consistent with the intent of the doctor of engineering degree.

**GEO ENG 5090 Geological Engineering Design** (LEC 2.0 and LAB 1.0)

Geological engineering design is an open-ended project course requiring the collection of data, analysis and synthesis of that data and design of a socially acceptable, economical solution to the selected problem. Oral and written reports are required. Prerequisite: To be taken in the semester before graduation.

**GEO ENG 5092 International Engineering and Design** (LEC 3.0)

A multi-disciplinary engineering course focused on sustainable design and technology transfer to developing countries. Course includes elements of traditional capstone design classes. Experiential learning through competitions and/or field work is a major component of the class. Prerequisites: Senior standing, instructor approval, Geo Eng 5211, Geo Eng 5247. (Co-listed with Met Eng 4510 and Cer Eng 4510).

**GEO ENG 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**GEO ENG 5144 Remote Sensing Technology** (LEC 2.0 and LAB 1.0)

Principles of digital image processing including image enhancement and multispectral classification. Emphasis upon design and implementation of remote sensing systems and analysis of remotely sensed data for geotechnical and environmental investigations. Prerequisite: Geo Eng 3148. (Co-listed with Geology 4310).

**GEO ENG 5146 Applications Of Geographic Information Systems** (LEC 2.0 and LAB 1.0)

Applications of Geographical Information Systems and remote sensing to environmental monitoring, mineral resource exploration, and geotechnical site evaluation. Prerequisite: Geo Eng 3175 or consent of instructor. (Co-listed with Geology 4821).

**GEO ENG 5153 Regional Geological Engineering Problems In North America** (LEC 3.0)

A physiographic approach to engineering materials and problems. Course emphasizes the distribution and engineering characteristics of soil and rock to construction and site problems and includes aggregates, foundations, excavations, surface and ground water, slope stability and arctic conditions.

**GEO ENG 5172 Soil Science In Engineering Practice** (LEC 3.0)

A study of the ways in which soils and geologic conditions influence engineered projects. Soil formation, soil chemistry and properties to include composition, organic component, ion exchange and water relationships as well as erosion control and revegetation will be covered. Prerequisite: Geo Eng 3175.

**GEO ENG 5173 Geologic Field Methods** (LAB 3.0)

Field practice in geologic mapping and interpretation in the Western United States using topographic base maps and aerial photos. Emphasizes the description and interpretation of stratigraphic sections, sedimentary and tectonic structures. Prerequisite: Two courses in either Geology or Geological Engineering.

**GEO ENG 5174 Geological Engineering Field Methods** (LAB 3.0)

Instruction in methods of field investigation required for geological engineering studies. Course will include procedures for qualitative and quantitative data collection for characterizing surficial geologic conditions, groundwater and surface water investigations, and other engineering activities. Written reports and field trip required.

**GEO ENG 5211 Introduction to International Engineering and Design Lab** (LAB 1.0)

The lab for multi-disciplinary design will be as follows: Students will develop a work plan to address design objectives and other considerations including scheduling, budgeting, environmental impacts, and life cycle design. Prerequisites: Senior standing, instructor approval, accompanied by GEO ENG 5247.

**GEO ENG 5233 Risk Assessment In Environmental Studies** (LEC 3.0)

This course will present the concepts required to assess the human health and environmental risks resulting from contaminants in soil and groundwater. Course topics include evaluation of data sets, exposure calculation, chemical fate and transport, and development of conceptual site models.

**GEO ENG 5235 Environmental Geological Engineering** (LEC 3.0)

Introduction to engineering geologic mapping for site selection for solid waste disposal facilities; landfill site selection, design, permitting, construction, operation, and closeout/reclamation. Prerequisites: Geo Eng 3175, accompanied or preceded by Civ Eng 3715.

**GEO ENG 5237 Geological Aspects Of Hazardous Waste Management** (LEC 3.0)

Nature and classification of hazardous wastes; federal and state regulation for treatment and disposal; geological characterization of facility sites; design of impoundments, storage and containment facilities; ground water monitoring and protection; site permitting and licensing planning. Prerequisite: Geo Eng 3175.

**GEO ENG 5239 Groundwater Remediation** (LEC 3.0)

A survey of conventional and innovative techniques for remediation of contaminated groundwater. Topics include groundwater cleanup standards, physico-chemical properties of groundwater and contaminants, fate and transport of contaminants in the subsurface, hydrogeologic site characterization, and selection process of a remedial technology. Various computer programs developed to assist in preliminary selection and design of remediation technologies will be used. Prerequisite: Geo Eng 5331.

**GEO ENG 5247 Introduction to International Engineering and Design** (LEC 2.0)

A multi-disciplinary design course focused on sustainable design and technology transfer to developing countries. Students will develop a work plan to address design objectives and other considerations including scheduling, budgeting, environmental impacts, and life cycle design. Prerequisites: Senior standing, instructor approval, accompanied by Geo Eng 5211.

**GEO ENG 5276 Advanced Environmental Aspects Of Mining** (LEC 3.0)

Applied and fundamental research issues pertaining to: permitting -- the legal environment of reclamation and environmental impact assessment; post-mining land-use selection and mine planning for optimum reclamation of all mines: metal, nonmetal, and coal; unit operations of reclamation: drainage, backfill, soil replacement, revegetation, maintenance, etc. Course project.

**GEO ENG 5315 Advanced Statistical Methods in Geology and Engineering** (LEC 3.0)

Application of statistical methods to study of geologic materials and practices, with emphasis on reliable interpretation of laboratory and field data for water, hydrocarbon, and mineral exploration, research, and engineering as well as other aspects of geological engineering. Prerequisites: Geo Eng 4115 or Stat 3111 or Stat 3113 or Stat 3115 or Stat 3117.

**GEO ENG 5320 Groundwater Modeling** (LEC 3.0)

This course is an introduction to advanced modeling techniques for understanding flow and transport in porous media under different hydrologic conditions. Emphasis is placed on both theoretical and practical modeling considerations. Computer demonstrations are incorporated. Practical applications are emphasized. Prerequisite: Civ Eng 3330 or Geo Eng 5331.

**GEO ENG 5331 Subsurface Hydrology** (LEC 3.0)

Introduction to the theory and engineering concepts of the movement of subsurface fluids. Properties of water and other subsurface fluids. Hydraulic characteristics of earth materials. Engineering problems related to subsurface fluids. Prerequisites: Geo Eng 1150, Math 3304.

**GEO ENG 5332 Fundamentals of Groundwater Hydrology** (LEC 3.0)

Focus on fundamental analysis and survey of groundwater hydrology with emphasis on practical geo-environmental and subsurface hydrology issues of interest to working professionals. Topics will include general hydrology, surface and subsurface interconnection, basic groundwater flow and well test analysis, and a brief intro to contaminant transport.

**GEO ENG 5381 Intermediate Subsurface Hydrology And Contaminant Transport Mechs** (LEC 3.0)

A study of the physical/chemical properties of rocks and sediments in the subsurface environment. Emphasis is put on waterrock properties such as permeability, capillarity, and mechanical dispersion. Both microscopic and macroscopic approaches are used. Prerequisites: Civ Eng 3330 & Geo Eng 5331.



**GEO ENG 5415 Soil Mechanics for Geoprofessionals** (LEC 3.0)

The basic principles of soil mechanics necessary for professionals to practice in the field of geoconstruction. Topics related to the practical aspects of engineering include: soil classification, index properties, water flow through soils, compaction, compressibility, and shear strength. These basic principles will be applied to real world problems.

**GEO ENG 5441 Engineering Geology And Geotechnics** (LEC 3.0)

Study of procedures and techniques used to evaluate geologic factors for site selection and the design of engineered structures. Prerequisite: Geo Eng 3175.

**GEO ENG 5443 Subsurface Exploration** (LAB 1.0 and LEC 2.0)

Lectures and field and laboratory exercises in the use of geologic and geophysical techniques for evaluation of subsurface geology and resources. Prerequisite: Geo Eng 1150.

**GEO ENG 5471 Rock Engineering** (LEC 3.0)

Data requirements for design; engineering properties of rock; characterization of fractures and rock masses; stereonet analysis of discontinuities; graphic analysis of failure; ground stress distribution; tunnel construction methods; ground support principles; selection of tunneling equipment; and specifications for underground construction. Prerequisite: Geo Eng 3175.

**GEO ENG 5556 Renewable Energy Systems** (LEC 3.0)

Introduction to the theory and performance prediction of typical renewable energy systems such as, but not limited to, those based on energy from the sun, wind and water, and geothermal. The use of environmental data, including stochastic modeling, for renewable energy system (including wind turbine, photovoltaic, and geothermal) design is addressed. Prerequisites: Math 3304, Physics 2135, and preceded or accompanied by Geo Eng 4115 or any Probability and Statistics class. Junior or senior standing is required.

**GEO ENG 5575 Aggregates And Quarrying** (LEC 3.0)

Properties and uses of aggregates. Finding aggregate deposits and methods of extraction. Aggregate processing. Aggregate testing. Economics and politics of aggregates. Special topics in aggregates and quarrying. Prerequisites: Geo Eng 1150, Geo Eng 3175.

**GEO ENG 5642 Military Geology** (LEC 3.0)

This course will familiarize geologists, geophysicists, civil and geological engineers with the fundamental principles of physical geology, geohydrology and geomorphology as applied to military problems, such as development of fortifications, core infrastructure, water resources and combat engineering requirements. Prerequisite: Geo Eng 3175 or graduate standing.

**GEO ENG 5736 Geophysical Field Methods** (LEC 2.0 and LAB 1.0)

Imaging of selected subsurface features and engineering structures using various geophysical tools. Special emphasis is placed on ground penetrating radar and surface wave techniques. One field trip at student expense required. Prerequisite: Junior level standing or higher. (Co-listed with Geophysics 5736).

**GEO ENG 5761 Transportation Applications of Geophysics** (LAB 1.0 and LEC 2.0)

Overview of geophysical and non-destructive test methods that are commonly used to investigate transportation structures and their foundations. Emphasis is placed on bridge system substructure, bridge system superstructure, pavement, roadway subsidence, subsurface characterization and vibration measurements. Prerequisite: Junior level standing or higher. (Co-listed with Geophysics 5761 and Civ Eng 5750).

**GEO ENG 5782 Environmental and Engineering Geophysics** (LEC 2.0 and LAB 1.0)

An introduction to the theory and application of the gravity, magnetic, resistivity, self-potential, induced polarization and electromagnetic methods as applied to the solution of engineering and environmental problems. Prerequisite: Math 2222. (Co-listed with Geophysics 5782).

## Geology (GEOLOGY)

**GEOLOGY 1110 Physical And Environmental Geology** (LEC 3.0)

Materials, structure, and surface features of the Earth and planets are studied in the context of the processes that continuously transform the Earth and affect management of Earth resources, hazards, engineering problems, and environmental challenges. Prerequisite: Entrance requirements. (Co-listed with Geo Eng 1150).

**GEOLOGY 1111 Introduction to Physical Geology** (LAB 1.0 and LEC 2.0)

A study of Earth materials, surface features, internal structures and processes. Particular attention is paid to Earth resources, geological hazards, engineering and environmental problems. Prerequisite: Entrance requirements.

**GEOLOGY 1119 Physical and Environmental Geology Laboratory** (LAB 1.0)

Geology 1119 is designed to accompany Geology 1110 and consists of laboratory explorations of the study of common rocks and minerals, air photographs, maps, and case studies of geological problems related to management of Earth resources, hazards, and environmental challenges. (Co-listed with Geo Eng 1119). Prerequisite: Preceded or accompanied by Geology 1110.

**GEOLOGY 1120 Evolution Of The Earth** (LEC 3.0)

A survey of the Earth history from the coalescence of the solar system to the present and the events that have profoundly transformed the planet in the context of the dynamic feedback between physical and biological systems. A one day field trip is required. Prerequisites: Recommend Geo Eng 1150 or Geology 1110 or Bio Sci 1113 but not required.

**GEOLOGY 1129 Evolution of the Earth Laboratory** (LAB 1.0)

Geology 1129 is designed to accompany Geology 1120 and consists of laboratory explorations of fundamental concepts in geology and the diversity of the fossil record. Prerequisite: Preceded or accompanied by Geology 1120.

**GEOLOGY 1141 Physical Oceanography** (LEC 3.0)

An introduction to the study of the physical and geological processes in the world's oceans including the importance of the oceans to the environment and to life on Earth. Prerequisites: GEOLOGY 1110 or GEOLOGY 1120 or equivalent.

**GEOLOGY 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEOLOGY 2096 Field Geology** (LEC 3.0)

Theory and practice in the qualitative and quantitative description of spatial relationships of major rock types, contacts, and structures through construction of geologic maps. Emphasis on developing fundamental field skills, including logistical planning, navigation, data collection and documentation, and professional protocol during site visits. Students will be charged a fee to cover the cost of field trip expenses. Prerequisites: GEOLOGY 1111, 1110, 1119, & 1129.

**GEOLOGY 2610 Mineralogy And Crystallography** (LEC 3.0 and LAB 1.0)

An introduction to the study of minerals, including their systematic classification, crystallography, morphology, chemistry, societal use, geologic occurrence, environmental application and impact, and identification by means of their physical and chemical properties. Prerequisites: Chem 1310 and Chem 1319.

**GEOLOGY 2611 Physical Mineralogy And Petrology** (LEC 2.0 and LAB 1.0)

An introduction to the study of physical mineralogy and petrology, overviewing systematic determination of minerals and rocks by means of their physical properties. Includes the recognition of crystal forms and field relationships of rocks. Course designed for non-geology majors, credit will not count towards a geology-geophysics degree. Prerequisites: Chem 1310 and Chem 1319 or Chem 1351; Geo Eng 1150 or Geology 1110.

**GEOLOGY 2620 Igneous And Metamorphic Petrology** (LEC 3.0 and LAB 1.0)

A comprehensive study of megascopic and microscopic characteristics of igneous and metamorphic rocks. Fundamental theories for their origin are presented. The class includes a trip to examine these rock types in the field. Prerequisite: Geology 2610.

**GEOLOGY 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GEOLOGY 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEOLOGY 3310 Structural Geology** (LEC 3.0)

Students will develop of an appreciation for the geometrical beauty of geologic structures through an understanding of crustal deformation at scales from mineral lattices to tectonic plates. Field trip fee required. Prerequisites: GEOLOGY 1110 or GEO ENG 1111.

**GEOLOGY 3319 Structural Geology Lab** (LAB 1.0)

This course reinforces the principles of Structural Geology through detailed analysis of rock deformation. Techniques will include using a geologic compass, preparing rock descriptions, stereographic analysis, interpretation of geologic maps, construction of cross-sections, and orthographic projections to solve scientific and engineering problems. Prerequisites: Preceded or accompanied by GEOLOGY 3310.

**GEOLOGY 3410 Introduction To Geochemistry** (LEC 3.0)

Application of basic chemical principals towards investigations of element distributions in geologic systems. Emphasis on origin of elements in our Solar System, element distribution during planetary formation, phase equilibria, rock-water interactions, thermodynamic principles, environmental and isotope geochemistry. Prerequisite: Chem 1310.

**GEOLOGY 3511 Introduction to Mineral Deposits** (LEC 3.0)

Basic processes involved in the formation of metallic and industrial mineral deposits illustrated by typical examples of deposits from throughout the world. Exploration and economic factors in mineral exploration and development are reviewed. Prerequisites: Geology 1110 and Geology 2610.

**GEOLOGY 3620 Stratigraphy And Sedimentation** (LEC 3.0)

Principles of physical stratigraphy, bio-stratigraphy and introductory sedimentation. Introduction to depositional systems, facies, unconformities, stratigraphic nomenclature and correlation. One field trip at student expense is required. Prerequisite: Geology 2620 or Geology 2611.

**GEOLOGY 3629 Stratigraphy Lab** (LAB 1.0)

This course re-enforces the principles of stratigraphy and sedimentation through the use of "hands-on" laboratory procedures such as sieve and pipette analyses, correlation problems, fence diagrams and stratigraphic maps. One field trip at student expense is required. Prerequisite: Concurrent with Geology 3620.

**GEOLOGY 3631 Systematic Paleontology** (LAB 1.0 and LEC 2.0)

Introduction to paleontological principles, biostratigraphy, paleoenvironments, and the study of fossil invertebrates, microfossils, plants and palynology. Emphasis of the course is on fossil morphology, classification, and environmental relationships. Prerequisite: Geology 1110 or Geology 1120 or Bio Sci 1113.

**GEOLOGY 3811 Fundamentals Of Geographic Information Systems** (LEC 2.0 and LAB 1.0)

Introduction to the fundamental concepts and components of Geographic Information Systems. Techniques for acquiring, manipulating and analyzing digital terrain data for geological and geotechnical applications. (Co-listed with Geo Eng 3148).

**GEOLOGY 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GEOLOGY 4001 Special Topics** (LAB 1.0 and LEC 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEOLOGY 4010 Seminar** (RSD 0.0-6.0)

Discussion of current topics. Required for two semesters during senior year. (Course cannot be used for graduate credit). Prerequisite: Senior standing.

**GEOLOGY 4085 Internship** (IND 3.0)

Students will select, with the advice of their advisor, appropriate problems for investigation through practical application of fundamental geoscience principles. The problems selected must provide higher level experiential learning. Assessment is based upon the quality of written and oral presentations and supervisor's evaluation. Prerequisite: Advisor's approval.

**GEOLOGY 4097 Advanced Field Geology** (LEC 3.0)

Advanced instruction in theory and practice of qualitative and quantitative description of spatial relationships of rock types in areas exhibiting complex deformation. Emphasis on experiential learning where students plan, implement, and reflect on outcomes for several scientific field campaigns in a manner consistent with professional scientific practices. Students will be charged a fee to cover the cost of field trip expenses. Prerequisites: GEOLOGY 2610, 2620, 3310, 3620, 3629, and 2096.

**GEOLOGY 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**GEOLOGY 4211 Electrical Methods In Geophysics** (LEC 3.0)

The theory and instrumentation for measurements of the electrical properties of the earth. Includes passive and active techniques, the advantages and disadvantages of the various techniques, and geologic interpretations of electrical soundings. Several weekends are spent making a variety of electrical surveys of local features. Prerequisites: Math 5325 and Geophys 3221.

**GEOLOGY 4310 Remote Sensing Technology** (LAB 1.0 and LEC 2.0)

Principles of digital image processing including image enhancement and multispectral classification. Emphasis upon design and implementation of remote sensing systems and analysis of remotely sensed data for geotechnical and environmental investigations. Prerequisite: Geo Eng 3148. (Co-listed with Geo Eng 5144).

**GEOLOGY 4411 Hydrogeology** (LEC 3.0)

This course discusses geologic aspects of major surface and subsurface hydrologic systems of North America. Chemical and physical relationships between groundwater and fractures, faults, karst, subsurface pressures, mineral deposits plus both contaminant and hydrocarbon migration are discussed. Prerequisites: Geo Eng 1150 or Geology 1110, Geology 3620 recommended.

**GEOLOGY 4421 Radioactive Waste Management And Remediation** (LEC 3.0)

Sources and classes of radioactive waste, long-term decay, spent fuel storage, transport, disposal options, regulatory control, materials issues, site selection and geologic characterization, containment, design and monitoring requirements, domestic and foreign waste disposal programs, economic and environmental issues; history of disposal actions, and conduct of remedial actions and cleanup. Prerequisite: Math 3304. (Co-listed with Nuc Eng 4367).

**GEOLOGY 4431 Methods Of Karst Hydrogeology** (LEC 3.0)

Familiarize geoscientists with the origin and identification of karst features, discuss groundwater movement, engineering problems, water quality and supply in karst areas, and teach investigative techniques including fluorescent dye tracing. Several field trips at student expense will be required. Prerequisite: Geology 1110 or Geo Eng 1150; Geology 3620.

**GEOLOGY 4441 Applied Geochemistry** (LEC 2.0 and LAB 1.0)

Application of the principles of geochemistry and techniques of geochemical analysis in a student research project investigating geochemical processes (mineral deposits, environmental geochemistry, trace element migration, or water-rock interaction). Field trip fee required. Prerequisites: Geology 2610 and Geology 3410.

**GEOLOGY 4451 Aqueous Geochemistry** (LEC 3.0)

Studies of the interaction of water with minerals and organic materials at low temperatures; including processes affecting the migration of elements (alteration, precipitation, and adsorption), the influence of geochemical processes on water composition, weathering, soil formation, and pollution. Field trip fee required. Prerequisite: Geology 3410.

**GEOLOGY 4461 Isotope Geochemistry** (LEC 2.0 and LAB 1.0)

Introduction to the fundamentals of radiogenic and stable isotopes as used to understand geologic processes. The use of selected isotopic systems in petrology, ore petrogenesis, paleontology, and the global climate systems will be discussed. Prerequisites: Geology 2620, 3620, 3410.

**GEOLOGY 4521 Ore Microscopy** (LAB 2.0 and LEC 1.0)

A study of polished sections of minerals and ores under reflected light. Includes the preparation of polished sections, the identification of ore minerals, and the study of the textures, associations, and alterations of ore minerals. Prerequisite: Geology 2610.

**GEOLOGY 4631 Advanced Igneous and Metamorphic Petrology** (LAB 1.0 and LEC 3.0)

Processes governing the formation of igneous and metamorphic rocks as constrained by geochemical, isotopic, and thermodynamic data, with particular reference to the relationship between rock suites and tectonic setting. The laboratory will emphasize the description of rock suites in hand sample and thin section. A field trip at the student's expense is required. Prerequisite: Geology 2620.

**GEOLOGY 4711 Paleoclimatology and Paleoeology** (LEC 3.0)

This course will introduce students to the elements of climate, evidence of climate changes, proxy measurements and paleoclimate models. There is a review of Holocene climates and Archean to Pleistocene paleoclimates. Prerequisite: Geology 1110 or Geology 1120 or Geo Eng 1150.

**GEOLOGY 4721 Meteorology and Climatology** (LEC 3.0)

An introduction to the atmospheric and climatic systems of the Earth including weather, paleoclimatology, and global climate change. Prerequisites: GEOLOGY 1110 or GEOLOGY 1120 or equivalent.

**GEOLOGY 4731 Astronomy and Planetary Science** (LEC 3.0)

Basic principles of astronomy, the origin and evolution of the universe, stellar evolution, and the origin, composition, and processes operating on the planetary bodies in the solar system (besides the Earth). Prerequisite: Entrance requirements for the MST program in Earth Science.

**GEOLOGY 4821 Applications Of Geographic Information Systems** (LAB 1.0 and LEC 2.0)

Applications of Geographical Information Systems and remote sensing to environmental monitoring, mineral resource exploration, and geotechnical site evaluation. Prerequisite: Geo Eng 31+D151275 or consent of instructor. (Co-listed with Geo Eng 5146).

**GEOLOGY 4831 Computational Geology** (LEC 2.0 and LAB 1.0)

This course introduces the technology used for both surface and subsurface geologic mapping. It utilizes common systems and programs such as UNIX, Windows and industry-standard mapping applications. The goal of the course is to fully prepare students for their first professional assignment. Prerequisites: Geology 1110 or Geology 1120 or Geo Eng 1150.

**GEOLOGY 4841 Geological Field Studies** (LEC 3.0)

Intensive review of the scientific literature corresponding to a selected geographical region of geologic interest; followed by a 7 to 10 day long field trip to be held over spring break or after the end of the semester. Students will be expected to bear a portion of the field trip expenses. Repeatable for credit. Prerequisites: Geology 1110 or Geo Eng 1150.

**GEOLOGY 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GEOLOGY 5001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GEOLOGY 5010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

**GEOLOGY 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**GEOLOGY 5085 Internship** (IND 3.0)

Students will select, with their committee's advice, problems for investigation and preparation of a graduate research proposal. Problems must provide higher level experiential learning consistent with a graduate degree in geology. Assessment is based upon the quality of written and oral presentations and supervisor's evaluation. Repeatable for credit. Prerequisite: Graduate Standing.

**GEOLOGY 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation.

**GEOLOGY 5111 Advanced Physical Geology** (LEC 3.0)

Examination of topics concerned with the physical properties of earth materials, processes affecting change of the surface and interior of the earth, and the driving forces causing these changes. Weekly critical assessment of literature, and an oral presentation and term paper required. Prerequisite: Consent of instructor.

**GEOLOGY 5121 Advanced Historical Geology** (LEC 2.0 and LAB 1.0)

Study of the physical and biological history of the Earth beginning with the origin of the solar system up to the present. Emphasis will be placed on processes that shaped the Earth and its ecosystems. Prerequisite: Entrance requirements for the MST program in Earth Science.

**GEOLOGY 5311 Depositional Systems** (LEC 3.0)

Development of three dimensional depositional models using Walther's Law, Walther's Warning and seismic stratigraphy. Emphasis on overall geometries and internal porosity and permeability characteristics of aquifers and hydrocarbon reservoirs. Includes 3-D models for clastic, carbonate and evaporate sequences. Prerequisites: Geology 1110 or Geo Eng 1150; accompanied or preceded by both Geology 3310 and Geology 3620.

**GEOLOGY 5411 Advanced Geochemistry** (LEC 3.0)

A study of the absolute and relative abundance of elements and isotopes in the Earth, principles of element transport, formation of the Earth's crust, mineral deposits, and soils. Field trip fee required. Prerequisite: Geology 3410.

**GEOLOGY 5511 Applied Petroleum Geology** (LEC 1.0 and LAB 2.0)

The principles of petroleum geology are applied in solving hydrocarbon exploration and developmental problems. Geological and economical techniques for evaluating hydrocarbonbearing reservoirs are presented, with methods for decisionmaking under conditions of extreme uncertainty. Prerequisite: Geology 5411.

**GEOLOGY 5513 Petroleum Geology** (LEC 2.0 and LAB 1.0)

Principles of origin, migration, and accumulation of oil and gas. The laboratory introduces the procedures used for exploration, and development of hydrocarbon resources. Prerequisites: Geology 1110 or Geo Eng 1150; accompanied or preceded by both Geology 3310 and Geology 3620.

**GEOLOGY 5521 Coal Petrology** (LEC 3.0)

Formation, composition, and properties of coals. Discussion of the geology of selected coal deposits, the analysis of coal, and the optical identification of coal minerals. Prerequisite: Permission of instructor.

**GEOLOGY 5611 Granites And Rhyolites** (LAB 1.0 and LEC 3.0)

Processes governing the generation and crystallization of felsic magma will be covered, with specific reference to: 1) crust vs mantle sources, 2) melt migration and emplacement, 3) magma chamber dynamics, 4) the volcanic-plutonic connection, and 5) the relationship to tectonic setting. A field trip at the student's expense is required. Prerequisite: Geology 2620.

**GEOLOGY 5631 Carbonate Petrology** (LEC 2.0 and LAB 1.0)

Petrology, chemistry and sedimentology of carbonates and other associated chemical sedimentary rocks. Prerequisites: GEOLOGY 2620, 3620 and CHEM 1320 or equivalent; GEOLOGY 3410 recommended.

**GEOLOGY 5641 Advanced Igneous Petrology** (LEC 2.0 and LAB 1.0)

The genesis of eruptive rocks as evidenced by the physico-chemical conditions of formation of their constituent minerals. A critical examination of various magmatic processes. Use of advanced petrographic techniques. Prerequisites: GEOLOGY 4631.

**GEOLOGY 5661 Advanced Stratigraphy and Basin Evolution** (LEC 3.0)

Advanced topics in sedimentary geology including: tectonic controls on sedimentary basin development, global sequence stratigraphy, regional facies and diagenetic patterns, basin hydrogeology, thermal evolution of basins and distribution of economic resources. This course should be preceded or accompanied by Geology 3410. Prerequisites: Geology 3620 and Geology 3310.

**GEOLOGY 5671 Clay Mineralogy** (LEC 2.0 and LAB 1.0)

Mineral structure, geochemical properties, occurrence, environment, and uses of clays. Determination of physical properties, optics, x-ray diffraction, and thermal features of clays. Field trip fee required. Prerequisites: Geology 2610 and 3410, or Chem 2310, or Civ Eng 5715, or Geo Eng 5172.

**GEOLOGY 5679 Field and Laboratory Studies in Earth Science** (LAB 3.0)

Hands-on laboratory and field experiences in the Earth Sciences. This course is designed to be taught in an intensive three week session during the summer on the S&T campus. Prerequisites: GEOLOGY 2096 or 5121 or equivalents.

**GEOLOGY 5681 Lidar Principles and Application** (LEC 3.0)

Provides a comprehensive understanding of light detection and ranging (lidar) technology as it has been developed for commercial use; various methods of deploying technology for collection of data for mapping, engineering and science, and application of the data using specialized software for editing and processing point cloud data. Assumes GIS experience. Prerequisite: Senior or graduate standing.

**GEOLOGY 5741 Micropaleontology** (LEC 2.0 and LAB 1.0)

This course studies the fossil and soft-body characteristics of bacteria, protists, microinvertebrates and organic-walled microfossils (palynomorphs). Focused discussions on systematics, evolutionary histories, paleoecology, and geologic applications of the microfossil groups. Extraction of foraminifera and palynomorphs from rocks in lab. Prerequisite: Geology 3631.



# Geophysics (GEOPHYS)

## **GEOPHYS 2211 Geophysical Imaging** (LEC 2.0 and LAB 1.0)

A study of the major geophysical methods applicable to shallow engineering and environmental geoscience. Topics include the background theory and practical application of gravity, magnetics, radiometrics, resistivity, induced polarization, spontaneous potential, reflection and refraction seismics, ground penetrating radar, electromagnetics, and borehole logging methods. Prerequisites: Physics 2135; Geo Eng 1150 or Geology 1110.

## **GEOPHYS 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course.

## **GEOPHYS 3210 Introduction to Geophysics** (LEC 3.0)

An introduction to a broad area of solid earth geophysics and exploration geophysics. Topics include plate tectonics, earthquake study, structure and dynamics of the Earth's deep interior, gravity, magnetism, heat flow, and geophysical exploration for natural resources. Prerequisites: Math 1208 and Geology 1110.

## **GEOPHYS 3211 Introduction To Geophysical Data Analysis** (LEC 3.0)

The application of time series and spatial series analysis techniques to geophysical data. Topics covered include digitization and aliasing of geophysical signals, frequency and wavenumber spectra, digital filtering and linear systems theory. Prerequisites: Math 2222 and Comp Sci 1570, 1970 & 1980, or 1971 & 1981.

## **GEOPHYS 3221 Potential Field Theory** (LEC 3.0)

The mathematics and physics of gravitational, magnetic, and electrical fields of the earth as derived from potential functions, with applications to practical problems. The theorems of Laplace, Poisson, Gauss, and Green and their applications to geophysics are presented. Prerequisite: Accompanied or preceded by Math 5325.

## **GEOPHYS 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

## **GEOPHYS 4001 Special Topics** (LEC 2.0 and LAB 1.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

## **GEOPHYS 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

## **GEOPHYS 4231 Seismic Interpretation** (LEC 2.0 and LAB 1.0)

An introduction to 2-D/3-D seismic structural interpretation, stratigraphic interpretation, reservoir identification and evaluation, and horizon and formation attributes. The students are expected to master interactive 2-D/3-D seismic interpretation software packages that are routinely used in the petroleum industry. Prerequisites: Math 1208 or Math 1214; Geology 1110 or Geo Eng 1150.

## **GEOPHYS 4241 Electrical Methods In Geophysics** (LEC 2.0 and LAB 1.0)

The theory and instrumentation for measurements of the electrical properties of the earth. Includes passive and active techniques, the advantages and disadvantages of the various techniques, and geologic interpretations of electrical soundings. Several weekends are spent making a variety of electrical surveys of local features. Prerequisites: Math 5325 and Geophys 2211 or Geophys 3251.

## **GEOPHYS 4261 Geophysical Instrumentation** (LAB 1.0)

Field and laboratory practice in the use of geophysical instrumentation. Techniques of geophysical data reduction and interpretation are also covered. May be taken more than once for credit with Geophys 4241 and Geophys 384. Prerequisite: Concurrent registration in Geophys 3251, 283 or 384.

## **GEOPHYS 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

## **GEOPHYS 5001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

## **GEOPHYS 5010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

## **GEOPHYS 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

## **GEOPHYS 5096 Global Tectonics** (LEC 3.0)

An integrated view of the Earth's structure and dynamics with an emphasis on information gained through geophysical methods. Topics include seismology, heat flow, gravity, rheological and compositional structure, plate motions and intermotions, and mantle driving mechanisms for plate tectonics. Prerequisite: Geology 3310.

## **GEOPHYS 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

## **GEOPHYS 5202 Exploration and Development Seismology** (LAB 1.0 and LEC 2.0)

Principles of reflection seismology as applied to the delineation of geologic structures and the determination of stratigraphy and lithology. Emphasis on both the capabilities and limitations of the seismic method. The laboratory utilizes both modeled and actual seismic data. Prerequisites: Math 1208 or Math 1214; Geology 1110 or Geo Eng 1150.

## **GEOPHYS 5211 Seismic Stratigraphy** (LEC 2.0 and LAB 1.0)

A study of the seismic expression of depositional models. Reflection patterns and reflection amplitudes are interpreted to determine bed thicknesses, fluid content, depositional environment, and lithology. Special data acquisition and processing techniques are examined. Prerequisites: Geophys 4521, Geology 3310, 3620.

## **GEOPHYS 5221 Wave Propagation** (LEC 3.0)

A study of Hamilton's principle and energy theorems, fundamentals of plane wave theory, waves in stratified fluids, elastic waves in solids, electromagnetic and hydromagnetic radiation, and Allen's functions and point sources. Prerequisites: Geophys 281, 3221.

