Aerospace Engineering

Bachelor of Science
Master of Science
Doctor of Philosophy

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

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

Your professional training in aerospace engineering will be directed generally toward the analysis and design of aerospace vehicles, including aircraft, missiles, and spacecraft with special emphasis on the fundamental treatment of aerospace science. You will accomplish your goals through your basic training in gas dynamics, stability control dynamics, structures, propulsion, and aerodynamics including cross-lineage between these areas. You will use this knowledge to design, build, and flight test aerospace systems during the sophomore and senior years.

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

Your design courses will be integrated with UMR's computer graphics system to unify the graphical capabilities of the computer into your design experience. The Mechanical and Aerospace Engineering Department also has a departmental honors program. This program provides enhanced educational opportunities for you if you qualify. Upon satisfactory completion of the program, the designation of "Honors Scholar in Engineering" will appear on your diploma and transcript. Undergraduate departmental research opportunities are also available through the NASA Space Grant Consortium and the OURE program.

Classes and laboratories are held in the Mechanical Engineering Building. There is a Mach 1.5 to 4 supersonic blow down wind tunnel with a five-inch diameter jet which has continuous run-time duration's of up to five minutes. There is instrumentation for Schlieren photography, pressure, temperature, and turbulence measurements. A large subsonic wind tunnel, capable of speeds of up to 300 miles per hour, has a test section 4 feet wide by 2.7 feet high by 11 feet long and is complemented by a six-component balance system. Other facilities include flight simulation laboratory, space systems engineering laboratory, aerospace structural test equipment, propulsion component analysis systems, and shock tubes.

Mission Statement

To build and enhance the excellent public program that the Department of Mechanical and Aerospace Engineering currently is, and to be recognized as such; to provide our students with experiences in solving open-ended problems of industrial and societal need through learned skills in integrating engineering sciences, and synthesizing and developing useful products and processes; to provide experiences in leadership, teamwork, communications-oral, written and graphic-, and hands-on activities, with the help of structured and unstructured real-life projects.

UMR Aerospace Engineering graduates will have:

1) A solid foundation of principles of science and engineering with strong background in mathematics and physics to serve as foundation for life-long learning.
2) A solid technical knowledge in the areas of aerodynamics, space dynamics, materials, structures, stability and control, and propulsion, including cross-linkage among the areas.
3) The ability to apply engineering knowledge and skills to engineering analysis, solve open-ended problems, design projects, and develop useful products and processes.
4) The ability to work in team environment, create group synergy in pursuing a given goal, and communicate technical information in written, oral, visual and graphical formats.
5) An awareness and understanding of their moral, ethical, and professional obligations to protect human health and the environment.

Aerospace Program Outcomes:

Aerospace graduates will be able to:
A) Apply knowledge of mathematics, science, and engineering.
B) Design and conduct experiments, as well as to analyze and interpret data.
C) Design a system, component, or process to meet desired needs.
D) Function on multi-disciplinary teams.
E) Identify, formulate, and solve engineering problems.
F) Understand professional and ethical responsibility.
G) Communicate effectively.
H) Understand the impact of engineering solutions in a global and societal context.
I) Engage in life-long learning
J) Handle contemporary issues.

K) Use the techniques, skills, and modern engineering tools necessary for engineering practice.

Faculty

Professors:

S.N. Balakrishnan, Ph.D., University of Texas,at Austin
K. Chandrashekhara, Ph.D., Virginia Polytechnic Institute and State University
L. R. Dharani (Curators'), Ph.D., Clemson
Walter Eversman[1] (Curators'), Ph.D., Stanford
Fathi Finaish (Associate Chair), Ph.D., University of Colorado
K.M.Isaac, Ph.D., Virginia Polytechnic Institute and State University
David W. Riggins, Ph.D., Virginia Polytechnic Institute and State University

Associate Professors:

Gearoid MacSithigh, Ph.D., Minnesota
Henry J. Pernicka, Ph.D., Purdue

Emeritus Professors:

Donald Cronin (Emeritus), Ph.D., California Institute of Technology
Leslie R. Koval (Emeritus), Ph.D., Cornell
Shen Ching Lee[1] (Emeritus), Ph.D., Washington
Terry Lehnhoff[1] (Emeritus), Ph.D., Illinois
Robert Oetting[1] (Emeritus), Ph.D., Maryland
Bruce Selberg (Emeritus), Aerospace Engineer, University of Michigan

[1]Registered Professional Engineer

Bachelor of Science Aerospace Engineering

Entering freshmen desiring to study Aerospace Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Aerospace 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 Aerospace Engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in Aerospace Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1) All students are required to take one American history course, one economics course, one humanities course, and English 20. The history course is to be selected from History 112, History 175, History 176, or Political Science 90. The economics course may be either Economics 121 or 122. The humanities course must be selected from the approved lists for Art, English, Foreign Languages, Music, Philosophy, Speech and Media Studies, or Theater.

2) Depth requirement. Three credit hours must be taken in humanities or social sciences at the 100 level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 70 or 80 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 300 level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.

3) The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to English 20.

4) Any specific departmental requirements in the general studies area must be satisfied.

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

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

FREE ELECTIVES FOOTNOTE:

Free electives. Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.

