Nuclear Engineering

Bachelor of Science
Master of Science
Doctor of Philosophy
Doctor of 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, 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 and communication, desalination, district heating or radioisotope production for industrial, medical or research applications.

In the Senior Nuclear Systems Design course (Nu Eng 323), 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, and a computer learning center. The students have access to state-of-the-art computing facilities including personal computers, workstations, and numerically intensive 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.

Program Educational Objectives

The Educational Objectives of the Nuclear Engineering undergraduate program are:

- 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.
- Leadership and professional ethics. Our graduates will continue to demonstrate leadership with an understanding of, and a commitment to, professional ethics.
- Technical communication and interpersonal skills. Our graduates will continue to demonstrate technical communication and interpersonal skills, enabling them to excel in their profession.
- 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.

Program Outcomes

The following Program Outcomes (a - k) apply to the Nuclear Engineering program.

(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.

Faculty

Professor:

Arvind Kumar, Ph.D., California-Berkeley, Program Chair, Nuclear Engineering

Associate Professor:

Gary Mueller[1], Ph.D., UM-Rolla

Assistant Professors:

Carlos Castano, Ph.D., University of Illinois at Urbana
Shoaib Usman, Ph.D., University of Cincinnati

Adjunct Professors:

Mariesa Crow[1], Ph.D., Illinois; Professor of Electrical & Computer Engineering, UM-Rolla
Delbert Day[1], Ph.D., Pennsylvania State; Curators' Professor Emeritus, UM-Rolla
Timothy Herrmann[1], B.S., UM-Rolla; Manager, Engineering Services, AmerenUE Callaway Nuclear Plant, Fulton, MO
Tod Moser[1], M.S., UM-Columbia; Manager, Plant Engineering, AmerenUE - Callaway Plant
David A. Summers, Ph.D., Leeds, England; Curators' Professor of Mining Engineering, UM-Rolla

Emeritus Professors:

D. Ray Edwards[1], Sc.D., MIT
Nicholas Tsoulfanidis[1], Ph.D., Illinois

[1] Registered Professional Engineer

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, if they wish, to state a Nuclear Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshmen 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 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 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 Nuclear Engineering.

The Nuclear 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 16 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 112, 175, History 176, or Political Science 90. The economics course may be either Economics 121 or 122. 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. One 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 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; 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	Credit
Freshman Chemistry Requirement[1]	5
Eng 20-Exposition and Argumentation	3
FE 10-Study and Careers in Engineering	1
Math 14-Calculus for Engineers I	4
Nu Eng 25-Nuclear Technology Applications[2]	1
	14
Second Semester	
Elective-Hum or Soc Sci[3]	3
History 112, 175, 176, or Political Science 90	3
Physics 23-Engineering Physics I	4
IDE 20-Intro to Engr Design.	3
Math 15-Calculus for Engineers II	4
	17

SOPHOMORE YEAR

First Semester	Credit
Cmp Sc 73 or 74-Basic Scientific Programming	2
Cmp Sc 77 or 78-Computer Programming Lab	1
IDE 50-Eng Mech-Statics	3
Math 22-Calculus w/Analytic Geometry III	4
Nu Eng 105-Intro to Nuclear Engineering	2
Physics 24-Engineering Physics II	4
	16
Second Semester	
Cmp Sc 228-Intro to Numerical Methods	3
Econ 121 or 122-Micro/Macroeconomics	3
Nu Eng 206-Reactor Operations I	1
IDE 110-Mechanics of Materials	3
Math 204-Elem Diff Equations	3
Nu Eng 203-Interactions of Radiation w/Matter or Physics 107-Intro to Modern Physics	3
	16

JUNIOR YEAR

First Semester	Credit
Elective-Hum or Soc Sci[3]	3
Stat 215-Engineering Statistics	3
Mt Eng 121-Metallurgy for Engineers	3
Nu Eng 205-Fundamentals of Nuclear Engineering	3
Nu Eng 221-Reactor Fluid Mechanics	3
	15
Second Semester	
English 160-Technical Writing	3
Nu Eng 312-Nuc Radiation Measurement & Spectro	3
Nu Eng 223-Reactor Heat Transfer	3
Nu Eng 303-Reactor Physics I	3
Nu Eng 319-Nuclear Power Plant Systems	3
Technical Electives-200 or 300 level[5]	3
	18

SENIOR YEAR

First Semester	Credit
Elective-Hum or Soc Sc[3]	3
Nu Eng 304-Reactor Lab I	2
Nu Eng 307-Nuclear Fuel Cycle	3
Elective-300 level Math	3
Nu Eng 322-Nuclear System Design I	1
Nu Eng 341-Nuclear Materials I	3
	15
Second Semester	
Elective-Hum or Soc Sci[3]	3
Technical Elective-300 level[5]	3
Free Elective[4]	6
Nu Eng 308-Reactor Lab II	2
Nu Eng 323-Nuclear System Design II	3
	17

NOTE: Minimum credit hours for graduation is 128.

1) Chemistry 1 and 2 or Chemistry 5 and Chemistry 4 or an equivalent training program approved by Missouri S&T.
2) Nuclear Engineering students are expected to take Nuclear Technology Applications (Nu Eng 25) during their Freshman year.
3) Humanities and Social Science to be taken in accordance with the policy described above.
4) 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).

5) Any Math, Science, or Engineering courses.

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. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.

Nuclear Engineering Minor Curriculum

Nuclear power plants and other nuclear installations employ not only nuclear but also civil, mechanical, electrical, and chemical engineers. A nuclear engineering minor, therefore, 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 Elementary Differential Equations (Math 204 or equivalent) and Atomic and Nuclear Physics (Physics 107 or Nu Eng 203 or equivalent). Required courses are:

- Nu Eng 204 Nuc Radiation Measurements (3 hrs)
- Nu Eng 205-Fundamentals of Nu Eng (3 hrs)
- Nu Eng 223-Reactor Heat Transfer (3 hrs)

The other 6 hours should be selected from nuclear engineering 300-level courses.

Nuclear Engineering Courses

25 **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.

101 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

105 **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 15 or Math 21.

200 **Special Problems** (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

201 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

203 **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 22, Physics 24.

205 **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 107 or Nu Eng 203; Math 204.

206 **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 14 or Math 8; preceded or accompanied by Nu Eng 25.

221 **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 204, Junior standing.

223 **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: Nu Eng 221.

300 **Special Problems** (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

301 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

303 **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: Nu Eng 205.

304 **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: Nu Eng 204, 205.

306 **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: Nu Eng 105, 206.

307 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: Nu Eng 205.

308 Reactor Laboratory II (LEC 1.0 and LAB 1.0) A continuation of Nuclear Engineering 304 with experiments of a more advanced nature. Prerequisite: Nu Eng 304.

309 Licensing Of Nuclear Power Plants (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.

310 Seminar (RSD 0.0-6.0) Discussion of current topics. Prerequisite: Senior standing.

311 Reactor Physics II (LEC 3.0) Analytic and computer based methods of solving problems of reactor physics. Prerequisites: Nu Eng 303, Cmp Sc 228.

312 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 205.

315 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. Prerequisite: Mc Eng 219 or Nu Eng 319.

317 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 221 or Chem Eng 231 or Mech Eng 231.

319 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: Nu Eng 205 and accompanied or preceded by Nu Eng 223.

322 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: Nu Eng 223, 303, 319, preceded or accompanied by Nu Eng 341.

323 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: Nu Eng 322.

327 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 205.

333 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: Nu Eng 203 or Physics 107.

335 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: Nu Eng 205.