## **GEOPHYS 5231 Seismic Data Processing** (LAB 1.0 and LEC 2.0)

Introduction to seismic data processing. Topics to be covered include statics corrections, filtering, velocity analysis, deconvolution, stacking and migration. The course has a field component to record seismic data. If this is offered in the summer, an off-campus trip may be needed. Extra fee may be charged to cover the field expenses. Prerequisites: Geophys 3210 or Geophys 5202.

**GEOPHYS 5241 Advanced Electrical And Electromagnetic Methods In Geophysical Exp** (LAB 1.0 and LEC 2.0)

Theory of the electrical geophysical methods as applied to subsurface investigations addressing geologic, engineering, groundwater and contaminant transport problems. Course content includes both passive and active methods and recent advances in the application of these methods. Course will include a field component illustrating application of techniques to local problems. Prerequisites: Geophys 3251, Math 2222.

**GEOPHYS 5261 Computational Geophysics** (LEC 1.0 and LAB 2.0)

Scientific programming in a UNIX/Linux environment, with emphasis on solving geophysical problems such as linear and nonlinear inversion, spectral analysis, seismicity, seismic wave attenuation, shear-wave splitting, and seismic tomography. Prerequisite: Geophys 3210.

**GEOPHYS 5736 Geophysical Field Methods** (LAB 1.0 and LEC 2.0)

Imaging of selected subsurface features and engineering structures using various geophysical tools. Special emphasis is placed on ground penetrating radar and surface wave techniques. One field trip at student expense required. Prerequisite: Junior level standing or higher. (Co-listed with Geo Eng 5736).

**GEOPHYS 5761 Transportation Applications of Geophysics** (LAB 1.0 and LEC 2.0)

Overview of geophysical and non-destructive test methods that are commonly used to investigate transportation structures and their foundations. Emphasis is placed on bridge system substructure, bridge system superstructure, pavement, roadway subsidence, subsurface characterization and vibration measurements. Prerequisite: Junior level standing or higher. (Co-listed with Geo Eng 5761 and Civ Eng 5750).

**GEOPHYS 5782 Environmental and Engineering Geophysics** (LEC 2.0 and LAB 1.0)

An introduction to the theory and application of the gravity, magnetic, resistivity, self-potential, induced polarization and electromagnetic methods as applied to the solution of engineering and environmental problems. Prerequisite: Math 2222. (Co-listed with Geo Eng 5782).

## German (GERMAN)

**GERMAN 1101 Elementary German I** (LEC 4.0)

Introduction to grammar, reading, and conversation. Prerequisites: Entrance requirements.

**GERMAN 1102 Elementary German II** (LEC 4.0)

A continuation of German 1101. Prerequisite: German 1101.

**GERMAN 1180 Classical And Modern German Readings** (LEC 4.0)

Readings in German narrative literature. Prerequisite: German 1102.

**GERMAN 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GERMAN 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GERMAN 2110 Basic German Conversation** (LEC 2.0)

Conversation and oral practice. Prerequisite: German 1102.

**GERMAN 2170 Masterpieces Of German Literature** (LEC 3.0)

A study of selected major works and movements in German literature. Prerequisite: German 1180.

**GERMAN 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GERMAN 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GERMAN 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**GERMAN 4001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**GERMAN 4010 Seminar** (RSD 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

## History (HISTORY)

**HISTORY 1100 Early Western Civilization** (LEC 3.0)

Growth and development of ideas and institutions of western culture from prehistoric man to the voyages of discovery.

**HISTORY 1200 Modern Western Civilization** (LEC 3.0)

A continuation of History 1100 to the present with special emphasis on the philosophical, political, social, and economic backgrounds of modern society.

**HISTORY 1300 American History To 1877** (LEC 3.0)

Survey of the history of the American colonies and United States from colonial times through Reconstruction.

**HISTORY 1310 American History Since 1877** (LEC 3.0)

Survey of the history of America since Reconstruction.

**HISTORY 1790 Introduction to History** (LEC 1.0)

This required course for history majors will introduce them to the study of history, the various fields of history, and the current faculty. The course will also introduce students to the research methods of historians.

**HISTORY 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**HISTORY 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**HISTORY 2110 World Regional Geography** (LEC 3.0)

An introduction to the distinguishing cultural and physical characteristics of the major regions of the world. Emphasis on the political problems within the regions and the contemporary issues involved.

**HISTORY 2210 European Diplomatic History 1814 - Present** (LEC 3.0)

A survey of European Diplomatic History beginning with The Congress of Vienna to the present, including the Congress system, the Eastern Question, the shift to realpolitik, the diplomatic origins and concluding conferences of the World Wars and Cold War diplomacy. Prerequisite: History 1200.

**HISTORY 2220 Making Of Modern Britain** (LEC 3.0)

A survey of modern Britain from the era of Restoration and Glorious Revolution (1660-1689) to the present. Major themes include the social, intellectual, cultural, political and economic aspects of modern and contemporary Britain. Prerequisite: History 1200.

**HISTORY 2221 Making of Modern Germany** (LEC 3.0)

A survey of modern Germany from 1815 through the present. Major themes include social, intellectual, cultural, political, and economic aspects of modern and contemporary Germany, with emphasis on developments during the twentieth century. Prerequisite: History 1200 or History 1300 or History 1310.

**HISTORY 2222 The Making Of Modern France** (LEC 3.0)

A survey of modern France from the era of Louis XIV (1660-1715) to the present. Major themes include the social, intellectual, cultural, political and economic aspects of modern and contemporary France. Prerequisite: History 1200.

**HISTORY 2224 Making Of Modern Russia** (LEC 3.0)

A survey of modern Russia from the era of "Westernization" and Peter the Great (1660-1725) to the present. Major themes include the social, intellectual, cultural, political and economic aspects of modern and contemporary Russia, with emphasis on the Soviet period. Prerequisite: History 1200.

**HISTORY 2430 History of the American Pacific** (LEC 3.0)

This course examines United States expansion into the Pacific as an extension of 19th century Manifest Destiny. Emphasizing American Pacific possessions, the course includes a historical, political, geographical, and cultural look at the islands from 1800 to the present. Prerequisite: History 1300 or History 1310 or History 1200.

**HISTORY 2510 History of Technology** (LEC 3.0)

Technological achievements from prehistoric times to present; topics include agriculture, building and construction, communications, transportation, power sources, the Industrial Revolution, relationships between science and technology, factors in invention and innovation and sociocultural effects. Prerequisite: History 1100 or 1200 or 1300 or 1310.

**HISTORY 2790 Historiography** (LEC 3.0)

Historical interpretation from Herodotus to the present. Emphasis will be placed on reading the works of prominent historians in analyzing the major developments in historical writing. Familiarization with historical source material will be another feature of this course. Serves as capstone course. Prerequisite: Sophomore standing.

**HISTORY 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**HISTORY 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**HISTORY 3010 Seminar** (IND 0.0-6.0)

Discussion of current topics.

**HISTORY 3120 Ancient Greece** (LEC 3.0)

Aegean and Greek Civilization from Homeric times to the Roman Conquest of the Hellenic World. Designed for the student who wishes to understand the fundamental conditions of classical life and to comprehend the ideas that inspired action. Emphasis will be on social, intellectual, political and religious aspects of the classical world. Prerequisite: History 1100.

**HISTORY 3125 Ancient Rome** (LEC 3.0)

Rome 509 B.C. to 337 A.D. The Roman world from the founding of the Republic through the reign of constantine. Special emphasis is on the transformation of classical culture during the Republic and Imperial age. Prerequisite: History 1100.

**HISTORY 3130 Medieval History I** (LEC 3.0)

The Early Middle Ages, 284 A.D.-753 A.D., transition from ancient to Medieval civilization. The fundamental differences between Roman and Medieval ideas, institutions and life. The triumph of Christianity, the conditions which made this triumph possible and its role in the development of Western Europe. Prerequisite: History 1100.

**HISTORY 3135 Medieval History II** (LEC 3.0)

Medieval Civilization, 11th-13th centuries. The transition from Medieval to Modern world, developments in the political, social and economic institutions of the Medieval world and their enduring effect on Western European Civilization, conflict of faith and reason during this period. Prerequisite: History 1100.

**HISTORY 3140 History Of Renaissance Thought** (LEC 3.0)

Concentrates on the political, religious, and social thought of the Renaissance. Particular emphasis on the revival of the classics, the spread of humanistic values, and reform efforts during the period with relationship to the material basis of society. Prerequisite: History 1100 or 1200.

**HISTORY 3150 Tudor and Stuart England** (LEC 3.0)

A study of England 1485 - 1689 covering the social, political, religious, and cultural developments. Prerequisite: History 1100 or History 1200.

**HISTORY 3230 Europe In The Age Of The French Revolution And Napoleon** (LEC 3.0)

An in-depth examination of the causes, courses and results of the French Revolution and the Napoleonic Era (1789-1815). The impact of the age of the French Imperium upon European economic, diplomatic, intellectual, political and social development. Prerequisite: History 1200.

**HISTORY 3235 Foundations Of Contemporary Europe 1815-1914** (LEC 3.0)

Europe after Napoleon, development of democracy and nationalism, revolutionary movements and leaders, unification of Italy and Germany, national developments of the major powers and the road to the First World War are the bases of this course. Prerequisite: History 1200.

**HISTORY 3240 Contemporary Europe** (LEC 3.0)

First World War, the Versailles Peace Settlement and its aftermath, the Soviet, Fascist and Nazi revolutions and regimes, Western culture between the wars, the Second World War, the age of the atom and Cold War. Prerequisite: History 1200 or History 1310.

**HISTORY 3280 European Migrations and Nationalism Formation** (LEC 3.0)

Analyzes migration patterns into, out of, and within Europe in context of global population movements from Roman Empire through the present. Students will learn to analyze and synthesize factors involved in these movements and correlations to personal and national identity formations. Prerequisites: History 1200 or History 1300 or History 1310.

**HISTORY 3320 Colonial America** (LEC 3.0)

Political and social trends in America to 1754. Emphasis placed upon native American culture, Spain and France in America, population trends, family, religion, class structure, economic change, social conflict, and the development of individualism in early America. Prerequisite: History 1300.

**HISTORY 3321 Religion And Witchcraft In Early America** (LEC 3.0)

An examination of the role of occult ideas and practices in the religious life of early Americans. Emphasis placed upon Puritan beliefs which contributed to seventeenth century effort to eradicate witchcraft. Prerequisite: History 1300 or History 1200.

**HISTORY 3325 Revolutionary America, 1754-1789** (LEC 3.0)

An examination of the causes and consequences of the American Revolution. Emphasis placed upon the social conditions in America which contributed to both the Revolution and the writing of the 1787 Constitution. Prerequisite: History 1300.

**HISTORY 3340 Age Of Jefferson And Jackson** (LEC 3.0)

Economic, political, social and constitutional development of the early American republic; the Federalist and Jeffersonian periods, Jacksonian Democracy, rise of sectionalism. Emphasis placed on historical interpretation and historiography of the period. Prerequisite: History 1300.

**HISTORY 3345 Civil War And Reconstruction** (LEC 3.0)

Lecture, discussion and readings on the causes and consequences of the American Civil War. Focuses on the prewar North-South sectional rivalry: impact of the war on American society, government and politics. Reconstruction including the development of racial crisis in United States history. Prerequisite: History 1300.

**HISTORY 3360 Recent United States History** (LEC 3.0)

Examines America's modern age including the New Era, the New Deal, Internationalism, post-war affluence, the post-industrial era as well as the cultural, intellectual, social and technological features of American society from 1920 to the present. Prerequisite: History 1310.

**HISTORY 3420 History Of Missouri** (LEC 3.0)

Survey of Missouri's political, social, economic and cultural development from the beginning of settlement to the present. Prerequisite: History 1300 or 1310.

**HISTORY 3425 History Of The Old South** (LEC 3.0)

Analysis of the southern region of the United States between 1607-1861 with emphasis on economic, social, political, intellectual, and racial themes. Prerequisite: History 1300.

**HISTORY 3426 History Of The Modern South** (LEC 3.0)

Analysis of the southern region of the United States between 1877 and the present with emphasis on economic, social, political, intellectual, and racial themes. Prerequisite: History 1310.

**HISTORY 3440 20th Century Americans In Combat** (LEC 3.0)

Through lectures, films, readings, exams, film reviews and discussions, this course examines the American military and combat experience throughout much of the twentieth century. The ultimate goal of the course is for students to understand the realities of warfare and its effect on ordinary Americans as well as American society. Prerequisite: History 1300 or 1310 or 1200.

**HISTORY 3441 The United States In World War II** (LEC 3.0)

Through lectures, readings and film this course will explore the American experience in World War II. The course will particularly focus on the war's American major battles along with the war's effect on Americans in combat and on the home front. Prerequisite: History 1300 or 1310.

**HISTORY 3442 The United States in Vietnam** (LEC 3.0)

Through lecture, film and readings, this course examines the American experience in the Vietnam War. The course covers the causes and consequences of the war as well as its effect on those who fought and on American society as a whole. There is a special emphasis on the realities of combat and the war's impact on individual Americans. Prerequisite: History 1310.

**HISTORY 3443 The American Military Experience** (LEC 3.0)

A study of American military history, strategy, policy and institutions from the colonial period to the present. War will be viewed in the mainstream of history with emphasis on the American Revolution, the Civil War, and the 20th century conflicts. Prerequisite: History 1200 or History 1300 or History 1310 or Pol Sci 1200.

**HISTORY 3450 American Intellectual History II** (LEC 3.0)

The ideas of intellectuals and the thought of popular culture, and possible relationships between the two. Among the climates of opinion studied are the Gilded Age, Darwinism, Progressivism, the Twenties, the Great Depression, the Affluent Fifties, the Counter-Culture Sixties. Prerequisite: History 1310.

**HISTORY 3480 History Of Baseball** (LEC 3.0)

This course will survey and interpret the history of baseball from its earliest beginnings down to the present. Main focus will be on the evolution of the professional game in all of its facets. Prerequisite: History 1300 or 1310.

**HISTORY 3510 Twentieth Century Technology And Society** (LEC 3.0)

An investigation of technological achievements since 1900 and their effects on society. Topics include: education in a technological society, technology and the state, the individual and the environment, cybernation, agriculture, scientific and industrial research. Prerequisite: History 1200 or 1310.

**HISTORY 3530 History of Science** (LEC 3.0)

A study of the history of science focusing on the leading conceptual developments within science, the scientific revolution, and science's role in society. Prerequisite: History 1100 or History 1200 or History 1300 or History 1310.

**HISTORY 3660 Modern East Asia** (LEC 3.0)

An analysis of the history of East Asia in the nineteenth and twentieth centuries. Topics include: social, historical, and intellectual traditions; imperialism and its impact; and the effects of World War II on Modern East Asia. Prerequisite: History 1200 or History 1300 or History 1310.

**HISTORY 3665 History of Japan** (LEC 3.0)

This course covers the history of modern Japan from 1600 to the present and includes Japan's political, social, and cultural/intellectual history. Prerequisite: History 1200 or History 1300 or History 1310.

**HISTORY 3760 The American Presidency** (LEC 3.0)

Historical development of the presidency; emphasis on the constitutional powers and limits of the office and the political contextual variables that influence presidential behaviors. Prerequisite: Pol Sci 1200 or History 1310. (Co-listed with Pol Sci 3760).

**HISTORY 3761 U.S. Diplomatic History to World War II** (LEC 3.0)

This course is a history of American foreign relations, broadly conceived, from the War for Independence to WWII. Among other things, it deals with the diplomacy of survival, of expansion and of economic and political hegemony. Prerequisites: History 1300, 1310 or Pol Sci 1200. (Co-listed with Pol Sci 3761).

**HISTORY 3762 American Diplomatic History Since World War II** (LEC 3.0)

American Diplomatic History Since World War II will address the major issues in American foreign policy from WWII to the present. Its primary focus is on the Cold War and the post-Cold War problems the U.S. has faced. Prerequisite: History 1310 or Pol Sci 1200. (Co-listed with Pol Sci 3762).

**HISTORY 3763 Contemporary Political Thought** (LEC 3.0)

This course will explore the impact of ideas on American politics and history, including the relationship between technological change and public policy; this will be pursued through the study of American political history, social institutions, and intellectual history. Prerequisite: History 1300 or History 1310 or Pol Sci 1200. (Co-listed with Pol Sci 3763).

**HISTORY 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.



**HISTORY 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**HISTORY 4010 Seminar** (RSD 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

**HISTORY 4085 Internship** (IND 0.0-6.0)

Internship will involve students applying critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisites: Senior status; must have completed 24 hours in major.

**HISTORY 4097 Senior Project** (LEC 3.0)

History majors interested in graduate school or professional school, such as law school, should complete an extended research project, or thesis, under the supervision of a department faculty member. Prerequisites: History 2790 and senior standing.

**HISTORY 4145 The Reformation** (LEC 3.0)

An examination of the backgrounds, events, ideas, and impact of the Reformation in Europe. Emphasis on the competing ideas of the reformers as well as on the Reformation's long-term social, cultural, and political impact. Prerequisite: History 1100 or History 1200.

**HISTORY 4245 Nazi Germany and the Holocaust** (LEC 3.0)

This course focuses on the rise of Nazism and its consequences for politics, society, and culture in Europe. The period's history will be examined from the perspective of perpetrators, victims, and bystanders with emphasis on the Holocaust and its legacy. Prerequisite: History 1200.

**HISTORY 4246 War and Society in Twentieth-Century Europe** (LEC 3.0)

This course explores individuals' experiences in France and Germany between 1914 and 1945. Ideas about society changed in the twentieth century due to war; these changes were reflected in politics and changed relationships between men and women. Seminar-style course. Prerequisite: History 1200 or History 1310.

**HISTORY 4435 History of the American West** (LEC 3.0)

This class examines the American settlement of the Trans-Mississippi West. Areas to be considered include cattle, mining, exploring, women, and Native Americans. Traditional and contemporary views of the American West will be analyzed. Prerequisite: History 1300 or History 1310.

**HISTORY 4470 American Environmental History** (LEC 3.0)

This class discusses the impact of human interactions with the physical environment and the natural world's influence on human civilizations with emphasis on the 19th and 20th centuries. Prerequisite: History 1200 or History 1300 or History 1310.

**HISTORY 4550 Architecture, Technology and Society; 1750 to Present** (LEC 3.0)

This course investigates the relationships between architecture and technology and, as a consequence, architecture's impact on modern culture and society. Topics include: the industrial revolution, housing styles, new materials, Bauhaus and international style, and post-modern architecture. A field trip to Chicago is an integral part of the course. Prerequisites: History 1100 or History 1200 or History 1300 or History 1310 or Pol Sci 1200. Recommended: Junior or Senior Standing. Recommended for Arch Eng majors: Art 3203 taken prior to course.

**HISTORY 5003 Readings In American History Since 1865** (IND 3.0-5.0)

Directed readings and writing on selected topics and areas in American History since 1865. Prerequisites: Graduate standing and consent of instructor.

**HISTORY 5004 Readings In European History To 1715** (IND 3.0-5.0)

Directed readings and writing on selected topics and areas in European History to 1715. Prerequisites: Graduate standing and consent of instructor.

**HISTORY 5005 Readings In European History Since 1715** (IND 3.0-5.0)

Directed readings and writing on selected topics and areas in European History since 1715. Prerequisites: Graduate standing and consent of instructor.

## Info Science & Technology (IS&T)

**IS&T 1001 Special Topics** (IND 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

**IS&T 1551 Implementing Information Systems: User Perspective** (LEC 3.0)

Introduction to object-oriented programming in the context of developing and implementing the various components of an information system with particular attention given to system interface such as window and web forms. Class will include numerous projects covering foundational programming.

**IS&T 1552 Implementing Information Systems: Data Perspective** (LEC 3.0)

Continuation of object-oriented programming in the context of developing and implementing the various components of an information system with particular attention given to database incorporation. Class will include numerous projects covering intermediate topics. Prerequisite: IS&T 1551.

**IS&T 1750 Introduction to Management Information Systems** (LEC 2.0 and LAB 1.0)

This course familiarizes the students with the fundamental concepts and principles of management information systems. Topics covered include the strategic role of IT, decision support systems, database and datawarehouse, enterprise applications, mobile applications, and social and ethical issues related to information systems.

**IS&T 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**IS&T 2001 Special Topics** (IND 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

**IS&T 2002 Cooperative Training in Information Science & Technology** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry with credit arranged through departmental co-op advisor. Grade received depends on quality of reports submitted and work supervisors's evaluation. Prerequisite: Completed 30 hours toward degree.

**IS&T 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**IS&T 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**IS&T 3131 Computing Internals And Operating Systems** (LEC 3.0)

Design-oriented introduction to computer components and operation. Standard codes; number systems; base conversions; computer arithmetic; boolean algebra; operating system components including memory management, device management, and I/O management; and related issues are covered. Prerequisite: IS&T 1552 or Comp Sci 1510.

**IS&T 3321 Network Performance Design And Management** (LEC 3.0)

This course provides analytical capabilities needed to effectively design, deploy, and manage computer networks and protocols. Prerequisites: IS&T 3333.

**IS&T 3333 Data Networks and Information Security** (LEC 3.0)

The course provides an overview of current and evolving networking and information security principles. Concepts include network standards and protocols; operation and management; switching and routing; area networks; wireless network infrastructure; security frameworks, policies, and management. Prerequisites: IS&T 1750; IS&T 1552 or Comp Sci 1510.

**IS&T 3343 Systems Analysis** (LEC 3.0)

Introduction to the processes by which business information systems are analyzed, designed, and introduced into the business environment. Topics include investigation of existing systems, requirements analysis, logical and physical design, database design, forms design, and report analysis. Prerequisite: IS&T 3423.

**IS&T 3420 Introduction to Data Science and Management** (LEC 3.0)

Introduces students to increasing business success through analysis of large-scale data collections. Topics include: import/export of data, summary statistics, cross-tabulation, data transformations (sub setting, merging, sorting and aggregation), modeling methods, and visualization. Significant programming in R is expected. Prerequisites: IS&T 1552 or Comp Sci 1510.

**IS&T 3423 Database Management** (LEC 3.0)

The course introduces the concepts of database management systems. Issues in database architecture, design, administration, and implementation are covered. Prerequisites: IS&T 1750; IS&T 1552 or Comp Sci 1510.

**IS&T 3443 Database Applications in Business** (LEC 3.0)

Design, development and implementation of application software typical to the modern business environment utilizing popular commercial database management systems such as Oracle and Access. Focus given to business case modeling, requirement analysis, database design, and implementation challenges. Project oriented. Prerequisite: IS&T 3343.

**IS&T 3553 Modular Software Systems in Java** (LEC 3.0)

Introduction to Software Life Cycle and characteristics of large modular software systems. Exploration of software support for such systems, using Java, including use of GUI interfaces, advanced I/O and String handling, Interfaces, Threads, and other modularity features. Program project included. Prerequisites: IS&T 1552 and IS&T 3131.

**IS&T 4001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

**IS&T 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**IS&T 4257 Network Economy** (LEC 3.0)

Emerging Network/Internet economy, using traditional economic tools. Topics: production and reproduction cost of information, information as an "experience good," versions of products, switching cost, lock-in effects, market adoption dynamics, first-mover advantage, intellectual property rights. Prerequisite: Econ 1100 or Econ 1200. (Co-listed with Econ 4130).

**IS&T 4261 Information Systems Project Management** (LEC 3.0)

The course overviews general project management principles and then focuses on information system application development. Topics include requirements analysis, project scheduling, risk management, quality assurance, testing, and team coordination. Prerequisites: IST 1552 or Comp Sci 1510; Senior Standing.

**IS&T 4335 Fundamentals of Mobile Technology for Business** (LEC 3.0)

A broad overview of mobile technology use in business environments. Topics include the mobile industry; mobile network and wireless standards; mobile devices; mobile web design and app development; social and user experience issues; mobile marketing and commerce. Prerequisites: IS&T 3333.

**IS&T 4450 Introduction to Information Visualization** (LEC 3.0)

Topics include: the visualization development framework, traditional presentations of data, human perception and aesthetics, colorspace theory, visualization algorithms and software, modern visualizations of large data sets. Application of R packages will be emphasized throughout. Prerequisites: Statistics, Calculus, and Programming Knowledge.

**IS&T 4641 Electronic and Mobile Commerce** (LEC 3.0)

Introduction to fundamental concepts of management and application to IT and support of commerce. Examines the use of IT in business processes and the management issues of integrating IT into organization processes to gain a competitive advantage. Prerequisites: IS&T 1750 and at least Sophomore standing.

**IS&T 4642 E-Commerce Architecture** (LEC 3.0)

Course will cover the issues associated with computer architecture, as it relates specifically to e-commerce applications. Topics will include e-commerce systems and processes, specialized software, and databases. Prerequisite: IS&T 3333.

**IS&T 4654 Web and Digital Media Development** (LEC 3.0)

This course covers techniques and tools for design and development of web-based media, including text, graphics, animation, audio, and video.

**IS&T 4680 Introduction to Web and New Media Studies** (LEC 3.0)

The course covers web culture, including topics such as social media, citizen journalism, crowd intelligence, privacy, and copyright. Prerequisite: Junior or Senior standing.

**IS&T 4780 Human and Organizational Factors in Cybersecurity** (LEC 3.0)

In-depth examination of human and organizational factors in cybersecurity and information assurance. Study of how to protect information integrity, availability, and confidentiality, as well as tools, methods, principles, and analytics for fraud prevention, insider threat detection, and forensic investigations. Assumes prior exposure to cybersecurity or IA.

**IS&T 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**IS&T 5001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

**IS&T 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**IS&T 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**IS&T 5131 Foundations of Computer Architecture** (LEC 3.0)

Design-oriented foundations of computer components and operation. Standard codes; number systems; base conversions; computer arithmetic; boolean algebra; operating system components including memory management, device management; plus related computer architecture topics. Research paper required. Prerequisites: IS&T 1552 and graduate standing.

**IS&T 5168 Law and Ethics in E-Commerce** (LEC 3.0)

Provides the ethical framework to analyze the ethical, legal, and social issues that arise for citizens and computer professionals regarding the computerization of society. Topics include: free speech, privacy, intellectual property, product liability, and professional responsibility. (Co-listed with Philos 4368).

**IS&T 5251 Technological Innovation Management and Leadership** (LEC 3.0)

The course focuses on the knowledge and skills necessary for the development and implementation of effective strategies for the management of technology-based organizations. This involves: developing a general management perspective on technology and innovation, examining the problems of new product development, identifying distinctive technological competencies, licensing and marketing technologies, assessing the organizational and industrial context of technology. Prerequisite: Senior or Graduate Standing.

**IS&T 5420 Business Analytics and Data Science** (LEC 3.0)

Analysis of large business data sets via statistical summaries, cross-tabulation, correlation, and variance matrices. Techniques in model selection, prediction, and validation utilizing general linear and logistic regression, Bayesian methods, clustering, and visualization. Extensive programming in R is expected. Prerequisites: Calculus, Statistics, and Programming knowledge.

**IS&T 5423 Foundations of Data Management** (LEC 3.0)

Foundational concepts of database management systems. Issues in database architecture, design, administration, and implementation. Extensive use of SQL with Oracle to create and manage databases. Significant project dealing with triggers or stored procedures. Prerequisites: IS&T 1750, IS&T 1552, and graduate standing.

**IS&T 5520 Data Methodologies in Python** (LEC 3.0)

Python methodologies for manipulating, processing, cleaning, grouping, slicing, reshaping and summarizing information in data-intensive applications; managing files, scraping web pages, mining social media; describing, modeling, analyzing, and visualizing data. Tools include pandas, NumPy, SciPy, and Matplotlib libraries. Prerequisites: One of Stat 3111, Stat 3113, Stat 3115, Stat 3117 and either IS&T 1552 or Comp Sci 1510; for Graduate Students: Graduate Standing and Knowledge of Calculus, Statistics, and Programming.

**IS&T 5652 Advanced Web Development** (LEC 3.0)

Advanced Web development techniques to provide dynamic interaction; methods for extracting and delivering dynamic information to/from Web servers - a hands-on approach. Emphasis on interaction with servers; mobile software development; processing of graphics and web video. Project work is required. Prerequisites: IS&T 1551 and IS&T 4654.

**IS&T 5885 Human-Computer Interaction** (LEC 3.0)

Introduction to the field of Human-Computer Interaction (HCI). Students examine issues and challenges related to the interaction between people and technology. The class explores the social and cognitive characteristics of people who use information systems. Students learn techniques for understanding user needs, interface prototyping & interface evaluation.

**IS&T 5886 Prototyping Human-Computer Interactions** (LEC 3.0)

This course explores novel HCI and UX technologies as well as methods and tools for creating system prototypes, including best practices and guidelines for optimal user experiences. Example concepts include mobile applications, behavioral monitoring, gamification, natural user interfaces, haptics, and computers as social actors. Prerequisite: Preceded or accompanied by IS&T 5885.

**IS&T 5887 Human-Computer Interaction Evaluation** (LEC 1.5 and LAB 1.5)

This course covers research and analysis methods and tools for evaluation of the impact of information technology systems on humans and organizations. The focus will be on practical evaluation with the goal of providing recommendations for improving system functionality and usability. Prerequisite: Preceded or accompanied by IS&T 5885.

## Marketing (MKT)

**MKT 2000 Special Problems** (IND 0.0-6.0)

(Variable) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MKT 2001 Special Topics** (LEC 0.0-6.0)

(Variable) This is designed to give the department an opportunity to test a new course. Variable title.

**MKT 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in marketing. Prerequisite: Consent of instructor required.

**MKT 3001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department and opportunity to test a new course. Variable title.

**MKT 3105 Marketing and Strategy Essentials** (LEC 1.5)

This course is an introduction to the essentials of marketing and strategy for running a business. It is designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit in this course cannot be applied to any major or minor in Business, IS&T, or Economics. Prerequisite: Bachelor Degree.

**MKT 3110 Marketing** (LEC 3.0)

The course examines the distribution, product, price, and promotion policies that underlie the activities of marketing institutions and the managerial, economic, and societal implications of such policies.

**MKT 3210 Consumer Behavior** (LEC 3.0)

Introduces and applies important concepts, principles, and theories to understand consumer decision-making processes in the purchase, usage and disposal of goods and services. Examines the influence of cultural, social, and psychological factors on consumer behavior. Prerequisite: MKT 3110.

**MKT 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Prerequisite: Consent of instructor required.

**MKT 4150 Customer Focus and Satisfaction** (LEC 3.0)

Major emphasis is given to the concept of customer focus, with coverage of techniques for obtaining customer needs, measuring customer satisfaction, developing products and services to satisfy customers, and maximizing the benefits of customer feedback. A semester long HoQ project will be done. Prerequisites: MKT 3110 or MKT 3105 or ENG MGT 3510. (Co-listed with BUS 4150).

**MKT 4580 Marketing Strategy** (LEC 3.0)

Identification and analysis of strategic managerial marketing issues. Integration of marketing concepts through theoretical overview and practical analysis, including extensive use of simulation. Prerequisite: MKT 3110 or MKT 5105 or Eng Mgt 3510.

**MKT 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in marketing. Prerequisite: Consent of instructor required.

**MKT 5001 Special Topics** (LEC 0.0-6.0)

This is designed to give the department an opportunity to test a new course. Variable title.

**MKT 5099 Research** (IND 0.0-9.0)

Research investigation of an advanced nature leading to a major report suitable for publication in a journal or in a conference proceedings. Prerequisite: Consent of instructor required.

**MKT 5105 Graduate Marketing and Strategy Essentials** (LEC 1.5)

This course is an introduction to the essentials of marketing and strategy for running a business. It's designed for students planning to enter the MBA program who need this area and for non-business students who want some business background. Credit cannot be applied to any major or minor in Business, IS&T or Economics. Additional case study or report required. Prerequisite: Bachelor Degree.

**MKT 5310 Digital Marketing and Promotions** (LEC 3.0)

A managerial examination of integrated marketing communication (IMC) and creativity, with a focus on digital media and new marketing concepts. Specifically, we will look at innovative marketing techniques such as viral marketing, brand communities, experiential marketing and guerilla tactics. Prerequisites: At least Junior standing.

**MKT 5320 Marketing for Non-Profits** (LEC 3.0)

Illustrates the importance of creating synergy within a marketing campaign. Speaking with "one voice" allows a brand to make a stronger impact; students will work with a local non-profit to improve their marketing message at each customer touch point. Students will analyze a marketing plan and work to improve it, including brochures & donation letters. Prerequisites: At least Junior standing.

## Materials Science & Eng (MS&E)

**MS&E 4001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MS&E 4810 Chemistry And Inherent Properties Of Polymers** (LEC 3.0)

A basic study of the organic chemistry of natural and synthetic high polymers, their inherent properties and their uses in plastic, fiber, rubber, resin, food, paper and soap industries. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with Chem 4810).

**MS&E 4819 Polymer Science Laboratory** (LEC 1.0 and LAB 2.0)

Lectures and laboratory experiments dealing with polymerization reactions, solution properties and bulk or solid properties will be presented. Each student will prepare polymers and carry out all characterization experiments on actual samples. Prerequisite: Chem 4810 or MS&E 4810 and preceded or accompanied by Chem 1100. (Co-listed with Chem 4819).

**MS&E 4850 Fundamentals Of Protective Coating I** (LEC 3.0)

Study of the basic principles of protective coatings with particular reference to the paint and varnish industry. Classifications, manufacture, properties and uses of protective coatings. Prerequisite: Chem 1320. (Co-listed with Chem 4850).

**MS&E 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MS&E 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MS&E 5010 Seminar** (RSD 0.0-6.0)

(Variable) Discussion of current topics.