FRESHMAN YEAR

First Semester	Credit
Freshman Engineering 10	1
Chemistry 1,2,4[1]	6
English 20	3
Math 14[4]	4
H/SS History elective[2]	3
	16
Second Semester	
IDE 20	3
Math 15[4]	4
Physics 23[4]	4
H/SS Economics elective[3]	3
	14

SOPHOMORE YEAR

First Semester	Credit
Cmp Sc 73 or 74-Basic Sci Prog	2
Cmp Sc 77 or 78-Comp Prog Lab	1

IDE 50 or 51-Eng Mech-Statics 3
Math 22-Calc/Analy Geom III[4] 4
Physics 24-Eng Physics II 4
Ae Eng 161-Aero Vehicle Performance 3
17

Second Semester
Ae Eng 180-Intro to Aerospace Design 2
Ae Eng 160-Eng Mech-Dyn[5] 3
Mc Eng 219-Thermodynamics[4,5] 3
Math 204-Elem Diff Equations 3
IDE 110-Mech of Materials 3
Elective/Literature 3
17

JUNIOR YEAR

First Semester — Credit
Ae Eng 213-Aerospace Mech I[4] — 3
Ae Eng 231-Aerodynamics I[4,5] 3
Ae Eng 377-Princ of Eng Materials 3
El Eng 281-Electrical Circuits 3
Electives-Advanced Math/Cmp Sc[6] 3
15

Second Semester
Ae Eng 251-Aerospace Structures I[4] 3
Ae Eng 261-Flight Dynamics and Control 3
Ae Eng 271-Aerodynamics II 3
Ae Eng 282-Exp Methods in Ae Eng I 2
Elective/Ethics[11] 3
Elective/Communications[8] 3
17

SENIOR YEAR

First Semester — Credit
Ae Eng 235-Aircraft & Space Vehicle Propulsion 3
Ae Eng 253-Aerospace Structures II 3
Ae Eng 280 or 380-Aero Sys Design I 2
Ae Eng 283-Experimental Methods in Ae Eng II 2
Electives-Technical[7] 3
Electives/Hum/Soc Sci[9] 3
16

Second Semester
Ae Eng 281 or 382-Aero Sys Design II 3
Electives-Technical[7] 3
Electives-Technical[7] 3
Electives Free[10] 3
Electives-Hum/Soc Sci[9] 3
15

List of Notes:

1) Chemistry 1 ,2 and 4 or an equivalent training program approved by UMR
2) Must be one of the following: Political Science 90, History 112, History 175, or History 176.
3) Must be one of the following: Economics 121 or Economics 122.
4) A grade of "C" or better in Math 14, 15, 22, and Physics 23 is required both for enrollment in ME 219, AE 213, AE 231, or AE 251 and for graduation.
5) A grade of "C" or better in Ae Eng 160 and ME 219 is required both for enrollment in any courses which require either Ae Eng 160 or ME 219 as prerequisites and for graduation.
6) Must be one of the following: Comp Sc 228, Math 203, Math 208, or any 300-level math or computer science course approved by the student's advisor.
7) Electives must be approved by the student's advisor. Nine hours of technical electives must be in the Mechanical and Aerospace Engineering. Three hours of departmental technical electives must be at the 300-level. Honors students have special requirements for technical electives.
8) This course can be selected from English 60, 160, SP&MS 85, or the complete four-course sequence in Advanced ROTC (Mil Sc 105, 106, 207, and 208 or Aerospace Studies 350, 351, 380, and 381).
9) All electives must be approved by the student's advisor. Students must comply with the requirements specified in the current catalog.
10) Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.
11) Must be a course on engineering ethics, business ethics, social ethics, or any ethics course approved by the student's advisor.

NOTE: All Aerospace 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 UMR assessment process as described in Assessment Requirements found elsewhere in the catalog. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.

Requirements for a Minor in Aerospace Engineering

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

- Ae Eng 161-Aerospace Vehicle Performance
- Ae Eng 213-Aerospace Mechanics I
- Ae Eng 231-Aerodynamics I
- Ae Eng 251-Aerospace Structures I
- Ae Eng 200 level 3-hour lecture course (student choice)

Aerospace Engineering Courses

60 Introduction To Aviation (LEC 3.0) A general introduction to aviation and preparation for the Federal Aviation Administration private pilot written examination. Areas of study include theory of flight, communication procedures, use of the flight computer, aviation weather, visual and radio

navigation, federal aviation regulations. Prerequisite: (Entrance requirements).

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.

160 Dynamics (LEC 3.0) The principles of mechanics are used to model engineering systems. Kinematics of particle motion, kinematics of plane- and three-dimensional motions of rigid bodies. Kinetics of particles and of rigid bodies. Energy and momentum methods. Prerequisites: Math 22, grade of "C" or better in IDE 50. (Co-listed with Mech Eng 160)

161 Aerospace Vehicle Performance (LEC 3.0) Nature and theory of lift, drag, performance, and stability and control of aerospace vehicles. Prerequisite: Physics 23.

180 Introduction To Aerospace Design (LAB 2.0) Introduction to methodology of aerospace vehicle design and principles of layout to meet a given specification, mission objective, component sizing, design iteration and building & performance testing of models. Prerequisite: Ae Eng 161.

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.

202 Cooperative Engineering Training (IND 0.0-6.0) On-the-job experience gained through cooperative education with industry with credit arranged through departmental co-op adviser. Grade received depends on quality of reports submitted and work supervisor's evaluation.

210 Seminar In Aerospace Engineering (RSD 1.0) Discussion of current topics.

213 Aerospace Mechanics I (LEC 3.0) Introduction to celestial mechanics and an analytical study of space flight. Emphasis is placed on satellite orbits and general theory of gyrodynamics. Prerequisites: A grade of "C" or better in Aero Eng 160 (or Mech Eng 160), Math 14 (or 8), 15 (or 21), 22, and Physics 23.

231 Aerodynamics I (LEC 3.0) A study of the fundamental concepts of fluid mechanics as applied to aerodynamic applications with both differential and control volume analysis. Theory and application of viscous and inviscid incompressible flow including boundary layer theory and two dimensional airfoil theory. Prerequisites: Accompanied or preceded by Ae Eng 161 and a grade of "C" or better in Math 14 (or 8), 15 (or 21), 22, Physics 23, and Mc Eng 219.

233 Introduction To Aerothermochemistry (LEC 3.0) Principles of thermochemistry in reacting flow including an introduction to fundamentals of quantum mechanics, statistical mechanics and statistical thermodynamics. Applications in flow through nozzles and shock waves, combustion, aerodynamic heating, ablation and propulsion. Prerequisites: Ae Eng 231, Ae Eng 271.