341 Nuclear Materials I (LEC 3.0) Fundamentals of materials selection for components in nuclear applications, design and fabrication of UO2 fuel; reactor fuel element performance; mechanical properties of UO2; radiation damage and effects, including computer modeling; corrosion of materials in nuclear reactor systems. Prerequisites: IDE 110; Nuc Eng 205; Nuc Eng 223; Met Eng 121. (Co-listed with Met Eng 341)

345 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 204. (Co-listed with Geo 345)

351 Reactor Kinetics (LEC 3.0) Derivation and solutions to elementary kinetics models. Application of the point kinetics model in fast, thermal reactor dynamics, internal and external feedback mechanism. Rigorous derivation and solutions of the space dependent kinetics model

fission product and fuel isotope changes during reactor operation. Prerequisite: Nu Eng 205.

361 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 204.

381 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: Nu Eng 205.

390 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.

Petroleum Engineering

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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 program emphasizes the importance of geomechanics in petroleum development, through building mechanical earth models.

Petroleum Engineering Educational Objectives

(a) 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.

(b) 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.

(c) 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 (a) through (k) plus specific MEM related outcomes. The outcomes statements are as follows: Petroleum Engineering seeks to graduate students who have:

(a) The ability to apply knowledge of mathematics, science, and engineering.

(b) The ability to design and conduct experiments, as well as to analyze and interpret data.

(c) 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.

(d) The ability to function on multidisciplinary teams.

(e) The ability to identify, formulate, and solve engineering problems.

(f) The understanding of professional and ethical responsibility.

(g) The 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) Recognition of the need for, and an ability to engage in life-long learning.

(j) Knowledge of contemporary issues.

(k) The ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

(l) The ability to use Mechanical Earth Modeling tools and techniques to solve problems associated with the production of oil and gas.

Faculty

Professors:

Leonard F. Koederitz[1] (Curators' Teaching Professor) (Emeritus), Ph.D., University of Missouri-Rolla

Daopu T. Numbere, (Emeritus), Ph.D., University of Oklahoma

Associate Professors:

Shari Dunn-Norman, Ph.D., Heriot-Watt University

Ralph Flori, Ph.D., University of Missouri-Rolla

Assistant Professors:

Baojun Bai, Ph.D., China University of Geoscience, Ph.D., New Mexico Tech

Runar Nygaard, Ph.D., University of Oslo

[1] Registered Professional Engineer

Bachelor of Science Petroleum Engineering

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1) All students are required to take one American history course and one economics course. The history course is to be selected from History 112, 175, History 176, or Political Science 90. The economics course may be either Economics 121 or 122. 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.

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5) Special topics, special problems courses and honors seminars are allowed only by petition to and approval by the student's department chairman.

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FRESHMAN YEAR

(See Freshman Engineering Program) Students planning on majoring in petroleum engineering should take a three hour elective in chemistry, geochemistry, or biology in the freshman year, in addition to Chem 1, 2, and 4.

First Semester	Credit
English 20-Expo & Argumentation	3
FE 10-Study & Careers in Eng	1
Chem 1-Gen Chemistry	4
Chem 2-Gen Chem Lab	1
History 112, 175, 176, or Poly Sci 90	3
Math 14-Calc for Engineers I	4
	16

Second Semester	
Pe Eng 121-Intro Oil Well Drilling	1
Math 15-Calc for Engineers II	4
Ge Eng 50 or 51-Geo for Engrs/Physical Geo	3
Physics 23-Eng Physics I	4
IDE 20-Intro to Engr Design	3
	15

SOPHOMORE YEAR

First Semester	Credit
Math 22-Calc w/Analytic Geom III	4
Physics 24-Eng Physics II	4
Geo 340 Petroleum Geology	3
PE 240-Properties of Petroleum Fluids	3
IDE 50-Statics	3
	17
Second Semester	
Math 204-Elem Diff Equations	3
PE 241-Petro Reservoir Engineering	3
PE 242-Petro Reservoir Lab	1
IDE 150-Dynamics	2
Mining 331-Statics and Mechanics of Rock Materials	3
Geo 332-Depositional Systems	3
	15

JUNIOR YEAR

First Semester	Credit
Geo 220-Structural Geology	3
Geop 377-Seismic Interpretation (3D Seismic)	3
PE 331-Drilling and Well Design	3
Cv Eng 230-Fluid Mechanics	3
Econ 121 or 122-Prin of Economics	3
PE 341-Well Testing	3
	18
Second Semester	
ME 227-Thermal Analysis	3
PE 316-Well Performance and Production Systems	3
PE 232-Well Logging	3
Humanities/Social Sci Elective[2]	3
PE 338-Finite Element Analysis with App in PE	4
	16

SENIOR YEAR

First Semester	Credit
Pe Eng 310-Ethics and Professionalism[3]	1
Pe Eng 357-Petroleum Econ and Asset Valuation	3
PE Elective[4]	3
PE 366-Mechanical Earth Modeling	3
IDE 110-Mechanics of Materials	3
Humanities/Social Sci Elective[2]	3
	16
Second Semester	
Pe Eng 347-Petro Eng Design	3
English 65-Technical Writer in Bus & Industry	3
GE 315-Geostatistical Methods in Eng and Geology	3
Hum/Soc Sci Elective[2]	3
PE Elective[4]	3
	15

[1] All freshmen petroleum engineering students must enroll in Chem 4.

[2] 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

[3] 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.

[4] 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.

The total number of credit hours required for a degree in Petroleum Engineering is 128.

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:

Required Course/Times Offered Hours

Pe Eng 331 Fall	3 hrs.
Pe Eng 240 Fall	3 hrs.
Pe Eng 241 Fall	3 hrs.
Pe Eng 316 Fall or Pe Eng 335 Spring	3 hrs.
One elective course*	3 hrs.
	Total 15 hrs.

*The elective course is to be selected from any other 200 or 300 level Petroleum Engineering courses offered except Seminars.

Petroleum Engineering Courses

121 Introduction to Oil Well Drilling (LEC 1.0) Introduction to the fundamentals of oil and gas well drilling. Fundamental physical principles and calculations used in drilling. Exposure to oil well drilling training software. Prerequisite: Entrance requirements.

200 Special Problems (IND 1.0-3.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

201 Special Topics (Variable 1.0-3.0) This course is designed to give the department an opportunity to test a new course. Variable title.

232 Well Logging I (LEC 2.0 and LAB 1.0) An introduction to the electrical, nuclear, and acoustic properties of rocks: theory and interpretation of conventional well logs. Prerequisite: Physics 24 or 25.

240 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 1.

241 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 240.

242 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 241.

271 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.

300 Special Problems (IND 1.0-3.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

301 Special Topics (Variable 1.0-3.0) This course is designed to give the department an opportunity to test a new course. Variable title.

302 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.

303 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 1.

308 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 241.

310 Seminar (RSD 1.0) Discussion of current topics. (Course cannot be used for graduate credit). Prerequisite: Senior standing in Pe Eng. (Co-listed with Geology 310, Geo Eng 310)

314 Advanced Drilling Technology (LEC 3.0) In-depth studies of directional well planning and bottom hole assemblies, hole problems and wellbore stability in deviated wells; computer aided drilling optimization and drill bit selection for directional wells. Field trip required. Prerequisite: Pet Eng 331.

316 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 241.

320 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 241.

323 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 316.

329 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: Pe 331 Drilling and Well Design (LEC 2.0 and LAB 1.0) 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: Pet Eng 121 and preceded or accompanied by Civ Eng 230.

331 Drilling and Well Design (LEC 2.0 and LAB 1.0) This course covers drilling fluids, including mixing and analysis of rheological properties; pressure loss calculations; casing design; well cementing; ore pressure and geomechanical considerations in drilling; completion equipment, and completion design. Prerequisite: Pet Eng 121 and preceded or accompanied by Civ Eng 230.

333 Reservoir Characterization (LEC 3.0) The integration and extrapolation of Geologic, Geophysical, and Petroleum Engineering data for flow model construction. Prerequisites: Pet Eng 241, Pet Eng 232; Geology 332 or Geology 340.

335 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 241, Pet Eng 242.