**MS&E 5040 Oral Examination** (IND 0.0)

(Variable) After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D students may be processed during intercession. Off-campus M.S. students must be enrolled in an oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**MS&E 5099 Research** (IND 0.0-15)

(Variable) Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**MS&E 5210 Tissue Engineering I** (LEC 3.0)

The course will introduce senior undergraduate students to the principles and clinical applications of tissue engineering including the use of biomaterials scaffolds, living cells and signaling factors to develop implantable parts for the restoration, maintenance, or replacement of biological tissues and organs. Prerequisite: Senior standing. (Co-listed with Bio Sci 5240).

**MS&E 5220 Advanced Phase Equilibria** (LEC 3.0)

Advanced aspects of unary, binary and ternary organic, phase equilibria. Includes practical examples of the applications of phase diagrams to solve engineering problems. Prerequisite: Graduate standing.

**MS&E 5230 Energy Materials** (LEC 3.0)

The objectives of the course are to understand how the rational design and improvement of chemical and physical properties of materials can lead to energy alternatives that can compete with existing technologies. Discussions on the present and future energy needs from a view point of multidisciplinary scientific and technological approaches. Prerequisite: Senior standing.

**MS&E 5310 Biomaterials I** (LEC 3.0)

This course will introduce senior undergraduate students to a broad array of topics in biomaterials, including ceramic, metallic, and polymeric biomaterials for in vivo use, basic concepts related to cells and tissues, host reactions to biomaterials, biomaterials-tissue compatibility, and degradation of biomaterials. Prerequisites: Senior undergraduate standing. (Co-listed with BIO SCI 5210, CHEM ENG 5200).



**MS&E 5517 Materials Selection in Mechanical Design** (LEC 3.0)

This course will introduce the basics of materials selection in mechanical design. It will also introduce the benefits of computational materials and process selection. The students will also learn to use a commercially available materials selection software. This course will be offered as Distance Ed. Prerequisite: Met Eng 2110.

**MS&E 5810 Introduction to Polymeric Materials** (LEC 3.0)

A basic study of the organic chemistry of natural and synthetic high polymers, their inherent properties and their uses in plastic, fiber, rubber, resin, food, paper and soap industries. Credit may not be given for both Chem 5810 and Chem 4810. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with Chem 5810).

**MS&E 5819 Polymer Synthesis and Characterization Lab** (LEC 1.0 and LAB 2.0)

Laboratory experiments dealing with polymerization syntheses and solution, bulk and solid properties will be presented. Each student will prepare polymers and carry out all characterization experiments on actual samples. Credit may not be given for both Chem 5819 and Chem 4819. Prerequisite: Chem 4810 or MS&E 4810 or Chem 5810 or MS&E 5810 or Chem Eng 5310, preceded or accompanied by Chem 1100 or Chem 5100 or an equivalent training program approved by S&T. (Co-listed with Chem 5819).

**MS&E 5850 Introduction to Coating Chemistry** (LEC 3.0)

Study of the basic principles of protective coatings with particular reference to the paint and varnish industry. Classifications, manufacture, properties and uses of protective coatings. Credit may not be given for both Chem 5850 and Chem 4850. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with Chem 5850).

## Mathematics (MATH)

**MATH 1000 Special Problems** (IND 0.0-6.0)

Problems or readings in specific subjects or projects in the department. Consent of instructor required.

**MATH 1001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MATH 1101 Introduction To Mathematics** (LEC 1.0)

Introduction to the department, program of study, methods of study, and an introduction of the various areas of mathematics. Required of fall semester freshman mathematics majors.

**MATH 1103 Fundamentals Of Algebra** (LEC 3.0)

Basic principles of algebra including the number line and an introduction to equations and inequalities, polynomials, rational expressions, exponents and radicals, the quadratic formula and functions. Prerequisite: Entrance requirements.

**MATH 1110 Introduction To Mathematical Ideas** (LEC 3.0)

A course for non-science majors, including liberal arts and education majors. A study of the nature of mathematics and its relation to western culture, number systems, sets, functions, and selected topics from algebra, computer science and other areas of mathematics. Prerequisite: Two years high school mathematics.

**MATH 1120 College Algebra** (LEC 5.0)

Contains the same topics as covered in Math 1140, and preceded by a thorough review of the basic principles of algebra. Prerequisite: By placement examination.

**MATH 1140 College Algebra** (LEC 3.0)

A study of linear equations, rational functions, radicals, quadratic equations, inequalities, determinants, progressions, theory of equations, permutations, combinations, and the binomial theorem. Prerequisite: By placement examination.

**MATH 1160 Trigonometry** (LEC 2.0)

A study of the trigonometric functions, radian measure, graphing trigonometric functions, identities, trigonometric equations and inverse trigonometric functions. Solutions of general triangles and trigonometric representation of complex numbers are included. Prerequisite: Math 1120 or 1140 with a grade of "C" or better; or by placement exam.

**MATH 1190 Success for Calculus** (LEC 3.0 and LAB 1.0)

This course focuses on the use of college algebra and trigonometry skills within the context of calculus, providing students with the opportunity to improve their preparedness for future calculus coursework. Pass/Fail only. Prerequisites: Consent of instructor.

**MATH 1208 Calculus With Analytic Geometry I** (LEC 5.0)

A study of limits, continuity, differentiation and integration of algebraic and trigonometric functions. Applications of these concepts in physical as well as mathematical settings are considered. Credit will only be given for one of Math 1208 or Math 1214. Prerequisites: Math 1160; Math 1120 or 1140, both with a grade of "C"; or better; or by placement exam.

**MATH 1212 Business Calculus** (LEC 3.0 and LAB 1.0)

Calculus for Bus. & Mgt. Sys, Econ & Finance, or Info. Sci. & Tech; also possibly Bio. Sci, Soc. Sci. or Humanities. Derivatives, optimization, exponential and logarithmic functions, integration, multivariate functions, partial derivatives, Lagrange multipliers, applications. May not be used as a prerequisite for either Math 1215 or Math 1221. Prerequisite: A grade of "C" or better in either 1120 or Math 1140; or by placement exam.

**MATH 1214 Calculus For Engineers I** (LAB 1.0 and LEC 3.0)

Introduction to limits, continuity, differentiation and integration of algebraic and elementary transcendental functions. Applications in physical science and engineering. Credit will be given for only one of Math 1208 or Math 1214. Math 1214 may be accompanied by Math 1160 with Math department approval. Prerequisites: A grade of "C" or better in both Math 1160 and one of Math 1120 or Math 1140; or by placement exam.

**MATH 1215 Calculus For Engineers II** (LAB 1.0 and LEC 3.0)

Continuation of Math 1214. Transcendental functions, techniques of integration, sequences, series including power series, polar coordinates, polar and parametric equations. Applications in physical science and engineering. Credit will be given for only one of Math 1215 or Math 1221. Prerequisites: Math 1160 and either Math 1208 or Math 1214 both with a grade of "C" or better; or by placement exam.

**MATH 1221 Calculus With Analytic Geometry II** (LEC 5.0)

A continuation of Math 8; differentiation and integration of elementary transcendental functions, integration techniques, improper integrals, conic sections, polar coordinates, introduction to sequences and series. Credit will only be given for one of Math 1221 or Math 1215. Prerequisites: Math 1160 and either Math 1208 or Math 1214 both with a grade of "C" or better; or by placement exam.

**MATH 2002 Cooperative Work Training** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry. Variable credit arranged with the advisor. P/F grading option is required and maximum credit per semester is 3 hrs., maximum for entire program is 6 hrs.

**MATH 2222 Calculus with Analytic Geometry III** (LEC 3.0 and LAB 1.0)

An introduction to multivariable calculus. Vector valued functions, curves and surfaces in two and three dimensions, partial differentiation, multiple integration, line and surface integrals, the major theorems of vector calculus, and applications of these ideas are studied. Prerequisites: Math 1215 or Math 1221 with a grade of "C" or better.

**MATH 3000 Special Problems** (IND 0.0-6.0)

Problems or readings in specific subjects or projects in the department. Consent of instructor required.

**MATH 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MATH 3010 Undergraduate Seminar** (SEM 1.0-3.0)

Discussion of advanced or current topics. (Course cannot be used for graduate credit).

**MATH 3103 Matrix Algebra** (LEC 3.0)

Matrix algebra is introduced by means of systems of linear algebraic equations. Gaussian elimination, least squares solutions, orthogonalization, determinants, eigenvalues and an introduction to vector spaces are discussed. Credit will not be given for both Math 3103 and 3108. Prerequisite: Math 2222 with a grade of "C" or better.

**MATH 3108 Linear Algebra I** (LEC 3.0)

Systems of linear equations, matrices, vector spaces, inner products, linear transformations, determinants, and eigenvalues are studied. Prerequisite: Math 1215 or 1221 or 2222 with a grade of "C" or better.

**MATH 3109 Foundations Of Mathematics** (LEC 3.0)

Introduction to mathematical reasoning through an axiomatic development of mathematical systems. Strong emphasis is placed on learning to understand what constitutes a sound mathematical argument. Communication, both written and spoken, is emphasized. Prerequisite: Math 1215 or 1221 with a grade of "C" or better.

**MATH 3304 Elementary Differential Equations** (LEC 3.0)

First order differential equations and linear differential equations of higher order are studied. The Laplace transform and systems of linear equations as well as selected physical applications are covered. Credit will not be given for both Math 3329 and Math 3304. Prerequisite: Math 2222 with a grade of "C" or better.

**MATH 3329 Elementary Differential Equations And Matrix Algebra** (LEC 3.0)

This course is a combination of selected topics from Math 3103 and 3304. Solutions of linear differential equations and systems of linear algebraic equations are emphasized. Credit will not be given for both 3304 and 3329. Prerequisite: Math 2222 with a grade of "C" or better.

**MATH 3921 Teaching Math in Elementary and Middle Schools** (LEC 3.0)

The course presents an overview of how children learn mathematics, various techniques in teaching mathematics, and examples of applying these techniques to specific mathematical concepts (such as geometry, measurement, basic operations, statistics and probability, etc.). Prerequisite: Math 1120 or Math 1140. (Co-listed with Educ 3221).

**MATH 3922 Geometric Concepts for Elementary Teachers** (LEC 3.0)

The course covers methods of teaching the study of points, lines, polygons, similarity, congruence, constructions, and proof in Euclidean Plane Geometry. Transformational geometry and trigonometry are introduced to elementary teachers. Prerequisites: Math 1120 or Math 1140. (Co-listed with Educ 3222).

**MATH 3940 Mathematical Software Applications In The Classroom** (LEC 3.0)

Students will be introduced to a variety of Mathematical Software applications, both PC and calculator based which will aid teachers in presenting concepts and in classroom management. Specific topics covered will be selected based on student interest. Prerequisites: Math 2222 and admission to the MST program.

**MATH 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MATH 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MATH 4010 Undergraduate Seminar** (SEM 1.0-3.0)

Discussion of advanced or current topics. (Course cannot be used for graduate credit).

**MATH 4096 Problem Solving In Pure Mathematics** (LEC 1.0)

Problems from pure mathematics, including analysis, algebra, number theory, set theory, finite mathematics, probability and statistics. Emphasis on identifying or inventing ways to solve problems based on the student's entire mathematics background. Prerequisites: Corequisite Math 4209 and Senior standing.

**MATH 4097 Problem Solving In Applied Mathematics** (LEC 1.0)

Problems from applied mathematics which are open-ended, and do not always have a unique correct solution. Emphasis on developing mathematical models and writing solution narratives, including clarity, analysis, and design. Prerequisites: Math 3109 and Senior standing.

**MATH 4098 Explorations in Pure Mathematics** (LEC 3.0)

Students interested in pure mathematics will be encouraged to use their entire mathematics background as a context for learning about some of the great theorems which have shaped the development of mathematics and solving novel problems in areas such as, but not limited to, analysis, algebra, number theory, set theory, topology, and finite mathematics. Prerequisites: Senior standing; preceded or accompanied by Math 4209.

**MATH 4099 Undergraduate Research** (IND 0.0-6.0)

This course is designed for the undergraduate student who wishes to engage in research. It is not to be used for graduate credit nor for more than six credit hours of undergraduate credit. The subject and credit are to be arranged with the instructor. Prerequisite: Consent of instructor.

**MATH 4209 Advanced Calculus I** (LEC 3.0)

Completeness of the set of real numbers, sequences and series of real numbers, limits, continuity and differentiability, uniform convergence, Taylor series, Heine-Borel theorem, Riemann integral, fundamental theorem of calculus, Cauchy-Riemann integral. Prerequisite: Math 2222 and Math 3109, or a 4000-level or higher mathematics course, or graduate standing.

**MATH 4211 Advanced Calculus II** (LEC 3.0)

Euclidean n-space, differentiation and integration of scalar functions of several variables, maxima and minima theory, change of variables, differentiation and integration of vector functions of several variables, Divergence theorem, Stokes' theorem. Prerequisite: Math 4209.

**MATH 4530 Topics In Geometry** (LEC 3.0)

A survey of non-Euclidean geometries, finite geometries, affine and projective planes, metric postulates for the Euclidean plane, and selected topics. Credit will not be given for both Math 4530 and Math 5530. Prerequisites: MATH 3108.

**MATH 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MATH 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MATH 5010 Graduate Seminar** (SEM 1.0)

Discussion of advanced or current topics.

**MATH 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**MATH 5099 Graduate Research** (IND 0.0-6.0)

Investigation of an advanced nature leading to the preparation of a MS thesis or dissertation.

**MATH 5105 Modern Algebra I** (LEC 3.0)

Equivalence relations and functions, basic properties of groups, subgroups, permutations, cosets and Lagrange's Theorem, homomorphisms and isomorphisms, factor groups. Prerequisite: Math 3109 or graduate standing; preceded or accompanied by Math 3108.

**MATH 5106 Modern Algebra II** (LEC 3.0)

This course is a continuation of Math 5105. Rings and fields are discussed. Euclidean domains, principal ideal domains, unique factorization domains, vector spaces, finite fields and field extensions are studied. Prerequisite: Math 5105.

**MATH 5107 Combinatorics And Graph Theory** (LEC 3.0)

Covers some basics of enumeration and graph theory. Topics are selected from the following: permutations combinations, the inclusion/exclusion principle, generating functions, recurrence relations, trees, networks, graph connectivity and graph coloring. Prerequisite: Comp Sci 1200 or Math 3109.

**MATH 5108 Linear Algebra II** (LEC 3.0)

Eigenvalue problems, Cayley-Hamilton theorem, Jordan normal form, linear functionals, bilinear forms, quadratic forms, orthogonal and unitary transformations, selected applications of linear algebra. Prerequisite: Math 3108.

**MATH 5154 Mathematical Logic I** (LEC 3.0)

A mathematical introduction to logic with some applications. Functional and relational languages, satisfaction, soundness and completeness theorems, compactness theorems. Examples from Mathematics, Philosophy, Computer Science, and/or Computer Engineering. Prerequisite: Philos 3254 or Math 5105 or Comp Sci 2500 or Comp Eng 2210. (Co-listed with Comp Eng 5803, Comp Sci 5203 and Philos 4354).

**MATH 5215 Introduction To Real Analysis** (LEC 3.0)

Riemann-Stieltjes integration, sequences and series of functions, uniform approximation, the Banach Space  $C(a,b)$ , Lebesgue measure and integration, the space  $LP(a,b)$ , Fourier series. Prerequisite: Math 4209.

**MATH 5222 Vector And Tensor Analysis** (LEC 3.0)

Vector algebra, vector differential and integral calculus, line and surface integrals, theorems of Stokes and Gauss, tensor algebra and tensor analysis, applications to problems in kinematics, elasticity theory, fluid mechanics, electromagnetic theory, relativity theory. Prerequisite: Math 2222; Math 3103 or Math 3108.

**MATH 5302 Intermediate Differential Equations** (LEC 3.0)

Linear differential equations, vector-matrix systems, existence and uniqueness theory, nonlinear systems, phase-plane analysis, introduction to stability theory. Prerequisite: Math 3304 or Math 3329.

**MATH 5325 Partial Differential Equations** (LEC 3.0)

Linear equations, heat equation, eigenfunction expansions, Green's formula, inhomogeneous problems, Fourier series, wave equation. Prerequisite: Math 3304 with a grade of "C" or better.

**MATH 5351 Introduction To Complex Variables** (LEC 3.0)

The basic tools of complex variables are studied. These include the Cauchy-Riemann equations, complex contour integration, the Cauchy-Goursat theorem, conformal mappings, the calculus of residues and applications to boundary value problems. Prerequisite: Math 3304.

**MATH 5483 Operational Calculus** (LEC 3.0)

The Laplace transformation, properties of the transformation, various applications to ordinary and partial differential equations, systems with step and Dirac functions as driving forces, various non-elementary functions and their transforms, problems in heat conduction and wave motion, Fourier transforms and their operational properties. Prerequisite: Math 3304.

**MATH 5530 Topics in Geometry - Graduate Option** (LEC 3.0)

A survey of non-Euclidean geometries, finite geometries, affine and projective planes, metric postulates for the Euclidean plane, and selected topics. Students will demonstrate graduate-level mastery of the subject matter. Credit will not be given for both Math 4530 and Math 5530. Prerequisites: MATH 3108.

**MATH 5585 Introduction To Topology** (LEC 3.0)

Metric spaces; general topological spaces; connectedness, compactness, separation properties, functions and continuity. Prerequisite: Math 4209.

**MATH 5603 Methods of Applied Mathematics** (LEC 3.0)

Methods to develop and analyze mathematical models. Topics include dimensional analysis and scaling, perturbation methods, and the construction of ordinary and partial differential equation models. Prerequisites: Math 3304 or 3329 with a grade of "C" or better, programming competency.

**MATH 5604 Introduction to Numerical Methods for Differential Equations** (LEC 3.0)

An introduction to finite difference methods for ordinary and partial differential equations, including (1) the derivation of the numerical methods, (2) implementation of the methods in Matlab, and (3) the mathematical accuracy and stability analysis of the methods. Prerequisites: MATH 3304 and programming competency (preferably Matlab).

**MATH 5737 Financial Mathematics** (LEC 3.0)

The course objective is to provide an understanding of the fundamental concepts of financial mathematics. Topics include pricing, assets-liability management, capital budgeting, valuing cash flow, bonds, futures, swaps, options. Preparation for the financial mathematics actuarial exam will be provided. Prerequisites: Math 1215 or Math 1221, Econ 2100 or Econ 2200 or Finance 2150 or Finance 5160, Stat 3111 or Stat 3113 or Stat 3115 or Stat 3117 or Stat 5643. (Co-listed with Econ 5337).

**MATH 5940 Mathematical Analysis For Secondary Teachers** (LEC 3.0)

Designed to help teachers gain a deeper understanding of the fundamental idea in analysis, that of a limit. A discovery method is used which includes both individual and group work. Students will present their results in written and oral format. Prerequisite: Math 2222 or equivalent.

**MATH 5948 Mathematical Analysis For Secondary Teachers Practicum** (LEC 1.0)

An instructional unit based on the discovery method used in Math 340 will be designed by each student. These units will be class tested. The unit and results of class testing will be presented both in written and oral format. Prerequisite: Math 5940.

## Mechanical Engineering (MECH ENG)

**MECH ENG 1720 Introduction to Engineering Design** (LAB 1.0 and LEC 2.0)

Introduction to a systematic approach to engineering design (problem clarification, concept generation, concept selection, prototyping methods, engineering ethics) and fundamental design communication techniques. Computer aided design tools are introduced to assist in design analysis.

**MECH ENG 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MECH ENG 2340 Statics and Dynamics** (LEC 3.0)

An introduction to the principles of mechanics pertaining to problems of equilibrium, motion, and acceleration in two dimensions. Particle and rigid body equilibrium and applications; general planar motion; force, mass, and acceleration; impulse/ momentum; work/energy. This course will not satisfy the prerequisite for Civ Eng 2210. Prerequisites: A grade of "C" or better in Physics 1135 or Physics 1111; preceded or accompanied by Math 2222.

**MECH ENG 2350 Engineering Mechanics-Dynamics** (LEC 2.0)

Application of the principles of mechanics to engineering problems of motion and acceleration. Topics include plane motion; force, mass and acceleration; work and energy; and impulse and momentum. Prerequisites: A grade of "C" or better in each of Civ Eng 2200 and Math 2222.

**MECH ENG 2360 Dynamics** (LEC 3.0)

The principles of mechanics are used to model engineering systems. Kinematics of particle motion, kinematics of plane- and three-dimensional motions of rigid bodies. Kinetics of particles and of rigid bodies. Energy and momentum methods. Prerequisite: Grade of "C" or better in each of Civ Eng 2200, Math 2222. (Co-listed with Aero Eng 2360).

**MECH ENG 2519 Thermodynamics** (LEC 3.0)

Energy transformations and the relation of energy to the status of matter. Fundamental laws, concepts, and modes of analysis which underlie all applications of energy conversion in engineering. Prerequisites: A grade of "C" or better in each of Comp Sci 1570 or Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972, Math 1214 (or Math 1208), Math 1215 (or Math 1221), Math 2222, and Physics 1135.

**MECH ENG 2527 Thermal Analysis** (LEC 3.0)

Basic principles of thermodynamics and heat transfer. First and second laws of thermodynamics and applications to engineering systems. Fundamentals of heat transfer by conduction, convection, and radiation with applications. Not for mechanical engineering majors. Prerequisites: Math 1215 (or 1221), Physics 1135.

**MECH ENG 2653 Introduction To Manufacturing Processes** (LEC 2.0 and LAB 1.0)

Introduction into the fundamentals of manufacturing processes. Welding, joining, casting, forming, powder metallurgy and material removal are covered. The material is presented in a descriptive fashion with emphasis on the fundamental working of the processes, their capabilities, applications, advantages and limitations. Prerequisite: Mech Eng 1720.

**MECH ENG 2761 Introduction To Design** (LEC 2.0 and LAB 1.0)

Introduces the process of design with emphasis on creativity and design visualization. Solid modeling is presented as a design tool. The solid modeling environment will also be used to reinforce the concepts of tolerancing, dimensioning, and multiview representation. Concurrent engineering will be introduced in a group design project. Prerequisites: Mech Eng 1720, Mech Eng 2653, preceded or accompanied by Civ Eng 2200; a grade of "C" or better in each of Math 1214 (or 1208), Physics 1135.

**MECH ENG 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MECH ENG 3002 Cooperative Engineering Training** (IND 0.0-6.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation.

**MECH ENG 3010 Seminar** (LEC 1.0)

Discussion of current topics.

**MECH ENG 3131 Thermofluid Mechanics I** (LEC 3.0)

Principles of viscous and inviscid flow in ducts, nozzles, diffusers, blade passages and application to design; dimensional analysis and laws of similarity; external flows; compressible flows. Prerequisite: A grade of "C" or better in Mech Eng 2519.

**MECH ENG 3313 Machine Dynamics** (LEC 3.0)

Motion analysis using vector methods is considered for machine elements including linkages, cams, and gears. Dynamic force analysis methods are applied to balancing, flywheels, and single and multicylinder engines. Prerequisites: A grade of "C" or better in each of Comp Sci 1570 or Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972, Mech Eng 2360 (or Aero Eng 2360), Math 1214 (or Math 1208), Math 1215 (or Math 1221), Math 2222, and Physics 1135.

**MECH ENG 3411 Modeling and Analysis of Dynamic Systems** (LEC 3.0)

Concepts of modeling mechanical systems as linear systems are studied and applied to hydraulic, pneumatic, and electromechanical systems. Analysis techniques described include matrix formulations, Laplace transforms, and time domain response methods. Prerequisites: A grade of "C" or better in each of Comp Sci 1570 or Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972, Mech Eng 2360 (or Aero Eng 2360), Math 1214 (or Math 1208), Math 1215 (or Math 1221), Math 2222, Math 3304, Physics 1135, Physics 2135.

**MECH ENG 3521 Applied Thermodynamics** (LEC 3.0)

Extended study of the laws and concepts of thermodynamics with emphasis on applications to power and refrigeration cycles, gas mixtures, psychrometrics, behavior of real gases and combustion processes. Prerequisite: A grade of "C" or better in Mech Eng 2519.



**MECH ENG 3525 Heat Transfer** (LEC 3.0)

Fundamental principles of heat transmission by radiation, conduction and convection; application of these principles to the solution of engineering problems. Prerequisites: A grade of "C" or better in each of Comp Sci 1570 or Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972, Math 3304, Mech Eng 2519.

**MECH ENG 3653 Manufacturing** (LEC 3.0)

Advanced analytical study of metal forming and machining processes such as forging, rolling, extrusion, wire drawing and deep drawing; mechanics of metal cutting - orthogonal, turning, milling, cutting temperature, cutting tool materials, tool wear and tool life, and abrasive processes. Prerequisites: Mech Eng 2653, Civ Eng 2211, and a grade of "C" or better in Civ Eng 2210.

**MECH ENG 3708 Machine Design I** (LEC 3.0)

Analysis of machine elements such as shafts, springs, screws, belts, bearings, and gears; analytical methods for the study of fatigue; comprehensive treatment of failure, safety, and reliability. Introduction to finite element methods in mechanical design. Prerequisites: Mech Eng 2653; accompanied or preceded by Mech Eng 2761; Met Eng 2110 or Aero Eng 3877; and a grade of "C" or better in Civ Eng 2210.

**MECH ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MECH ENG 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MECH ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**MECH ENG 4479 Automatic Control Of Dynamic Systems** (LEC 3.0)

Use of classical control methods to analyze mechanical systems. Topics include root locus, Bode plots, and Nyquist diagrams. Applications to design situations are examined. Prerequisite: A grade of "C" or better in Mech Eng 3411.

**MECH ENG 4480 Control System Laboratory** (LAB 1.0)

Experiments dealing with data acquisition, manipulation, and control of systems with particular emphasis on computer data acquisition and control applied to mechanical engineering systems. Microcomputer systems are used as measurement and control devices. Prerequisites: Preceded or accompanied by Mech Eng 4479.

**MECH ENG 4761 Engineering Design** (LEC 1.0 and LAB 2.0)

Real-life design projects emphasize problem definition, conceptualization, modeling, approximation techniques and optimization. Teamwork, communication, leadership and group discussions are encouraged. Student group and professional expert presentations bring awareness to diverse design issues and methodology, and professional engineering practice. Prerequisites: Preceded or accompanied each of Mech Eng 3708, 3525, 3131, 4479.

**MECH ENG 4840 Mechanical Instrumentation** (LAB 2.0)

A basic course in the theory and application of instrumentation to typical measurement problems in mechanical and aerospace engineering. Experiments employing basic devices to measure quantities such as strain, pressure, force, temperature, motion, flow, sound level are performed. Accepted procedures for recording, interpretation, and presentation of experimental results are illustrated. Prerequisites: A grade of "C" or better each of Math 3304, Mech Eng 2519, Physics 2135.

**MECH ENG 4842 Mechanical Engineering Systems** (LAB 2.0)

A laboratory course focusing on experimental design and evaluation of complete mechanical engineering systems. Analysis of both mechanical and thermodynamic systems is included. Emphasis is on evaluating system performance and improving student written and oral communication skills. Prerequisites: Mech Eng 4840, 3521, 3131, 3525, 3313.

**MECH ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MECH ENG 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title. (Co-listed with Aero Eng 5001).

**MECH ENG 5131 Intermediate Thermofluid Mechanics** (LEC 3.0)

Derivation of Navier-Stokes equations, analytical solutions of viscous flows; flow in pipes, flow networks; intermediate treatment of boundary layer theory; micro-fluidics and MEMS; introduction to numerical methods for solving fluid flows; and, preliminary treatise on turbulence. Prerequisite: Mech Eng 3131 or Aero Eng 3131. (Co-listed with Aero Eng 5131).

**MECH ENG 5135 Fluid Machinery** (LEC 3.0)

Fundamental investigation of positive displacement and turbomachinery including pumps, fans, compressors, turbines, and oil hydraulic systems. Operating characteristics, selection, and comparison of types are studied. Prerequisite: Mech Eng 3131 or Aero Eng 5135.

**MECH ENG 5139 Computational Fluid Dynamics** (LEC 3.0)

Introduction to the numerical solution of the Navier-Stokes equations, by finite difference methods, in both stream function-vorticity and primitive variable formulations. Course format emphasizes student development of complete computer programs utilizing a variety of solution methods. Prerequisites: Comp Sci 1570 or 1970 or 1971; one course in fluid mechanics. (Co-listed with Aero Eng 5139).

**MECH ENG 5205 Lubrication** (LEC 3.0)

Development of basic principles of bearing analysis including manufacture and properties of lubricants, hydrodynamics and hydrostatic lubrication, journal and thrust bearings, ball and roller bearings, boundary considerations, and bearing materials. Prerequisite: Mech Eng 3131.

**MECH ENG 5211 Introduction To Continuum Mechanics** (LEC 3.0)

Introductory cartesian tensor analysis to aid in the development of the theory of a continuum. Kinematics of deformation, stress tensor, equations of motion, equations of mass and energy balance. Examples from specific material theories in solid and fluid mechanics. Prerequisites: Civ Eng 2210, Math 3304.

**MECH ENG 5212 Introduction to Finite Element Analysis** (LEC 3.0)

Variational formulation of the governing equations. Finite element model, interpolation functions, numerical integration, assembly of elements and solution procedures. Applications to solid mechanics, fluid mechanics and heat transfer problems. Two-dimensional problems. Computer implementation and use of commercial finite element codes. Prerequisite: Mech Eng 3708 or Aero Eng 4253 or consent of instructor for majors that do not require either of these courses, or graduate standing. (Co-listed with Aero Eng 5212).

**MECH ENG 5214 Applications Of Numerical Methods To Mechanics Problems** (LEC 3.0)

Numerical solutions of statics, vibrations, and stability problems. Direct stiffness formulations are developed and user-oriented computer codes are used to solve practical structures problems. Computer graphics techniques are utilized to prepare data and display results. Prerequisites: Civ Eng 2210; Mech Eng 2360 or Aero Eng 2360.

**MECH ENG 5220 Advanced Mechanics of Materials** (LEC 3.0)

Comprehensive insight into mechanics of materials. Topics to include: theories of failure, torsion of noncircular sections, shear flow and shear center, unsymmetric bending, bending of curved members, beams on elastic foundation and pressurization of thick walled cylinders. Prerequisites: Civ Eng 2210, Math 3304. (Co-listed with Aero Eng 5220).

**MECH ENG 5222 Introduction To Solid Mechanics** (LEC 3.0)

Review of basic concepts in continuum mechanics. Finite elasticity: some universal solutions for isotropic materials, application of special mechanical models. Linear elasticity: compatibility, stress functions, superposition, special examples such as extension, torsion, bending, and plane problems. Elements of plasticity. Prerequisite: Mech Eng 5211. (Co-listed with Aero Eng 5222).

**MECH ENG 5229 Smart Materials And Sensors** (LEC 2.0 and LAB 1.0)

Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multi-disciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior standing and Math 3304. (Co-listed with Aero Eng 5229, Elec Eng 5270 and Civ Eng 5118).

**MECH ENG 5234 Stability of Engineering Structures** (LEC 3.0)

Solution of stability problems with applications to columns, plates and shell structures. Torsional and lateral buckling of columns. Buckling under high temperatures. Effect of imperfections introduced by a technological process on stability. Design issues related to stability requirements. Prerequisites: Civ Eng 2210; Math 3304; and Mech Eng 2350 or Mech Eng 2360 or Aero Eng 2360. (Co-listed with Aero Eng 5234).

**MECH ENG 5236 Fracture Mechanics** (LEC 3.0)

Linear elastic and plastic mathematical models for stresses around cracks; concepts of stress intensity; strain energy release rates; correlation of models with experiment; determination of plane stress and plane strain parameters; application to design. Prerequisite: Civ Eng 2210. (Co-listed with Aero Eng 5236).

**MECH ENG 5238 Fatigue Analysis** (LEC 3.0)

The mechanism of fatigue, fatigue strength of metals, fracture mechanics, influence of stress conditions on fatigue strength, stress concentrations, surface treatment effects, corrosion fatigue and fretting corrosion, fatigue of joints, components and structures, design to prevent fatigue. Prerequisite: Civ Eng 2210. (Co-listed with Aero Eng 5238).

**MECH ENG 5254 Variational Formulations Of Mechanics Problems** (LEC 3.0)

Introduction and study of variational problems in classical dynamics and solid mechanics emphasizing the concepts of virtual work, minimum potential energy, and complementary energy. Variational inequalities. Prerequisites: Civ Eng 2210; Math 3304; and Mech Eng 2350 or Mech Eng 2360 or Aero Eng 2360. (Co-listed with Eng Mech 354).

**MECH ENG 5282 Introduction to Composite Materials & Structures** (LEC 3.0)

Introduction to fiber-reinforced composite materials and structures with emphasis on analysis and design. Composite micromechanics, lamination theory and failure criteria. Design procedures for structures made of composite materials. An overview of fabrication and experimental characterization. Prerequisite: Civ Eng 2210. (Co-listed with Aero Eng 5282).

**MECH ENG 5283 Industrial Applications Of Composite Materials Technology** (LEC 3.0)

Composite materials-industrial applications. Fibers and matrices. Fabrication and NDI. Lamination theory overview. Composite joints. Postbuckling. Fatigue and environmental effects. Testing and certification of composite structures. A majority of the presentations will be made by engineers in the industry. Prerequisite: Civ Eng 2210. (Co-listed with Eng Mech 303).

**MECH ENG 5307 Vibrations I** (LEC 3.0)

Equations of motion, free and forced vibration of single degree of freedom systems and multidegree of freedom systems. Natural frequencies, resonance, modes of vibration and energy dissipation are studies. The vibration of continuous systems is introduced. Prerequisites: Mech Eng 3411 and 3313, or Aero Eng 3613 and Math 3304. (Co-listed with Aero Eng 5307).