235 Aircraft And Space Vehicle Propulsion (LEC 3.0) Analysis of aircraft and missile propulsion systems; fundamentals of jet propulsion including air breathing and rocket engines. Introduction to advanced propulsion systems for space flights such as nuclear, thermonuclear, and plasma jets. Prerequisite: Mc Eng 231, or Ae Eng 271.

251 Aerospace Structures I (LEC 3.0) An introduction to various loads on aerospace vehicles. Basic theory and analysis of typical aerospace and related vehicle structures subjected to steady loading. An overview of various failure theories including yielding, buckling, fracture and fatigue. Design of thin walled structures. Introduction to advanced composite materials. Prerequisites: IDE 110 and a grade of "C" or better in Math 14 (or 8), 15 (or 21), 22, and Physics 23.

253 Aerospace Structures II (LEC 3.0) Introduction to the finite element method for static and dynamic analysis of aerospace structures. Analysis of beams, trusses and frames. Plane stress and plane strain analysis. Isoparametric elements and numerical integration. Free vibration and time dependent problems.

261 Flight Dynamics And Control (LEC 3.0) Static stability and control of conventional aircraft and implications in aircraft design. Six degrees of freedom time dependent equations of motion and their linearized solutions. Consideration of stability vs maneuverability, and the dynamic modes of motion of the aircraft. Prerequisites: Ae Eng 213, Ae Eng 231, and accompanied or preceded by Ae Eng 180.

271 Aerodynamics II (LEC 3.0) Three dimensional incompressible wing theory. Compressible one dimensional flow with normal and oblique shock waves, heat addition, and friction. Compressible transonic, and supersonic linearized flow theory. Supersonic wings and wing/fuselage configurations. Prerequisite: Ae Eng 231.

273 Aerodynamics Applied To Current Problems (LEC 3.0) Applications of aerodynamic principles to current problems including such topics as V/STOL aerodynamics, transonic and hypersonic aerodynamics, sonic boom, rarefied gas dynamics, reactive aerodynamics. Additional topics in diffusion and dispersion processes of micro-, macro-, meso-, and global-scale aerodynamics. Prerequisite: Ae Eng 271.

280 Aerospace Systems Design I (LEC 2.0) Consideration of the creative design process with emphasis on aeronautical-aerospace systems. Short design problems to illustrate the process. Selection of design projects for AE 281. Information gathering for the design projects which will be completed in Aerospace Systems Design II. Fall semester. Prerequisites: Ae Eng 251, 261, 271.

281 Aerospace Systems Design II (LAB 3.0) Preliminary design of aerospace systems. Project to integrate the knowledge of different aerospace engineering areas through synthesis and analysis. The creative design will include a consideration of

such factors as performance reliability, cost, human factors, energy and ecology. Spring semester. Prerequisites: Ae Eng 235, 253, 280.

282 Experimental Methods In Aerospace Engineering I (LAB 2.0) Introduction to experimental methods in low-speed aerodynamics, flight simulation, and aircraft structures. Measurements of drag, boundary layer flows, and aerodynamic forces and moments. Flight simulations, and structural testing of aircraft components. Statistical methods and probability distributions in data analysis and interpretation. Prerequisites: Ae Eng 231 and El Eng 281.

283 Experimental Methods In Aerospace Engineering II (LAB 2.0) Laboratory investigations related to aerospace engineering. Investigations include high-speed aerodynamics, flow visualization measurements in turbulent flow, aircraft vibration and flutter, propeller acoustics, flight simulation, propulsion systems, flame measurements, and control experiments. Statistical error analysis. Prerequisites: Ae Eng 251, 261, 271, & 282.

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.

307 Vibrations I (LEC 3.0) Equations of motion, free and forced vibration of single degree of freedom systems. Natural frequencies, resonance, modes of vibration and energy dissipation are studied. The vibration of continuous systems is introduced. Prerequisites: Mc Eng 211 and 213, or Ae Eng 213 and Math 204. (Co-listed with Mc Eng 307, E Mech 361)

309 Engineering Acoustics I (LEC 3.0) Introduction to acoustical theory and measurement with emphasis on mechanical and aerospace engineering applications. Plane and spherical wave propagation, resonators and filters, absorption, room acoustics, human response to noise, noise legislation, noise control. Use of common instrumentation in several projects. Prerequisites: Mc Eng 211 & 213, or Ae Eng 213 & Math 204. (Co-listed with Mc Eng 309)

311 Introduction To Composite Materials & Structures (LEC 3.0) Introduction to fiber-reinforced composite materials and structures with emphasis on analysis and design. Composite micromechanics, lamination theory and failure criteria. Design procedures for structures made of composite materials. An overview of fabrication and experimental characterization. Prerequisite: IDE 110. (Co-listed with Eng Mech 381 and Mech Eng 382)

313 Intermediate Dynamics Of Mechanical And Aerospace Systems (LEC 3.0) Principles of dynamics are applied to problems in the design of mechanical and aerospace systems; basic concepts in kinematics and dynamics; dynamics of systems of particles; dynamics of rigid bodies, three-dimensional effects in machine elements; dynamic stability, theory and applications; methods of analytical dynamics. Prerequisite: Mc Eng 213 or Ae Eng 213. (Co-listed with Mc Eng 313)

314 Spaceflight Mechanics (LEC 3.0) Further topics in orbital mechanics. Time equations, Lambert's problem, patched-conic method, orbital maneuvers, orbit determination, orbit design, re-entry problem. Prerequisite: Ae Eng 213.