338 Finite Element Analysis with Applications in Petroleum Engineering (LEC 3.0 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 241; Geology 220 or Min Eng 232.

341 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 241.

347 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: Pe Eng 241, Pe Eng 316, and senior standing.

357 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 241, Econ 121 or Econ 122.

360 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 Pe Eng 241.

366 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. Prerequisite: Pet Eng 232 or Geology 220 or Min Eng 232.

Philosophy

Bachelor of Arts

The Philosophy program is offered in the Department of Arts, Languages & 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.

Faculty

Professors:

Wayne Cogell (Emeritus), Ph.D., University of Missouri-Columbia

Richard Miller (Department Chair), Ph.D., Illinois

Robert Oakes (Emeritus), Ph.D., Pennsylvania

Associate Professor:

Carol Ann Smith (Emeritus), Ph.D., Pittsburgh

Assistant Professor:

Adam Potthast, Ph.D., University of Connecticut

Lecturer:

Darin Finke, M.A., University of Missouri-Columbia

Bachelor of Arts Philosophy

Guidelines for a major in philosophy are as follows:

1) Completion of general Missouri S&T B.A. requirements.

2) Phil 005, Introduction to Philosophy, and Phil 015, Introduction to Logic.

3) A minimum of 24 hours in philosophy beyond courses Phil 005 and 015, at least 12 of which must be at the 300 level. Courses to be taken should be determined in consultation with the student's major advisor.

An individualized program of study will be designed in conference between student and advisor in order to best serve student interests and needs.

NOTE: Entering students will normally take English 20 either semester of the first year.

Philosophy Minor Curriculum

1) A student with a minor in philosophy must meet the following requirements:
   A) Twelve hours in philosophy course beyond Phil 005, Introduction to Philosophy (Phil 005 is a prerequisite to a minor in philosophy).
   B) Six of the twelve hours must be completed in philosophy courses numbered 300 or above.

2) A student should declare his or her intention to minor in philosophy by his or her junior year.

3) 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 Courses

5 **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.

10 **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.

15 **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.

75 **Comparative Religious Philosophy** (LEC 3.0) A comparison of the philosophic ideas and foundations of the major Eastern and Western religions. Prerequisite: Entrance requirements.

100 **Special Problems** (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

101 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

200 **Special Problems** (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

201 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

223 **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: Introductory level (below 100) Philosophy course.

225 **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: An introductory (below 100) level philosophy course.

235 **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: An introductory (below 100) level philosophy course.

300 **Special Problems** (IND 0.0-6.0) Problems or readings on specific subjects of projects in the department. Consent of instructor required.

301 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

320 **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 introductory (below 100) level philosophy course.

333 **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 100) level Philosophy course.

335 **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 100) level philosophy course.

340 **Social Ethics** (LEC 3.0) Discussion of 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 lower level ethics course.

345 **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 introductory (below 100) level philosophy course.

350 Environmental Ethics (LEC 3.0) Study of the 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, takings, etc. Prerequisite: Any introductory (below 100) level philosophy course.

354 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 15 with junior standing or Math 305 or Comp Sci 253 or Comp Eng 111. (Co-listed with Comp Eng 354, Comp Sci 354 and Math 354)

360 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 introductory (below 100) level Philosophy course.

368 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. Prerequisite: Any intro level Philosophy course. (Co-listed with IST 368)

399 Topics In Philosophy (LEC 3.0) An intensive course 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: An introductory (below 100) level Philosophy course.

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 aerobics, aquatics, golf, racquetball, swimming fitness, methods in elementary physical education, weight training, theory of coaching basketball and football, care and prevention of athletic injuries, 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. A golf course, tennis courts, and multi-use intramural fields highlight the outdoor facilities.

Faculty

Professors:

Dewey Allgood (Emeritus), M.A., Colorado State
Billy Key (Emeritus), M.S.,Washington University

Instructors:

Joe Ahearn, B.A., DePaul University
Andy Ball, M.S., Central Missouri State University
Travis Boulware, M.S., Tennessee Tech University
Kirby Cannon, M.S., Iowa State
Todd Degraffenreid, M.Ed., William Woods
Alan Eads, M.S., Univ. of Missouri - Columbia
L. Douglas Grooms, B.S.E., Northeast Missouri
Keri Hessel, B.S., University of Missouri-Rolla
Jason Holt, M.S., Fort Hays State University
Don Kennedy, M.S., Central Missouri State University
Jon Kiester, B.A., Hawaii Pacific University
Dale Martin, M.S., Central Missouri State University
Sterling Martin, B.S., Drake
Sarah Moore (Department Chair), M.S.,University of Tennessee
Mark Mullin (Athletic Director), M.S., Northeast Missouri
Megan Remley, B.S., Truman State
Josh Richards, B.A., Central Methodist University
Bryan Schiding, M.B.A., LaSalle
Kyran Weaver, B.S., University of Missouri-Rolla

Physical Education Courses

100 Special Problems (IND 0.0-6.0) Problems of readings on specific subjects or projects in the department. Consent of instructor required.

101 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

102 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.

103 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.

104 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.

105 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 cardio-vascular system and improve muscle tone.

108 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.

109 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.

110 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.

111 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.

112 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.

113 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.

150 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.

151 Care And Prevention Of Athletic Injuries (LEC 3.0) Technique, principles, and theory underlying the prevention and care of athletic injuries.

152 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.

153 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.

200 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

201 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

230 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 230)

231 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 231)

Physics

Bachelor of Science
Master of Science
Master of Science for Teachers
Doctor of Philosophy

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. From the lasers used in high-speed communications and micro-surgery, to 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; atomic and molecule interactions with intense electric fields; 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 and Missouri Academy of Science 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 advanced electricity and magnetism, classical and modern optics, astrophysics, physical mechanics, quantum mechanics, general relativity, thermal physics, solid state physics, and laser physics. The curriculum also includes advanced laboratory courses where students design and participate in original research with other enthusiastic 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. With 50 credit hours in physics, 23 in mathematics, 9 in chemistry, and 3 in computer science, the rest of the 128 required hours are in 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.

Faculty

Professors:
Ralph Alexander, Jr., Ph.D., Cornell
Ronald Bieniek, Ph.D., Harvard
Robert Dubois, Ph.D., Nebraska
Don Hagen, Ph.D., Purdue
Barbara Hale, Ph.D., Purdue
Don Madison (Curators'), Ph.D., Florida State
Paul Parris, Ph.D., Rochester
Jerry Peacher, Ph.D., Indiana
Allan Pringle (Curators' Teaching Professor), Ph.D., University of Missouri-Columbia
Michael Schulz (Curators'), Ph.D., Heidelberg
Dan Waddill (Department Chair), Ph.D., Indiana
Gerald Wilemski, Ph.D., Yale
Associate Professors:
John Schmitt, Ph.D., Michigan
Greg Story, Ph.D., Southern California
Thomas Vojta, Ph.D., Chemnitz
Assistant Professors:
Ulrich Jentschura, Ph.D., Dresden University of Technology
Julia Medvedeva, Ph.D., Russian Acad. of Science
Alexey Yamilov, Ph.D., CUNY
Adjunct Assistant Professor:
Agnes Vojta, Ph.D., Technische Universitaet Dresden

Emeritus:

Professors:
Ibrahim Adawi (Emeritus), Ph.D., Cornell
Robert Bell (Emeritus), Ph.D., Virginia Polytechnic Institute
John Carstens (Emeritus), Ph.D., University of Missouri-Rolla
Robert Gerson (Emeritus), Ph.D., New York
Edward Hale (Emeritus), Ph.D., Purdue
Otto Hill (Emeritus), Ph.D., Texas
Robert McFarland (Emeritus), Ph.D., Wisconsin
Ronald Olson (Curators' Emeritus), Ph.D., Purdue
John Park (Emeritus), Ph.D., Nebraska
Don Sparlin (Emeritus), Ph.D., Northwestern
Associate Professors:
Charles McFarland (Emeritus), Ph.D., Washington University
William Parks (Emeritus), Ph.D., Iowa

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 60 or English 160. A minimum of nine semester hours is required in social sciences, including either History 175, 176, 112, or Pol Sc 90 or 176. Specific requirements for the bachelor degree are outlined in the sample program listed below.