**MECH ENG 5309 Engineering Acoustics I** (LEC 3.0)

Introduction to acoustical theory and measurement with emphasis on mechanical and aerospace engineering applications. Plane and spherical wave propagation, resonators and filters, absorption, room acoustics, human response to noise, noise legislation, noise control. Use of common instrumentation in several projects. Prerequisites: Mech Eng 3411 and 3313, or Aero Eng 3613 and Math 3304. (Co-listed with Aero Eng 5309).

**MECH ENG 5313 Intermediate Dynamics Of Mechanical And Aerospace Systems** (LEC 3.0)

Principles of dynamics are applied to problems in the design of mechanical and aerospace systems; basic concepts in kinematics and dynamics; dynamics of systems of particles; dynamics of rigid bodies, three-dimensional effects in machine elements; dynamic stability, theory and applications; methods of analytical dynamics. Prerequisite: Mech Eng 3313 or Aero Eng 3613. (Co-listed with Aero Eng 5313).

**MECH ENG 5420 Signal Processing for Instrumentation and Control** (LEC 3.0)

The course presents fundamental techniques for analysis and processing of experimental data and real-time signals. Continuous- and discrete-time development of signal spectra, Fourier Transform, convolution, filter design, and system identification. The emphasis is on practical problems that arise in instrumentation and control applications. Prerequisites: Math 3304; Mech Eng 3411 or permission of instructor for non-Mech Eng majors.

**MECH ENG 5449 Robotic Manipulators and Mechanisms** (LAB 1.0 and LEC 2.0)

Overview of industrial applications, manipulator systems and geometry. Manipulator kinematics; hand location, velocity and acceleration. Basic formulation of manipulator dynamics and control. Introduction to machine vision. Projects include robot programming, vision-aided inspection and guidance, and system integration. Prerequisites: Mech Eng 3313; Comp Sci 1970 or Comp Sci 1971 or Comp Sci 1972 or Comp Sci 1570. (Co-listed with Aero Eng 5449).

**MECH ENG 5478 Mechatronics** (LEC 2.0 and LAB 1.0)

This course will introduce students to the basics of mechatronics (i.e., the integration of mechanical, electrical, computer, and control systems). Students will learn the fundamentals of sensors and actuators for mechanical systems, computer interfacing, microcontrollers, real-time software, and control. Prerequisite: Mech Eng 4479 or equivalent. (Co-listed with Aero Eng 5478, Elec Eng 5870 and Comp Eng 5820).

**MECH ENG 5481 Mechanical And Aerospace Control Systems** (LEC 3.0)

Synthesis of mechanical and aerospace systems to perform specific control functions. Response and stability are studied. Singular value analysis for stability margins is introduced. Prerequisite: Mech Eng 4479 or Aero Eng 3361. (Co-listed with Aero Eng 5481).

**MECH ENG 5519 Advanced Thermodynamics** (LEC 3.0)

After a short review of classical thermodynamics, the elements of chemical reactions, chemical equilibrium, statistical thermodynamics, and the basic concepts of kinetic theory are presented. Prerequisite: Mech Eng 2519. (Co-listed with Aero Eng 5519).

**MECH ENG 5523 Transport Phenomena In Manufacturing Processes** (LEC 3.0)

A study of the important role that transport phenomena (heat and mass transfer and fluid flow) play during various manufacturing processes including metal casting, joining and welding extrusion, forging, crystal growth, chemical deposition, and thermal spray deposition. Prerequisites: Mech Eng 3525 and 3131.

**MECH ENG 5525 Intermediate Heat Transfer** (LEC 3.0)

Analytical study of conduction; theory of thermal radiation and applications; energy and momentum equations in convective heat transfer and review of empirical relations. Current topics are included. Prerequisite: Mech Eng 3525. (Co-listed with Aero Eng 5525).

**MECH ENG 5527 Combustion Processes** (LEC 3.0)

Application of chemical, thermodynamic, and gas dynamic principles to the combustion of solid, liquid, and gaseous fuels. Includes stoichiometry, thermochemistry, reaction mechanism, reaction velocity, temperature levels, and combustion waves. Prerequisite: Mech Eng 3521. (Co-listed with Aero Eng 5527).

**MECH ENG 5533 Internal Combustion Engines** (LEC 3.0)

A course dealing primarily with spark ignition and compression ignition engines. Topics include: thermodynamics, air and fuel metering, emissions and their control, performance, fuels, and matching engine and load. Significant lecture material drawn from current publications. Prerequisite: Mech Eng 3521.

**MECH ENG 5537 Fuel Cell Principles** (LEC 3.0)

Fuel cell fundamentals including thermodynamics, reaction kinetics, mass transport, characterization, and modeling are discussed. Different types of fuel cells such as proton exchange membrane and solid oxide are covered together with subsystem design and system integration as well as environmental impacts. Prerequisites: MECH ENG 3521.

**MECH ENG 5541 Applied Energy Conversion** (LEC 3.0)

The study of the principles of energy conversion. Specific applications include fuel cells and other direct energy conversion devices used in plug-in hybrid electric vehicles. Prerequisite: Mech Eng 3521.

**MECH ENG 5544 Non-Intrusive Measurement Methods** (LEC 3.0)

Fundamentals of non-contact measurement methods for engineers. Basic engineering optics with a focus on radiation measurement methods including the effects of various sources and detectors. Prerequisites: Phys 2135; Mech 3525 or consent of instructor for non-Mech Eng majors.

**MECH ENG 5566 Solar Energy Technology** (LEC 3.0)

Introduction to the nature of solar radiation and associated thermal energy transfers. Methods of collecting and storing solar energy. Analysis and design of systems for utilizing solar energy, including heating and cooling. Prerequisite: Mech Eng 3525, or consent of instructor for non-Mech Eng majors.

**MECH ENG 5567 Heat Pump And Refrigeration Systems** (LEC 3.0)

The various methods used in the thermal design and analysis of both refrigeration and heat pumps systems are investigated. Various methods of producing heating and cooling are examined including vapor compression, absorption, air cycle, steam jet, and thermoelectric systems. Prerequisites: Mech Eng 3521, 3525.

**MECH ENG 5570 Plasma Physics I** (LEC 3.0)

Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Aero Eng 5570, Nuc Eng 4370, Physics 4543).

**MECH ENG 5571 Environmental Controls** (LEC 3.0)

Theory and applications of principles of heating, ventilating, and air conditioning equipment and systems; design problems. Physiological and psychological factors relating to environmental control. Prerequisites: Mech Eng 3521 and accompanied or preceded by Mech Eng 3525; or Mech Eng 2527 and Civ Eng 3330. (Co-listed with Arch Eng 5872).

**MECH ENG 5575 Mechanical Systems For Environmental Control** (LEC 3.0)

Analysis of refrigeration, heating, and air-distribution systems. Synthesis of environmental control systems. Prerequisites: Mech Eng 3521 and 3525; or Mech Eng 2527 and Civ Eng 3330.

**MECH ENG 5606 Material Processing By High-Pressure Water Jet** (LEC 3.0)

Methods of generating high pressure water jets; standard equipment, existing techniques, and basic calculations. Application of water jets to materials cutting and mineral processing. Safety rules. The course will be supported by laboratory demonstrations. Prerequisite: Mech Eng 3131 or undergraduate fluids course. (Co-listed with Min Eng 4413).

**MECH ENG 5644 Interdisciplinary Problems In Manufacturing Automation** (LEC 2.0 and LAB 1.0)

The course will cover material necessary to design a product and the fixtures required to manufacture the product. Participants will gain experience with CAD/CAM software while carrying out an actual manufacturing design project. (Co-listed with Chem Eng 4310, Eng Mgt 5315).

**MECH ENG 5653 Computer Numerical Control of Manufacturing Processes** (LEC 2.0 and LAB 1.0)

Fundamental theory and application of computer numerical controlled machine tools from the viewpoint of design principles, machine structural elements, control systems, and programming. Projects include manual and computer assisted part programming and machining. Prerequisites: Preceded or accompanied by Mech Eng 3653.

**MECH ENG 5655 Manufacturing Equipment Automation** (LEC 2.0 and LAB 1.0)

Manufacturing automation at the equipment level. Topics include sensors, actuators, and computer interfacing for manufacturing equipment, dynamic modeling and control of manufacturing equipment, interpolation, coordinated motion control, kinematic and geometric error modeling, and runout. Prerequisites: Preceded or accompanied by Mech Eng 4479 or equivalent.

**MECH ENG 5656 Design For Manufacture** (LEC 3.0)

Course covers the approach of concurrent product and process design. Topics includes: principle of DFM, New product design process, process capabilities and limitations, Taguchi method, tolerancing and system design, design for assembly and AI techniques for DFM. Prerequisites: Mech Eng 3708, Mech Eng 3653.

**MECH ENG 5702 Synthesis Of Mechanisms** (LEC 3.0)

Synthesis of planar mechanisms for function generation, path generation, and motion generation. Emphasis is on analytical methods for synthesis. Prerequisite: Mech Eng 3313.

**MECH ENG 5704 Compliant Mechanism Design** (LEC 3.0)

Introduction to compliant mechanisms; review of rigid-body mechanism analysis and synthesis methods; synthesis of planar mechanisms with force/energy constraints using graphical and analytical methods; pseudo-rigid-body models; force-deflection relationships; compliant mechanism synthesis methods; and special topics, e.g. bistable mechanisms, constant-force mechanisms, parallel mechanisms, and chain algorithm in design. Emphasis will be on applying the assimilated knowledge through a project on compliant mechanisms design. Prerequisites: Mech Eng 3313, Civ Eng 2210.

**MECH ENG 5708 Rapid Product Design And Optimization** (LEC 3.0)

Product Life cycle design; Finding design solutions using optimization technique; Rapid product realization using rapid prototyping and virtual prototyping techniques. Prerequisite: Mech Eng 3708.

**MECH ENG 5709 Machine Design II** (LEC 3.0)

A continuation of the study of machine elements; bearings, spur, bevel, worm, and helical gearing, and indeterminate machine elements; impact and shrink stresses. Prerequisite: Mech Eng 3708.

**MECH ENG 5715 Concurrent Engineering** (LEC 3.0)

Students will be introduced to the concurrent engineering approach to product development. They will learn to set up quantitative requirements and then use a quantitative rating process to identify the critical requirements relating to the desired product. The interaction between design, manufacturing, assembly, cost, and supportability will be covered. The students will form teams and practice the concurrent engineering process for simple products. Prerequisites: Mech Eng 3313 or Aero Eng 3131, and Civ Eng 2210. (Co-listed with Aero Eng 5715).

**MECH ENG 5757 Integrated Product And Process Design** (LEC 3.0)

Emphasize design policies of concurrent engineering and teamwork, and documenting of design process knowledge. Integration of product realization activities covering important aspects of a product life cycle such as "customer" needs analysis, concept generation, concept selection, product modeling, process development, and end of product life options. Prerequisites: Junior or above standing. (Co-listed with ENG MGT 5515).

**MECH ENG 5758 Integrated Product Development** (LEC 1.0 and LAB 2.0)

Students in design teams will simulate the industrial concurrent engineering development process. Areas covered will be design, manufacturing, assembly, process quality, cost, supply chain management, and product support. Students will produce a final engineering product at the end of the project. Prerequisite: Eng Mgt 5515 or Mech Eng 5757 or Mech Eng 3653 or Mech Eng 5708. (Co-listed with Eng Mgt 5516).

**MECH ENG 5760 Probabilistic Engineering Design** (LEC 3.0)

The course deals with uncertainties in engineering analysis and design at three levels - uncertainty modeling, uncertainty analysis, and design under uncertainty. It covers physics-based reliability analysis and reliability-based design, robustness assessment and robust design, their integration with design simulations, and their engineering applications. Prerequisite: Mech Eng 3708 or Aero Eng 3361. (Co-listed with Aero Eng 5760).

**MECH ENG 5761 Engineering Design Methodology** (LEC 3.0)

This course examines structured engineering design theory and methodologies for conceptual design and redesign of products. Topical coverage includes customer needs gathering, functional modeling, engineering specifications creation (OFD), concept generation, selection and design embodiment. Team work/hands-on projects emphasized. Prerequisite: At least Senior standing in engineering.

**MECH ENG 5763 Principles And Practice Of Computer Aided Design** (LEC 2.0 and LAB 1.0)

Lectures cover the fundamentals of computer-aided design with emphasis on geometric modeling of curves, surfaces and solids, CAD/CAM data exchange, and computer graphics. In the lab session, students practice with commercial CAD/CAM systems including NX and SolidWorks to gain practical experience. Prerequisites: Comp Sci 1570 or Comp Sci 1970 or Comp Sci 1971, Mech Eng 2761, Math 2222, at least Junior standing.

**MECH ENG 5764 Introduction to Decision Analysis** (LEC 3.0)

This course is an introduction to decision analysis, a decision-making method under uncertainty. The course topics include probability theory, influence diagram, decision tree, subjective probability, sensitivity analysis, value of information, risk attitude, and utility models. Prerequisite: Stat 3111 or Stat 3113 or Stat 3115 or Stat 3117.

**MECH ENG 5830 Applied Computational Methods** (LEC 3.0)

Detailed study of computational methods for efficient solution of selected fluids, structures, thermodynamics, and controls problems in aerospace and mechanical engineering. Besides basic numerical techniques, topics covered include gradient-based optimization and uncertainty quantification. Prerequisite: Comp Sci 1570 or 1970 or 1981; Math 3304. (Co-listed with Aero Eng 5830).

## Metallurgical Engineering (MET ENG)

**MET ENG 1017 Introduction To Metallurgical Engineering** (LEC 1.0)

Introduction to the field of metallurgical engineering with specific reference to the emphasis areas of extractive, manufacturing and physical metallurgy. The course will include lectures, videos and field trips to local industry.



**MET ENG 1027 Computer Application In Metallurgical Engineering** (LEC 2.0 and LAB 1.0)

Introduction to the use of microcomputers for simulation, data analysis including statistics, data acquisition from laboratory instruments, and automatic process control systems. The course will provide instruction in programming and software usage, and the laboratory will enable students to fully utilize the potential of microcomputer in later courses.

**MET ENG 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MET ENG 2110 Metallurgy For Engineers** (LEC 3.0)

Introduction to the structure and properties of metals and alloys and to processes used to modify the structure and properties of metallic materials, including alloying, deformation and heat treating. Prerequisite: Preceded or accompanied by Chem 1310, prior or concurrent.

**MET ENG 2125 Microstructural Development Laboratory** (LAB 1.0 and LEC 1.0)

Investigation of the relationships between microstructures, and processing for various materials. Prerequisite: Accompanied or preceded by Met Eng 3130.

**MET ENG 2410 Applied Metal Forming** (LEC 1.0 and LAB 1.0)

Introduction to the art and science of blacksmithing. Students to use forges to heat steel for shaping it. Techniques for shaping, cutting, chiseling, twisting, etc. Knowledge of hand and power tools and their use. Safety in the shop will be emphasized. History of blacksmithing will also be covered. Includes a lab portion which will work on projects. Prerequisite: Chem 1100.

**MET ENG 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MET ENG 3001 Special Topics** (LAB 0.0 and LEC 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MET ENG 3002 Cooperative Training** (IND 1.0-2.0)

On-the-job experience gained through cooperative education in the field of metallurgical engineering with credit arranged through department cooperative advisor. A pass/fail grade will be given based on the quality of reports submitted and work supervisor's evaluation.

**MET ENG 3120 Fundamentals Of Materials Behavior** (LEC 3.0)

An introduction to crystal defects and deformation; mechanical testing; creep; fracture mechanics and fatigue. Prerequisite: "C" or better grade in both Met Eng 2110 and Civ Eng 2210.

**MET ENG 3125 Mechanical Testing of Materials** (LAB 1.0 and LEC 1.0)

Deformation of materials and mechanical testing of materials; tensile testing, creep; impact testing; fracture mechanics and fatigue. Prerequisite: "C" or better in Met Eng 2110 and preceded or accompanied by Met Eng 3120.

**MET ENG 3130 Metals Microstructural Development** (LEC 3.0)

Fundamentals of microstructural developments as relating to solid solutions, solidification and transformations; phase diagrams; case studies. Prerequisites: "C" or better grade in MET ENG 2110; accompanied or preceded by CER ENG 3230.

**MET ENG 3220 Introduction To Extractive Metallurgy** (LEC 3.0)

Production and refining of metals by pyrometallurgy, hydrometallurgy, and electrometallurgy. Emphasis on heat and mass balance calculations for the unit processes of metals extraction. Introduction to the principles of combustion, heat utilization and recovery. Prerequisites: A grade of "C" or better in either Chem 1320 or Met Eng 1210. Preceded or accompanied by Met Eng 3330 or Cer Eng 3230 or Chem Eng 2210.

**MET ENG 3225 Extractive Metallurgy Laboratory** (LAB 1.0)

A series of laboratory experiments designed to illustrate the principles of pyrometallurgy, hydrometallurgy, and electrometallurgy. Prerequisite: Preceded or accompanied by Met Eng 3220.

**MET ENG 3320 Transport Phenomena In Metallurgy** (LEC 3.0)

The application of the principles of fluid flow and heat transfer to the solution of practical problems in metallurgical engineering. Prerequisite: "C" or better grade in Civ Eng 2200.

**MET ENG 3330 Metallurgical Thermodynamics I** (LEC 3.0)

Thermodynamic laws and thermodynamic functions and their relation to problems of metallurgical interest, thermochemistry, thermophysics, and chemical or phase equilibria. Prerequisite: Met Eng 1210 or Chem 1320.

**MET ENG 3420 Principles Of Materials Processing** (LEC 3.0)

An introduction to various methods of processing of metals and influences of processing on design. Includes: casting, welding, shaping, inspection and testing. Prerequisite: "C" or better grade in Met Eng 2110.

**MET ENG 3425 Metals Processing** (LAB 1.0)

Laboratory study of the methods of processing of metals. Prerequisite: Accompanied or preceded by Met Eng 3420.

**MET ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MET ENG 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MET ENG 4002 Cooperative Training** (IND 1.0-2.0)

On-the-job experience gained through cooperative education in the field of metallurgical engineering with credit arranged through department cooperative advisor. A pass/fail grade will be given based on the quality of reports submitted and work supervisor's evaluation.

**MET ENG 4010 Seminar** (IND 0.0-3.0)

Discussion of current topics.

**MET ENG 4096 Materials Senior Design I** (LEC 3.0)

Overview of the methods, approaches, and techniques required to execute materials related capstone senior design projects. Formation of teams, assignment of projects, review of department curriculum concepts and topics, and comprehensive project management skills needed to complete projects will be used as means to learn the design process. Prerequisites: Met Eng 3125 and Met Eng 2125, or Cer Eng 3315 with a "C" or better. (Co-listed with Cer Eng 4096).

**MET ENG 4097 Materials Senior Design II** (LAB 3.0)

A continuation of the Materials Senior Design I. Students working in groups will complete a capstone design project including process and product simulation and/or fabrication, safety aspects, environmental impact and capital and operating economics. Prerequisite: "C" or better in either Cer Eng 4096 or Met Eng 4096. (Co-listed with Cer Eng 4097).

**MET ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**MET ENG 4230 Corrosion And Its Prevention** (LEC 3.0)

A study of the theories of corrosion and its application to corrosion and its prevention. Prerequisite: A grade of "C" or better in either Chem Eng 3120 or Cer Eng 3230. (Co-listed with Chem Eng 5315).

**MET ENG 4320 Steels And Their Treatment** (LEC 3.0)

Industrially important ferrous alloys are described and classified. The selection of proper heat treatments to facilitate fabrication and to yield required service properties in steels suitable for various applications is considered. Prerequisite: "C" or better grade in both Met Eng 3130 and Met Eng 2125.

**MET ENG 4350 Process Metallurgy Applications** (LEC 3.0)

Application of thermodynamics to process metallurgy. Equilibrium calculations with stoichiometry and heat balance restrictions, phase transformations, and solution thermodynamics. Use of thermodynamic software to solve complex equilibria in metallurgical applications. Prerequisite: "C" or better grade in Cer Eng 3230.

**MET ENG 4420 Metals Casting** (LEC 3.0)

An advanced course in the materials and methods used in modern metals casting processes. Application of metallurgical principles to the casting of metals. Design of castings and metals casting mold features using commercial casting process simulation software. Prerequisite: "C" or better grade in either Met Eng 3420 or Mech Eng 2653.

**MET ENG 4425 Metals Casting Lab** (LAB 1.0)

A laboratory study of mold materials, metal flow, and cast metals. Emphasis is given to design of gating, risering, and ladle treatment techniques required for economical, high quality castings. Prerequisites: Accompanied or preceded by MET ENG 4420.

**MET ENG 4450 Steelmaking** (LEC 3.0)

Introduction to the fundamentals and unit processes used to turn impure iron and scrap into steel. Includes desulfurization, BOF and electric furnace operations, ladle metallurgy, casting, and stainless steel manufacture. Prerequisite: Grade of "C" or better in Cer Eng 3230 or Met Eng 3330.

**MET ENG 4510 International Engineering and Design** (LEC 3.0)

A multi-disciplinary engineering course focused on sustainable design and technology transfer to developing countries. Course includes elements of traditional capstone design classes. Experiential learning through competitions and/or field work is a major component of the class. Prerequisites: Senior standing, instructor approval, Geo Eng 5211, Geo Eng 5247. (Co-listed with Geo Eng 5092 and Cer Eng 4510).

**MET ENG 4617 Metallurgical Process Design Principles** (LEC 2.0)

Application of mass, component and energy balances for metallurgical design. The fundamentals of engineering economic analysis will be examined and experimental design techniques will be introduced. Students will be prepared for the selection and planning of the subsequent design project. Prerequisite: Senior standing in Met Eng.

**MET ENG 4627 Metallurgical Design Project** (LAB 2.0)

Student groups will undertake selected projects, which will represent a capstone design experience utilizing skills, understanding and data from previous courses. The faculty supervised open-ended design projects will involve a variety of tasks appropriate to the metallurgical engineer. Prerequisite: Met Eng 4617.

**MET ENG 4637 Material Selection, Fabrication, And Failure** (LEC 3.0)

Factors governing the selection of materials for specific needs, fabrication, heat treatment, surface treatment, and other aspects in the production of a satisfactory component. Failure analysis and remedies. Lecture plus assigned problems. Prerequisite: "C" or better grade in all of Met Eng 3130, Met Eng 2125, and Met Eng 3420.

**MET ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MET ENG 5001 Graduate Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MET ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**MET ENG 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**MET ENG 5110 High Temperature And Corrosion Resistant Alloys** (LEC 3.0)

Fabrication and use of nickel, titanium, and refractory metal based alloys for use at high temperatures or in chemically corrosive environments. Properties and strengthening mechanisms of these alloys. Theory of high temperature oxidation and corrosion and design of alloys to prevent them. Prerequisites: Met Eng 3130, 2125.

**MET ENG 5150 Introduction to Particulate Materials** (LEC 3.0)

Powder metallurgy and ceramic components, filters, catalysts, nanomaterials, vitamins and more depend strongly on particulate, or powder, characteristics and processing. Aspects of powder fabrication, characterization, safety, handling, component fabrication, secondary processing, and applications will be covered. Prerequisite: Met Eng 2110.

**MET ENG 5160 Mechanical Metallurgy** (LEC 3.0)

Elastic and plastic behavior of metallic single crystals and polycrystalline aggregates. Resulting changes in mechanical properties are considered. Included are applications to metal fabrication. Prerequisites: Met Eng 3120, 3125, Civ Eng 2210.

**MET ENG 5170 Nuclear Materials I** (LEC 3.0)

Fundamentals of materials selection for components in nuclear applications. Design and fabrication of UO<sub>2</sub> fuel; reactor fuel element performance; mechanical properties of UO<sub>2</sub>; radiation damage and effects, including computer modeling; corrosion of materials in nuclear reactor systems. Prerequisites: Civ Eng 2210; Nuc Eng 3205; Nuc Eng 3223; Met Eng 2110. (Co-listed with Nuc Eng 4241).

**MET ENG 5171 Nuclear Materials II** (LEC 3.0)

Extractive metallurgy of uranium, thorium, and zirconium. Equation of state of UO<sub>2</sub> and fuel chemistry. LMFBR fuel and interaction of sodium and stainless steel. Materials for fusion and other advanced nuclear applications. Reprocessing of spent fuel and disposal. Prerequisite: Met Eng 5170.

**MET ENG 5220 Recent Advances In Extractive Metallurgy** (LEC 2.0)

A survey of extractive processes recently developed in the light of modern requirements with respect to raw materials, product quality, environmental impact, energy consumption, capital cost and process control. Prerequisite: Met Eng 4350.

**MET ENG 5270 Mineral Processing II (Mechanics and Design)** (LAB 1.0 and LEC 2.0)

Mineral particle mechanics of comminution, sizing, classification, concentration, filtering and thickening. Mill and equipment selection and design including flowsheet, development and plant assessment. Prerequisite: Min Eng 3412. (Co-listed with Min Eng 4424).

**MET ENG 5330 Nonferrous Alloys** (LEC 3.0)

Structure and properties of nonferrous alloys (Al, Ti, Mg, Ni and Cu) are described. The role of processing and microstructure in the development of mechanical properties is emphasized. Prerequisite: Met Eng 3130 or Met Eng 5810.

**MET ENG 5420 Advanced Metals Casting** (LEC 3.0)

An advanced course in the materials and methods used in modern metals casting processes. Application of metallurgical principles to the casting of metals. Design of castings and metals casting mold features using commercial casting process simulation software. Prerequisite: Met Eng 3420 or Mech Eng 2653.

**MET ENG 5425 Metals Casting Laboratory** (LAB 1.0)

An advanced laboratory study of mold materials, metal flow, and cast metals. Emphasis is given to design of gating, risering, and ladle treatment techniques required for economical, highquality castings. Prerequisite: Accompanied or preceded by Met Eng 4420.

**MET ENG 5430 Metals Joining** (LEC 2.0)

Metals joining processes such as welding and brazing. Effects of welding on materials. Treatment and properties of welded joints. Welding defects and quality control. Prerequisite: Met Eng 2110 or 3420.

**MET ENG 5440 Metal Deformation Processes** (LEC 3.0)

An introduction to metal deformation concepts followed by a study of various forming processes from both the analytical and applied viewpoints. Processes to include: forging, wire drawing, extrusion, rolling, sheet metal forming, and others. Prerequisite: Met Eng 3120 and Met Eng 3420 both with "C" or better grade.

**MET ENG 5450 Advanced Steelmaking** (LEC 3.0)

This course is designed to provide students with an enhanced understanding of the chemistry and physics of ironmaking, steelmaking and casting, to apply these concepts to a wide range of problems in modern steelmaking and casting operations, and to perform advanced design and operational calculations associated with refining and continuous casting processes. Prerequisite: Grade of "C" or better in Cer Eng 3230 or Met Eng 3330.

**MET ENG 5460 Metal Coating Processes** (LEC 3.0)

Introduction to the current technologies used to enhance metal performance, particularly corrosion resistance, by overlay coatings. Deposition processes are emphasized and the fundamentals of the behavior of the films in high technology and electronic materials applications is discussed. Prerequisite: Senior or Graduate Standing.

**MET ENG 5470 Ferrous Metals Casting** (LEC 3.0)

An advanced study of the metallurgy of cast irons and net shape cast steel alloys. Includes theories of nucleation and growth in gray, nodular, compacted graphite and malleable irons. The effects of deoxidation practice and inclusion shape control for cast steels are also included. The effects of alloying elements, processing variables and heat treatment. Prerequisite: Met Eng 4420 or Met Eng 5420 or graduate standing with permission of instructor.

**MET ENG 5480 Refining Of Metals** (IND 2.0-3.0)

Principles and applications of thermochemistry, phase equilibria, and kinetics as applied to the refining of metals and alloys. Theory of dilute solutions, interaction coefficients and reactions of metals with gases and slags. Analysis and design of refining processes. Optional third credit hour requires a term paper. Prerequisite: Met Eng 4350 or Cer Eng 3230.

**MET ENG 5510 Nondestructive Testing** (LEC 3.0)

Principles and applications of various means of non-destructive testing of metallic materials. Radiological inspection methods, ultrasonic testing, magnetic methods, electrical and eddy current methods and others. Prerequisite: Physics 2135 or 2111. (Co-listed with Elec Eng 5670).

**MET ENG 5515 Nondestructive Testing Laboratory** (LAB 1.0)

Application of radiological and ultrasonic methods of nondestructive testing of metallic materials. A radiographic X-ray units and ultrasonic equipment are used in the inspection of a variety of materials and manufactured parts. Prerequisite: Accompanied or preceded by Met Eng 5510.

**MET ENG 5520 Electron Microscopy** (LEC 3.0)

A course in the theory and application of both scanning and transmission electron microscopy and x-ray microanalysis. Topics considered are electron optics, image formation and analysis; x-ray generation, detection and analysis; and characterization of fracture surfaces. Prerequisites: Met Eng 3130 and Met Eng 2125, or a course in optical microscopy.

**MET ENG 5525 Scanning Electron Microscopy Lab** (LAB 1.0)

A course in the practical use and operation of scanning electron beam instruments and their associated techniques. Prerequisite: Preceded or accompanied by Met Eng 5520.

**MET ENG 5620 Materials Behavior** (LEC 3.0)

A course in crystal defects and deformation; mechanical testing; creep; fracture mechanics and fatigue. Prerequisites: Grade of "C" or better in both Met Eng 2110 and Met Eng 3120.

**MET ENG 5630 Environmental Aspects Of Metals Manufacturing** (LEC 3.0)

Introduction to environmental aspects of metal extraction, melting, casting, forming, and finishing. Subjects include history of environmental movement and regulations permitting, risk analysis, disposal and recycling of metal manufacturing residues, environmental ethics, environmental technologies and case studies. Prerequisite: Junior/Senior standing.

**MET ENG 5810 Principles Of Engineering Materials** (LEC 3.0)

Examination of engineering materials with emphasis on selection and application of materials in industry. Particular attention is given to properties and applications of materials in extreme temperature and chemical environments. A discipline specific design project is required. (Not a technical elective for undergraduate metallurgy or ceramic majors) (Co-listed with Aero Eng 3877, Chem Eng 5300, Physics 4523, Cer Eng 5810).

## Military Science - Air Force (MIL AIR)

### **MIL AIR 1100 Leadership Laboratory** (LAB 0.50 and LEC 0.50)

The course involves a study of Air Force customs and courtesies, drill and ceremonies, career opportunities in the Air Force and the life and work of an Air Force junior officer. Students develop their leadership potential in a practical supervised training laboratory, which typically includes field trips to Air Force installations throughout the United States.

### **MIL AIR 1110 Foundations Of The U.S. Air Force I** (LAB 0.50 and LEC 0.50)

This survey course is designed to introduce students to the Air Force and ROTC. Topics include: military customs and courtesies, uniform wear, officership qualities, professionalism, Air Force core values, equal opportunity and treatment, officer benefits and opportunities and an introduction to communication skills. Leadership Lab is mandatory for cadets planning on a career in the Air Force.

### **MIL AIR 1120 Foundations Of The U.S. Air Force II** (LEC 0.50 and LAB 0.50)

This survey course is a continuation of Mil Air 1110. Covered topics include: origin of the Air Force, mission and organization of the Air Force, organization of a standard Air Force base, and further communication skills development. Leadership Lab is also mandatory for cadets.

### **MIL AIR 2110 The Evolution Of USAF Air And Space Power I** (LEC 0.50 and LAB 0.50)

This course is designed to examine the general aspects of air and space power through a historical perspective...covering a time period from the first balloons to the beginning of the space age. It provides students with a knowledge level understanding of the general elements and employment of air and space power from an institutional doctrinal and historical perspective. Examples of the importance of AF core values in historical events and in past AF leaders are pointed out. Continued development of communication skills is also emphasized. Leadership Lab is mandatory for cadets planning on a career in the Air Force.

### **MIL AIR 2120 The Evolution Of USAF Air And Space Power II** (LEC 0.50 and LAB 0.50)

This course is a continuation of Mil Air 2110. It covers a time period in Air Force history from the beginning of the space age in the early 1960's to the present...with a continued emphasis on recognizing how past leaders and events have shaped our current Air Force organization and doctrine. Communication skills exercises are continued. Leadership Lab is also mandatory for cadets.

### **MIL AIR 3110 Air Force Leadership Studies I** (LEC 2.5 and LAB 0.50)

This course introduces students to the leadership and management skills required of an Air Force junior officer. Special topics include leadership ethics, the Air Force personnel and evaluation systems, and management fundamentals. Through the use of classroom tools that include case studies, Air Force leadership and management situations are examined and practical applications of studies concepts are exercised. The principles and theories of ethical behavior as well as the complete understanding of the individual responsibility and authority of an Air Force officer are stressed. This course includes a Leadership Lab that provides the students the opportunity to apply leadership and management principles.

### **MIL AIR 3120 Air Force Leadership Studies II** (LEC 2.5 and LAB 0.50)

This course is a continuation of Mil Air 3110. Emphasis is placed on professional knowledge, communication skills, and ethical behavior. Varied Air Force-peculiar formats and situations are offered to apply learned listening, writing, and speaking skills. This course includes a Leadership Lab that provides the students the opportunity to apply leadership and management principles.

### **MIL AIR 4110 National Security Affairs/Preparation For Active Duty I** (LEC 2.5 and LAB 0.50)

This course examines national security policies, processes, and issues along with Air Force strategy and doctrine. Special topics include Air Force roles and missions, the roles of various federal government departments, military organizations and functions, and the concept of joint operations. Within this structure, continued emphasis is given to refining communication skills. This course includes a Leadership Laboratory that provides advanced leadership experiences, giving students the opportunity to apply the leadership and management principles of this course.