315 Concurrent Engineering I (LEC 3.0) Students will be introduced to the concurrent engineering approach to product development. They will learn to set up quantitative requirements and then use a quantitative rating process to identify the critical requirements relating to the desired product. The interaction between design, manufacturing, assembly, cost, and supportability will be covered. The students will form teams and practice the concurrent engineering process for simple products. Prerequisites: Mech Eng 213 or Aero Eng 231, and IDE 110. (Co-listed with Mech Eng 315)

316 Concurrent Engineering II (LAB 3.0) Students will form groups and then using the electronic data based approach apply the concurrent engineering process to develop products. Areas to be covered are the customer, design, manufacturing, assembly, cost and supportability. Prerequisite: Ae Eng 315 or Mc Eng 315. (Co-listed with Mc Eng 316)

319 Advanced Thermodynamics (LEC 3.0) After a short review of classical thermodynamics, the elements of chemical reactions, chemical equilibrium, statistical thermodynamics, and the basic concepts of kinetic theory are presented. Prerequisite: Ae Eng 233. (Co-listed with Mc Eng 319)

321 Aerodynamics Cad Design (LAB 3.0) Aircraft fuselages, wings, and fuselage-wing configurations will be constructed with a 3D CAD package, UNIGRAPHICS. These configurations will then be analyzed with an aerodynamics paneling program. Emphasis will be placed on the designing of these shapes for maximizing the aerodynamic performance. Prerequisite: Ae Eng 231.

322 Introduction To Solid Mechanics (LEC 3.0) Review of basic concepts in continuum mechanics. Finite elasticity: some universal solutions for isotropic materials, application of special mechanical models. Linear elasticity: compatibility, stress functions, superposition, special examples such as extension, torsion, bending, and plane problems. Elements of plasticity. Prerequisite: E Mech 311. (Co-listed with E Mech 322, Mc Eng 322)

325 Intermediate Heat Transfer (LEC 3.0) Analytical study of conduction; theory of thermal radiation and applications; energy and momentum equations in convective heat transfer and review of empirical relations. Current topics are included. Prerequisite: Mc Eng 225. (Co-listed with Mc Eng 325)

327 Combustion Processes (LEC 3.0) Application of chemical, thermodynamic, and gas dynamic prin-

ciples to the combustion of solid, liquid, and gaseous fuels. Includes stoichiometry, thermochemistry, reaction mechanism, reaction velocity, temperature levels, and combustion waves. Prerequisite: Mc Eng 221. (Co-listed with Mc Eng 327)

329 Smart Materials And Sensors (LEC 2.0 and LAB 1.0) Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multi-disciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior standing and Math 204. (Co-listed with Mc Eng, E Mech, El Eng 329 and Cv Eng 318)

331 Thermofluid Mechanics II (LEC 3.0) Derivation of Navier-Stokes equations, exact solutions of some simple flows. Superposition methods for inviscid flows. Intermediate treatment of boundary layer theory, and gas dynamics. Introduction to turbulence and kinetic theory. Prerequisite: Mc Eng 231 or Ae Eng 231. (Co-listed with Mc Eng 331)

334 Stability Of Engineering Structures (LEC 3.0) Solution of stability problems with applications to columns, plates and shell structures. Torsional and lateral buckling of columns. Buckling under high temperatures. Effect of imperfections introduced by a technological process on stability. Design issues related to stability requirements. Prerequisites: IDE 110; Math 204; and IDE 150 or Mech Eng 160 or Aero Eng 160. (Co-listed with Mech Eng 334 and Eng Mech 334)

335 Aerospace Propulsion Systems (LEC 3.0) Study of atmospheric and space propulsion systems with emphasis on topics of particular current interest. Mission analysis in space as it affects the propulsion system. Power generation in space including direct and indirect energy conversion schemes. Prerequisite: Ae Eng 235.

336 Fracture Mechanics (LEC 3.0) Linear elastic and plastic mathematical models for stresses around cracks; concept of stress intensity; strain energy release rates; correlation of models with experiment; determination of plane stress and plane strain parameters; application to design. Prerequisite: IDE 110. (Co-listed with Mech Eng 336, Eng Mech 336)

339 Computational Fluid Dynamics (LEC 3.0) Introduction to the numerical solution of the Navier-Stokes equations, by finite difference methods, in both stream function-vorticity and primitive variable formulations. Course format emphasizes student development of complete computer programs utilizing a variety of solution methods. Prerequisites: Comp Sci 53 or 73 or 74; one course in fluid mechanics. (Co-listed with Mc Eng 339)

341 Experimental Stress Analysis I (LEC 2.0 and LAB 1.0) Acquaints the student with some techniques of experimental stress analysis. Principal stresses, strain to stress conversion, mechanical and optical strain gages, electrical resistance strain gages, transducers, and brittle coatings. Prerequisite: IDE 110. (Co-listed with Mech Eng 341, Eng Mech 341)

342 Experimental Stress Analysis II (LEC 2.0 and LAB 1.0) Acquaints the student with some techniques of experimental stress analysis. Topics include principal stresses, strain to stress conversion, transmission and reflection photoelastic methods, Moire fringe methods, and analogies. Prerequisites: IDE 110, Eng Mech 321. (Co-listed with Mech Eng 342, Eng Mech 342)

343 Photographic Systems For Engineering Applications (LEC 2.0 and LAB 1.0) Study of photographic techniques applied to engineering uses including observations of events, recording and storage of data, and communication and dissemination of information. Both conventional and special photo-optical systems are covered. Prerequisite: Senior standing. (Co-listed with Mc Eng 343)

344 Fatigue Analysis (LEC 3.0) The mechanism of fatigue, fatigue strength of metals, fracture mechanics, influence of stress conditions on fatigue strength, stress concentrations, surface treatment effects, corrosion fatigue and fretting corrosion, fatigue of joints components and structures, design to prevent fatigue. Prerequisite: IDE 110. (Co-listed with Eng Mech 337, Mech Eng 338)

349 Robotic Manipulators & Mechanisms (LEC 2.0 and LAB 1.0) Overview of industrial applications, manipulator systems and geometry. Manipulator kinematics; hand location, velocity and acceleration. Basic formulation of manipulator dynamics and control. Introduction to machine vision. Projects include robot programming, vision-aided inspection and guidance, and system integration. Prerequisites: Cmp Sc 73, Ae Eng 213. (Co-listed with Mc Eng 349)

350 Integrated Product Development (LEC 2.0 and LAB 1.0) Students in design teams will simulate the industrial concurrent engineering development process. Areas covered will be design, manufacturing, assembly, cost, and product support. Using a 3-D solid modeling program, students will design, analyze, and send the data base to the automated machine shop where the parts will be manufactured. The parts will then be assembled, tested and analyzed for their performance. Prerequisites: Ae Eng 251 or Mc Eng 208 for Design; Mc Eng 213 for Assembly; Accompanied or preceded by Mc Eng 353 for Manufacturing; Eng Mg 375 or 385 for Cost/Product Support.