FRESHMAN YEAR

First Semester	Credit
Chem 1-General Chemistry	4
Chem 2-General Chemistry	1
Chem 4-Intro to Lab Safety & Hazardous Materials	1
English 20-Exposition & Argumentation	3
Math 8-Calculus w/Analytic Geometry I	5
Physics 1-Intro to Physics	1
	15
Second Semester	
Chem 3-General Chemistry	3
History (112, 175, 176) or Pol Sc 90	3
Math 21-Calculus w/Analytic Geometry II	5
Physics 21-General Physics 1	4
Physics 22 or 27-General Physics Lab	1
	16

SOPHOMORE YEAR

First Semester	Credit
English 60-Writing & Research	3
Math 22-Calculus w/Analytic Geometry III	4
Physics 25-General Physics II	4
Physics 26 or 28-General Physics Lab	1
Cmp Sc 73 & 77 or 74 & 78 or 53	3
Elective[1]	3
	18
Second Semester	
Math 204-Elementary Differential Equations	3
Physics 207-Modern Physics I	3
Physics 212-Intermediate Physics Lab	3
Physics 208-Intro to Theoretical Physics	3
Elective[1]	3
	15

JUNIOR YEAR

First Semester	Credit
Physics 308-Physical Mechanics	3
Physics 322-Advanced Physics Lab I	3
Physics 307-Modern Physics II	3
Math/Stat Elective[2]	3
Electives[1]	6
	18
Second Semester	
Physics 221-Electricity & Magnetism I	3
Physics 332-Advanced Physics Lab II	3
Math/Stat Elective[2]	3
Electives[1]	7
	16

SENIOR YEAR

First Semester	Credit
Physics 321-Electricity & Magnetism II	3
Physics 361-Intro to Quantum Mechanics	3
Physics Elective[3]	3
Electives[1]	6
	15
Second Semester	
Physics 311-Thermal Physics	3
Elective-Humanities (300 level)[1]	3
Physics Elective[3]	3
Electives[1]	6
	15

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.

[1] Electives, in addition to the Math/Stat electives[2] and Physics electives[3], 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 300 level (Phil 345 recommended). Twenty-one hours of free electives may be used to develop an emphasis area in applied physics or geophysics. Eighteen hours of elective credit shall be in courses at the junior or senior level.

[2] Six hours of mathematics or statistics beyond Math 204 are required. Math 208, 322, 325, or 351 are recommended.

[3] In addition to the specific physics courses listed (Physics 307, 308, 311, 321,322,332, and 361) two other physics 300 level courses are required. Physics 305, 323, 337, 357, 371, or 381 are recommended.

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 addidtional requirements:

a. Take the education Professional Requirements courses: Educ. 40, 174, 216, 251, 280, 298; Psych. 155, 208, 354. 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. 104, 164, 299.

c. Take these additional courses: Speech 85, Pol. Sc. 90, Psych. 50, Bio 110, Phys. 6, Hist. 275, and a 3 hour Art/Music/Theater elective.

d. Complete the requirements for teacher certification listed in this catalog.

e. Physics 23 and 24 may be substituted for Physics 21, 22, 25, and 26, and Math 14 and 15 for Math 8 and 21.

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 107 or Physics 207 and 12 additional hours of physics courses at the 200 level or above. The program will be designed to conform to the individual's interests and needs.

Physics Courses

1 **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.

6 **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.

8 **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 006. To be taken simultaneously with Environmental Physics 006. Prerequisite: Corequisite Physics 6.

9 **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 9 and Physics 11.

10 **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 9 or 11.

21 **General Physics I** (LEC 4.0) An introduction to the fundamental ideas of physics, including mechanics, heat, and sound. Prerequisite: Preceded by Math 8 or Math 14.

22 **General Physics Laboratory** (LAB 1.0) Experiments related to topics studied in Physics 21. Prerequisite: Preceded or accompanied by Physics 21.

23 **Engineering Physics I** (LEC 1.5, RSD 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 8 or 14.

24 **Engineering Physics II** (LEC 1.5, RSD 1.5, and LAB 1.0) An introduction to electricity, magnetism, and light, with emphasis on topics needed by engineering students. Prerequisites: Physics 23, Math 21 or 15.

25 **General Physics II** (LEC 4.0) An introduction to the fundamental ideas of physics including electricity, magnetism, and light. Prerequisites: Preceded by Physics 21 and preceded or accompanied by Math 21 or Math 15.

26 **General Physics Laboratory** (LAB 1.0) Experiments related to topics studied in Physics 25. Prerequisite: Preceded or accompanied by Physics 25.

31 **College Physics I** (LEC 3.0) An introduction to the ideas of physics, including mechanics, heat, and sound. Prerequisites: Math 6 and either of Math 2 or Math 4.

35 **College Physics II** (LEC 3.0) An introduction to the ideas of physics, including electricity, magnetism, and light. Prerequisites: Math 6, Physics 31.

101 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

107 **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 22 and Physics 24 or 25.

201 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

207 **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 24 or 25, preceded or accompanied by Math 204 or 229.

208 **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 204 co-requisite; Physics 24 or 25.

212 **Intermediate Physics Laboratory** (LEC 1.0 and LAB 2.0) 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.

221 **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 208.

300 **Special Problems** (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

301 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

302 **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.)

303 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 22 and admission to the MST program.

305 Astrophysics (LEC 3.0) The structure, physical characteristics and evolution of stars, binary systems, nebulae and galaxies. Prerequisite: Physics 107.

306 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 300-level elective for a B.S. in Physics. Prerequisite: Admissions to the MST program.

307 Modern Physics II (LEC 3.0) A continuation of Physics 207. An introduction to nuclear and particle physics. Topics include nuclear models, decays, and reactions, and elementary particles and fundamental forces. Prerequisites: Math 204 or 229, and either Physics 107 with consent of instructor or Physics 207.

308 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 208.

309 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 22 or admission to the MST program.

311 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 107 or 207.

313 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 208.

321 Electricity And Magnetism II (LEC 3.0) A continuation of Physics 221. Topics covered include the magnetostatic field, the magnetic vector potential, the magnetostatic field in matter, electrodynamics, and electromagnetic waves. Prerequisite: Physics 221.

322 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 212.

323 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 22 and Physics 24 or 25. (Co-listed with El Eng 323)

324 Fourier Optics (LEC 3.0) Applications of Fourier analysis and linear system theory to optics. Topics include scalar diffraction theory, Fouriertransforming properties of lenses, optical information processing, and imaging systems. Prerequisites: El Eng 261 & 275 or Physics 208 & 321. (Co-listed with El Eng 324)

326 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: El Eng 275 or Physics 321. (Co-listed with El Eng 326)

332 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 212.

351 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 107 or Physics 207; Math 204; programming experience.

355 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 204; Physics 24 or Physics 25.

357 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 307.

361 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 107 or 207, 208.

371 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 107 or 207.

377 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 Ae Eng 377, Ch Eng 347, Mt Eng 377, Cr Eng 377)

381 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 204 and Physics 107 or 207.

390 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.

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.

Faculty

Associate Professors:
Tseggai Isaac, Ph.D.,University of Missouri-Columbia
Michael Meagher, Ph.D., Southern Illinois University

Political Science Minor Curriculum

(Missouri S&T)

The Department of History and Political Science offers a minor degree in political science which must include 15 hours divided as follows: completion of American Government (Pol Sc 90) and Theories and Issues of Political Science (Pol Sc 235), plus an approved sequence of 9 hours of 200 and 300 level courses.