### **MIL AIR 4120 National Security Affairs/Preparation For Active Duty II** (LEC 2.5 and LAB 0.50)

Continuation of Mil Air 4110. This final course of the Air Force ROTC curriculum examines officership, advanced leadership ethics, military law, current Air Force issues, regional studies, core values, and preparation for active duty. This course includes a Leadership Laboratory that provides leadership experiences, giving students the opportunity to apply the leadership and management principles of this course.

## Military Science - Army (MIL ARMY)

### **MIL ARMY 1000 Army Physical Readiness Program** (LAB 1.0)

Course instruction includes planning, implementing and managing the Army physical fitness program; the conducting of an Army physical fitness test; physical fitness training to include conditioning, calisthenics, and cross-country running. Fundamentals of drills and ceremony will also be taught.

### **MIL ARMY 1250 Leadership and Personal Development** (LEC 1.0)

Introduces cadets to the personal challenges and competencies that are critical for effective leadership. Cadets learn how the personal development of life skills such as critical thinking, goal setting, time management, physical fitness, and stress management relate to leadership, officership, and the Army profession.

### **MIL ARMY 1500 Introduction to Tactical Leadership** (LEC 1.0)

Overviews leadership fundamentals such as setting direction, problem-solving, listening, presenting briefs, providing feedback, and using effective writing skills. Cadets explore dimensions of leadership values, attributes, skills, and actions in the context of practical, hands-on, and interactive exercises.

### **MIL ARMY 1700 Rifle Marksmanship** (LEC 1.0)

The course teaches basic rifle marksmanship and firearm safety. Students will be required to learn common rules of firearms safety and fire airguns using standard firing positions. Targets will be scored. Students will also become familiar with military marksmanship techniques and weapons.

### **MIL ARMY 1750 Wilderness Survival And Life-Saving Techniques** (LEC 1.0)

Basic life-saving techniques that will enable the student to assist an injured person or himself in an emergency, and survival techniques that will help the student survive in the wilderness.

### **MIL ARMY 1800 Ranger Operations** (LEC 1.0)

Learn about one of the world's most elite fighting forces -the U. S. Army Rangers. Get some hands-on training with actual army equipment. Learn rappelling, land navigation, orienteering and combat patrolling.

### **MIL ARMY 2250 Innovative Team Leadership** (LEC 3.0)

Develop knowledge of self, self-confidence and individual leadership techniques through problem solving and critical thinking skills. Apply communication, feedback, and conflict resolution skills.



**MIL ARMY 2500 Foundations of Tactical Leadership** (LEC 3.0)

Examines the challenges of leading tactical teams in the complex contemporary operating environment (COE). The course highlights dimensions of terrain analysis, patrolling, and operation orders. Further study of the theoretical basis of the Army leadership framework explores the dynamics of adaptive leadership in the context of military operations.

**MIL ARMY 2750 Basic Leadership Laboratory** (LAB 1.0)

Hands-on experience in basic military leadership skills, supplementing, but not duplicating classroom instruction in MSI and MSII courses. Training is conducted at squad (8 person group) level with emphasis on leadership development at that level. Topics include oral communication and presentations, decision making, drill and ceremonies, squad tactics, land nav, and the tactical bivouac. Prerequisite: To accompany Mil Army 2500.

**MIL ARMY 3250 Adaptive Tactical Leadership** (LEC 2.0 and LAB 1.0)

Challenges cadets to study, practice, and evaluate adaptive leadership skills as they are presented with scenarios related to squad operations. Cadets receive systematic and specific feedback on their leadership attributes and actions. Based on such feedback and self-evaluations, cadets continue to develop their leadership and critical thinking abilities. Prerequisites: Mil Army 1250, 1500, 2250, 2500 - Exceptions to be made by Dept Chair Only In Accordance with Army (Cadet Command) Policies.

**MIL ARMY 3500 Leadership in Changing Environments** (LAB 1.0 and LEC 2.0)

Uses increasingly intense situational leadership challenges to build cadet awareness and skills in leading tactical operations up to platoon level. Cadets review aspects of combat, stability, and support operations. They also conduct military briefings and develop proficiency in garrison operation orders. Prerequisites: Mil Army 3250 - Exceptions to be made by Department Chair Only In Accordance With Army (Cadet Command) Policies.

**MIL ARMY 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required. Prerequisites: Mil Army 4250 and 4500 - Exceptions to be made by Dept Chair Only in accordance with Army (Cadet Command) policies.

**MIL ARMY 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course.

**MIL ARMY 4250 Developing Adaptive Leaders** (LEC 2.0 and LAB 1.0)

Develops cadet proficiency in planning, executing, and assessing operations, functioning as a member of a staff, and providing performance feedback to subordinates. Cadets assess risk, make ethical decisions, and lead fellow ROTC cadets. Lessons on military justice and personnel processes prepare cadets to make the transition to Army officers. Prerequisites: Mil Army 3250 and 3500 - Exceptions to be made by Dept Chair Only in accordance with Army (Cadet Command) policies.

**MIL ARMY 4500 Leadership in a Complex World** (LAB 1.0 and LEC 2.0)

Explores the dynamics of leading current military operations in the contemporary operating environment. Cadets examine differences in customs, military law, principles of war, and rules of engagement in terrorism. They also explore aspects of interacting with non-government organizations, civilians on the battlefield, and host nation support. Prerequisite: Mil Army 4250 - Exceptions to be made by Department Chair Only In Accordance With Army (Cadet Command) Policies.

## Mining Engineering (MIN ENG)

**MIN ENG 1912 Principles Of Mining Engineering** (LEC 2.0)

Principles and definitions related to mining engineering including one or more field trips to familiarize the student with current mining practices.

**MIN ENG 1913 Computing In Mining Engineering** (LAB 1.0)

Basic software needed by mining engineers for computer applications in various phases of mine planning, development, and operations will be covered. The overarching goal is developing early familiarity with relevant software so it can be integrated across mining engineering courses.

**MIN ENG 2126 Introduction To Mining Safety** (LAB 1.0)

Safety aspects of mining in accordance with the MSHA Training Program required for all new miners. Subjects include self-rescue and respiratory protection, ground control, hazard recognition, mine gases, and legal aspects associated with mining.

**MIN ENG 2412 Principles Of Mineral Processing** (LAB 1.0 and LEC 2.0)

Introduction to the principles of mineral processing including mineral resources; particle comminution, classification, separation and dewatering; flowsheet and equipment design.

**MIN ENG 2914 Surface Mine Design** (LAB 2.0 and LEC 1.0)

Surface mining methods. Conventional methods for ore reserves estimation. Geomechanics, geometrics and computer-aided mine design, haul roads and waste dump design and layouts optimization. Materials scheduling and sequencing using a commercially available mine design software. Prerequisite: Min Eng 1912.

**MIN ENG 2924 Underground Mine Design** (LAB 2.0 and LEC 1.0)

Underground mining methods. Parametric statistics and introductory geostatistics. Geomechanics, geometrics and computer-aided mine design. Empirical and numerical methods for mine openings, pillar and roof span design; caving and ore drawing mechanics. Materials scheduling and sequencing using commercially available software. Prerequisite: Min Eng 1912 and Min Eng 2914.

**MIN ENG 2925 Surveying For Mineral Engineers** (LAB 2.0)

Principles of surface and underground survey practice utilizing total station, engineer's level and GPS. Traversing and details, note taking and computations, balancing surveys and error analysis, staking-out new points, and map construction with AutoCAD. Prerequisite: Preceded or accompanied by Min Eng 1912.

**MIN ENG 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MIN ENG 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MIN ENG 3002 Mine Rescue** (LAB 1.0 and LEC 2.0)

Utilization of the principles of mine safety concerning mine gases, ventilation, explosives, fires, and first aid in the organization of mine rescue personnel and techniques. Training in the use of current mine rescue equipment, recognition and control of common recovery hazards, handling of survivors. Prerequisite: Min Eng 2126.

**MIN ENG 3512 Mining Industry Economics** (LEC 3.0)

Importance of the mineral industry to national economy, uses, distribution, and trade of economic minerals, time value of money, mineral taxation, economic evaluation utilizing depreciation, depletion, and discounted cashflow concepts, social and economical significance of mineral resources. Prerequisite: Econ 1100 or 1200. (Co-listed with Econ 3512).

**MIN ENG 3812 Statics And Mechanics Of Rock Materials** (LEC 2.0 and LAB 1.0)

Application of the principles of mechanics to engineering problems of equilibrium, strength, and stiffness concerning rock materials and mine support structures. This course extends the study of statics to rock materials in mines and covers rock-related and support structure-related mechanics of materials. The course is complemented by rock mechanics laboratory. Prerequisites: MECH ENG 2340; or IDE 50 and 150.

**MIN ENG 3912 Materials Handling In Mines** (LAB 1.0 and LEC 2.0)

Mining applications of material transport and handling. Truck haulage and haulroads. Conveyors: belt, armored, and others; feeders; bins and bunkers; material stockpiling and homogenization; rail transport; water transport; slurry transport; mine hoists and hoisting. Prerequisite: Min Eng 1912.

**MIN ENG 3913 Mineral Identification and Exploration** (LEC 3.0)

Characterization of mineral deposits. Ore body definition. Mineral Exploration techniques. Sample methods, errors and mitigation. Rock Identification. Prerequisites: Either both Chem 1310 and Chem 1319 or Chem 1351; either Geo Eng 1150 or Geology 1110.

**MIN ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MIN ENG 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MIN ENG 4096 Computer Aided Mine Design** (LAB 3.0)

Mine planning and design using commercial software. Orebody description. Surface mining: geometric design, pit limits, and production planning. Underground mining: development planning, opening and support design, ventilation and production planning. Group projects with real-world mining data. Preparation for capstone design project. Prerequisites: Min Eng 4522, Min Eng 4932, and Min Eng 4933.

**MIN ENG 4097 Capstone Design Project** (LEC 1.0 and LAB 3.0)

Capstone project with written and oral presentations. Includes mine design and optimization, production plan, equipment and flowsheet design based on geology, resources/reserves, geotechnics, hydrology and hydro-geology. Project also incorporates markets, environmental and permitting, mine-mill organization, support facilities, economic and risk analyses. Prerequisite: Min Eng 4096.

**MIN ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**MIN ENG 4113 Mine Atmosphere Control** (LEC 2.0 and LAB 1.0)

Fundamentals of mine ventilation, including the principles of airflow, control of gases, dust, and temperature, methane drainage, mine fans, network theory, computer network simulation, and economics of airflow, with emphasis on analysis, systems design and practical application. Prerequisites: Chem 3410 and Civ Eng 3330.

**MIN ENG 4122 Advanced Mine Health and Safety** (LEC 3.0)

A detailed study of health and safety principles, practices, analyses, regulations, issues and technology in the mining industry. Prerequisite: Min Eng 2126.

**MIN ENG 4212 Advanced Aggregate and Quarrying** (LEC 3.0)

Advanced coverage of topics on the stone and aggregate industry, including surface and underground operations, plant equipment, economics, marketing, transportation, and environmental topics. The course will include at least one field trip and a design project. Prerequisite: Min Eng 3912, co-requisite: Civ Eng 3116.

**MIN ENG 4322 Coal Mine Development And Production** (LEC 3.0)

An in-depth study of all aspects of coal mining, including an overview of coal industry, reserves and geology, planning and development of coal mines, surface and underground mechanized methods of face preparation, equipment, coal extraction, handling and preparation as practiced in the United States. Prerequisite: Accompanied or preceded by Min Eng 4912.

**MIN ENG 4412 Aggregate Materials Sizing and Characterization** (LAB 1.0 and LEC 2.0)

Geological formation of aggregates; aggregate properties and their measurements; aggregates for specific end-user applications; specifications and standards; processing (crushing, screening, classification, and washing); plant design and flow sheet analysis; quality control and assurance. Prerequisite: Min Eng 3412.

**MIN ENG 4413 Material Processing By High-Pressure Water Jet** (LEC 3.0)

Methods of generating high pressure water jets; standard equipment, existing techniques and basic calculations. Applications of water jets to materials cutting and mineral processing. Safety rules. The course will be supported by laboratory demonstrations. (Co-listed with Mech Eng 5606).

**MIN ENG 4414 Mine Plant Management** (LEC 2.0)

Optimization of mine plant and equipment performance. Availability, utilization and reliability of equipment; matching equipment and plant to minesite specific conditions; maintenance planning, scheduling and control; parts and materials supply systems; mine information and management systems. Basics of mine automation and robotics. Prerequisite: Senior standing or consent of instructor.

**MIN ENG 4422 Coal Preparation** (LEC 2.0 and LAB 1.0)

Coal properties, sampling, testing, breaking, sizing, cleaning and dewatering. Disposal of refuse. Prerequisites: Min Eng 3412 and senior standing.

**MIN ENG 4423 Mineral Processing I (Flotation and Hydrometallurgy)** (LAB 1.0 and LEC 2.0)

Forth flotation including mineral surfaces, double layer theory, zeta potential, hydrophobicity, adsorption, collectors, frothers, modulation, kinetics, and sulphide and acid flotation systems. Hydrometallurgy including leaching, ion exchange and liquid/liquid extraction. Prerequisite: Min Eng 3412.

**MIN ENG 4424 Mineral Processing II (Mechanics and Design)** (LEC 2.0 and LAB 1.0)

Mineral particle mechanics of comminution, sizing, classification, concentration, filtering and thickening. Mill and equipment selection and design including flowsheet, development and plant assessment. Prerequisite: Min Eng 3412. (Co-listed with Met Eng 5270).

**MIN ENG 4512 Mine Management** (LEC 3.0)

Theory and practice of mine management, including basic managerial functions, management theories, communication skills, motivation, leadership, organization, maintenance management, managerial decision making, cost control, labor relations, government relations, ethics and risks management with emphasis in presentation skills. Prerequisite: Completion of 50 credits toward Mining Engineering degree. (Co-listed ECON 4512).

**MIN ENG 4522 Ore Reserve Analysis And Geostatistics** (LAB 1.0 and LEC 2.0)

An introduction to principles of geostatistics, theory of spatially correlated random variables, variance and co-variances and their application on the evaluation of mineral resources, ore reserve estimation, strategic exploration, and production planning. Real case studies from mining industry will be presented. Prerequisite: Stat 3113 or Stat 3115.

**MIN ENG 4523 Environmental And Natural Resource Economics** (LEC 3.0)  
Optimum use of replenishable and non-replenishable resources, public goods and common resources, externalities, private vs. public costs, and quality of the environment; emphasis on public policy related to environmental and natural resource economics. Prerequisite: Econ 2100. (Co-listed with Econ 4440).

**MIN ENG 4524 Energy Economics** (LEC 3.0)  
Market structure. World resource development. Supply and demand analysis on energy production and consumption within domestic and global settings. Prerequisite: Econ 2100. (Co-listed with Econ 4540).

**MIN ENG 4742 Environmental Aspects Of Mining** (LEC 3.0)  
Permitting: the legal environment of reclamation and environmental impact assessment; post-mining land-use selection and mine planning for optimum reclamation of all mines: metal, nonmetal, and coal; unit operations of reclamation: drainage, backfill, soil replacement, revegetation, maintenance, etc. Prerequisites: Co-requisites: MIN ENG 4933 or GEO ENG 5441 or ENV ENG 5619. (Co-listed with GEO ENG 4276).

**MIN ENG 4823 Rock Mechanics** (LAB 1.0 and LEC 2.0)  
Applications of the fundamental principles of mechanics to engineering problems of equilibrium, strength and stiffness of rock materials. Review of in-situ stresses, laboratory and field instrumentation, rock and rockmass properties, pillar design, roof span design, rock reinforcement, surface subsidence, slope stability, and violent failures. Field trip required. Prerequisites: Physics 2135; Civ Eng 2210; Geology 3310.

**MIN ENG 4824 Soils and Overburden Materials for Mining Engineering** (LEC 2.0)  
Physical and mechanical properties of soils and overburden materials. Soils and overburden characterization for reclamation and mine closure and overburden blasting. Soil failure modes and slope stability for surface mine layouts, waste dumps, tailings and earth dams, and foundations for heavy mining machinery. Prerequisites: Civ Eng 2210.

**MIN ENG 4912 Mine Power And Drainage** (LEC 2.0 and LAB 1.0)  
Engineering principles of mine power distribution and application and mine dewatering. Basics of electrical circuits, AC/DC power, transformers, electric meters, power distribution, power management. Hydraulic power systems. Compressed air in mines. Mine dewatering. Controlling water inflow. Dewatering wells. Water pumping and pumping systems. Prerequisites: Chem 3410 and Civ Eng 3330.

**MIN ENG 4922 Tunneling & Underground Construction Techniques** (LAB 1.0 and LEC 2.0)  
Cover both mechanical excavation and conventional excavation techniques to underground tunneling and construction. The emphasis will be on equipment selection and prediction of performance expected of the equipment. Ground control systems will be covered as technology emerges. Excavation methods and support of large caverns, often found in civil structures, will also be discussed. A limited focus will be on underground construction specifications and underground advance rate and cost estimation techniques. Prerequisites: Min Eng 4823, Min Eng 4932 or Civ Eng 3715, Civ Eng 3116 or Geo Eng 5471.

**MIN ENG 4932 Underground Mining Methods And Equipment** (LEC 3.0)  
Principles of planning, constructing, and operating economically viable underground mines. Cost effective mining methods: room-and-pillar, sublevel open stoping, VCR, shrinkage, sublevel caving, cut-and-fill, block caving, longwall. Selection of equipment for underground mining operations. Optimization of mine performance. Field Trip Required. Prerequisite: Preceded or accompanied by Min Eng 3913.

**MIN ENG 4933 Surface Mining Methods And Equipment** (LEC 3.0)  
Principles of planning, constructing, and operating economically viable surface mines. Cost effective mining methods: placer mining, strip mining, open pit mining, quarrying. Selection of equipment for surface mining operations. Optimization of mine performance. Field trip required. Prerequisites: Min Eng 3912; Min Eng 3512; preceded or accompanied by Min Eng 4823.

**MIN ENG 5000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of the instructor required.

**MIN ENG 5001 Special Topics** (IND 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**MIN ENG 5113 Advanced Mine Atmosphere Control** (LEC 2.0 and LAB 1.0)  
Advanced mine ventilation network based on airflow requirements, control of gases, dust, and temperature, methane drainage, mine fans, network theory based on the Code of Federal Regulations. Computer simulation of ventilation systems, mine fire simulation, and economics of airflow based on underground mine layouts. Research paper or design project required. Prerequisite: Mi Eng 4113 or Consent of Instructor.

**MIN ENG 5122 Advanced Topics in Mine Health and Safety** (LEC 3.0)  
Advanced topics in mine health and safety including practices and regulations; risks and hazards recognition, mitigation and control; disaster prevention and control. Students will complete a research paper or project report. Pre-requisite: Mi Eng 4122 or Consent of Instructor.

**MIN ENG 5212 Advanced Aggregates and Quarrying** (LEC 3.0)  
Advanced topics in aggregates mining, mine design and planning, and project valuation. In-pit crushing and conveying, and advances in comminution technology for the aggregates industry. Design project or research paper required. Prerequisite: Mi Eng 4212 or Consent of Instructor.

**MIN ENG 5322 Advanced Coal Mining Methods** (LEC 3.0)  
Advanced topics in coal mining methods, planning and development of surface and underground mining systems; planning of logistics, resources, infrastructure for large-scale surface coal mines; face preparation, equipment interface, haulage systems, sequencing and scheduling and extraction from underground coal mines. Students will complete a research paper or project report. Prerequisites: Min Eng 4322 or Consent of Instructor.

**MIN ENG 5412 Advanced Aggregates Sizing and Characterization** (LEC 2.0 and LAB 1.0)  
Advanced methods for evaluating aggregate occurrences, extraction, material flow sheet analysis; Advances in processing and classification; advanced statistical methods for quality control and assurance, and standards. Students will complete and present a research paper on the subject. Field trip to a nearby quarry required. Prerequisite: Mi Eng 4412 or Consent of Instructor.

**MIN ENG 5413 Adv Mtl Proc Hghpres Wtr Jet** (LEC 3.0)

Advanced methods for continuously generating high pressure, power calculations, applications of waterjets in the mining and manufacturing industries, and safety considerations. Research paper or design project required. Prerequisite: Mi Eng 4413 or Consent of Instructor.

**MIN ENG 5422 Advanced Coal Preparation** (LEC 2.0 and LAB 1.0)

Advanced methods for designing coal processing circuitry and practices, flowsheet design, sampling, advanced ash and moisture analyzers; coarse, intermediate, and fine coal cleaning; dewatering; dry coal cleaning research. Research paper or design project required. Prerequisite: Mi Eng 4422 or Consent of Instructor.

**MIN ENG 5423 Advanced Flotation and Hydrometallurgy** (LEC 2.0 and LAB 1.0)

Theoretical basis of froth flotation, electrical characteristics at interfaces, interfacial forces, adsorption kinetics and thermodynamics, flotation reagents, flotation process flowsheets. Physicochemical principles of hydrometallurgical processes, leaching methods and reagents. Hydrometallurgical processes flowsheets. Research paper or design project required. Prerequisites: Mi Eng 4423 or Consent of Instructor.

**MIN ENG 5424 Advanced Mechanics And Design** (LAB 1.0 and LEC 2.0)

Strategy of beneficiation as a combination of unit operations: Mineral sampling and particle size distribution, mineral particle mechanics of comminution and energy requirement, mineral crushing and grinding circuits, classification, solid-liquid separation and instrumentation, Mineral processing plant flow sheet design. Research paper or design project required. Prerequisites: Mi Eng 4424 or Consent of Instructor.

**MIN ENG 5522 Advanced Ore Reserve Analysis And Geostatistics** (LEC 2.0 and LAB 1.0)

Advanced discussions on principles of geostatistics, theory of spatially correlated random variables, variance and co-variances and their application on the evaluation of mineral resources, ore reserve estimation, strategic exploration, and production planning. Real case studies from mining industry will be presented. Course project. Prerequisites: Math 3304 & Stat 3113 or instructor consent.

**MIN ENG 5532 Advanced Mining Economics** (LEC 3.0)

Mining industry & national economics. Social & economics significance of mined commodities. Marketing of mined commodities. Innovation approaches to mine financing, project loans, and leasing. Mining feasibility studies, government influence & policy, mining industry foreign investment, investment strategies, mining taxation, cost predictions. Case Studies.

**MIN ENG 5612 Principles of Explosives Engineering** (LEC 2.0 and LAB 1.0)

Theory and application of explosives in the mining industry; explosives, initiating systems, characteristics of explosive reactions and rock breakage, fundamentals of blast design, drilling and blasting, regulatory and safety considerations. Prerequisites: Min Eng 2126; successful background check. (Co-listed with Exp Eng 5612).

**MIN ENG 5622 Blasting Design And Technology** (LEC 2.0 and LAB 1.0)

Advanced theory and application of explosives in excavation; detailed underground blast design; specialized blasting including blast casting, construction and pre-splitting. Introduction to blasting research. Examination of field applications. Prerequisites: Min Eng 5612. Student must be at least 21 years of age. Successful background check. (Co-listed with Exp Eng 5622).

**MIN ENG 5742 Advanced Environmental Aspects of Mining** (LEC 3.0)

Applied and fundamental research issues pertaining to: permitting -- the legal environment of reclamation and environmental impact assessment; post-mining land-use selection and mine planning for optimum reclamation of all mines: metal, nonmetal, and coal; unit operations of reclamation: drainage, backfill, soil replacement, revegetation, maintenance, etc. Course project. Prerequisites: Min Eng 5932 and 5933 or instructor consent. (Co-listed with GE XXXX).

**MIN ENG 5822 Strata Control** (LEC 3.0)

A detailed review of artificial ground support, both above and below ground, including slope stabilization techniques and shaft and tunnel liner design. The use of shotcrete, roofbolts, and solid liners and the principles of underground longwall and room and pillar mine support. Longwall and hydraulic mining practice is covered. Prerequisite: Min Eng 4823.

**MIN ENG 5823 Rock Mechanics III** (LAB 1.0 and LEC 2.0)

Advanced methods for designing rock excavation to resolve geotechnical and ground control problems. Topics including stress analysis, rock properties, instrumentation, pillar design, roof span design, rock reinforcement, surface subsidence, rock burst, and slope stability. Research paper or design project required. Prerequisites: Mi Eng 4823 or Consent of Instructor.

**MIN ENG 5912 Advanced Mine Power And Drainage** (LEC 2.0 and LAB 1.0)

Advanced methods for evaluating electric power requirements and distribution mining geometries; Design and evaluation of mine drainage systems based on power requirements, layouts efficiency, hydraulic gradients, water-bearing formations; Risk evaluation of emergency power failures and mine flooding. Research paper or project required. Prerequisite: Mi Eng 4912 or Consent of Instructor.

**MIN ENG 5913 Advanced Computer Aided Mine Design** (LEC 2.0 and LAB 1.0)

Project-based mine planning and design course. Engineering design process applied to computer-aided mine planning and design. Mine layouts, production planning, and materials scheduling optimization. Prerequisite: Graduate standing.

**MIN ENG 5922 Advanced Tunneling & Underground Construction Techniques** (LEC 2.0 and LAB 1.0)

Advanced topics in mechanical and conventional excavation techniques in underground tunneling and construction. Topics include tunneling layouts design, equipment and performance modeling, ground control systems including support, drainage, and structural integrity. Construction specifications, advance rate and contractual and cost estimation. Prerequisite: Consent of instructor. (Co-listed with Exp Eng 5922).

**MIN ENG 5932 Advanced Underground Mining Methods** (LEC 3.0)

Advanced methods for designing, planning, developing and operating economic and efficient underground mining systems. Systems include mass mining methods, room and pillar, longwall, cut and fill with equipment, ventilation and drainage control interface. Research paper or design project required. Prerequisite: Mi Eng 4932 or Consent of Instructor.



**MIN ENG 5933 Advanced Surface Mining Methods** (LEC 3.0)

Advanced topics in surface mine planning, methods and equipment acquisition, and deployment in surface mining operations. Strategic and tactical mine planning with focus on efficiency, safety, environmental standards and economics. It will also focus on fleet management with emphasis on repair, rebuild and replacement for higher availabilities, utilization and production output. Students will complete a research paper or project report. Prerequisites: Min Eng 4933 or Consent of Instructor.

## Music (MUSIC)

**MUSIC 1111 Individual Music Instruction I** (LAB 1.0)

Individual music instruction in student's concentration area. Prerequisite: Consent of instructor required.

**MUSIC 1121 Individual Music Instruction II** (LAB 1.0-2.0)

Individual music instruction in student's concentration area. Prerequisite: Consent of instructor.

**MUSIC 1130 Wind Symphony** (LAB 2.0)

Open to all students who play a band instrument. Auditions may be used for placement in ensemble.

**MUSIC 1131 Marching Band** (LAB 2.0)

Open to all students who play a band instrument. Auditions may be used for placement in ensemble.

**MUSIC 1132 University Orchestra** (LAB 2.0)

Open to all students who play stringed, wind, percussion or keyboard instruments used in the symphony orchestra. Students assigned to the orchestra after satisfactory audition.

**MUSIC 1134 Instrumental Chamber Ensemble-Strings** (LAB 1.0)

Open to all students who play violin, viola, cello or double bass. Students assigned to the ensemble after satisfactory audition.

**MUSIC 1135 Symphonic Band** (LAB 0.0-2.0)

Open to all students who play a band instrument. Auditions may be used for placement in ensemble.

**MUSIC 1136 Jazz Ensemble** (LAB 1.0)

A study of the various instrumental jazz forms. Students are assigned by audition to a jazz ensemble. Prerequisite: Consent of instructor.

**MUSIC 1140 University Choir** (LAB 1.0)

SATB choral group. Open to all who are interested in learning to sing in a choral setting. No audition required.

**MUSIC 1141 Chamber Vocal Ensembles** (LAB 1.0)

An SATB choral group. Audition required. Auditions are open to all who are interested and are held during class time the first week of classes.

**MUSIC 1150 Music Understanding And Appreciation** (LEC 3.0)

A study of the development of music with emphasis on understanding music forms and the role music has played in the various historical periods.

**MUSIC 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MUSIC 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MUSIC 2111 Individual Music Instruction III** (LAB 1.0-2.0)

Individual music instruction in student's concentration area. Prerequisite: Consent of instructor.

**MUSIC 2121 Individual Music Instruction IV** (LAB 1.0-2.0)

Individual music instruction in student's concentration area. Prerequisite: Consent of instructor.

**MUSIC 2161 Theory of Music I** (LEC 3.0)

Basic musicianship. Notation, rhythm, meter, scales, intervals, triads, nonharmonic tones, major-minor seventh, modulations of common practice period. Applications of these materials in original composition and analysis of melodies and elementary homophonic form.

**MUSIC 2162 Theory of Music II** (LEC 3.0)

A continuation of the requisite theory and fundamentals of Music 2161. Prerequisite: Music 2161.

**MUSIC 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MUSIC 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**MUSIC 3010 Seminar** (IND 0.0-6.0)

Discussion of current topics.

**MUSIC 3251 History and Analysis of Music I** (LEC 3.0)

General survey of history of music from Greek period to 18th century. Score reading required.

**MUSIC 3252 History and Analysis of Music II** (LEC 3.0)

General survey of history of music from the 18th century to the present. Score reading required.

**MUSIC 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**MUSIC 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

## Nuclear Engineering (NUC ENG)

**NUC ENG 1105 Nuclear Technology Applications** (LEC 1.0)

It is a project oriented course that examines various aspects of nuclear technology, such as radiation detection, radiation protection, food irradiation, medical and industrial applications. The students will work in small groups on stimulating projects.

**NUC ENG 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**NUC ENG 2105 Introduction To Nuclear Engineering** (LEC 2.0)

Atoms and nuclei; nuclear reactions; radioactivity; interactions of radiation with matter; fission and fusion reactors; nuclear fuels; radiation effects on materials and man; radioactive waste disposal; reactor safety; radiation protection. Prerequisite: Math 1215 or Math 1221.

**NUC ENG 2406 Reactor Operations I** (LAB 1.0)

A first course in reactor operations training and practical approach to nuclear reactor concepts. Students will receive hands-on training and are encouraged to take the NRC Reactor Operator's Exam. Prerequisites: Math 1214 or Math 1208; preceded or accompanied by Nuc Eng 1105.

**NUC ENG 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**NUC ENG 3001 Special Topics** (LAB 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**NUC ENG 3103 Interactions Of Radiation With Matter** (LEC 3.0)

Atoms and nuclei; relativistic kinematics; quantum theory; nuclear decay; cross sections; neutron, gamma, and charged particle interactions; production of radioisotopes; electrical, thermal and magnetic properties of solids. Prerequisites: Math 2222, Physics 2135.

**NUC ENG 3205 Fundamentals Of Nuclear Engineering** (LEC 3.0)

An introduction to the principles and equations used in nuclear fission reactor technology including: reactor types; neutron physics and reactor theory; reactor kinetics and control; radiation protection; reactor safety and licensing; and environmental aspects of nuclear power. Prerequisite: Physics 2305 or Nuc Eng 3103; Math 3304.

**NUC ENG 3221 Reactor Fluid Mechanics** (LEC 3.0)

A study of the fundamental principles of incompressible viscous and inviscid flows in ducts, nozzles, tube bundles and applications to nuclear engineering; fluid statics; dimensional analysis and similitude; boundary layer theory. Prerequisites: Math 3304, Junior standing.

**NUC ENG 3223 Reactor Heat Transfer** (LEC 3.0)

A study of the fundamental principles of conduction, convection and thermal radiation with volumetric source terms for nuclear engineering applications; empirical correlations; finite difference methods; analysis of nuclear reactor cores. Prerequisite: Nuc Eng 3221.

**NUC ENG 3377 Nuclear Forensics and Radiochemistry** (LEC 3.0)

Learn the fundamentals of radiochemistry and its application to the broad field of Nuclear Forensics. Includes a review of nuclear science and cosmochemistry (the origin of the chemical elements), a historical review of spent fuel reprocessing techniques including solvent extraction. A broad review of the modern nuclear forensics field and its importance. Prerequisites: NUC ENG 2105 recommended.

**NUC ENG 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**NUC ENG 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**NUC ENG 4010 Seminar** (RSD 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

**NUC ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**NUC ENG 4203 Reactor Physics I** (LEC 3.0)

Study of neutron interactions, fission, chain reactions, neutron diffusion and neutron slowing down; criticality of a bare thermal homogeneous reactor. Prerequisite: Nuc Eng 3205.

**NUC ENG 4207 Nuclear Fuel Cycle** (LEC 3.0)

Nuclear fuel reserves and resources; milling, conversion, and enrichment; fuel fabrication; in-and-out-of core fuel management; transportation, storage, and disposal of nuclear fuel; low level and high level waste management; economics of the nuclear fuel cycle. Prerequisite: Nuc Eng 3205.

**NUC ENG 4211 Reactor Physics II** (LEC 3.0)

Analytic and computer based methods of solving problems of reactor physics. Prerequisites: Nuc Eng 4203, Comp Sci 3200.

**NUC ENG 4215 Space Nuclear Power And Propulsion** (LEC 3.0)

A study of the design, operation and application of radioisotope power generators and nuclear reactors for space power and propulsion systems used on both manned and unmanned missions. Prerequisites: Nuc Eng 4203 and Nuc Eng 4229.

**NUC ENG 4229 Nuclear Power Plant Systems** (LEC 3.0)

A study of current nuclear power plant concepts and the environmental, economics and safety considerations affecting their design. Includes such topics as: thermodynamics, thermal hydraulics, and mechanical and electrical aspects of nuclear power facilities. Prerequisites: Nuc Eng 3205 and accompanied or preceded by Nuc Eng 3223.