351 Intermediate Aerospace Structures (LEC 3.0) Discussion of the finite element method for static and dynamic analysis of complex aerospace structures. Solution of basic problems using established finite element computer programs. Prereq-

uisite: Ae Eng 253 or Mc Eng 212. (Co-listed with Mc Eng 351)

352 Finite Element Approximation I--An Introduction (LEC 3.0) Variational statement of a problem. Galerkin Approximation, finite element basis functions and calculations, element assembly, solution of equations boundary conditions, interpretation of the approximation solution, development of a finite element program, two-dimensional problems. Prerequisite: Math 204. (Co-listed with Mc Eng 312, E Mech 307)

353 Aeroelasticity (LEC 3.0) Study of phenomena involving interactions among inertial, aerodynamic, and elastic forces and the influence of these interactions on aircraft and space vehicle design. Some aeroelastic phenomena are: divergence, control effectiveness, control reversal, flutter, buffeting, dynamic response to rapidly applied loads, aeroelastic effects on load distribution, and static and dynamic stability. Prerequisites: Ae Eng 251 and 271.

360 Probabilistic Engineering Design (LEC 3.0) The course deals with uncertainties in engineering analysis and design at three levels - uncertainty modeling, uncertainty analysis, and design under uncertainty. It covers physics-based reliability analysis and reliability-based design, robustness assessment and robust design, their integration with design simulations, and their engineering applications. Prerequisite: Mech Eng 208 or Aero Eng 261. (Co-listed with Mech Eng 360)

361 Flight Dynamics-Stability And Control (LEC 3.0) Review of static stability, dynamic equations of motion, linearized solutions, classical control design and analysis techniques, introduction to modern control. Prerequisite: Ae Eng 261.

362 Experimental Vibration Analysis (LEC 2.0 and LAB 1.0) Methods for measuring and analyzing motion and strain response of dynamically excited structures. Includes frequency-response testing of elementary beam, torsion bar, plate and shell structures. Experiments on the effectiveness of isolators and dynamic absorbers. Prerequisite: E Mech 361 or Mc Eng 307 or Ae Eng 307. (Co-listed with Mc Eng 362, E Mech 362)

369 Introduction To Hypersonic Flow (LEC 3.0) A study of the basic principles of hypersonic flow. Invisvid and viscous hypersonic flow. Application of numerical methods. High temperature flow. Consideration of real gas and rarefied flow. Applications in aero-dynamic heating and atmospheric entry. Prerequisite: Ae Eng 271 or Mc Eng or Ae Eng 331.

371 V/Stol Aerodynamics (LEC 3.0) Basic concepts of V/STOL flight. Take-off transition and landing performance, thrust vectoring. Propeller and helicopter aerodynamics. Unblown and blown flaps. Boundary layer control. Lift fans and ducted propellers. Wing-propeller interaction and thrust augmentation. Prerequisite: Ae Eng 271.

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

380 Spacecraft Design I (LEC 3.0) Fundamentals of spacecraft design. Systems engineering, subsystem analysis and design. Gantt charts, organizational charts. Oral presentations and technical documentation. Term project to involve design and development of actual flight hardware, continuing into Spacecraft Design II. Prerequisites: Ae Eng 251, 261, and 271 for Ae Eng majors; consent of instructor for non-Ae Eng majors.

381 Mechanical And Aerospace Control Systems (LEC 3.0) Synthesis of mechanical and aerospace systems to perform specific control functions. Response and stability are studied. Singular value analysis for stability margins is introduced. Prerequisite: Mc Eng 279 or Ae Eng 361. (Co-listed with Mc Eng 381)

382 Spacecraft Design II (LAB 3.0) As a continuation of Ae Eng 380, detailed spacecraft design is performed, leading to procurement of components. As schedules permit, spacecraft fabrication and test commence. Development of labs to facilitate spacecraft test, operation, and data analysis continues. Prerequisites: Ae Eng 235, 253, and 380 for Ae Eng majors; consent of instructor for non-Ae Eng majors.

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.

Aerospace Studies

Air Force ROTC

Air Force Reserve Officer Training Corps (ROTC) is administered by the Department of Aerospace Studies . The mission of Air Force ROTC is to develop quality leaders for the Air Force. As the largest source of Air Force officers, Air Force ROTC offers a number of opportunities for UMR students who wish to become commissioned officers by offering professional, academic, and military training. Leadership, communication, and basic military skills are the focus of the ROTC program. In addition to helping a student succeed during college, Air Force ROTC also fosters self-confidence and self-discipline.

Opportunities in the Air Force are excellent, with over 100 possible career fields available. Career field availability depends on academic discipline, medical condition, desires of the individual, and needs of the Air Force. As newly commissioned Second Lieutenants on active duty, Air Force ROTC graduates can serve worldwide, performing challenging and rewarding duties in

highly technical, scientific, and operational areas. A few of these include design, research, engineering, systems development, space operations, computer science, procurement, flying, management, acquisitions, and maintenance.

Although Air Force ROTC is set up as a four-year program, students can choose a four, three, or two-year course of study. The first two years of the program, called the General Military Course (GMC), cover basic introductory military topics as well as communication and leadership. The final two years of the program, called the Professional Officer Course (POC), cover topics such as leadership, management, doctrine, international events, quality, communication, and officership. In addition to the academic ROTC class, all cadets attend a two hour leadership laboratory each week. Leadership laboratory provides cadets with the knowledge and practical command and staff leadership experience in preparation for active duty as Air Force officers. It is largely cadet planned, directed, and centered.