Science, Technology and Politics Minor

The Science, Technology and Politics (STP) 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 and 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 STP the student must complete one of the following history survey courses: 111 or 112 or 175 or 176; and Political Science 90. After completing the required six hours, the student will select one of two options: The History of Science and Technology option; or the Politics and Public Policy option. Under the History of Science and Technology option, students will complete six additional hours from courses in history plus three hours in political science. Under the Politics and Public Policy option students will complete six additional hours in political science and three hours from history. The upper-level courses to satisfy degree requirements are as follows: HIST 270, 271, 274, 275, 280, or PHIL 345 and POL SC 237, 315, 317, and 325.

Political Science Courses

90 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.

100 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

101 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable credit.

200 **Special Problems** (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

201 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

210 **Seminar** (IND 0.0-6.0) Discussion of current topics.

225 **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 Sc 90 or Hist 175.

226 **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 Sc 90 or Hist 175 or 176.

235 **Theories And Issues Of 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. Prerequisite: Pol Sc 90 or Hist 175 or 176.

237 **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: Hist 175 or 176 or Pol Sc 90. (Co-listed with Hist 237)

250 **State And Local Politics** (LEC 3.0) An examination of the political organizations, policies, and pressure at work in the sub-national level of American government. State, county, and city governments will be explored, along with the growing number of special land use boards, environmental protection commissions, etc. Prerequisite: Pol Sc 90, Hist 175 or 176.

290 **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 Sc 90.

300 **Special Problems And Readings** (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

301 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

302 **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 Sc 90 or Pol Sc 235.

310 **Seminar** (RSD 0.0-6.0) Discussion of current topics Prerequisite: Senior standing.

315 **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 Sc 90.

316 **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 Sc 90 or Hist 176. (Co-listed with Hist 316)

317 **Program Analysis And Evaluation** (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 Sc 90.

350 **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 Sc 90 or Hist 112 or 175 or 176.

383 **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: Hist 175, 176 or Pol Sc 90. (Co-listed with Hist 383)

384 **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 176 or Pol Sci 90. (Co-listed with History 384)

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 Biological 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. Dave Westenberg, 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 Biological Engineering which already offer a Pre-Medicine approved curriculum. Required courses for the Pre-Medicine minor are:
BioSc 111 (or 110) and 112 - Foundations in Biology (General Biology) with lab
BioSc 211 and 212 - Cellular Bioloby with lab
Chem 1, 2, 3, 4 - General Chemistry with labs
Chem 221, 226, 223, 228 - Organic Chemistry with labs
Physics 31 (21), 22, 35 (25) and 26 College (General) Physics with labs
Mathematics two semesters to include Math 8 or 14
One of the following three courses (taking all three courses is highly recommended):
BioSc 231 - General Genetics
BioSc 242 - Human Physiology
Chem 361 - Biochemistry

Premedicine Courses

110 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.

310 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

Bachelor of Science

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 Pre-lawadvisor.

Prelaw Minor

To qualify, students must complete a minimum of 18 hours of coursework in the following disciplines. Phil 015 is required for all minors. Take two of the following: Hist 175, 176, Pol Sc 90, or Phil 005; Take three from the following. Two of the tree courses must come from the humanities and social sciences disciplines of History, English, Etymology, Philosophy, or Political Science: Comp Sci 317, Bus 120, Bus 230, Engl 281, Engl 302, Hist 270, Hist 275, Phil 235, Phil 340, Phil 345, Phil 350, Phil 360, IST/Phil 368, Econ 335, Econ 375, Econ 220, Pol Sci 237, Pol Sci 315, Pol Sci 317, EMgt 369, EMgt 327, Etly 306.

Psychology

Bachelor of Science
Bachelor of Arts

Psychology is the scientific study of behavior and cognative 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 in your junior or senior years. 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 practicum 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 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 multicultural and diversity.

Faculty

Professors:

Frances Haemmerlie, (Curators' Teaching Professor) Ph.D., Florida State University

Robert Montgomery, Ph.D., Oklahoma State University

Nancy J. Stone (Department Chair), Ph.D., Texas Tech University

Associate Professors:

James Martin, Ph.D., Louisiana State University

Donald Sharpsteen, Ph.D., University of Denver

Assistant Professors:

Jacqueline Bichsel, Ph.D., University of Alabama

Lecturer:

Merilee Krueger, M.A., University of Nebraska-Omaha

Instructors:

Eugene Gianladis, Ph.D., St. Louis University

Bachelor of Arts Psychology

Requirements for Bachelor of Arts in 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. Twelve 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 twelve semester hours is required in social sciences in at least two of the following four areas: economics, political science, and history. 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 20 and one additional three hour composition course. (6 hours)

2) Western Civilization (History 111 and 112) (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 one 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 (34 hours):

A) Introduction to Psychology, General Psychology Experimental Psychology and Capstone course (Psy 302, 310, 312, 350, 375, 380, or 390, 3 hours credit).

B) Three additional courses from each of the following two areas of psychology:

a) Sensation & Perception, Cognitive, Learning, Neuroscience,

Developmental, Abnormal, Social, or Personality

b) Educational, Adolescent, Human-Commputer Interaction, Industrial, Human Factors, Clinical, Group Dynamics, or Organizational.

C) Electives from psychology to complete the 34 hour major 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 (200-300-level) courses completed with grades of "D" may not be included in the major field without the approval of the chairman 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.

Bachelor of Science Psychology

A minimum of 124 credit hours is required for a Bachelor of Science degree in Psychology 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 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 20 and 60 (entering students will normally take English 20 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 Stat 115, Cmp Sc 53 or 73 or IST 51 and at least one course taken in the biological and one in the physical sciences. Of the biological and physical science offering, 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, Sociology, or History/Political science). A course in Western Civilization II (Hist 112), American History to 1877 (Hist 175) or American History since 1877 (Hist 176), or American Government (Pol Sc 90) 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 2 or 4 and Math 6.

8) Psychology Requirements:

A) Introduction to Psychology, General Psychology, Experimental Psychology and Capstone course (Psych 302, 310, 312, 350, 375, 380, or 390, 3 hours credit).

B) Three additional courses from each of the following two areas of psychology:

a) Sensation & Perception, Cognitive, Learning, Neuroscience, Developmental, Abnormal, Social, or Personality

b) Educational, Adolescent, Human-Computer Interaction, Industrial, Human Factors, Clinical, Group Dynamics, or Organizational.

C) Electives from psychology to complete a requirement of 34 hours.

D) A cumulative grade point average of 2.0 must be earned in all course work taken in the major field. Upper class (200- and 300- level) courses completed with grades of "D" may not be included in the major field without the approval of the advisor and the chairman 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.

Human Resources/Personnel **Credit**
Psych 307-Industrial Psychology 3
Psych 308-Social Psychology 3
Psych 372-Group Dynamics 3
Psych 374-Organizational Psychology 3
Human Services
Psych 208-Psych & Ed Dev Adolescent or Psych 250-Development Psych 3
Psych 362-Abnormal Psychology 3
Psych 360-Personality Theory 3
Psych 368-Clinical Psychology 3

Cognitive Neuroscience
Psych 340-Sensation & Perception 3
Psych 240-Theories of Learning or Psych 262-Abnormal Psych 3
Psych 305-Cognitive Psychology 3
Psych 330-Neuroscience 3
Usability of Technology
Psych 155-Educational Psychology 3
Psych 211-Web Design and Development 3
Psych 311-Human Factors 3
Psych 314-Human-Computer Interaction 3
Psychology of Leadership
Psych 308-Social Psychology or Psych 378-Social Influence 3
Psych 316-Psychology of Leadership 3
Psych 350-Psychology of Women or Psych 372-Group Dynamics 3
Psych 374-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 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 Psychology Department.