**NUC ENG 4241 Nuclear Materials I** (LEC 3.0)

Fundamentals of materials selection for components in nuclear applications; design and fabrication of UO<sub>2</sub> fuel; reactor fuel element performance; mechanical properties of UO<sub>2</sub>; radiation damage and effects, including computer modeling; corrosion of materials in nuclear reactor systems. Prerequisites: Civ Eng 2210; Nuc Eng 3205; Nuc Eng 3223; Met Eng 2110. (Co-listed with Met Eng 5170).

**NUC ENG 4251 Reactor Kinetics** (LEC 3.0)

Derivation and solutions to elementary kinetics models. Application of the point kinetics model in fast and thermal reactor dynamics, internal and external feedback mechanisms, rigorous derivation and solutions of the space dependent kinetics model fission product and fuel isotope changes during reactor operation. Prerequisite: Nuc Eng 3205.

**NUC ENG 4253 Monte Carlo Approach to Reactor Analysis** (LEC 3.0)

An introduction to a stochastic method for solving particle transport problems with a view to utilize the method in reactor design and analysis, shielding problems, flux calculations, reaction rates determination and general steady state reactor physics analysis. Prerequisites: Accompanied by NUC ENG 3205.

**NUC ENG 4257 Two-phase Flow in Energy Systems - I** (LEC 3.0)

It is an introductory course for both undergraduate or graduate students who are interested in the application of two-phase flow in energy systems. It will acquaint students with governing equations for both single-phase and two-phase fluid flow, state-of-the-art analytical methods and various two-phase flow phenomena related to energy systems. Prerequisite: Nuc Eng 3221 or Chem Eng 3100 or Mech Eng 3131.

**NUC ENG 4259 Licensing Of Nuclear Power Plants** (LAB 1.0 and LEC 2.0)

The pertinent sections of the Code of Federal Regulations, the Nuclear Regulatory Commission's Regulatory Guides and Staff Position Papers, and other regulatory requirements are reviewed. Safety analysis reports and environmental reports for specific plants are studied. Operational aspects of the nuclear power plant will be covered by including field trips. Prerequisite: Nuc Eng 3205.

**NUC ENG 4281 Probabilistic Risk Assessment I** (LEC 3.0)

A study of the techniques for qualitative and quantitative assessment of reliability, safety and risk associated with complex systems such as those encountered in the nuclear power industry. Emphasis is placed on fault tree analysis. Prerequisite: Nuc Eng 3205.

**NUC ENG 4312 Nuclear Radiation Measurements and Spectroscopy** (LAB 1.0 and LEC 2.0)

Contemporary radiation detection theory and experiments with high resolution gamma-ray spectroscopy, solid state detectors, neutron detection and conventional gas filled detectors. Neutron activation analysis of unknown material, statistical aspects of nuclear measurements. Prerequisite: Nuc Eng 3205.

**NUC ENG 4345 Nuclear Engineering Mathematical Methods** (LEC 3.0)

Application of mathematical methods used in the solution of nuclear engineering problems, particularly with the neutron kinetics equations, the Navier-Stokes equations, and the heat conduction equation with nuclear heat generation terms. Prerequisites: Nuc Eng 4203.

**NUC ENG 4347 Radiological Engineering** (LEC 3.0)

Radiation exposure pathways analysis. Modeling of radionuclides transport through atmosphere, surface and ground water. Human health impact. Transportation of nuclear waste. Nuclear Waste characterization. Regulatory structure and requirements. Scenario case studies and computer simulation of transport. Prerequisite: Nuc Eng 3205.

**NUC ENG 4350 Introduction to Nuclear Medical Science** (LEC 3.0)

Introduction to physics and technologies involved in various radiological imaging and treatment systems in the medical field, such as digital radiography, digital mammography, computed tomography and nuclear medicine instruments will be covered. Prerequisites: Nuc Eng 4312 or equivalent. (Co-listed with Nuc Eng 5350).

**NUC ENG 4361 Fusion Fundamentals** (LEC 3.0)

Introduction to the plasma state, single particle motion, kinetic theory, plasma waves, fusion, power generation, radiation mechanisms, inertial confinement and fusion devices, including conceptual fusion power plant designs. Prerequisite: Preceded or accompanied by Math 3304.

**NUC ENG 4363 Applied Health Physics** (LEC 3.0)

Radiation sources; external and internal dosimetry; biological effects of radiation; radiation protection principles; regulatory guides; radioactive and nuclear materials management. Prerequisite: Nuc Eng 3103 or Physics 2305.

**NUC ENG 4365 Radiation Protection Engineering** (LEC 3.0)

Radiation fields and sources including nuclear reactors, radioactive wastes, x-ray machines, and accelerators. Stopping of radiation (Charges particles, photons, and neutrons) by matter. Radiation transport methods. Radiation shielding design. Dose rate calculations. Biological effects of radiation. Regulatory guides (10CFR20). Prerequisite: Nuc Eng 3205.

**NUC ENG 4367 Radioactive Waste Management And Remediation** (LEC 3.0)

Sources and classes of radioactive waste, long-term decay, spent fuel storage, transport, disposal options, regulatory control, materials issues, site selection and geologic characterization, containment, design and monitoring requirements, domestic and foreign waste disposal programs, economic and environmental issues, history of disposal actions, and conduct of remedial actions and clean up. Prerequisite: Math 3304. (Co-listed with Geology 4421).

**NUC ENG 4370 Plasma Physics I** (LEC 3.0)

Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Aero Eng 5570, Mech Eng 5570, Physics 4543).

**NUC ENG 4428 Reactor Laboratory I** (LAB 1.0 and LEC 1.0)

Acquaints the student with neutron flux measurement, reactor operation, control rod calibration, reactor power measurement and neutron activation experiments. Experiments with the thermal column and neutron beam port are also demonstrated. Prerequisites: Nuc Eng 4312, 3205.

**NUC ENG 4438 Reactor Laboratory II** (LEC 1.0 and LAB 1.0)

A continuation of Nuclear Engineering 4428 with experiments of a more advanced nature. Prerequisite: Nuc Eng 4428.

**NUC ENG 4456 Reactor Operation II** (LAB 1.0)

The operation of the training reactor. The program is similar to that required for the NRC Reactor Operator's license. Students from other disciplines will also benefit from the course. Prerequisite: Nuc Eng 2105, 2406.

**NUC ENG 4496 Nuclear System Design I** (LEC 1.0)

A preliminary design of a nuclear system (e.g. a fission or fusion nuclear reactor plant, a space power system, a radioactive waste disposal system). Prerequisites: Nuc Eng 3223, 4203, 4229, preceded or accompanied by Nuc Eng 4241.

**NUC ENG 4497 Nuclear System Design II** (LEC 3.0)

A complete design of a nuclear system (e.g. a fission or fusion nuclear reactor plant, a space power system, a radioactive waste disposal system). Prerequisite: Nuc Eng 4496.

**NUC ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**NUC ENG 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**NUC ENG 5203 Reactor Physics I** (LEC 3.0)

Study of neutron interactions, fission, chain reactions, neutron diffusion and neutron slowing down; criticality of a bare thermal homogeneous reactor. Prerequisite: Nuc Eng 3205.

**NUC ENG 5207 Nuclear Fuel Cycle** (LEC 3.0)

Nuclear fuel reserves and resources; milling, conversion, and enrichment; fuel fabrication; in-and-out-of core fuel management; transportation, storage, and disposal of nuclear fuel; low level and high level waste management; economics of the nuclear fuel cycle. Prerequisite: Nuc Eng 3205.

**NUC ENG 5241 Nuclear Materials I** (LEC 3.0)

Fundamentals of materials selection for components in nuclear applications; design and fabrication of UO<sub>2</sub> fuel; reactor fuel element performance; mechanical properties of UO<sub>2</sub>; radiation damage and effects, including computer modeling; corrosion of materials in nuclear reactor systems. Prerequisites: Civ Eng 2210; Nuc Eng 3205; Nuc Eng 3223; Met Eng 2110. (Co-listed with Met Eng 5170).

**NUC ENG 5251 Reactor Kinetics** (LEC 3.0)

Derivation and solutions to elementary kinetics models. Application of the point kinetics model in fast and thermal reactor dynamics, internal and external feedback mechanisms, rigorous derivation and solutions of the space dependent kinetics model fission product and fuel isotope changes during reactor operation. Prerequisite: Nuc Eng 3205.

**NUC ENG 5257 Introduction to Nuclear Thermal Hydraulics** (LEC 3.0)

An introductory course in the application of thermal-hydraulic principles to energy systems, with emphasis on nuclear energy issues. Will include the development of constitutive models and applications to power systems, fluid mechanics, and heat transfer problems (including multiphase flows). Prerequisite: Graduate standing.

**NUC ENG 5281 Probabilistic Risk Assessment I** (LEC 3.0)

A study of the techniques for qualitative and quantitative assessment of reliability, safety and risk associated with complex systems such as those encountered in the nuclear power industry. Emphasis is placed on fault tree analysis. Prerequisite: Nuc Eng 3205.

**NUC ENG 5312 Nuclear Radiation Measurements and Spectroscopy** (LEC 2.0 and LAB 1.0)

Contemporary radiation detection theory and experiments with high resolution gamma-ray spectroscopy, solid state detectors, neutron detection and conventional gas filled detectors. Neutron activation analysis of unknown material, statistical aspects of nuclear measurements. Prerequisite: Nuc Eng 3205.

**NUC ENG 5347 Radiological Engineering** (LEC 3.0)

Radiation exposure pathways analysis. Modeling of radionuclides transport through atmosphere, surface and ground water. Human health impact. Transportation of nuclear waste. Nuclear Waste characterization. Regulatory structure and requirements. Scenario case studies and computer simulation of transport. Prerequisite: Nuc Eng 3205.

**NUC ENG 5350 Advanced Nuclear Medical Science** (LEC 3.0)

Advanced level of technologies involved in medical modalities, such as digital radiography, digital mammography, modern computed tomography, gamma camera, SPECT and PET will be covered. Prerequisites: Nuc Eng 4312 or equivalent.

**NUC ENG 5363 Applied Health Physics** (LEC 3.0)

Radiation sources; external and internal dosimetry; biological effects of radiation; radiation protection principles; regulatory guides; radioactive and nuclear materials management. Prerequisite: Nuc Eng 3103 or Physics 2305.

**NUC ENG 5365 Radiation Protection Engineering** (LEC 3.0)

Radiation fields and sources including nuclear reactors, radioactive wastes, x-ray machines, and accelerators. Stopping of radiation (Charges particles, photons, and neutrons) by matter. Radiation transport methods. Radiation shielding design. Dose rate calculations. Biological effects of radiation. Regulatory guides (10CFR20). Prerequisite: Nuc Eng 3205.

**NUC ENG 5367 Radioactive Waste Management And Remediation** (LEC 3.0)

Sources and classes of radioactive waste, long-term decay, spent fuel storage, transport, disposal options, regulatory control, materials issues, site selection and geologic characterization, containment, design and monitoring requirements, domestic and foreign waste disposal programs, economic and environmental issues, history of disposal actions, and conduct of remedial actions and clean up. Prerequisite: Math 3304. (Co-listed with Geology 4421).

**NUC ENG 5370 Plasma Physics I** (LEC 3.0)

Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Aero Eng 5570, Mech Eng 5570, Physics 4543).

**NUC ENG 5428 Reactor Laboratory I** (LEC 1.0 and LAB 1.0)

Acquaints the student with neutron flux measurement, reactor operation, control rod calibration, reactor power measurement and neutron activation experiments. Experiments with the thermal column and neutron beam port are also demonstrated. Prerequisites: Nuc Eng 4312, 3205.

**NUC ENG 5438 Reactor Laboratory II** (LEC 1.0 and LAB 1.0)

A continuation of Nuclear Engineering 304 with experiments of a more advanced nature. Prerequisite: Nuc Eng 4428.

**NUC ENG 5456 Reactor Operation II** (LAB 1.0)

The operation of the training reactor. The program is similar to that required for the NRC Reactor Operator's license. Students from other disciplines will also benefit from the course. Prerequisite: Nuc Eng 2105, 2406.

## Petroleum Engineering (PET ENG)

**PET ENG 2000 Special Problems** (IND 1.0-3.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PET ENG 2001 Special Topics** (IND 1.0-3.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PET ENG 2002 Cooperative Work Training** (IND 1.0-3.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation.

**PET ENG 2510 Properties Of Hydrocarbon Fluids** (LEC 3.0)

Physical properties of petroleum fluids; chemical components of petroleum fluids. Elementary phase behavior; calculations of the physical properties of gases, liquids, and gas-liquid mixtures in equilibrium. Prerequisite: Chem 1310.

**PET ENG 3000 Special Problems** (IND 1.0-3.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PET ENG 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PET ENG 3320 Petrophysics** (LEC 2.0 and LAB 1.0)

Fundamental properties of petroleum reservoir rocks, including lithology, porosity, absolute permeability, pore surface area, relative and effective permeability, fluid saturations, rock wettability, capillary characteristics, acoustic properties, and electrical properties. Darcy's law for single phase linear horizontal and tilted flow and radial flow. Prerequisites: Preceded or accompanied by both Pet Eng 2510 and Physics 1135.

**PET ENG 3330 Well Logging** (LAB 1.0 and LEC 2.0)

An introduction to the electrical, nuclear, and acoustic properties of rocks: theory and interpretation of conventional well logs. Prerequisites: Physics 2135 or 2111; Pet Eng 3520.

**PET ENG 3520 Petroleum Reservoir Engineering** (LEC 3.0)

Properties of reservoir formations and fluids; reservoir volumetrics, reservoir statics, reservoir dynamics. Darcy's law and the mechanics of single and multiphase fluid flow through reservoir rock, capillary phenomena, material balance, reservoir drive mechanisms. Prerequisite: Accompanied or preceded by Pet Eng 2510.

**PET ENG 3529 Petroleum Reservoir Laboratory** (LAB 1.0)

Core analysis determination of intensive properties of crude oil and its products; equipment and methods used to obtain petroleum reservoir information. Prerequisite: Accompanied or preceded by Pet Eng 3520.

**PET ENG 4000 Special Problems Special Problems Special Problems** (IND 0.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.



**PET ENG 4001 Special Topics** (LAB 1.0 and LEC 2.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PET ENG 4010 Ethics and Professionalism** (LEC 1.0)

Topics related to Ethics and Professionalism. Lifelong learning, teamwork and discussion of current events. (Course cannot be used for graduate credit). Prerequisite: Senior standing in Pet Eng.

**PET ENG 4097 Petroleum Engineering Design** (LEC 3.0)

Senior capstone design project(s) based on industry data. Application of reservoir engineering: drilling and production engineering principles to evaluate and solve an industry problem such as a new field development, evaluation of an existing reservoir asset, or analysis of field re-development. Prerequisites: Pet Eng 3520, Pet Eng 3410, and senior standing.

**PET ENG 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

**PET ENG 4109 Field Studies** (LAB 1.0)

Field trip, which studies different aspects of petroleum engineering like reservoirs, caprocks and traps, drilling rigs, petroleum production facilities, refineries and petroleum engineering research facilities. This course takes the students for one week to petroleum operations and geological outcrops in Oklahoma and Texas to expose students to field work.

**PET ENG 4111 Fundamental Digital Applications In Petroleum Engineering** (LEC 3.0)

Applications of Windows-based Visual Basic solutions to engineering problems including selected topics in fluid flow, PVT behavior, matrices in engineering solutions, translating curves to computer solutions, predictor-corrector material balance solutions, and graphical display of results. Prerequisite: Junior Standing.

**PET ENG 4210 Drilling and Well Design** (LAB 1.0 and LEC 2.0)

This course covers drilling fluids, including mixing and analysis of rheological properties; pressure loss calculations; casing design; well cementing; pore pressure and geomechanical considerations in drilling; completion equipment; and completion design. Prerequisite: Preceded or accompanied by Civ Eng 3330.

**PET ENG 4211 Advanced Drilling Technology** (LEC 3.0)

In-depth study of directional well planning and drilling. The course covers the bottom hole assemblies and operational techniques used in drill directional drilling as well as the limiting factors and hole problems related to horizontal wells. Prerequisites: Pet Eng 4210.

**PET ENG 4311 Reservoir Characterization** (LEC 3.0)

The integration and extrapolation of Geologic, Geophysical, and Petroleum Engineering data for flow model construction. Prerequisites: Pet Eng 3520 and Pet Eng 3310.

**PET ENG 4410 Well Performance and Production Systems** (LEC 2.0 and LAB 1.0)

Introduction to the producing wellbore system; inflow performance relationships, effect of formation damage on well flow, nodal systems analysis; perforating methods and their effect on inflow; stimulation treatments to enhance well performance. Introduction to well completions, diagnostics and well servicing. Overview of production systems. Prerequisite: Preceded or accompanied by Pet Eng 3520.

**PET ENG 4421 Artificial Lift** (LEC 3.0)

This course is a study of artificial lift methods used to produce liquids (oil/water) from wellbores. Methods covered include sucker rod (piston) pumps, electric submersible pumps, gas lift, hydraulic lift and plunger lift. Prerequisite: Pet Eng 4410.

**PET ENG 4431 Well Completion Design** (LEC 3.0)

An overview of the hardware, fluids and processes employed in completing oil and gas wells. Examination of types of well completions and considerations in their design. Introduction to downhole mechanics and tubing movement and stress calculations. Prerequisite: Pet Eng 3520.

**PET ENG 4441 Well Stimulation** (LEC 3.0)

This course reviews fundamentals of hydraulic fracturing and builds on the basic theory through the use of STIMPLAN software and hands on industry examples. The course teaches the methods used to plan, execute and evaluate hydraulic fracturing treatments. Students may not earn credit for both Pet Eng 4441 and Pet Eng 6441. Prerequisites: Pet Eng 3520 and Pet Eng 3330.

**PET ENG 4511 Applied Petroleum Reservoir Engineering** (LEC 3.0)

Quantitative study of oil production by natural forces, gas cap, water influx, solution gas, etc.; material balance equations, study of gas, non-retrograde gas condensate, and black oil reservoirs. Predictive calculations of oil recovery from different reservoir types. Prerequisites: Pet Eng 3520 and 3529.

**PET ENG 4520 Well Test Analysis** (LEC 2.0 and LAB 1.0)

Causes of low well productivity; analysis of pressure buildup tests, drawdown tests, multi-rate tests, injection well fall off tests, and open flow potential tests; design of well testing procedures. Prerequisite: Pet Eng 3520.

**PET ENG 4531 Natural Gas Engineering** (LEC 3.0)

Gas reserves estimation, deliverability, and future production performance prediction. Deliverability testing of gas wells including isochronal, flow after flow, drawdown and buildup. Gasfield development and underground storage. Gas production metering gauging and transmission. Prerequisite: Preceded or accompanied by Pet Eng 3520.

**PET ENG 4590 Petroleum Economics and Asset Valuation** (LEC 3.0)

Uncertainty in the estimation of oil and gas reserves; tangible and intangible investment costs; depreciation; evaluation of producing properties; federal income tax considerations; chance factor and risk determination. Petroleum economic evaluation software is introduced. Prerequisites: Pet Eng 3520, Econ 1100 or Econ 1200.

**PET ENG 4611 Secondary Recovery Of Petroleum** (LEC 3.0)

Oil recovery by water injection. Effects of wettability, capillary pressure, relative permeability, mobility ratio on displacement, sweep, and recovery efficiencies. Piston-like and Buckley-Leverett models. Fractional flow and frontal advance equation. Oil recovery prediction methods for linear and pattern waterfloods in single and multi-layered reservoirs. Prerequisites: Pet Eng 3520, Pet Eng 3529.

**PET ENG 4621 Fundamentals Of Petroleum Reservoir Simulation** (LEC 3.0)

An introduction to petroleum reservoir simulation. Fundamentals of finite difference approximation of the partial differential equations of flow through porous media. Discussion of various simulation schemes, data handling, boundary conditions. Use of a dry gas and black oil simulators. Prerequisite: Pet Eng 3520.

**PET ENG 4631 Applied Reservoir Simulation** (LEC 3.0)

Simulation of actual reservoir problems using both field and individual well models to determine well spacing, production effects of secondary and enhanced recovery processes, future rate predictions and recovery, coning effects, relative permeability adjustments and other history matching techniques. Prerequisite: Pet Eng 3520.

**PET ENG 4710 Finite Element Analysis with Applications in Petroleum Engineering** (LEC 2.0 and LAB 1.0)

This course introduces finite element analysis (FEA) methods and applications of FEA in subsurface engineering. The course is intended to provide a fundamental understanding of FEA software and experience in creating meshes for petroleum reservoirs or other subsurface features. Prerequisites: Pet Eng 3520, Geology 3310, and Math 3304.

**PET ENG 4720 Mechanical Earth Modeling** (LEC 3.0)

This course introduces the work process necessary to create the Mechanical Earth Model's principle components, formation in-situ stress and strength. 1-D modelign methods are reviewed and extended to 3-D; and the integration of MEM with well design is shown. An MEM model will be created and compared to actual field results. Prerequisites: Pet Eng 3310 and Geology 3310.

**PET ENG 4811 Offshore Petroleum Technology** (LEC 3.0)

An introduction to the development of oil and gas fields offshore, including offshore leasing, drilling, well completions, production facilities, pipelines, and servicing. Subsea systems, and deepwater developments are also included. This course is suitable for mechanical, electrical and civil engineering students interested in ultimately working offshore.

**PET ENG 4821 Environmental Petroleum Applications** (LEC 3.0)

This course is a study of environmental protection and regulatory compliance in the oil and gas industry. The impact of various environmental laws on drilling and production operations will be covered. Oilfield and related wastes and their handling are described. Federal, state and local regulatory agencies are introduced, and their role in permitting and compliance monitoring is presented. Legal and ethical responsibilities are discussed. Prerequisite: Chem 1310.

**PET ENG 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects of projects in the department. Consent of instructor required.

**PET ENG 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PET ENG 5010 Seminar** (RSD 0.0-6.0)

Discussion of current topics.

**PET ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**PET ENG 5085 Internship** (IND 0.0-15)

Students working toward a doctor of engineering degree will select, with the advice of their committees, appropriate problems for preparation of a dissertation. The problem selected and internship plan must conform to the purpose of providing a high level engineering experience consistent with the intent of the doctor of engineering degree.

**PET ENG 5099 Research** (IND 0.0-12)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

## Philosophy (PHILOS)

**PHILOS 1105 Introduction To Philosophy** (LEC 3.0)

An historical survey of the major approaches to philosophical problems, especially those of the nature of reality, human nature, and conduct. Prerequisite: Entrance requirements.

**PHILOS 1110 Practical Reasoning** (LEC 3.0)

An introduction to the study of non-formal reasoning. The course examines the subtle ways that the form in which information is presented can color the way that information is understood. Prerequisite: Entrance requirements.

**PHILOS 1115 Introduction To Logic** (LEC 3.0)

A study of the basic rules of both formal and symbolic logic, including types of argumentation, methods of reasoning, valid reasoning, inductive and deductive reasoning as used in the sciences and in communication in general. Prerequisite: Entrance requirements.

**PHILOS 1130 Introduction to Ethics** (LEC 3.0)

A complex and rich tradition in philosophical thought, Ethics - from the Ancient Greeks up into contemporary thought philosophers - returns again and again to discuss theories in proper behavior. No previous exposure to philosophy is required.

**PHILOS 1175 Comparative Religious Philosophy** (LEC 3.0)

A comparison of the philosophic ideas and foundations of the major Eastern and Western religions. Prerequisite: Entrance requirements.

**PHILOS 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PHILOS 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHILOS 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PHILOS 3001 Special Topics** (LAB 1.0 and LEC 3.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHILOS 3204 Ancient Philosophy** (LEC 3.0)

A study of selected philosophical works from the pre-Socratics to William of Occam. Prerequisites: An introductory (below 2000) level Philosophy course.

**PHILOS 3205 Early Modern Philosophy** (LEC 3.0)

Principal figures in the development of rationalism, empiricism, and skepticism in early modern Europe, from Descartes through Hume. Prerequisites: A previous class in philosophy is recommended.

**PHILOS 3223 Bioethics** (LEC 3.0)

This course covers several areas of ethical interest in biotechnology, medicine, and medical care. Topics may include stem-cell research, cloning, genetic engineering, reproductive issues, pharmaceutical ethics, privacy, physician-assisted suicide, patient rights, human and animal experimentation, and resource allocation. Prerequisite: Sophomore standing or above.

**PHILOS 3225 Engineering Ethics** (LEC 3.0)

Engineering ethics, examines major ethical issues facing engineers in the practice of their profession: the problem of professionalism and a code of ethics; the process of ethical decision-making in different working environments; the rights, duties, and conflicting responsibilities of engineers. Prerequisite: Sophomore standing or above.

**PHILOS 3235 Business Ethics** (LEC 3.0)

Develop ethical concepts relevant to deciding the moral issues that arise in business. Topics include: Economic systems, government regulations, relations to external groups and environment, advertising, product safety and liability, worker safety and rights, rights and responsibilities of business professionals. Prerequisite: Sophomore standing or above.

**PHILOS 3254 Symbolic Logic in Argumentation** (LEC 3.0)

An introduction to sentential and predicate logic. Focuses on various techniques used to examine logical relationships within an artificial symbolic language, such as truth tables, derivations, and models. Includes metatheoretic discussions of syntax and semantics, and soundness and completeness. Prerequisites: Comp Eng 2210, or Comp Sci 1200, or any 1000-level or higher Philosophy course. Philosophy 1115 is recommended.

**PHILOS 3276 Thematics Studies in Film and Philosophy** (LEC 3.0)

A study of special topics at the intersection of film and philosophy. Topics vary but may include films on the nature of reality, films on the problem of evil, films on concepts of consciousness and the self, and more. Prerequisites: Art 1185 or one philosophy course, or junior standing. (Co-listed with Art 3276).

**PHILOS 3302 Medieval Philosophy** (LEC 3.0)

A critical study of the important philosophies of the period from Augustine to the Renaissance. Although there is no formal prerequisite, it is recommended that students have taken at least one other philosophy course. Prerequisites: A previous class in philosophy is recommended.

**PHILOS 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects of projects in the department. Consent of instructor required.

**PHILOS 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHILOS 4320 Minds And Machines** (LEC 3.0)

The course will be centered on the topic of artificial intelligence and the problems raised by contemporary attempts to simulate human thinking and perception in machines. Special emphasis will be placed on recent developments in psychology, physiology, cybernetics and computer technology. Prerequisite: Any philosophy course.

**PHILOS 4325 Epistemology: Knowledge and Justification** (LEC 3.0)

An introduction to the field of epistemology, the study of the scope, the limits, the sources, and the nature of knowledge and justified belief. Includes analyses of knowledge and justification, skepticism, scientific knowledge, and naturalism, among other topics. Prerequisite: Any 1000 or higher level philosophy course. Philosophy 1105 recommended.

**PHILOS 4333 American Philosophy** (LEC 3.0)

A study of American philosophical development with emphasis upon the "Classical Age of American Philosophy", i.e., Pierce, James, Dewey, Royce, Santayana and Whitehead. Prerequisite: An introductory (below 2000) level Philosophy course.

**PHILOS 4335 Philosophy Of Religion** (LEC 3.0)

A consideration of the major presuppositions of western theism, such as the existence of god and the cognitive meaningfulness of religious language. Prerequisite: Any introductory (below 2000) level philosophy course.

**PHILOS 4340 Social Ethics** (LEC 3.0)

This Communication Emphasized course discusses ethical issues confronting society and the arguments offered for alternative laws and public policies. Topics might include: freedom of speech/action, government regulation, welfare, capital punishment, euthanasia, abortion, the environment, affirmative action, just wars, foreign aid, world hunger. Prerequisite: Any philosophy course.

**PHILOS 4345 Philosophy Of Science** (LEC 3.0)

An examination of the fundamental methods and assumptions of the sciences, with emphasis on scientific reasoning and theories. Prerequisite: Any philosophy course.

**PHILOS 4350 Environmental Ethics** (LEC 3.0)

This Communication Emphasized course studies complex moral issues concerning our relationship to the environment and the ethical foundations of our environmental responsibilities. Discussion topics include: conservation, preservation, resource development, pollution, toxic substances, future generations, endangered species, regulation, zoning, and takings. Prerequisite: Any philosophy course.

**PHILOS 4354 Mathematical Logic I** (LEC 3.0)

A mathematical introduction to logic with some applications. Functional and relational languages, satisfaction, soundness and completeness theorems, compactness theorems. Examples from Mathematics, Philosophy, Computer Science, and/or Computer Engineering. Prerequisite: Philos 3254 or Math 5105 or Comp Sci 2500 or Comp Eng 2210. (Co-listed with Comp Eng 5803, Comp Sci 5203 and Math 5154).

**PHILOS 4360 Foundations Of Political Conflict** (LEC 3.0)

This course is designed as a survey of the philosophical foundation of major political systems. For example, communism, fascism, democracy. Materials will be drawn from relevant historical and/or contemporary sources. Prerequisite: Any philosophy course.

**PHILOS 4368 Law and Ethics in E-Commerce** (LEC 3.0)

Provides the ethical framework to analyze the ethical, legal, and social issues that arise for citizens and computer professionals regarding the computerization of society. Topics include: free speech, privacy, intellectual property, product liability, and professional responsibility. (Co-listed with IS&T 5168).

**PHILOS 4399 Topics in Philosophy** (LEC 3.0)

This communication intensive course is designed for students with a special interest in philosophy. The content of the course may vary and the course may be repeated for additional credit. Prerequisite: Any Philosophy course.

**PHILOS 5000 Special Problems** (IND 1.0-3.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PHILOS 5001 Special Topics** (IND 1.0-3.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

## Physical Education (PHYS ED)

**PHYS ED 1001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYS ED 1100 Weight Training** (LAB 1.0)

Course instruction emphasizes the cognitive aspects of weight lifting, covering such topics as motivation, common injuries, procedures for warm-up and cool down, and safety procedures.

**PHYS ED 1102 Fundamentals Of Golf** (LAB 1.0)

To give the student the theory and practical application of the golf swing while at the same time developing increasing skills, and an interest in the history, rules, and etiquette of the game of golf.

**PHYS ED 1103 Fundamentals Of Tennis** (LAB 1.0)

Lectures, demonstration, and supervised practice are designed to acquaint the student participants with theory and execution which govern the playing of sound and effective tennis.

**PHYS ED 1104 Beginning Aquatics** (LAB 1.0)

The course will provide the student with basic swimming, diving, and elementary life saving skills to prepare the student for additional work in the field of aquatics.

**PHYS ED 1105 Aerobics** (LAB 1.0)

The course intent is to improve the physical condition of the student through various mediums of exercise aimed at demanding more oxygen over an extended period of time to increase the efficiency of the cardiovascular system and improve muscle tone.

**PHYS ED 1108 Beginning Racquetball** (LAB 1.0)

Course instruction familiarizes the student with the rules, playing strategy, and court etiquette of racquetball. Actual playing experience allows the opportunity for skill development in this leisure activity.

**PHYS ED 1109 Basketball/Volleyball** (LAB 1.0)

The Basketball/Volleyball course will contribute to the mastery of fundamental skills in two of the world's leading participation sports. History, rules and strategy will be emphasized.

**PHYS ED 1110 Special Problems** (IND 0.0-6.0)

Problems of readings on specific subjects or projects in the department. Consent of instructor required.

**PHYS ED 1111 Swimming Fitness** (LAB 1.0)

The Swimming Fitness course will provide an environment which will be conducive for the student to improve physical skills and conditioning through training in the water. Benefits of exercise, training principles and safety precautions will be emphasized.

**PHYS ED 1120 Fundamentals And Theory Of Coaching Basketball** (LEC 2.0)

To make the student aware of skills, fundamentals, court situations, strategy, and administrative procedures for successful basketball coaching.

**PHYS ED 1130 Fundamentals And Theory Of Coaching Football** (LEC 2.0)

To present materials that will provide the student with a working knowledge of coaching, administration, and appreciation of football.

**PHYS ED 1500 Administration Of Interscholastic Athletics** (LEC 3.0)

To present materials that will provide the student with a working knowledge of the major administration and day to day problems that are associated with interscholastic athletics.

**PHYS ED 1510 Care And Prevention Of Athletic Injuries** (LEC 3.0)

Technique, principles, and theory underlying the prevention and care of athletic injuries.

**PHYS ED 1520 Elements Of Health Education** (LEC 2.0)

This course surveys various health topics and attempts to provide some answers related to them. Presents pertinent scientific and medical facts of current health concepts and their relation to the principles and theories of health education.

**PHYS ED 1530 Fundamentals And Theory Of Sports Officiating** (LEC 2.0)

To prepare students with knowledge and skills so that they may both officiate competently and adequately critique officiating by others.

**PHYS ED 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PHYS ED 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYS ED 2300 Methods In Physical Education K-4** (LEC 3.0)

The course will provide the opportunity to learn how to promote student fitness and skill development while building the foundation for a physically active life through specific activities aimed at the younger child. (Co-listed with Educ 2230).

**PHYS ED 2310 Methods In Physical Education 5-9** (LEC 3.0)

The course will provide the opportunity to learn how to promote student fitness and skill development while building the foundation for a physically active life through specific activities aimed at the student in transition from childhood to young adulthood (5-9). (Co-listed with Educ 2231).

## Physics (PHYSICS)

**PHYSICS 1001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYSICS 1101 Introduction To Physics** (LEC 1.0)

An introduction to the study of physics and its intellectual and professional opportunities. The student will be acquainted with the various areas of physics and with departmental and campus facilities useful to their future studies. Required of all freshman majors.

**PHYSICS 1111 General Physics I** (LEC 4.0)

An introduction to the fundamental ideas of physics, including mechanics, heat, and sound. Prerequisite: Preceded by Math 1208 or Math 1214.