Scholarships, which may cover up to full tuition and fees, based on residency are available to qualified cadets. A monthly stipend is given during the academic year to each cadet on scholarship and also to members of the POC. Students who receive an AFROTC scholarship also receive an annual $2000 supplement from UMR, which will currently cover most room costs excluding board. Lastly, scholarship recipients receive a $750/year book allowance to offset costs. ROTC scholarship recipients are eligible to receive other UMR scholarships. Students do not have to be on a scholarship to complete our program and be an Air Force officer.

There is no obligation connected in taking Air Force ROTC for a non-scholarship cadet during the freshman and sophomore years. Obligations begin only at the start of a student's last two years of the program or after a ROTC scholarship is awarded and activated.

Students usually attend summer field training prior to their junior year, before enrollment into the POC. Entrance into the POC is based on an extensive evaluation and selection process during the student's sophomore year. Cadets who complete the POC in good standing and earn their academic degree are commissioned as second lieutenants and serve on active duty for four or more years, depending on their selected Air Force career field. Pilots incur a ten-year active duty service commitment after completing undergraduate pilot training. Navigators incur a eight-year active duty service commitment after completing undergraduate navigator training.

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

Faculty

Professor:

Jonathan Hines, (Department Chair), M.S., University of N. Dakota and B.S., Southeast Missouri State

Assistant Professors:

Angela L. McLane, B.S., Oklahoma State

Stanley J. Woronick, M.A., Webster University

Aerospace Studies Courses

150 Foundations Of The U.S. Air Force I (LEC 0.5 and LAB 0.5) This survey course is designed to introduce students to the USAF and AFROTC. Topics include: military customs and courtesies, uniform wear, officership qualities, professionalism, AF core values, equal opportunity and treatment, AF officer benefits and opportunities and an introduction to communication skills. Leadership Lab is mandatory for cadets planning on a career in the AF.

151 Foundations Of The U.S. Air Force II (LEC 0.5 and LAB 0.5) This survey course is a continuation of Arosp S 150. Covered topics include: origin of the AF, mission and organization of the AF, organization of a standard AF base, and further communication skills development. Leadership Lab is also mandatory for cadets.

200 Leadership Laboratory (LEC 0.5 and LAB 0.5) The course involves a study of Air Force customs and courtesies, drill and ceremonies, career opportunities in the Air Force and the life and work of an Air Force junior officer. Students develop their leadership potential in a practical supervised training laboratory, which typically includes field trips to Air Force installations throughout the United States.

250 The Evolution Of USAF Air And Space Power I (LEC 0.5 and LAB 0.5) This course is designed to examine the general aspects of air and space power through a historical perspective..covering a time period from the first balloons to the beginning of the space age. It provides students with a knowledge level understanding of the general elements and employment of air and space power from an institutional doctrinal and historical perspective. Examples of the importance of AF core values in historical events and in past AF leaders are pointed out. Continued development of communication skills is also emphasized. Leadership Lab is mandatory for cadets planning on a career in the AF.

251 The Evolution Of USAF Air And Space Power II (LEC 0.5 and LAB 0.5) This course is a continuation of Arosp S 250. It covers a time period in AF history from the beginning of our space age in the early 1960's to the present...with a continued emphasis on recognizing how past leaders and events have shaped our current AF organization and doctrine. Communication skills exercises are continued. Leadership Lab is also mandatory for cadets.

350 Air Force Leadership Studies I (LEC 2.5 and LAB 0.5) This course introduces students to the leadership and management skills required of an Air Force junior officer. Special topics include leadership ethics, the Air Force personnel and evaluation systems, and management fundamentals. Through the use of classroom tools that include case studies, Air Force leadership and management situations are examined and practical applications of studies concepts are exercised. The principles and theories of ethical behavior as well as the complete understanding of the individual responsibility and authority of an Air Force officer are stressed. This course includes a Leadership Lab that provides the students the opportunity to apply leadership and management principles.

351 Air Force Leadership Studies II (LEC 2.5 and LAB 0.5) This course is a continuation of Arosp S 350. Emphasis is placed on professional knowledge, communication skills, and ethical behavior. Varied Air Force-peculiar formats and situations are offered to apply learned listening, writing, and speaking skills. This course includes a Leadership Lab that provides the students the opportunity to apply leadership and management principles.

380 National Security Affairs/Preparation For Active Duty I (LEC 2.5 and LAB 0.5) This course examines national security policies, processes, and issues along with Air Force strategy and doctrine. Special topics include Air Force roles and missions, the roles of various federal government departments, military organizations and functions, and the concept of joint operations. Within this structure, continued emphasis is given to refining communication skills. This course includes a Leadership Laboratory that provides advanced leadership experiences, giving students the opportunity to apply the leadership and management principles of this course.

381 National Security Affairs/Preparation For Active Duty II (LEC 2.5 and LAB 0.5) Continuation of Arosp S 380. This final course of the Air Force ROTC curriculum examines officership, advanced leadership ethics, military law, current Air Force issues, regional studies, core values, and preparation for active duty. This course includes a Leadership Laboratory that provides leadership experiences, giving students the opportunity to apply the leadership and management principles of this course.

Architectural Engineering

Bachelor of Science

Emphasis areas include structural engineering, construction engineering and project management, environmental systems for buildings, and construction materials.

Architectural engineers plan, design, and supervise construction of many essential facilities and structures for residential, commercial, industrial and institutional buildings. These building systems include electrical, communications and control, lighting, heating, ventilating, air conditioning, fire protection, plumbing, and structural systems. Architectural engineers are problem solvers ... applying the latest in high-tech equipment and sophisticated procedures to address challenges concerning our environment and infrastructure. The diversity of architectural engineers complements the use of multiple systems to the intent and purpose of the project's design.

The Bachelor of Science in Architectural Engineering (BSAE) degree requires satisfactory completion of 128 credit hours. In your first two years, you will complete mathematics, physics, English, architectural design and other prerequisite courses. In your third and fourth years, most of your course work will be in engineering sciences. Also in your fourth year you will complete engineering design courses in general and specific areas.