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 all Psychology courses. 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 127 credit hours. The required courses are provided below.

Communications Skills: 9 semester hours
English 20, English 60, Speech 85
Humanities: 12 semester hours
One must be in Art, Music, or Theatre (3 hours); one must be in Philosophy (3 hours) and in Literature (3 hours); and one additional humanities from the above course groups, Foreign Language (3-4 hours), or Etymology (3 hours)
Social Sciences: 18 semester hours
History 175 or 176, Political Science 90, Political Science 237, 250, 290, 315 or 316, Psychology 50, Economics 121 or 122, Geography (3 hours)
Natural Science/Mathematics: 13 semester hours
Physics, Chemistry or Geology (3-4 hours), Mathematics (3 hours), Biology 110 (3 hours), Statistics 115 (3 hours)
Professional Requirements: 26 semester hours
Educ 40, Educ 174, Educ 216, Educ 251, Educ 280, Educ 298, Psych 155, Psych 208, Psych 354
Clinical Experience: 16 semester hours
Educ 104, Educ 164, Educ 299
Psychology Degree Requirements: 16 semester hours
Psych 140, Psych 240, Psych 250, Psych 362 or 360, Psych 308
Certification: 17 semester hours
9 hours of American History (Hist 341, 342, 343, 344, 347, 348, 351, 353, 354, 355, 357, 358, 360, 370, 380, 382, 383, or 385); 8 hours of World History (Hist 111, 112, 220, 222, 224, 225, 226, 321, 323, 324, 325, 327, 328, or 329)

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 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 Psychology Department.

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 all Psychology courses. 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 135 credit hours. The required courses are provided below.

Communications Skills: 9 semester hours
English 20, English 60, Speech 85
Humanities: 12 semester hours
One must be in Art, Music, or Theatre (3 hours); one must be in Philosophy (3 hours) and in Literature (3 hours); and one additional humanities from the above course groups, Foreign Language (3-4 hours), or Etymology (3 hours)
Social Sciences: 18 semester hours
History 175 or 176, Political Science 90, Political Science 237, 250, 290, 315 or 316, Psychology 50, Economics 121 or 122, Geography (3 hours)

Natural Sciences/Mathematics: 21 semester hours
Physics, Chemistry or Geology (3-4 hours), Mathematics (3 hours), Biology 110, Statistics 115, Computer Science 53, 73, or 77, 5-6 additional hours of math &/or science courses
Professional Requirements: 26 semester hours
Educ 40, Educ 174, Educ 216, Educ 251, Educ 280, Educ 298, Psych 155, Psych 208, Psych 354
Clinical Experience: 16 semester hours
Educ 104, Educ 164, Educ 299
Psychology Degree Requirements: 16 semester hours
Psych 140, Psych 240, Psych 250, Psych 362 or 360, Psych 308
Certification: 17 semester hours
9 hours of American History (Hist 341, 342, 343, 344, 347, 348, 351, 353, 354, 355, 357, 358, 360, 370, 380, 382, 383, or 385); 8 hours of World History (Hist 111, 112, 220, 222, 224, 225, 226, 321, 323, 324, 325, 327, 328, or 329)

Psychology Minors

The psychology department offers five minors: a general minor, an Industrial/Organizational minor, Psychology of Leadership minor, a minor in Cognitive Neuroscience, and a minor in Psychometrics. "At least 6 hours of work in the Psychology Minor must be completed in residence at Missouri S&T"

Option (1)
General Psychology Minor requirements require 15 hours of courses in psychology. At least nine of these hours must be at the 200-level or above.
Option (2)
Industrial/Organizational Psychology Minor requirements include:
- General Psychology (Psych 50)
- Industrial Psychology (Psych 307)
- Social Psychology (Psych 308)
- Human Factors (Psych 311)
- Organizational Psychology (Psych 374)

Option (3)
Psychology of Leadership requirements include any 5 of the following 6 courses:
- General Psychology (Psych 50)
- Social Psychology (Psyc 308)
- Psychology of Leadership (Psych 316)
- Group Dynamics (Psych 372)
- Organizational Psychology (Psych 374)
- Social Influence: Science and Practice (Psych 378)

Option (4)
Cognitive Neuroscience Minor requirements include:
- General Psychology (Psych 50)
- Sensation and Perception (Psych 340)
- Cognitive Psychology (Psych 305)
- Neuroscience (Psych 330)
- Abnormal Psychology (Psych 362) or Theories of Learning (Psych 240)

Option (5)
The Psychometric minor requirements include the following courses:
- General Psychology (Psych 50)
- Psychometrics (Psych 403)
- Industrial Psychology (Psych 307)
- Tests and Measurements (Psych 364)
- Regression Analysis (Stat 346) or Statistical Data Analysis (Stat 353)

Option (6)
Multiculturalism and Diversity Minor
See website for minor requirements at: http://explore.mst.edu/multidiv_minor.html

Psychology Courses

10 Introduction to Psychology (LEC 1.0) An introduction to the study of psychology at Missouri 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.

50 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.

100 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

101 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

140 Research Methods (LEC 3.0 and LAB 1.0) 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. Prerequisite: Psych 50, Stat 115.

154 Psychology Of Personal Adjustment (LEC 3.0) Major factors related to adjustment and everyday coping: dating, parent-child relationships, death and dying, stress, and modifying one's own behavior. Prerequisite: Psych 50.

155 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 50. (Co-listed with Educ 102)

200 Special Problems In Psychology (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

201 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

208 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 50.

211 Web Design And Development (LEC 1.5 and LAB 1.5) In this course students learn design principles for effectively structuring information for the World Wide Web; how to use tools to deploy this information; and methods for assessing Web usability. The course is project based with an emphasis on the application of design and usability assessment within the context of student projects. Prerequisite: IST 151.

240 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 50.

246 Motivation And Emotion (LEC 3.0) An examination of the ways in which situational, cognitive, and emotional factors influence, and are influenced by, human motivation. Prerequisite: Psych 50.

250 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 50.

290 History Of Psychology (LEC 3.0) An examination of the origin of psychology within the framework of philosophy and science. Traces the major trends, schools, and individuals. Major scientific, cultural, philosophical and personal influences in the development of psychology. Prerequisite: Psych 50.

300 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.

301 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

302 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.

305 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 50.

307 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 50.

308 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 50.

310 Seminar (RSD 0.0-6.0) Prerequisite: Senior Standing.

311 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 50. (Co-listed with Eng Mg 311)

312 Practicum In Human Services Psychology (LAB 3.0) Practicum involves experience in a human service setting. Depending on the student background and setting, activities may involve learning psychological testing, interviewing, assessment and/or counseling skills. Prerequisites: Psych 50; Psych 356, 362, 364, or 368.

314 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 50.

315 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 50.

316 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: General Psychology.

330 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 50.

340 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 50.

345 Evolutionary Psychology (LEC 3.0) Fundamental principles of evolution, and their applicability to human behavior and psychological processes are examined. Topics include interpersonal attraction, sperm competition, altruism, aggression, and creationism/intelligent design. Prerequisites: Psych 50 and Psych 140.

350 Psychology of Women (LEC 3.0) A history of the psychology of women with a focus on the latest research and theories in the field (e.g., research methods, gender theories, biological and social factors, communication and leadership styles, nature of interpersonal relationships, and health and mental issues). Prerequisite: Psych 50.

354 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 50. (Co-listed with Educ 354)

356 Behavior Modification (LEC 3.0) Theory and techniques of influencing human behavior through the use of behavior modification and behavior therapy techniques. Applications to normal and abnormal child, adolescent and adult populations will be considered as well as ethical and legal issues. Prerequisite: Psych 50.

360 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 50.

362 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 50.

364 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 50.

368 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 50 and Psych 362.

370 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 308.

372 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 50.

374 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 50.

375 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 50.