**PHYSICS 1119 General Physics Laboratory** (LAB 1.0)

Experiments related to topics studied in Physics 1111 and Physics 1145. Prerequisites: Preceded or accompanied by either Physics 1111 or Physics 1145.

**PHYSICS 1135 Engineering Physics I** (RSD 1.5 and LEC 1.5 and LAB 1.0)

An introduction to mechanics, with an emphasis on topics needed by engineering students, including kinematics, dynamics, statics, and energetics. Prerequisite: Math 1208 or 1214.

**PHYSICS 1145 College Physics I** (LEC 3.0)

An introduction to the ideas of physics, including mechanics, heat, and sound. Prerequisites: Math 1160 and either of Math 1120 or Math 1140.

**PHYSICS 1505 Introductory Astronomy** (LEC 3.0)

An introductory course in basic astronomy designed primarily for students other than those in science and engineering. Topics include history, the sky, the solar system, stars, stellar evolution, galaxies and the origin and evolution of the universe. Credit will not be given for both Physics 1505 and Physics 1515.

**PHYSICS 1509 Astronomy Laboratory** (LAB 1.0)

A science laboratory course in which the student analyzes and interprets astronomical data and makes observations with a telescope. Prerequisite: Preceded or accompanied by Physics 1505 or 1515.



**PHYSICS 1605 Environmental Physics I** (LEC 3.0)

A course for non-science majors which will consider, without mathematics, the production of energy and the environmental consequences of its use, and the physical problems associated with pollution.

**PHYSICS 1609 Laboratory For Environmental Physics** (LAB 1.0)

A laboratory course to accompany the Environmental Physics lecture course as an option. A set of experiments will be performed related to environmental impacts studied in Environmental Physics 1605. To be taken simultaneously with Environmental Physics 1605. Prerequisite: Corequisite Physics 1605.

**PHYSICS 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYSICS 2111 General Physics II** (LEC 4.0)

An introduction to the fundamental ideas of physics including electricity, magnetism, and light. Prerequisites: Preceded by Physics 1111 or Physics 1135 and preceded or accompanied by Math 1221 or Math 1215.

**PHYSICS 2119 General Physics Laboratory** (LAB 1.0)

Experiments related to topics studied in Physics 2111 and Physics 2145. Prerequisite: Preceded or accompanied by either Physics 2111 or Physics 2145.

**PHYSICS 2129 Intermediate Physics Laboratory** (LAB 2.0 and LEC 1.0)

A laboratory study of the principles of instrumentation used in all modern branches of physics. Analog and digital methods of data gathering are surveyed. Laboratory practice evolves from elementary operations to the design and assembly of a simple instrument.

**PHYSICS 2135 Engineering Physics II** (RSD 1.5 and LEC 1.5 and LAB 1.0)

An introduction to electricity, magnetism, and light, with emphasis on topics needed by engineering students. Prerequisites: Physics 1135 or Physics 1111, Math 1221 or Math 1215.

**PHYSICS 2145 College Physics II** (LEC 3.0)

An introduction to the ideas of physics, including electricity, magnetism, and light. Prerequisites: Math 1160, Physics 1145.

**PHYSICS 2305 Introduction To Modern Physics** (LEC 3.0)

An elementary survey of the modern concepts in physics and their applications; relativity, quantum mechanics, atomic physics, solid state physics, nuclear and particle physics. Prerequisites: Math 2222 and Physics 2135 or 2111.

**PHYSICS 2311 Modern Physics I** (LEC 3.0)

An introduction to quantum mechanics, atomic physics, and solid state physics. Topics include historically important experiments and interpretations. Prerequisites: Physics 2135 or 2111, preceded or accompanied by Math 3304 or 3329.

**PHYSICS 2401 Introduction To Theoretical Physics** (LEC 3.0)

Fundamental physical concepts are elaborated in mathematical terms emphasizing the coherence and economy of Physics. Topics include elementary vector analysis, introduction to physical mechanics (motion of a point mass, conservation laws, relativity), Fourier series, and introduction to partial differential equations. Prerequisites: Math 3304 co-requisite; Physics 2135 or 2111.

**PHYSICS 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PHYSICS 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYSICS 3119 Advanced Physics Laboratory I** (LAB 3.0)

A laboratory study of the principles of basic experiments in all major branches of physics. The experiments stress design of apparatus, and procedures and analysis in projects involving electronic, optical, mechanical, and vacuum techniques. Prerequisite: Physics 2129.

**PHYSICS 3129 Advanced Physics Laboratory II** (LAB 3.0)

A senior laboratory involving experimental design. The student must specify his objectives, assemble apparatus, take measurements, analyze the results, form conclusions, write a report, and deliver an oral presentation of the results. Prerequisite: Physics 2129.

**PHYSICS 3201 Physical Mechanics** (LEC 3.0)

This course covers topics of rigid body motion in three dimensions, moving coordinate frames, two body collisions, conservation laws, small oscillations, generalized coordinates, and LaGrange's and Hamilton's equations. Prerequisite: Physics 2401.

**PHYSICS 3211 Electricity And Magnetism I** (LEC 3.0)

A study of electric and magnetic fields, leading to Maxwell's equations. Topics covered include the electrostatic field, the electric potential, and the electrostatic field in matter. Prerequisite: Physics 2401.

**PHYSICS 3311 Modern Physics II** (LEC 3.0)

A continuation of Physics 2311. An introduction to nuclear and particle physics. Topics include nuclear models, decays, and reactions, and elementary particles and fundamental forces. Prerequisites: Math 3304 or 3329, and either Physics 2305 with consent of instructor or Physics 2311.

**PHYSICS 4001 Special Topics** (LEC 3.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYSICS 4099 Undergraduate Research** (IND 0.0-6.0)

This course is designed for the undergraduate student who wishes to engage in research. It is not to be used for graduate credit nor for more than six credit hours of undergraduate credit. The subject and credit are to be arranged with the instructor.

**PHYSICS 4203 Introduction To General Relativity** (LEC 3.0)

An introduction to the theory of general relativity. Topics covered include the formalism of general relativity, Einstein's gravitational field equations, the Schwarzschild solution, black holes, and cosmological models of the universe. Prerequisite: Physics 2401.

**PHYSICS 4211 Electricity And Magnetism II** (LEC 3.0)

A continuation of Physics 3211. Topics covered include the magnetostatic field, the magnetic vector potential, the magnetostatic field in matter, electrodynamics, and electromagnetic waves. Prerequisite: Physics 3211.

**PHYSICS 4301 Introduction To Quantum Mechanics** (LEC 3.0)

The fundamental concepts, postulates and methods of quantum mechanics and their applications to physical systems. Topics include solutions of the Schrodinger equation for simple systems and operator methods. Prerequisites: Physics 2305 or 2311, 2401.

**PHYSICS 4311 Thermal Physics** (LEC 3.0)

A study of the equilibrium states of matter as governed by the first and second laws of thermodynamics. Emphasis is placed on the microscopic approach with an introduction to statistical mechanics. Topics include the kinetic theory of (uniform) gases, phase equilibria in pure systems, and an introduction to quantum statistics. Prerequisite: Physics 2305 or 2311.

**PHYSICS 4323 Elementary Solid State Physics** (LEC 3.0)

An introductory study of the structure and physical Properties of crystalline solids. Included are topics in crystal structure, x-ray diffraction, crystal binding, thermal properties of solids, free electron theory and elementary energy band theory. Prerequisites: Math 3304 and Physics 2305 or 2311.

**PHYSICS 4503 Classical Optics** (LEC 3.0)

Physical optics and advanced topics in geometrical optics. Topics include ray propagation, electromagnetic propagation, mirrors, lenses, interference, diffraction, polarization, imaging systems, and guided waves. Prerequisites: Math 2222 and Physics 2135 or 2111. (Co-listed with Elec Eng 5200).

**PHYSICS 4513 Laser Physics** (LEC 3.0)

The generation of coherent radiation by lasers and the interaction of laser radiation with matter. Topics include stimulated emission, population inversion, optical cavities, optical gain, properties of laser media and other applications. Prerequisite: Physics 2305 or 2311.

**PHYSICS 4523 Principles Of Engineering Materials** (LEC 3.0)

Examination of engineering materials with emphasis on selection and application of materials in industry. Particular attention is given to properties and applications of materials in extreme temperature and chemical environments. A discipline specific design project is required. (Not a technical elective for undergraduate metallurgy or ceramic majors) (Co-listed with Aero Eng 3877, Chem Eng 5300, Met Eng 5810, Cer Eng 5810).

**PHYSICS 4533 Transport in Nanostructures: An Introduction** (LEC 3.0)

The course overviews how wave interference, energy quantization and tunneling phenomena influence the wave (electron and light) transport in modern nanostructured materials and devices such as quantum dots, quantum wells, quantum wires, and photonic crystals. Prerequisite: Physics 2305 or 2311.

**PHYSICS 4543 Plasma Physics I** (LEC 3.0)

Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices. Introduction to plasma kinetic theory. Prerequisite: Aero Eng 3131 or Mech Eng 3131 or Physics 3211 or Nuc Eng 3221 or Elec Eng 3600. (Co-listed with Aero Eng 5570, Mech Eng 5570, Nuc Eng 4370).

**PHYSICS 4553 Astrophysics** (LEC 3.0)

The structure, physical characteristics and evolution of stars, binary systems, nebulae and galaxies. Prerequisite: Physics 2305.

**PHYSICS 4563 Astrophysical Concepts** (LEC 3.0)

A comprehensive course in modern astrophysics. Topics include: Earth and sky, planetary science, stellar structure and evolution, galaxies, and structure and evolution of the universe. The course includes hands-on computer simulation and telescope use. (For secondary teachers or Master of Science for Teachers candidates.) Prerequisite: Math 2222 or admission to the MST program.

**PHYSICS 4605 Physics For Elementary School Teachers** (LEC 2.0 and LAB 1.0)

A nonmathematical review of the fundamental ideas of physics, including mechanics, matter, energy, sound, electricity, magnetism, astronomy, and light. Emphasis is placed on the development of hands-on activities. (For elementary school teachers or Master of Science for Teachers candidates only.).

**PHYSICS 4615 Physics For Secondary School Teachers** (LEC 3.0)

A review of the fundamental ideas of physics, including mechanics, matter, energy, sound, electricity, magnetism, and light with an emphasis on how mathematics can be used to help understand the underlying concepts. (For secondary teachers or Masters of Science Teachers candidates only.) Prerequisites: Math 2222 and admission to the MST program.

**PHYSICS 4625 Science Education and Quantitative Literacy for Middle School Teachers** (LEC 3.0)

An integrated science-mathematics course for middle school teachers. Course covers selected science/mathematics topics/skills specified in Missouri standards for grades 5-7. Inquiry based methods of teaching these topics in an integrated manner will be emphasized. Prerequisite: Current enrollment in a Teacher Education Program or a full or part-time teacher in a K-12 school. (Co-listed with Stat 5904).

**PHYSICS 4635 Physics, Energy, and the Environment** (LEC 3.0)

Applications of physics to the environment, including energy, its conservation and transformation, environmental consequences of energy use; world energy resources; atmospheric physics; sources of air, water, and land pollution, and the role physics plays in controlling those resources. May not be used as a 3000- or 4000-level elective for a B.S. in Physics. Prerequisite: Admissions to the Master of Science for Teachers program.

**PHYSICS 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PHYSICS 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYSICS 5201 Classical Mechanics I** (LEC 3.0)

Methods of Newton, Lagrange, and Hamilton applied to the motion of particles and rigid bodies. Introduction to canonical transformations and Poisson brackets. Classical scattering and small oscillations. Prerequisites: Math 3304, Physics 3201.

**PHYSICS 5211 Electrodynamics I** (LEC 3.0)

A rigorous development of the fundamentals of electromagnetic fields and waves. Electrostatics, magnetostatics, Maxwell's equations--Green's function, boundary value problems, multipoles, conservation laws. Prerequisites: Physics 4211.

**PHYSICS 5301 Quantum Mechanics I** (LEC 3.0)

Basic formalism applied to selected problems. Schroedinger equation and one dimensional problems, Dirac notation, matrix mechanics, harmonic oscillator, angular momentum, hydrogen atom, variational methods, introduction to spin. Prerequisite: Physics 4301 or equivalent.

**PHYSICS 5333 Subatomic Physics** (LEC 3.0)

An introduction to elementary particles. Topics include particle properties, nuclear forces, particle interactions, the Standard Model for quarks and leptons, fundamental forces in gauge field theory models, and the role of elementary particle interactions in cosmology. Prerequisite: Physics 3311.

**PHYSICS 5403 Computational Physics** (LEC 3.0 and LAB 1.0)

An introduction to modern computer simulations for solving physics problems. The course will be project-oriented with examples including planetary motion, chaotic dynamics, quantum scattering, structure of atoms and clusters, molecular dynamics, and Monte-Carlo simulations. Prerequisites: Physics 2305 or Physics 2311; Math 3304; programming experience.

**PHYSICS 5413 Chaos, Fractals, and Nonlinear Dynamics** (LEC 3.0)

An introduction into nonlinear dynamics, deterministic chaos, and fractals. Topics covered include phase plane analysis, iterated maps, routes to chaos, Lyapunov exponents, strange attractors and pattern formation with applications to chaotic vibrations, population dynamics, chemical oscillations and lasers. Prerequisites: Math 3304; Physics 2135 or Physics 2111.

**PHYSICS 5503 Fourier Optics** (LEC 3.0)

Applications of Fourier analysis and linear system theory to optics. Topics include scalar diffraction theory, Fourier transforming properties of lenses, optical information processing, and imaging systems. Prerequisites: Both ELEC ENG 3400 and 3600 or both PHYSICS 2401 and 4211. (Co-listed with ELEC ENG 5210).

**PHYSICS 5513 Fiber And Integrated Optics** (LEC 3.0)

Introduction to optical waveguides and their applications to communication and sensing. Topics include dielectric waveguide theory, optical fiber characteristics, integrated optic circuits, coupled-mode theory, optical communication systems, and photonic sensors. Prerequisite: Elec Eng 3600 or Physics 4211. (Co-listed with Elec Eng 5220).

**PHYSICS 5603 Advanced Physics Laboratory Teaching Methods** (LEC 3.0)

Objectives, methods and problems related to teaching of introductory physics, with an emphasis on laboratory instruction, the development of educational laboratory experiments and techniques, student learning styles, student assessment, student work groups, computer-based data acquisition, and communication techniques. Prerequisite: Graduate standing.

## Political Science (POL SCI)

**POL SCI 1100 Introduction to Political Science** (LEC 3.0)

This course will introduce the student to the fundamental concepts and phenomena of political life and to the variety of political organizations characteristic of the modern age.

**POL SCI 1200 American Government** (LEC 3.0)

National, state and local government in the United States with special emphasis on political behavior and the institutions that determine and execute public policy. Topics include basic structure of American government, (i.e., democracy, the Constitution, the branches of government), as well as citizenship, parties, pressure groups and American economic policy. The course views government in its relation to its people, its services and protection.

**POL SCI 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**POL SCI 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable credit.

**POL SCI 2400 Comparative Politics** (LEC 3.0)

A comparative study of states, institutional structures, ideologies, political culture, political parties, interest groups and forms of government. How these social forces are organized to articulate national or parochial interests within the framework of participatory or centralized political systems will be studied. Prerequisite: Pol Sci 1200 or History 1300.

**POL SCI 2500 International Relations** (LEC 3.0)

A general introduction to the theoretical framework, pattern and personalities of international relations with special emphasis upon American foreign policy making. Problems of international economic development, resources, and armaments will also be examined. Prerequisite: Pol Sci 1200 or History 1300 or 1310.

**POL SCI 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**POL SCI 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**POL SCI 3010 Seminar** (IND 0.0-6.0)

Discussion of current topics.

**POL SCI 3210 Constitutional Law: Government Powers and Civil Liberties** (LEC 3.0)

This course will examine constitutional powers of American governmental institutions and leading Supreme Court decisions dealing with civil liberties including speech, religion, equal protection and the rights of the accused. The course will include study of current political issues and problems relating to these foundational civil liberties. Prerequisites: Pol Sci 1200, History 1200, 1300, or 1310.

**POL SCI 3211 American Political Parties** (LEC 3.0)

The origin and development of political parties in the United States, the two-party system, the functions, organizations and operation of parties. Prerequisite: Pol Sci 1200.

**POL SCI 3300 Principles Of Public Policy** (LEC 3.0)

This course presents a study of public policy in the United States. Students analyze the policy process, the resulting policy choices and the impact of the choices on the American people. Prerequisite: Pol Sci 1200.

**POL SCI 3310 Public Policy Analysis** (LEC 3.0)

An advanced study of major U.S. national policies. A wide range of public policies, including education, economics, and health and welfare will be studied. Students will be introduced to the methods of policy analysis. Emphasis will be placed on the use of tools used by policy analysts to determine program effectiveness and impact. Prerequisite: Pol Sci 1200.

**POL SCI 3760 The American Presidency** (LEC 3.0)

Historical development of the presidency; emphasis on the constitutional powers and limits of the office and the political contextual variables which influence presidential behavior. Prerequisite: Pol Sci 1200 or History 1310. (Co-listed with History 3760).

**POL SCI 3761 U.S. Diplomatic History to World War II** (LEC 3.0)

This course is a history of American foreign relations, broadly conceived, from the War for Independence to WWII. Among other things, it deals with the diplomacy of survival, of expansion and of economic and political hegemony. Prerequisites: History 1300, 1310 or Pol Sci 1200. (Co-listed with History 3761).

**POL SCI 3762 American Diplomatic History Since World War II** (LEC 3.0)

American Diplomatic History Since World War II will address the major issues in American foreign policy from WWII to the present. Its primary focus is on the Cold War and the post-Cold War problems the U.S. has faced. Prerequisite: History 1310 or Pol Sci 1200. (Co-listed with History 3762).

**POL SCI 3763 Contemporary Political Thought** (LEC 3.0)

This course will explore the impact of ideas on American politics and history, including the relationship between technological change and public policy; this will be pursued through the study of American political history, social institutions, and intellectual history. Prerequisite: History 1300 or History 1310 or Pol Sci 1200. (Co-listed with History 3763).

**POL SCI 4000 Special Problems And Readings** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**POL SCI 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**POL SCI 4010 Seminar** (RSD 0.0-6.0)

Discussion of current topics Prerequisite: Senior standing.

**POL SCI 4085 Political Science Internship** (IND 0.0-6.0)

Internship will involve students applying critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisite: Pol Sci 1200 or Pol Sci 1100.

**POL SCI 4510 The Politics of the Third World** (LEC 3.0)

This course explores the processes and problems of the developing nations of the world. It examines the internal political processes of third world nations, as well as the position of the third world in international affairs. Prerequisite: Pol Sci 1200 or History 1200 or History 1300 or History 1310.

## Pre-Medicine (PREMED)

**PREMED 1211 Introduction To Health Careers** (LEC 1.0)

This course is for Pre-Medicine students or other interested in careers in the health care industry. Students will be introduced to different career options through invited speakers and independent research. Prerequisite: Admission Requirements.

**PREMED 3010 Communication Workshop for the Pre-Health Student** (RSD 1.0)

This course is for Pre-Medicine students or others interested in careers in the health care industry or graduate studies. Students in this course will learn and develop writing and speaking skills necessary for success in health and science careers. Prerequisite: Junior Standing.

## Psychology (PSYCH)

**PSYCH 1100 Introduction to Psychology** (LEC 1.0)

An introduction to the study of psychology at S&T. Students will learn about personal and professional opportunities associated with the different areas of psychology and become acquainted with the psychology faculty and campus facilities.

**PSYCH 1101 General Psychology** (LEC 3.0)

An introduction to the science of the human mind and behavior. Topics include brain structure and function, human development, learning and memory, motivation, emotion, personality and psychological health, psychological disorders and their treatment, and social cognition and human relationships.

**PSYCH 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PSYCH 2001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PSYCH 2200 Research Methods** (LAB 1.0 and LEC 3.0)

An introduction to the content, models and methodologies of psychological research. This course covers the fundamental components of psychological research including the literature review, correlational and descriptive methods, experimental design, statistical analyses, interpretation, and ethics. Prerequisites: Psych 1101; Stat 1115, Stat 3113, or Stat 3115. Stat 1115 preferred.

**PSYCH 2300 Educational Psychology** (LEC 3.0)

Principles of psychology relevant to the field of education. Course covers theoretical and applied information on such topics as human growth and development, and cognitive and behavioral views of learning and intelligence. The course also covers motivation, creation of learning environments, measurement and evaluation of learning. Prerequisite: Psych 1101. (Co-listed with Educ 2102).

**PSYCH 3000 Special Problems In Psychology** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PSYCH 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PSYCH 3310 Developmental Psychology** (LEC 3.0)

A study of human growth and development across the lifespan. The course emphasizes the interaction of physical, psychological, and social changes and their resulting impact on the developing person at all stages in life. Prerequisite: Psych 1101.

**PSYCH 3311 Psychological & Educational Development Of The Adolescent** (LEC 3.0)

An examination of the biological, social, and cognitive transitions that occur during adolescence. Other topics include the role of families, the role of peers, the adolescent identity, sexuality, the impact of schools, the role of achievement, how adolescents spend their time (work, leisure), the role of the media, and problems encountered by the adolescent. Prerequisite: Psych 1101.

**PSYCH 3400 Theories Of Learning** (LEC 3.0)

An examination of basic learning processes and the behavioral phenomena that arise from them. Topics include non-associative learning, classical conditioning, operant conditioning, and vicarious learning. Prerequisite: Psych 1101.

**PSYCH 4000 Special Problems And Readings In Psychology** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PSYCH 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**PSYCH 4010 Seminar** (RSD 0.0-6.0)

Prerequisite: Senior Standing.

**PSYCH 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Prerequisite: Instructor consent.



**PSYCH 4200 Tests and Measurements** (LEC 3.0)

Theoretical and statistical basis of psychological testing and measurement; test development and validation; examination of standardized tests of intelligence, aptitude, interest, personality, attitudes, and psychopathology; use of test and test batteries for diagnostics and prediction of criteria. Prerequisite: Psych 1101.

**PSYCH 4310 Psychology Of The Exceptional Child** (LEC 3.0)

Study of the psychology of children on both ends of the educational spectrum. The course presents the fundamentals of providing services as well as understanding the abilities and disabilities of children classified as exceptional. Includes coverage of various disabilities, and the implications of dealing with personal, family and classroom issues. Prerequisite: Psych 1101. (Co-listed with Educ 4310).

**PSYCH 4400 Cognitive Psychology** (LEC 3.0)

This course covers basic cognitive processes and their application. Theory and research are presented on attention, perception, memory, problem solving, decision making and language. Prerequisite: Psych 1101.

**PSYCH 4410 Neuroscience** (LEC 3.0)

The neurophysiological bases of behavior and cognition are examined. Topics covered include neuroanatomy, neurotransmission, neuropharmacology, brain systems, learning and memory, emotion, attention and consciousness, and neurologic/psychological disorders. Prerequisite: Psych 1101.

**PSYCH 4411 Sensation and Perception** (LEC 3.0)

An in-depth examination of the human senses, with special emphasis on vision and hearing. Topics include the anatomy and physiology of the eye and ear, neural transduction, the organization and interpretation of sensory signals by the brain, selective attention, and the neural basis of the perception of color, form, space, depth, motion, music, and language. Prerequisite: Psych 1101.

**PSYCH 4500 Personality Theory** (LEC 3.0)

An examination of the ways in which personality traits develop and the sources of differences among people in the traits they exhibit. The emphasis is on major theories of personality development, as well as recent research in the field. Prerequisite: Psych 1101.

**PSYCH 4501 Abnormal Psychology** (LEC 3.0)

An introductory study of various forms of personality and behavioral disorders. Consideration will be given to neurosis, psychosis, mental deficiency and other deviations, with emphasis on etiology and treatment. Prerequisite: Psych 1101.

**PSYCH 4510 Clinical Psychology** (LEC 3.0)

Comprehensive survey of the field of clinical psychology. Course will cover a variety of assessment and treatment procedures relevant to psychology and other professionals who treat human adjustment problems; techniques based on experimental outcome research and psychological testing will be emphasized. Prerequisites: Psych 1101 and Psych 4501.

**PSYCH 4590 Health Psychology** (LEC 3.0)

This course examines Health Psychology. Topics include basic behavioral pharmacology (involving alcohol and other drugs), illusions of invulnerability to risk, stress and coping, and the science of persuading people to protect their health. Students learn how to construct a public service announcement towards a societal problem as part of the course. Prerequisite: Psych 1101.

**PSYCH 4600 Social Psychology** (LEC 3.0)

An exploration of the phenomena involved in human social behavior and the theories that explain them. Topics typically include social thinking, attitudes and attitude change, conformity, persuasion, interpersonal attraction, and more. Prerequisite: Psych 1101.

**PSYCH 4601 Group Dynamics** (LEC 3.0)

A review of the concepts and theories related to group dynamics. Topics include group goals, communication within groups, group structure, norms, leadership, decision making, controversy, conflict resolution, power, diversity issues, and team development. Prerequisite: Psych 1101.

**PSYCH 4602 Organizational Psychology** (LEC 3.0)

Analysis, comprehension, and prediction of human behavior in organizational settings through the scientific study of individual processes, group processes, and organizational structure and function. Prerequisite: Psych 1101.

**PSYCH 4603 Social Influence: Science and Practice** (LEC 3.0)

Principles and procedures that affect the process of social influence, with consideration given to attitudinal, compliance inducing, and perceptual influences. Prerequisite: Psych 1101.

**PSYCH 4610 Psychology of Leadership in Organizations** (LEC 3.0)

Examination of conceptual and empirical research on determinants of effective vs. ineffective leadership. Topics include leadership measurement, traits, skills, leader-member exchange, charismatic and transformational leadership, change management, team leadership, and ethical leadership. Practical guidelines for developing leadership skills are discussed. Prerequisite: Psych 1101.

**PSYCH 4700 Industrial Psychology** (LEC 3.0)

An overview of the field of industrial psychology including topics such as criterion development, job analysis, selection, training, performance assessment, and some human factors concerns. Prerequisite: Psych 1101.

**PSYCH 4710 Human Factors** (LEC 3.0)

An examination of human-machine systems and the characteristics of people that affect system performance. Topics include applied research methods, systems analysis, and the perceptual, cognitive, physical and social strengths and limitations of human beings. The focus is on user-centered design of technology, particularly in manufacturing environments. Prerequisite: Psych 1101. (Co-listed with Eng Mgt 4330).

**PSYCH 4720 Human-Computer Interaction** (LEC 3.0)

Research, theory, and practice from psychology and other social science disciplines have implications for the effective design and use of computers in organizations. This course introduces students to the psychological issues in software engineering, technology in the workplace, and organizational design. Prerequisite: Psych 1101.

**PSYCH 4730 Environmental Psychology** (LEC 3.0)

An examination of the psychological effects of various environmental designs and ways to design environments effectively. Topics include: environmental attitudes, perception, and cognition; environmental influences, crowding, and the application of environmental design principles to living, educational, work, and recreational settings. Prerequisite: Psych 1101.

**PSYCH 4990 Internship** (IND 0.0-6.0)

Internship will involve students applying critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisite: Junior or Senior Psychology major; consent of instructor; must have completed 9 hours in major.

**PSYCH 4992 Cross-Cultural Psychology** (LEC 3.0)

Study of the impact of ethnic and national culture on psychological processes and behaviors. Topics include the effects of individualism and collectivism on patterns of socialization, personality, motivation, emotion and cognition; cultural differences in diagnosis and treatment of mental and physical health; and group and organizational behavior. Prerequisite: Psych 1101.

**PSYCH 4993 Psychology of Gender** (LEC 3.0)

Overview of current research and theory on the psychology of gender. The course explores gender as a psychological and social construct that influences women's and men's lives across a variety of contexts including work, family, relationships, self-perceptions, and health. Considers how gender intersects with other social categories to shape experience. Prerequisite: Psych 1101.

**PSYCH 4994 Psychology in Media** (LEC 3.0)

Examples drawn from the media (e.g., television, movies, newspapers) will be used as the basis for discussing a wide variety of psychological phenomena, principles, and theories, and their applicability to everyday life. Prerequisite: Psych 1101.

**PSYCH 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**PSYCH 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new graduate level course. Variable title.

**PSYCH 5010 Introduction to Industrial / Organizational Psychology** (LEC 3.0)

Review of the most recent theoretical and applied research in advanced personnel and organizational psychology. Topics will include personnel selection, training and performance appraisal, job attitudes, motivation, work groups and teams, leadership, organizational culture, and organizational development. Prerequisite: Graduate standing.

**PSYCH 5012 Ethics and Professional Responsibilities** (LEC 1.0)

Case studies examining the ethical practice of psychology in organizations will be discussed. This will include covering both the legal and ethical standards surrounding the consulting and practice of I-O psychology and personnel management in organizations. Prerequisite: Graduate standing.

**PSYCH 5200 Theories and Practice of Psychological Measurement** (LEC 3.0)

An overview of psychological tests and batteries used in a variety of disciplines. An emphasis is placed on the proper development and use of these tests and test batteries. Tests examined will include tests of intelligence, aptitude, personality, and psychopathology. Prerequisite: Psych 4200 or graduate standing.

**PSYCH 5201 Psychometrics** (LEC 3.0)

An examination of statistical methods used to develop and refine measures of human performance, aptitudes, and personality. Topics include reliability and validity, data reduction, measuring inter-relationships among variables (e.g., factor analysis, multiple regression), and testing group differences. Prerequisite: Psych 5202.

**PSYCH 5202 Applied Psychological Data Analysis** (LEC 3.0)

This course will focus on those statistical methods most useful for advanced research in psychology. We will learn to use R, a powerful, open-source statistical programming platform, and work through examples with psychological data sets including such techniques as correlation, ANOVAs, regression, and chi-squared. Prerequisite: Graduate standing.

**PSYCH 5210 Advanced Research Methods** (LEC 3.0)

Research methods and techniques, with an emphasis on conducting psychological research in organizational settings. Topics discussed include: ethics, reliability and validity in measurement and application, proper uses of experimental, quasi-experimental, and survey methodologies, as well as advanced methodologies IRT, SEM, HLM, and Meta-Analyses. Prerequisite: Graduate standing.

**PSYCH 5600 Advanced Social Psychology** (LEC 3.0)

An advanced study of the behavior of individuals in interaction within groups. Consideration will also be given to the experimental literature dealing with the formal properties of groups, conformity and deviation, intergroup relations, and attitude formation and attitude change. Prerequisite: Psych 4600.

**PSYCH 5601 Small Group Dynamics** (LEC 3.0)

This course covers group perception, identification, leadership, structure, conflict, cohesion, commitment, performance, norms, roles, influence, and decisions, and groups; relations, networks, and work teams. Students consider both theory and applications to their lives and organizations through observational, research, team and applied assignments. Prerequisite: Psych 4601 or graduate standing.

**PSYCH 5602 Organizational Development** (LEC 3.0)

Examination of the field of organizational development theories and interventions. An emphasis is placed on research methods and application of practices related to individual processes, group processes, and organizational structures and functions that impact change and development strategies and interventions. Prerequisite: Psych 4602 or graduate standing.

**PSYCH 5603 Advanced Social Influence** (LEC 3.0)

An in-depth review of the principles and procedures that affect the process of social influence, with consideration given to attitudinal, compliance inducing, and perceptual influences. Students will consider the theoretical implications and practical applications of topics in social influence in the form of independent reading, research proposals and/or projects, and observational assignments. Prerequisite: Psych 4603 or graduate standing.

**PSYCH 5700 Job Analysis and Performance Management** (LEC 3.0)

A focus on the scientific measurement of job performance. An in-depth discussion of the science and methods of appropriate job and task analysis will be discussed. Additionally, students will focus on current issues in performance management and appraisal including scientific findings related to both objective and subjective measures of performance. Prerequisite: Psych 4700 or graduate standing.

**PSYCH 5710 Advanced Human Factors** (LEC 3.0)

An in-depth review of the foundations of human factors, focusing on the interaction of people with various forms of technology in a variety of environments. Topics include research and evaluation methods, displays (e.g., visual, auditory), attention and information processing, decision making, motor skills, anthropometry, and biomechanics. (Co-listed with ENG MGT 5330).

**PSYCH 5720 Advanced Human-Computer Interaction** (LEC 3.0)

This course examines the psychological research and theories that contribute to the field of human-computer interaction. An emphasis will be placed on engaging in critical evaluation of research and applying theoretical knowledge to effectively use computers in organizations. Prerequisite: Psych 4720 or graduate standing.

**PSYCH 5730 Environmental Psychology: Research and Practice** (LEC 3.0)

An in-depth review of the theoretical perspectives in environmental psychology and the psychological effects of various environments. An emphasis is placed on the review and integration of the research to explain the psychological issues related to various environments as well as to understand ways to effectively design living, educational, work, and recreational environments. Prerequisite: Psych 4730 or graduate standing.

## Russian (RUSSIAN)

**RUSSIAN 1101 Elementary Russian I** (LEC 4.0)

Introduction to reading, conversation, and grammar. Prerequisite: Entrance requirements.

**RUSSIAN 1102 Elementary Russian II** (LEC 4.0)

Continuation of Russian 1101. Prerequisite: Russian 1101.

**RUSSIAN 1180 Readings In Science And Literature** (LEC 4.0)

Readings in scientific writings and literature for improving comprehension of Russian publications. Prerequisite: Russian 1102.

**RUSSIAN 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**RUSSIAN 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**RUSSIAN 2110 Basic Russian Conversation** (LEC 2.0)

Russian conversation and oral practice. Prerequisite: Russian 1102.

**RUSSIAN 2170 Masterpieces Of Russian Literature** (LEC 3.0)

Selected major works of Russian literature. Prerequisite: Russian 1180.