Courses in structural, electrical, mechanical and lighting design are directed toward providing reliable and economical structures such as stadiums, retail complexes, office buildings and airports. Courses in construction engineering include studies in construction techniques, cost estimating, quality control/quality assurance, and contract administration. History, architectural design and humanities provide the necessary tools to appreciably coexist in the fabric of society.

Architectural engineering is a broad field of endeavor. Because of this breadth, courses are required in each of the above areas. Although you, as a architectural engineer, may specialize within a given area, by the very nature of the profession you will be required to interact with specialists in the other areas. You will find that you will be working with architects and engineers in the other disciplines in the planning, design, and construction of complex facilities.

Architectural engineers also must be effective in communicating with the public. You may be expected to work with property owners, concerned citizens, city officials, attorneys, and even medical doctors for concerns related to public health measures. The results of your work as a architectural engineer will be seen everywhere. Projects in which you will become involved must be economical, appreciable to self and community, and provide a reasonable life expectancy. Use of computer hardware and software is a key component of the BSAE program of study.

Mission Statement

The Architectural Engineering Program will provide students with the tools necessary to solve architectural engineering problems critical to our society's well-being. This will be accomplished through a comprehensive, forward-looking and broad-based architectural engineering curriculum emphasizing fundamentals, practical applications, oral and written communication skills, computer applications skills, and professional practice issues and ethics. The Program will prepare graduates for entry into the architectural engineering profession, for

life-long learning, and to function as architectural engineers in a global society.

BSAE Program Objectives

Our graduates will have:

1) a strong fundamental scientific and technical knowledge base which they will be able to apply to experimental design, and analysis and interpretation of data in conducting experiments;

2) an ability to apply engineering skills and work in multi-disciplinary teams to identify and formulate solutions for architectural engineering problems, and to analyze and design architectural engineering projects;

3) a recognition of the professional and personal value of the continuing acquisition of knowledge;

4) competence in the use of the latest tools and techniques in architectural engineering practice and the ability to effectively communicate resulting technical and professional information in written, oral, and visual formats; and,

5) an awareness and understanding of the ethical, legal and professional obligations needed to function as part of a professional enterprise and to protect human health and welfare, and the environment in a global society.

Faculty

Professors:

Abdeldjelil Belarbi, (Curators' Teaching Professor) Ph.D., Houston
Genda Chen[1], Ph.D., Suny-Buffalo
Walter Eversman[1] (Curators'), Ph.D., Stanford
Roger LaBoube[1] (Curators' Teaching Professor), Ph.D., Missouri-Rolla
Thomas M. Petry[1], (Emeritus) Ph.D., Oklahoma State
Harry Sauer[1], Ph.D., Kansas State
William Schonberg[1] , Ph.D., Northwestern
Richard Stephenson[1], Ph.D., Oklahoma State

Associate Professors:

Jerry Bayless[1], M.S., Missouri-Rolla
Rodney Lentz[1], (Emeritus) Ph.D., Michigan State
Ronaldo Luna[1], Ph.D., Georgia Tech.
Glenn Morrison, Ph.D., California, Berkley
John Myers[1], Ph.D., Texas-Austin
David Richardson[1], Ph.D., Missouri-Rolla

Assistant Professors:

Ashraf Ayoub, Ph.D., California, Berkley
Stuart Baur[2], Ph.D., Missouri - Rolla
Jeff Schramm, Ph. D., Lehigh

Lecturer:

William Eric Showalter, Ph.D., Purdue

[1]Registered Professional Engineer
[2]Registered Architect

Bachelor of Science Architectural Engineering

Entering freshmen desiring to study Architectural Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Architectural Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the 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 Architectural Engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in Architectural Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1) All students are required to take one American history course, one economics course, one humanities course, and English 20. The history course is to be selected from History 112, History 175, History 176, or Political Science 90. The economics course may be either Economics 121 or 122. The humanities course must be selected from the approved lists for Art, English, Foreign Languages, Music, Philosophy, Speech and Media Studies, or Theater.

2) Depth requirement. Three credit hours must be taken in humanities or social sciences at the 100 level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 70 or 80 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 300 level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.

3) The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to English 20.

4) Any specific departmental requirements in the general studies area must be satisfied.

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

The Architectural Engineering program at UMR is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as

they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

FREE ELECTIVES FOOTNOTE:

Free electives. Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.

FRESHMAN YEAR

First Semester	Credit
FE 10-Study & Careers in Eng[2]	1
Chem 1 & 2-Gen Chem for Eng	5
Math 14-Calc for Engr I	4
English 20-Expos & Argumentation	3
General Ed Elective[1]	3
	16
Second Semester	
IDE 20-Eng Design w/Comp Appl	3
Math 15-Calc for Eng II	4
Phy 23-Eng Physics I	4
General Ed Elective[1]	3
	14

SOPHOMORE YEAR

First Semester	Credit
CE 001-Fund Survey & Intro to CE[2]	3
IDE 50-Eng Mc/Statics[2]	3
Math 22-Calc/Analytic Geom III	4
Physics 24-Eng Physics II	4
ArchE 003-Eng Communication	2
	16
Second Semester	
IDE 150 - Engr Mech/Dynamics	2
Stat 213 - Probability & Statistics	3
IDE 110-Mech of Materials[2]	3
IDE 120-Materials Testing Lab	1
ArchE 103-Mat & Meth of Const	2
Art 203- Arch Design I	3
Math 204-Diff Equations	3
	17

JUNIOR YEAR

First Semester	Credit
ArchE 217-Structural Analysis[2]	3
CE 230 - Elementary Fluid Mech[2]	3
El Eng 281-Elec Circuits	3
ME 227-Thermal Analysis	3
ArchE 204- Arch Design II	3
CE 215 - Elementary Soil Mechanics	3
	18
Second Semester	
ArchE 205- Bldg Elec and Lighting Systems.	2
E Mgt 207 - Econ of Engr Design[2]	2
ArchE 223 - Reinf Concrete Design	3
ME 371 - Environmental Controls	3
CE 216-Construction Materials	3
His 270 - History of Technology	3
	16

SENIOR YEAR

First Semester	Credit
ArchE 210-Senior Seminar	1
ArchE 221-Struct Design Metals	3
ArchE 248-Contracts & Construction Engng.	3
History 375-Recent American Art & Tech	3
ArchE Technical Elective[3,4]	3
General Ed Elective[1]	3
	16
Second Semester	
ArchE 298-Senior Design Project	3
ArchE Technical Elective[3,4]	3
CE 229-Foundation/Pavement Eng	3
Free Elective[5]	3
Free Elective[5]	3
	15

1) A general education electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog.