376 Sports And Exercise Psychology (LEC 3.0) Examines psychological theories and research related to sport and exercise behavior by providing a broad overview of topics from the literature of psychology. Prerequisite: Psych 50.

378 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: General Psychology

380 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 50.

390 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.

Russian

Russian Courses

1 Elementary Russian I (LEC 4.0) Introduction to reading, conversation, and grammar. Laboratory required (one extra hour per week). Prerequisite: Entrance requirements.

2 Elementary Russian II (LEC 4.0) Continuation of Russian I. Prerequisite: Russ 1.

80 Readings In Science And Literature (LEC 4.0) Readings in scientific writings and literature for improving comprehension of Russian publications. Prerequisite: Russ 2.

100 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

101 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

110 Basic Russian Conversation (LEC 2.0) Russian conversation and oral practice. Prerequisite: Russ 2.

170 Masterpieces Of Russian Literature (LEC 3.0) Selected major works of Russian literature. Prerequisite: Russ 80.

200 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

201 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

300 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

301 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

310 Seminar (IND 0.0-6.0) Discussion of current topics. Prerequisite: Senior standing.

360 Russian Civilization (LEC 3.0) Introduction to Russian history and culture from the 9th to the 20th century exploring the interrelation between Russian society, its history and its cultural expression in painting, literature, music and architecture over the past thousand years. The periods covered include Kievan Russia, the birth of Christianity, the Mongol invasion, Ivan the Terrible, Peter the Great, Catherine the Great, and Imperial Russia. Prerequisite: Hist 112.

370 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: Russ 170.

375 Survey Of Russian Literature II(Modern Period) (LEC 3.0) 20th Century Russian Literature. Prerequisite: Russ 170.

Spanish

Spanish Courses

1 Elementary Spanish I (LEC 4.0) Introduction to Spanish. Oral drills, readings, grammar and composition. Laboratory required (one extra hour per week). Prerequisite: Entrance requirements.

2 Elementary Spanish II (LEC 4.0) Continuation of Spanish I. Laboratory required (one extra hour per week). Prerequisite: Span 1.

60 Hispanic Civilization (LEC 3.0) General survey of Spanish culture and life with an emphasis on the 20th century. (Taught in English). Prerequisite: Entrance Requirements.

80 Readings And Composition (LEC 4.0) Intermediate readings in Spanish. Prerequisite: Span 2.

100 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

101 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new coures. Variable title.

110 Basic Spanish Conversation (LEC 2.0) Spanish conversation and oral practice. Prerequisite: Span 2.

160 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: Span 80.

170 Masterpieces Of Hispanic Literature (LEC 3.0) A study of the major works in Spanish and Spanish American literature. Prerequisite: Span 80.

180 Intermediate Spanish Composition (LEC 3.0) Practice in writing Spanish: compositions and written translations. Prerequisite: Span 80.

200 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

201 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

300 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects of projects in the department. Consent of instructor required.

301 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

302 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. Prerequisite: Spanish 80.

310 Seminar (IND 1.0-3.0) Discussion of current topics.

311 Advanced Spanish Conversation (LEC 2.0) Advanced Spanish conversation and oral practice. Prerequisite: Span 110.

370 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: Span 170 or native ability.

377 Spanish-American Novel And Short Story (LEC 3.0) A study of the development of narrative prose in Spanish America. Prerequisite: Span 170.

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 & Media Studies program offers two minors to Missouri S&T undergraduates: Communication Studies and a 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.

Most important courses in speech and media studies serve as a basis for many aspects of students' lives including not only school and vocation, but also family, society, and civic responsibility.

Faculty

Professor:

W. Lance Haynes, (Director) Ph.D., University of Minnesota

Lecturer:

Aaron Eckstein, M.A., U.WISC-Milwaukee
Cheryl Lillie, M.A., SIU-Edwardsville
Marsha Kaiser, M.A., University of Nebraska

Minor Curriculum in Communications

The Speech and Media Studies program of the department of Arts, Languages & Philosophy offers two minor degrees in communication: **Communication Studies** and **Leadership Communication**. Each minor requires fifteen hours of study.

I. Communication Studies

Core Requirements (3 hours):

- SP&M S 181-Communication Theory

Elective requirements, select 4 (12 hours):

- SP&M S 85-Principles of Speech
- SP&M S 100-Special Problems
- SP&M S 101-Special Topics
- SP&M S 150-Interpersonal Communication
- SP&M S 200-Special Problems
- SP&M S 201-Special Topics
- SP&M S 235-Intercultural Communication
- SP&M S 255-Discussion & Conference Methods
- SP&M S 275-Foundations of Video Communication
- SP&M S 283-Business and Professional Communication

Advisor or approved substitute for one of the above.

II. Leadership Communication

Core Requirement (3 hours)

- SP&M S 181-Communication Theory

Additional Requirements (12 hours):

- SP&M S 150-Interpersonal Communication or
- SP&M S 235-Intercultural Communication
- SP&M S 255-Discussion & Conference Methods
- SP&M S 265-Leadership Communication
- SP&M S 270-Leadership Practices

Advisor or approved substitute for one of the above.

Speech and Media Studies Courses

85 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.

100 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

101 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

181 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.

200 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

201 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

210 Seminar (IND 0.0-6.0) Discussion of current topics.

221 Introduction to 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 85 or 181 (required for Speech minor credit); Art 80 or Art 85 (required for Art minor credit). (Co-listed with Art 221)

235 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 181.

250 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 181.

255 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 181.

265 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 181, 250.

270 Leadership Practices (LEC 3.0) This course provides opportunities for students to do qualitative and quantitative research in leadership, small group, and organizational communication associated with activities in the Oral Communication Center. Prerequisite: Sp&M S 265 or permission of instructor.

275 Foundations Of Video Communication (LEC 3.0) Examines the historical, social, and psychological impact of television as a base from which the course explores and applies critical and creative theories of effective television communication. Includes limited video production experience. Prerequisite: Sp&M S 181 or consent of instructor.

283 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 150, 181 or permission of instructor.

300 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects of projects in the department. Consent of instructor required.

301 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

310 Seminar (IND 0.0-6.0) Discussion of current topics. Prerequisite: Senior standing.

390 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.

Statistics

(See Mathematics and Statistics)

Statistics Courses

101 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

111 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 2 or Math 4 with a grade of "C" or better. (Co-listed with Econ 111)

115 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.

116 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 115 with a grade of "C" or better.

201 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

211 Statistical Tools For Decision Making (LEC 2.0 and LAB 1.0) 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 211, 213, 215 or 217. Prerequisite: Math 8 or 12 or 14 with a grade of "C" or better.

213 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 211, 213, 215 or 217. Prerequisite: Math 15 or 21 with a grade of "C" or better.

215 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 211, 213, 215 or 217. Prerequisite: Math 15 or 21 with a grade of "C" or better.

217 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 211, 213, 215, or 217. Prerequisite: Math 22 with a grade of "C" or better.

300 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

301 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

305 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.

306 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.

307 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.

314 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 213, 215, 217, 343 and one of Math 203, 208, or 308.

320 Statistical Methods (LEC 3.0) A continuation of Stat 215 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 215.

325 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. Prerequisite: Math 4 or equivalent.

343 Probability And Statistics (LEC 3.0) Intorduction to the theory of probability and its applications, sample spaces, random variables, binomial, Poisson, normal distributions, derived distributions, and moment generating functions. Prerequisite: Math 22.

344 Mathematical Statistics (LEC 3.0) A continuation of Stat 343 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 343.

346 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 22 and one of Stat 211, 213, 215, 217, or 343. (Co-listed with Cmp Sc 366)

353 Statistical Data Analysis (LEC 3.0) 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 22 and one of Stat 115, 213, 215 and 217.

355 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 343. (Co-listed with Econ 355)

356 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 343.

390 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.