**RUSSIAN 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**RUSSIAN 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**RUSSIAN 3790 Scientific Russian** (LEC 3.0)

The course focuses on acquisition of Russian scientific vocabulary for STEM disciplines and development of practical skills in translating, discussing, and interpreting intermediate Russian scientific texts. Prerequisite: Russian 1180 or above.

**RUSSIAN 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**RUSSIAN 4001 Special Topics** (LAB 1.0 and LEC 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**RUSSIAN 4010 Seminar** (IND 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

**RUSSIAN 4320 Russian Phonetics and Intonation** (LEC 3.0)

This course focuses on pronunciation improvement, development of basic transcription skills, comprehension of Russian speech at fast tempo, interactions of intonation and syntax. Prerequisite: Russian 1102.

**RUSSIAN 4330 Business Russian** (LEC 3.0)

The course addresses practical language skills and strategies for conducting business in Russian-speaking countries. Students will improve their knowledge of contemporary Russian culture and business etiquette. Readings, lectures, and discussions are in Russian. Prerequisite: Russian 1180.

**RUSSIAN 4360 Russian Civilization** (LEC 3.0)

Introduction to Russian civilization and culture from the 9th to the 19th century exploring the interrelation between Russian society, its history and its cultural expression in painting, literature, music, visual arts and architecture over the past thousand years. Prerequisite: Any 1000 or higher level history course.

**RUSSIAN 4370 Survey Of Russian Literature I (Early Period)** (LEC 3.0)

A study of the history and development of 16th, 17th, 18th, and 19th century Russian literature. Prerequisite: Russian 2170.

**RUSSIAN 4375 Survey Of Russian Literature II (Modern Period)** (LEC 3.0)

20th Century Russian Literature. Prerequisite: Russian 2170.

**RUSSIAN 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**RUSSIAN 5790 Advanced Scientific Russian** (LEC 3.0)

The course focuses on acquisition of advanced Russian scientific vocabulary for STEM disciplines and development of practical skills in translating, discussion, and interpreting advanced Russian scientific texts. The final research project is required. Prerequisite: Russian 1180 or above.

## Spanish (SPANISH)

**SPANISH 1101 Elementary Spanish I** (LEC 4.0)

Introduction to Spanish. Oral drills, readings, grammar and composition. No previous knowledge of Spanish or no more than two years of Spanish in High School Prerequisites: Entrance requirements.

**SPANISH 1102 Elementary Spanish II** (LEC 4.0)

Continuation of Spanish 1101. Prerequisite: Spanish 1101.

**SPANISH 1180 Readings And Composition** (LEC 4.0)

Intermediate readings in Spanish. Prerequisite: Spanish 1102.

**SPANISH 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SPANISH 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**SPANISH 2110 Basic Spanish Conversation** (LEC 2.0)

Spanish conversation and oral practice. Prerequisites: SPANISH 1180.

**SPANISH 2160 Hispanic Culture** (LEC 3.0)

An interdisciplinary course that examines the culture of the Hispanic world (with an emphasis on Latin America). The presentation is in Spanish, and social science concepts and methods are stressed. Topics include: bilingualism, multiculturalism, economic development, and political stability. Prerequisite: Spanish 1180.

**SPANISH 2170 Masterpieces Of Hispanic Literature** (LEC 3.0)

A study of the major works in Spanish and Spanish American literature. Prerequisite: Spanish 1180.

**SPANISH 2180 Intermediate Spanish Composition** (LEC 3.0)

Practice in writing Spanish: compositions and written translations. Prerequisite: Spanish 1180.

**SPANISH 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SPANISH 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**SPANISH 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SPANISH 4001 Special Topics** (LAB 1.0 and LEC 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**SPANISH 4010 Seminar** (IND 1.0-3.0)

Discussion of current topics.

**SPANISH 4302 Phonetics and Phonology of Spanish** (LEC 3.0)

Theoretical and practical approach to the phonetics and phonology of Spanish from the dual perspective of the mental representation of the sound system and pronunciation within syllables, words and phrases. Practice in listening comprehension, and sound discrimination with transcription exercises. Prerequisites: Any Spanish course at the 2000 or 3000 level.

**SPANISH 4311 Advanced Spanish Conversation** (LEC 2.0)

Advanced Spanish conversation and oral practice. Prerequisites: Any Spanish course at the 2000 or 3000 level.

**SPANISH 4370 Survey Of Spanish Literature** (LEC 3.0)

Survey of Spanish literature from Medieval to Modern Times, including the Renaissance, Siglo De Oro, Enlightenment, Romanticism, and the 20th century.. Prerequisite: Spanish 2170 or native ability.

**SPANISH 4377 Spanish-American Novel And Short Story** (LEC 3.0)

A study of the development of narrative prose in Spanish America. Prerequisite: Spanish 2170.

## Speech & Media Studies (SP&M S)

**SP&M S 1185 Principles Of Speech** (LEC 3.0)

A study of the arts of expression, oral communication, and listening (theory and practice); effective interaction of speech, speaker, listener, and occasion. Prerequisite: Entrance requirements.

**SP&M S 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SP&M S 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**SP&M S 2181 Communication Theory** (LEC 3.0)

Deals with the concerns addressed by communication theory: language, cybernetics, visual arts, general semantics, information theory, and electronic communications. The university's fairly extensive media and communications resources are made use of, both for their content and for a study of the impact of their forms upon the transfer of information.

**SP&M S 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SP&M S 3001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**SP&M S 3010 Seminar** (IND 0.0-6.0)

Discussion of current topics.

**SP&M S 3221 Fundamentals in Photography** (LEC 3.0)

In this course the student will learn the basics of photographic composition and the use of the digital camera. A brief history of photography will provide context for the student's own development. Prerequisite: Sp&M S 1185 or 2181 (required for Speech minor credit); Art 1180 or Art 1185 (required for Art minor credit). (Co-listed with Art 3221).

**SP&M S 3235 Intercultural Communication** (LEC 3.0)

Examines the range of human differences as variables in the communication process; emphasis on broadening individual perspectives regarding the range of human experience. Particularly useful for students who will work and live in environments unlike those previously encountered. Prerequisite: Sp&M S 2181.

**SP&M S 3245 Voice, Diction and Interpretation** (LEC 3.0)

Training the speaking voice; study of vocal mechanism, breathing, projection, articulation, enunciation; practical application of speaking principles in oral interpretation reading; mastering clarity and variation of speech through vocal exercises. Students will attend one on-campus play to review the speech of one of the actors (Co-listed with Theatre 3245).

**SP&M S 3250 Interpersonal Communication** (LEC 3.0)

Explores the theoretical and practical dimensions of human communication in significant one-on-one relationships. Emphasis on theoretical approaches to identify and achieve particular outcomes desired in professional and personal interactions. Prerequisite: Sp&M S 2181.

**SP&M S 3255 Discussion And Conference Methods** (LEC 3.0)

Explores the theoretical and practical dimensions of human communication in task-oriented small groups with emphasis on producing desired outcomes. Particularly useful for students who wish to improve their ability to work in small group environments. Prerequisite: Sp&M S 2181.

**SP&M S 3265 Leadership Communication** (LEC 3.0)

This course explores various approaches to leadership with emphasis on the communication theories and behaviors associated with leadership in modern corporate and public contexts. Prerequisites: Sp&M S 2181, 3250.

**SP&M S 3270 Leadership Practices** (LEC 3.0)

This course provides opportunities for students to do qualitative and quantitative research in leadership, small group, and organizational communication. Prerequisites: SP&M S 5265.

**SP&M S 3275 Foundations of Media Communication** (LEC 3.0)

The course explores the historical, social, and psychological impact of media through study and practice of academic and non-academic theories of effective media communication. The course supplies an integrated critical framework for application in student's day-to-day consumption of media. Prerequisite: Sp&M S 1185. (Co-listed with Art 3275).

**SP&M S 3283 Business And Professional Communication** (LEC 3.0)

Examines culture and communication in the workplace from theoretical and practical perspectives. Topics include: group communication, interviewing, networking, planning and presenting material to technical and general audiences interpersonal communication and leadership in the workplace context. Prerequisites: Sp&M S 1999, 2181 or permission of instructor.

**SP&M S 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.



**SP&M S 4001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**SP&M S 4010 Seminar** (IND 0.0-6.0)

Discussion of current topics. Prerequisite: Senior standing.

**SP&M S 4099 Undergraduate Research** (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Prerequisite: Consent of instructor.

**SP&M S 5000 Special Problems** (IND 0.0-6.0)

Graduate level problems or readings on specific subjects of projects in the department. Consent of instructor required.

**SP&M S 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course with senior/graduate level emphasis. Variable title.

**SP&M S 5010 Seminar** (IND 0.0-6.0)

Advanced discussion of current topics.

## Statistics (STAT)

**STAT 1001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**STAT 1111 Business And Economic Statistics I** (LEC 3.0)

This is an introductory course in business and economic statistics. Our main objective is to familiarize the student with elementary statistical concepts within the context of numerous applications in Business and Economics. We will highlight the primary use of statistics, that is, to glean information from an available sample regarding the underlying population. Prerequisite: Math 1120 or Math 1140 with a grade of "C" or better. (Co-listed with Econ 1300).

**STAT 1115 Statistics For The Social Sciences I** (LEC 3.0)

A survey course in statistics for the social and behavioral sciences. Main emphasis is on inductive rather than traditional descriptive statistics. Attention given to the design of experiments, sampling procedures, basic probability distributions, tests of significance, linear regression and correlation, and analysis of variance. Not advised for engineering or science curricula.

**STAT 1116 Statistics For The Social Sciences II** (LEC 3.0)

A course on statistical methodology for the social and behavioral sciences. Regression, analysis of variance, forecasting, and use of statistical computer packages. Prerequisite: Stat 1115 with a grade of "C" or better.

**STAT 2001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**STAT 3111 Statistical Tools For Decision Making** (LAB 1.0 and LEC 2.0)

An introduction to statistical techniques commonly used in management decision making. Topics include statistical inference of population parameters, linear regression, basics of experimental design and analysis, analysis of categorical data, and the use of statistical software. Credit will be given for only one of Stat 3111, 3113, 3115 or 3117. Prerequisite: Math 1208 or 1212 or 1214 with a grade of "C" or better.

**STAT 3113 Applied Engineering Statistics** (LEC 3.0)

An introduction to applied statistical methods in engineering dealing with basic probability, estimation, tests of hypotheses, regression, design of experiments and control charts. Statistical computer packages will be used in connection with some of the material studies. Credit will be given for only one of Stat 3111, 3113, 3115 or 3117. Prerequisite: Math 1215 or 1221 with a grade of "C" or better.

**STAT 3115 Engineering Statistics** (LEC 3.0)

An introduction to statistical methods in engineering and the physical sciences dealing with basic probability, distribution theory, confidence intervals, significance tests, and sampling. Credit will be given for only one of Stat 3111, 3113, 3115 or 3117. Prerequisite: Math 1215 or 1221 with a grade of "C" or better.

**STAT 3117 Introduction To Probability And Statistics** (LEC 3.0)

Introduction to probability, distribution theory, statistical inference, with applications to physical and engineering sciences. Probability, probability and joint distributions, functions of random variables, system reliability, point and interval estimation, testing hypotheses, regression analysis. Credit will be given for only one of Stat 3111, 3113, 3115, or 3117. Prerequisite: Math 2222 with a grade of "C" or better.

**STAT 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**STAT 4001 Special Topics** (LEC 3.0 and LAB 1.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**STAT 4099 Undergraduate Research** (IND 0.0-6.0)

This course is designed for the undergraduate student who wishes to engage in research. It is not to be used for graduate credit nor for more than six credit hours of undergraduate credit. The subject and credit are to be arranged with the instructor. Prerequisite: Consent of instructor.

**STAT 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**STAT 5001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**STAT 5099 Graduate Research** (IND 0.0-6.0)

Investigation of an advanced nature leading to the preparation of a MS thesis or dissertation.

**STAT 5120 Statistical Methods** (LEC 3.0)

A continuation of Stat 3115 with emphasis on statistical methods. Topics would include further work on regression analysis, control charts, acceptance sampling, nonparametric statistics, goodness of fit tests, reliability and life-testing, analysis of experimental designs. Prerequisite: Stat 3115.

**STAT 5260 Statistical Data Analysis Using SAS** (LAB 1.0 and LEC 2.0)

This course will introduce the student to selected data analytic tools implemented in the Statistical Analysis System (SAS) and appropriate and effective use of these tools. Focus would be on both the use of SAS data analytic tools and the theoretical and methodological rationale that form the basis of such analyses. Prerequisite: One of Stat 3113 or 3115 or 3117 or 5643; and one of Stat 5346 or 5353 or 6841 or 6343 or 6344 or 6545.

**STAT 5346 Regression Analysis** (LEC 3.0)

Simple linear regression, multiple regression, regression diagnostics, multicollinearity, measures of influence and leverage, model selection techniques, polynomial models, regression with autocorrelated errors, introduction to non-linear regression. Prerequisites: Math 2222 and one of Stat 3111, 3113, 3115, 3117, or 5643. (Co-listed with Comp Sci 5204).

**STAT 5353 Statistical Data Analysis** (LEC 3.0)

Introduction to methods for analyzing statistical data from experiments and Introduction to methods for analyzing statistical data from experiments and surveys. Analysis of variance, correlation, introduction to regression techniques, contingency tables, non-parametric techniques and introduction to modern statistical software. Prerequisites: Math 2222 and one of Stat 1115, 3113, 3115 and 3117.

**STAT 5425 Introduction to Biostatistics** (LEC 3.0 and LAB 1.0)

Introduction to common biostatistical methods for designing research studies, collecting and analyzing data, with application to problems originating from the biological, environmental, and health sciences. Topics include randomization, means comparisons, ANOVA, regression, and analysis of count data. Prerequisites: A grade of "C" or better in Math 1120, Math 1140, Math 1208, Math 1212, or Math 1214.

**STAT 5643 Probability And Statistics** (LEC 3.0)

Introduction to the theory of probability and its applications, sample spaces, random variables, binomial, Poisson, normal distributions, derived distributions, and moment generating functions. Prerequisite: Math 2222.

**STAT 5644 Mathematical Statistics** (LEC 3.0)

A continuation of Stat 5643 with introduction to the theories of point estimation, hypothesis testing, and interval estimation. Includes sufficiency, completeness, likelihood and how they apply to the exponential family. Prerequisite: Stat 5643.

**STAT 5755 Statistical Models in Actuarial Science** (LEC 3.0)

This course covers the statistical foundation of actuarial models and their applications. Topics include survival and severity models, Kaplan-Meier and Nelson-Aalen estimators, aggregate and credibility models for insurance losses, discrete time Markov chains, ruin theory, and simulation. Prerequisite: Stat 5643 and either Stat 5644 or a 3000-level Stat course. (Co-listed with Econ 4350).

**STAT 5756 Statistical Models for Life Contingencies** (LEC 3.0)

The basic statistical theory of actuarial models for life uncertainties such as time of death. Multiple life and multiple decrement models, statistical models for life and contingent insurance; last survivor, disability, withdrawal, retirement and reserving models for life insurance. Prerequisite: Stat 5643.

**STAT 5814 Applied Time Series Analysis** (LEC 3.0)

Introduction to time series modeling of empirical data observed over time. Topics include stationary processes, autocovariance functions, moving average, autoregressive, ARIMA, and GARCH models, spectral analysis, confidence intervals, forecasting, and forecast error. Prerequisites: One of Stat 3113, 3115, 3117, 5643 and one of Math 3103, 3108, or 5108.

**STAT 5904 Science Education and Quantitative Literacy for Middle School Teachers** (LEC 3.0)

An integrated science-mathematics course for middle school teachers. Course covers selected science/mathematics topics/skills specified in Missouri standards for grades 5-7. Inquiry based methods of teaching these topics in an integrated manner will be emphasized. Prerequisite: Current enrollment in a Teacher Education Program or a full or part-time teacher in a K-12 school. (Co-listed with Physics 4625).

**STAT 5905 Making Sense Of Data For Elementary School Teachers** (LEC 3.0)

An activity based course that is intended to provide elementary school teachers with the skills necessary to implement the Probability & Statistics strand of the American Statistical Association of the National Council of Teachers of Mathematics (NCTM) joint. Prerequisite: Graduate Standing.

**STAT 5906 Making Sense Of Data For Middle School Teachers** (LEC 3.0)

An activity based course that is intended to provide middle school teachers with the skills necessary to implement the Probability & Statistics strand of the American Statistical Association of the National Council of Teachers of Mathematics (NCTM) joint.

**STAT 5907 Making Sense Of Data For High School Teachers** (LEC 3.0)

An activity based course that is intended to provide high school teachers with the skills necessary to implement the Probability & Statistics strand of the American Statistical Association of the National Council of Teachers of Mathematics (NCTM) joint.

## Systems Engineering (SYS ENG)

**SYS ENG 5000 Special Problems** (IND 1.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**SYS ENG 5001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**SYS ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examination for on-campus MS/PhD students may be processed during intersession. Off-campus MS students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive exam (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**SYS ENG 5099 Research** (IND 1.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required. Prerequisite: Graduate standing.

**SYS ENG 5101 System Engineering and Analysis** (LEC 3.0)

The concepts of Systems Engineering are introduced through a project. Students work in virtual teams. The topics covered are architecture development, basic system architectural design techniques, functional decomposition, design and technical review objectives, and initial specifications. Prerequisite: Graduate Standing.

**SYS ENG 5211 Computational Intelligence** (LEC 3.0)

Introduction to Computational Intelligence (CI), Biological and Artificial Neuron, Neural Networks, Evolutionary Computing, Swarm Intelligence, Artificial Immune Systems, Fuzzy Systems, and Hybrid Systems. CI application case studies covered include digital systems, control, power systems, forecasting, and time-series predictions. Prerequisite: Graduate Standing. (Co-listed with Elec Eng 5310 and Comp Eng 5310).

**SYS ENG 5212 Introduction to Neural Networks and Applications** (LEC 3.0)

The course provides an introduction to basic neural network architectures and their applications. Students learn to construct neural networks and train them to solve engineering problems, specifically pattern recognition and function approximation. Mathematical analysis of network architectures, training algorithms and practical applications of neural nets. Prerequisites: Graduate Standing. (Co-listed with Elec Eng 5370).

**SYS ENG 5323 Wireless Networks** (LEC 2.0 and LAB 1.0)

Introduction to wireless communications and networking. Topics include transmission fundamentals, wireless channel, coding techniques and error control, satellite and cellular networks, cordless systems, mobile IP and management, multiple access techniques and wireless protocols, wireless LAN, IEEE 802.11, and adhoc and sensor networks. Prerequisites: Hardware competency, Elec Eng 3420 or Comp Eng 3150 and graduate standing. (Co-listed with Comp Eng 5430 and Elec Eng 5430).

## Technical Communication (TCH COM)

**TCH COM 1600 Introduction to Technical Communication** (LEC 3.0)

Introduction to the role of the professional technical communicator in business and industry and practice in methods of developing technical documents. Prerequisite: English 1120. (Co-listed with English 1600).

**TCH COM 2540 Layout and Design** (LEC 3.0)

Theory and practice of layout and design for print and electronic media. Prerequisite: TCH COM 1600 or English 1600. (Co-listed with English 2540).

**TCH COM 2560 Technical Marketing Communication** (LEC 3.0)

An introduction to technical marketing communication with an emphasis on relevant genres such as (but not limited to) the data sheet, white paper, and technical demonstration. Prerequisites: English 1600 or Tch Com 1600 or English 1160. (Co-listed with ENGLISH 2560).

**TCH COM 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**TCH COM 3001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**TCH COM 3010 Seminar** (RSD 0.0-6.0)

Discussion of current topics. Prerequisites: One semester of college composition or technical writing.

**TCH COM 3440 Theory of Visual Technical Communication** (LEC 3.0)

A study of the relationships between visual and conceptual elements of technical communication. Prerequisites: TCH COM 1600 or ENGLISH 1600; TCH COM 2540 or ENGLISH 2540.

**TCH COM 3570 Writing in the Sciences** (LEC 3.0)

This course is designed to teach students how to write effectively in the sciences. Writing assignments include short reports, proposals, and a major project such as a research or analytical report or a procedures/instructions manual. Emphasis is placed on clarity, conciseness, organization, format, style, and tone. Prerequisites: English 1120 or equivalent.

**TCH COM 4085 Internship** (IND 0.0-6.0)

Internship will involve students applying critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisites: Must have completed 24 hours in the major core curriculum.

**TCH COM 4410 Theory and Practice of Technical Communication** (LEC 3.0)

This capstone course enables the student to work on individual and group projects that put into play the theories and practices of technical communication. Students are expected to develop professional portfolios. Prerequisites: Tch Com 1600 or English 1600; Tch Com 2540 or English 2540.

**TCH COM 4450 International Dimensions of Technical Communication** (LEC 3.0)

Examines complexity of communication of technical information worldwide. Includes topics such as graphics, icons, symbols; user interface design; intercultural communication. Students may not earn credit for both TCH COM 4450 and TCH COM 6450. Prerequisites: One semester of college composition or technical writing and undergraduate standing.

**TCH COM 4520 Help Authoring** (LEC 3.0)

Students will acquire the technological and rhetorical skills necessary for creating effective online help systems, including context-sensitive help for computer applications. Prerequisites: One semester of college composition or technical writing, or graduate standing.

**TCH COM 4550 Proposal Writing** (LEC 3.0)

Familiarizes students with many aspects of writing proposals for various purposes in academic, professional, and public spheres. Offers students opportunities to write documents to promote their academic, professional, or personal goals or those of their organization(s). Prerequisite: One semester of college composition or technical writing.

**TCH COM 5000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**TCH COM 5001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**TCH COM 5010 Seminar** (RSD 0.0-6.0)

Discussion of current topics. Prerequisites: One semester of college composition or technical writing, or graduate standing.

**TCH COM 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**TCH COM 5099 Research** (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

**TCH COM 5510 Technical Editing** (LEC 3.0)

The principles and practices of technical editing, including usability, audience analysis, contextual editing, the conventions of scientific and technical communication, and the role of the editor in document development and publication. Students will also learn standard practices of copy editing and the use of style guides. Prerequisites: One semester of college composition or technical writing, or graduate standing.

**TCH COM 5530 Usability Studies** (LEC 3.0)

Students in this course will study and apply methods used by technical communicators to evaluate usability. Students will study methods used to evaluate human interaction with communication tools and how to make those products more suitable for human use. Prerequisites: One semester of college composition or technical writing, or graduate standing.

**TCH COM 5540 Advanced Layout and Design** (LEC 3.0)

Advanced theory and practice of layout and design for print and electronic media. Students who have taken TCH COM 2540 may not take this course for credit. Prerequisite: Graduate standing.

**TCH COM 5550 Advanced Proposal Writing** (LEC 3.0)

Familiarizes graduate students with many aspects of writing proposals for various purposes in academic, professional, and public spheres. Offers opportunities to write documents to promote their academic, professional, or personal goals or those of their organization(s). Credit will not be given for both TCH COM 4550 and TCH COM 5550. Prerequisites: Graduate standing.

**TCH COM 5560 Web-Based Communication** (LEC 3.0)

Covers such topics as advanced writing and editing for the web; the creation of rhetorically effective websites; the use of blogs, wikis, and other web genres to communicate technical information. Prerequisites: One semester of college composition or technical writing, or graduate standing.

**TCH COM 5610 History of Technical Communication** (LEC 3.0)

Introduction to the roles of the technical communicator and the technologies of communication from ancient cultures to the present. Prerequisites: One semester of college composition or technical writing, or graduate standing.

**TCH COM 5620 Research Methods in Technical Communication** (LEC 3.0)

Students learn essential research methods in technical communication, including audience analysis, interviewing techniques, working with subject matter experts, and experimental research design. Prerequisites: One semester of college composition or technical writing, or graduate standing.

## Theatre (THEATRE)

**THEATRE 1142 Stage Productions, Performers** (LAB 1.0)

Performers: The student must request permission from the theatre professor prior to taking this course. A skills course, not a humanities elective. Prerequisite: Participants selected by audition.

**THEATRE 1143 Stage Productions, Technicians** (LAB 1.0)

Technicians and production assistants; participants selected by interview. A skills course, not a humanities elective.

**THEATRE 1190 Theatre via Video** (LEC 3.0)

Provides knowledge and internal understanding of theatre. After watching plays on video through online resources on the student's own time and live productions, students will meet as a class weekly to discuss. Online journaling and field trip required. Approximately \$12 cost for online resources. \$5 for live performances.

**THEATRE 2000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**THEATRE 2001 Special Topics** (LAB 1.0 and LEC 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**THEATRE 2141 Acting I** (LEC 3.0)

Covers basic techniques for comprehension of theory and practice of acting. Explores inner/outer techniques to create a role. Follows working steps to create performance of a fully realized characterization. Designed as an introductory course.

**THEATRE 2143 Stagecraft** (LEC 1.0 and LAB 2.0)

Students will learn the fundamentals of theatrical construction, production, and organization.

**THEATRE 3000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**THEATRE 3001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**THEATRE 3220 Theatre Ensemble** (LAB 1.0)

This course offers the opportunity for a student to develop imagination and performance abilities through improvisation, clowning, readers theatre, exercises, mime; emphasis varies. Members selected by interview/audition. A skills course, not a humanities elective.

**THEATRE 3241 Acting II** (LAB 1.0 and LEC 2.0)

Continuation of Acting I, covering acting styles, more complicated, nuanced roles, and more detailed character analysis and performance—special emphasis on British and Classical performance. Prerequisite: Theatre 2141.

**THEATRE 3243 Entertainment Design** (LAB 2.0 and LEC 1.0)

Students will learn the fundamentals of design for live theatre, film, theme parks, clubs, concerts, and dance events.

**THEATRE 3245 Voice, Diction and Interpretation** (LEC 3.0)

Training the speaking voice; study of vocal mechanism, breathing, projection, articulation, enunciation; practical application of speaking principles in oral interpretation reading; mastering clarity and variation of speech through vocal exercises. (Co-listed with SP&M S 3245).

**THEATRE 4000 Special Problems** (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**THEATRE 4001 Special Topics** (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

**THEATRE 4341 Directing** (LEC 3.0)

This course studies the theories, technique, and approaches of directing for the stage, culminating in the preparation, rehearsal, and presentation of directing scenes. Prerequisite: Theatre 2141.



# INDEX

<b>A</b>		<b>E</b>	
Academic Calendar .....	6	Economics - Undergraduate .....	113
Academic Resources On Campus .....	7	Economics (ECON) - Undergraduate .....	284
Administrators .....	4	Education - Undergraduate .....	118
Admission Requirements - Undergraduate .....	7	Education (EDUC) - Undergraduate .....	286
Aerospace Engineering - Undergraduate .....	47	Educational Goals of Missouri S&T .....	3
Aerospace Engineering (AERO ENG) - Undergraduate .....	252	Electrical Engineering - Undergraduate .....	121
Aerospace Studies - Undergraduate .....	53	Electrical Engineering (ELEC ENG) - Undergraduate .....	288
Aerospace Studies (Air Force ROTC) .....	10	Engineering Management - Undergraduate .....	130
Architectural Engineering - Undergraduate .....	55	Engineering Management (ENG MGT) - Undergraduate .....	293
Architectural Engineering (ARCH ENG) - Undergraduate .....	255	English - Undergraduate .....	137
Art .....	60	English (ENGLISH) - Undergraduate .....	296
Art (ART) - Undergraduate .....	257	Enterprise Resource Planning - Undergraduate .....	141
Arts, Languages & Philosophy .....	62	Enterprise Resource Planning (ERP) - Undergraduate .....	299
<b>B</b>		Environmental Engineering - Undergraduate .....	142
Bioinformatics Minor Curriculum .....	62	Environmental Engineering (ENV ENG) - Undergraduate .....	300
Biological Sciences - Undergraduate .....	62	Etymology - Undergraduate .....	146
Biological Sciences (BIO SCI) - Undergraduate .....	258	Etymology (ETYM) - Undergraduate .....	301
Business and Management Systems - Undergraduate .....	68	Explosives Engineering - Undergraduate .....	146
Business (BUS) - Undergraduate .....	262	Explosives Engineering (EXP ENG) - Undergraduate .....	301
<b>C</b>		<b>F</b>	
Career Opportunities and Employer Relations (COER) - Undergraduate ...	11	Fees - Undergraduate .....	16
Ceramic Engineering - Undergraduate .....	74	Finance - Undergraduate .....	148
Ceramic Engineering (CER ENG) - Undergraduate .....	264	Finance (FINANCE) - Undergraduate .....	302
Chemical & Biochemical Engineering - Undergraduate .....	78	Financial Assistance - Undergraduate .....	18
Chemical Engineering (CHEM ENG) - Undergraduate .....	266	Foreign Languages - Undergraduate .....	149
Chemistry - Undergraduate .....	84	French .....	149
Chemistry (CHEM) - Undergraduate .....	270	French (FRENCH) - Undergraduate .....	302
Civil Engineering - Undergraduate .....	92	Freshman Engineering (FR ENG) .....	303
Civil Engineering (CIV ENG) - Undergraduate .....	273	Freshman Engineering Program .....	150
Computer Engineering - Undergraduate .....	101	<b>G</b>	
Computer Engineering (COMP ENG) - Undergraduate .....	278	General Information .....	7
Computer Science - Undergraduate .....	107	Geological Engineering - Undergraduate .....	150
Computer Science (COMP SCI) - Undergraduate .....	280	Geological Engineering (GEO ENG) - Undergraduate .....	303
Cooperative Education Program (Co-op) .....	12	Geology and Geophysics - Undergraduate .....	157
Counseling, Disability Support, and Student Wellness .....	13	Geology (GEOLOGY) - Undergraduate .....	306
Course Information .....	251	Geophysics (GEOPHYS) - Undergraduate .....	310
Course List .....	252	German - Undergraduate .....	165
Curtis Laws Wilson Library .....	15	German (GERMAN) - Undergraduate .....	311
<b>D</b>		Global Learning .....	21
Degree Programs .....	44	Global Studies - Undergraduate .....	165

<b>H</b>		Petroleum Engineering (PET ENG) - Undergraduate	337
History - Undergraduate	166	Philosophy - Undergraduate	221
History (HISTORY) - Undergraduate	311	Philosophy (PHILOS) - Undergraduate	339
<b>I</b>		Physical Education and Recreation - Undergraduate	224
Info Science & Technology (IS&T) - Undergraduate	314	Physical Education (PHYS ED) - Undergraduate	340
Information Science and Technology - Undergraduate	171	Physics - Undergraduate	225
Information Technology (IT)	21	Physics (PHYSICS) - Undergraduate	341
International Affairs	23	Political Science - Undergraduate	229
Introduction to Missouri University of Science and Technology	5	Political Science (POL SCI) - Undergraduate	344
<b>L</b>		Pre-Medicine (PREMED) - Undergraduate	345
Latin American Studies for Technical Applications Minor	176	Prehealth Professions - Undergraduate	231
<b>M</b>		Prelaw - Undergraduate	232
Marketing - Undergraduate	177	Professional Leadership and Campus Engagement	30
Marketing (MKT) - Undergraduate	316	Psychology - Undergraduate	232
Materials Science & Eng (MS&E) - Undergraduate	317	Psychology (PSYCH) - Undergraduate	345
Materials Science & Engineering - Undergraduate	178	<b>R</b>	
Mathematics - Undergraduate	179	Required Assessment Testing	30
Mathematics (MATH) - Undergraduate	318	Residential Life	31
Mechanical Engineering - Undergraduate	186	Russian - Undergraduate	240
Mechanical Engineering (MECH ENG) - Undergraduate	321	Russian (RUSSIAN) - Undergraduate	348
Metallurgical Engineering - Undergraduate	195	<b>S</b>	
Metallurgical Engineering (MET ENG) - Undergraduate	325	S&T Police Department	32
Military Science - Air Force (MIL AIR)	329	Spanish - Undergraduate	241
Military Science - Air Force (MIL AIR) - Undergraduate	200	Spanish (SPANISH) - Undergraduate	348
Military Science - Army (MIL ARMY) - Undergraduate	329	Speech & Media Studies (SP&M S) - Undergraduate	349
Military Science (Army ROTC)	24	Speech and Media Studies - Undergraduate	242
Mining Engineering - Undergraduate	202	Statistics (STAT) - Undergraduate	350
Mining Engineering (MIN ENG) - Undergraduate	330	Statistics- Undergraduate	243
Minors	41	Student Design and Experiential Learning Center (SDELC)	35
Missouri S&T	3	Student Diversity Initiatives	35
Multiculturalism & Diversity - Undergraduate	210	Student Health Services	36
Multidisciplinary Studies - Undergraduate	210	Student Organizations	36
Music - Undergraduate	211	Student Success Programs	37
Music (MUSIC) - Undergraduate	334	Sustainability	245
<b>N</b>		Systems Engineering - Undergraduate	245
Nuclear Engineering - Undergraduate	211	Systems Engineering (SYS ENG) - Undergraduate	351
Nuclear Engineering (NUC ENG) - Undergraduate	334	<b>T</b>	
Nuclear Reactor	26	Teacher Certifications	43
<b>O</b>		Teacher Education Program - Undergraduate	38
Oak Ridge Associated Universities (ORAU)	26	Technical Communication - Undergraduate	246
Office of the Registrar	26	Technical Communication (TCH COM) - Undergraduate	352
Other Programs	29	The Honors Academy	39
<b>P</b>		Theatre - Undergraduate	249
Petroleum Engineering - Undergraduate	217		

Theatre (THEATRE) - Undergraduate .....353

**U**

Undergraduate Certificates ..... 42

**V**

Veteran Affairs ..... 39

**W**

Writing Center .....40