Systems Engineering

Systems Engineering Courses

300 Special Problems (IND 1.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

301 Special Topics (Variable 1.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

348 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 243 or Comp Eng 213 and graduate standing. (Co-listed with Comp Eng 348 and Elec Eng 348)

367 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: Stat 217. (Co-listed with Elec Eng 367 and Comp Eng 358)

368 System Engineering and Analysis I (LEC 3.0) The concepts of Systems Engineering are covered. The objective is to provide the basic knowledge and tools of transforming an operational need into a defined system configuration through the iterative process of analysis, system integration, synthesis, optimization, and design. Prerequisite: Graduate or senior standing. (Co-listed with Eng Mgt 368)

378 Introduction To Neural Networks & Applications (LEC 3.0) Introduction to artificial neural network architectures, adaline, madaline, back propagation, BAM, and Hopfield memory, counterpropagation networks, self organizing maps, adaptive resonance theory, are the topics covered. Students experiment with the use of artificial neural networks in engineering through semester projects. Prerequisite: Math 204 or 229. (Co-listed with Cmp Sc 378, El Eng 368)

Technical Communication

Bachelor of Science
Master of Science

The Technical Communication program is offered in the Department of English and Technical Communication.

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, techhnical 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.

Faculty

Associate Professors:
Gene Doty, (Emeritus), M.A., Emporia State University
Ed Malone, Ph.D., University of Southern Illinois-Carbondale
Kristine Swenson, Ph.D., University of Iowa
Assistant Professors:
Kathryn Northcut, Ph.D., Texas Tech University
David Wright, Ph.D., Oklahoma State University

Bachelor of Science Technical Communication

The Technical Communication degree requires 33 credit hours of core courses: ENGL 281, TCH COM 240, 260, 302, 340, 385, and five additional courses from the following list: ENGL 160, 305, TCH COM 301, 310, 331, 333, 361, 380. 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	Credit
English 20-Exposition & Argumentation	3
Math 4-College Algebra	3
Psychology 50-General Psychology	3
Interdisciplinary Course[1]	3
Humanities, Art, Music, Theater	3
	15
Second Semester	
Tch Com 65-Intro to Tech Com	3
BioSci 110, 231, 235, or 251	3
History 175, 176, 111, or 112	3
Interdisciplinary Course[1]	3
Econ 121-Microeconomics	3
	15

SOPHOMORE YEAR

First Semester	Credit
Sp&M 85-Principles of Speech	3
English Literature	3
Tch Com 240-Layout and Design	3
English 281-Theory of Written Com.	3
Interdisciplinary Course[1]	3
	15
Second Semester	
Humanities, Art, Music, Theater	3
Political Science 90-American Govt.	3
Tch Com 260-Practicum in Tech Com	3
Tch Com Elective	3
Chemistry, Geology, Physics	3
Interdisciplinary Course[1]	3
	18

JUNIOR YEAR

First Semester	redit
Math/Statistics	3
Tch Com 340-Theory of Visual TCom	3
Interdisciplinary Course[1]	3
Interdisciplinary Course[1]	3
Interdisciplinary Course[1]	3
	15
Second Semester	
Tch Com 302-Research Methods	3
Tch Com Elective	3
Tch Com Elective	3
Interdisciplinary Course[1]	3
Interdisciplinary Course[1]	3
Free Elective	3
	18

SENIOR YEAR

First Semester	Credit
Tch Com Elective	3
Interdisciplinary Course[1]	3
Interdisciplinary Course[1]	3
Free Elective	3
Free Elective	3
	15
Second Semester	
Tch Com 385-Theory and Practice of Tech Com	3
Tch Com Elective	3
Interdisciplinary Course[1]	3
Free Elective	3
Free Elective	3
	15

Note:
1) 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 200 or above. The student's course selections must be approved by the Department of English and Technical Communication's technical communication committee.

Technical Communication Minor Curriculum

To complete this minor students must take Technical Communication 65, 240, and 260 plus six additional hours elected from the 300-level technical communication courses.

Technical Communication Courses

65 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 20. (Co-listed with English 65)

240 Layout and Design (LEC 3.0) Theory and practice of layout and design for print and electronic media. Prerequisite: TCH COM 65 or English 65. (Co-listed with English 240)

260 Practicum in Technical Communication (LEC 3.0) Practice in writing, editing, and designing layouts of technical publications using the personal computer for desktop publication. Prerequisite: English 65 or TCH COM 65 (Co-listed with English 260)

300 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

301 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

302 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: TCH COM 65 AND TCH COM 240 or English 65 and English 240.

310 Seminar (RSD 0.0-6.0) Discussion of current topics. Prerequisite: TCH COM 65 and TCH COM 240.

331 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: TCH COM 65 AND TCH COM 240.

333 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.

340 Theory of Visual Technical Communication (LEC 3.0) A study of the relationships between visual and conceptual elements of technical communication. Prerequisites: TCH COM 65 and TCH COM 240 or English 65 and English 240.

361 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: TCH COM 65 and TCH COM 240.

380 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 the major core curriculum.

385 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: Senior Status and TCH COM 65 and TCH COM 240 or English 65 and English 240.

Theatre

The Missouri S&T Theatre Program offers courses in theatre production and performance, theatre appreciation, and special projects. The University Theatre presents a major production of a play, operetta, or musical each semester. You are encouraged to participate as a performer, technician or production assistant.

Recent productions have included, The Imaginary Invalid by Moliere, A Funny Thing Happened on the Way to the Forum by Larry Gelbart, The Odd Couple by Neil Simon, Joseph and the Amazing Technicolor Dreamcoat by Webber and Rice, My Fair Lady by Lerner & Loewe, The Liar by Carlo Goldoni, Camalot by Lerner & Loewe, The Foreigner by Larry Shue, Annie Get Your Gun by Irving Berlin, Harvey by Mary Chase, Footloose by Dean Pitchford, and Little Shop of Horrors by Ashman & Menken.

Faculty

Assistant Professor:
Jeanne Stanley, M.F.A., Lindenwood University

Theatre Minor Curriculum

1) A minor in theatre requires a minimum of 13 hours comprised of the following courses:
- **A)** Theatre 141-Acting One
- **B)** Theatre 42-Stage Production-Perfromers or The 220-Theatre Ensemble
- **C)** Theatre 43-Stage Productions-Technicians
- **D)** Theatre 143-Stagecraft

2) 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 13 hours.

Acting/Directing
- **A)** Theatre 241-Acting Two
- **B)** Theatre 341-Directing
- **C)** Theatre 243-Entertainment Design or Music 11-Individual Music Instruction

Technical Theatre
- **A)** Theatre 243-Entertainment Design
- **B)** Theatre 241-Acting Two or the 341-Directing

Theatre Courses

42 **Stage Productions, Performers** (LAB 1.0) Performers; participants selected by audition. A skills course, not a humanities elective. Prerequisite: Participants selected by audition.

43 **Stage Productions, Technicians** (LAB 1.0) Technicians and production assistants; participants selected by interview. A skills course, not a humanities elective.

90 **Theatre Appreciation** (LEC 3.0) A survey of technical and artistic developments in theatre in Western Civilization.

100 **Special Problems** (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

101 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

141 **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.

143 **Stagecraft** (LEC 1.0 and LAB 2.0) Students will learn the fundamentals of theatrical construction, production, and organization.

200 **Special Problems** (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

201 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

220 **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.

241 **Acting II** (LEC 2.0 and LAB 1.0) Continuation of Acting I, covering acting styles, more complicated, nuanced roles, and more detailed character analysis and performance-special emphasis on Shakespearean performance. Prerequisite: Theatre 141.

243 **Entertainment Design** (LEC 1.0 and LAB 2.0) Students will learn the fundamentals of design for live theatre, film, theme parks, clubs, concerts, and dance events.

300 **Special Problems** (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

301 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

341 **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 141.