2) A grade of 'C' or better required to satisfy graduation requirements.

3) A grade of 'C' or better may be required in ArchE technical elective prerequisite courses. Refer to the UMR undergraduate catalog for this prerequisite information.

4) Choose technical electives from approved lists under Emphasis Areas for Architectural Engineering Students.

5) Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.

Note: All Architectural Engineering students must take the Fundamentals of Engineering examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree, however, it is the first step toward becoming a registered professional engineer. This requirement is part of the UMR assessment process as described in Assessment Requirements found elsewhere in this catalog. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.

Emphasis Areas and Course Listings by Area for Architectural Engineering Students

Area I, Structural Engineering

ArchE 301	Structural Dynamics
ArchE 319	Applied Mechanics in Structural Engr
ArchE 320	Structural Analysis II
ArchE 322	Analysis and Design of Wood Structures
ArchE 323	Classical and Matrix Meth Strucl Analy
ArchE 326	Advanced Steel Structures Design
ArchE 327	Advanced Concrete Structures Design

ArchE 328 Prestressed Concrete Design
ArchE 329 Foundation Engineering II
ArchE 3XX Masonry Engineering
ArchE 374 Infrast. Strengthening with Composites

Area II, Construction Engineering and Project Management

ArchE 345 Construction Methods
ArchE 346 Management of Construction Costs
ArchE 349 Eng and Construc Contract Specs
Eng Mg 211 Managing Engineering and Technology
Eng Mg 252 Financial Management
Eng Mg 313 Human Relations in Technical Management
Eng Mg 364 Value Analysis
Eng Mg 375 Total Quality Management

Area III, Environmental Systems for Buildings
Mechanical Emphasis Courses

Mc Eng 309 Engineering Acoustics I
Mc Eng 375 Mech Systems for Environ Control

Electrical Emphasis Courses

El Eng 235 Controllers for Factory Automation
El Eng 282 Electronic Circuits and Machines
El Eng 283 Electronics for Instrumentation
Cp Eng 111/112 Intro to Computer Eng

Area IV, Construction Materials

ArchE 319 Applied Mechanics in Structural Eng
Cv Eng 313 Composition & Properties of Concrete
Cv Eng 317 Pavement Design
Arch E 3XX Special Concretes
Ch Eng 381 Corrosion and Its Prevention

Architectural Engineering Courses

ArchE 103 Materials and Methods of Construction
ArchE 203 Architectural Design I
ArchE 204 Intro to Architectural Design II
ArchE 205 Illumination of Buildings

(to be developed in AY2006/2007)

ArchE 3xx Masonry Engineering
ArchE 3xx Special Concretes

Architectural Engineering Courses (cross–list with existing civil engineering courses)

ArchE 001 Fundamentals of Surveying
ArchE 003 Engineering Communication
ArchE 101 Special Topics
ArchE 200 Special Problems
ArchE 201 Special Topics
ArchE 202 Co-operative Eng Training
ArchE 210 Senior Seminar
ArchE 217 Structural Analysis I
ArchE 221 Structural Design in Metals
ArchE 223 Reinforced Concrete Design
ArchE 241 Economy of Engineering Design
ArchE 242 Building Systems
ArchE 247 Ethical, Legal, and Prof Eng Prac
ArchE 248 Fund of Contracts & Construction Eng
ArchE 298 Senior Design
ArchE 300 Special Problems
ArchE 301 Special Topics
ArchE 310 Seminar
ArchE 320 Intermediate Structural Analysis
ArchE 322 Analysis & Design of Wood Struct
ArchE 323 Classical and Matrix Meth Struct Analy
ArchE 324 Numerical Methods of Structural Analysis
ArchE 326 Advanced Steel Structures Design
ArchE 327 Advanced Concrete Structures Design
ArchE 328 Prestressed Concrete Design
ArchE 345 Construction Methods
ArchE 346 Management of Construction Costs
ArchE 349 Eng & Construction Contract Spec
ArchE 374 Infrast. Strengthening with Composites
ArchE 390 Undergraduate Research

Civil Engineering Courses (required courses, emphasis area, and/or technical electives)

Cv Eng 215 Elementary Soil Mechanics
Cv Eng 216 Const Materials, Prop, & Test
Cv Eng 229 Foundation/Pavement Eng
Cv Eng 230 Elementary Fluid Mechanics
Cv Eng 313 Composition and Properties of Concrete
Cv Eng 317 Pavement Design
Cv Eng 329 Foundation Engineering II
Cv Eng 341 Professional Aspects of Eng Practice
Cv Eng 345 Construction Methods
Cv Eng 346 Management of Construction Costs
Cv Eng 349 Eng & Construction Contract Spec

Architectural Engineering Courses

3 Engineering Communications (LEC 1.0 and LAB 1.0) Introduction to programming concepts and software tools (computer aided design drafting, computer mathematics, word processing, spreadsheets, and presentation software) with application to written and oral communication in professional civil and architectural engineering practice. Prerequisite: Sophomore standing. (Co-listed with Cv Eng 003)

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.

103 Architectural Materials And Methods Of Construction (LEC 2.0) A study of the origin and properties of construction materials, methods of construction, and installation. Materials include mineral based, wood, steel, concrete, masonry, asphalt, and gypsum as components of architectural engineering. Prerequisites: Chem 1, Chem 2 and Sophomore standing.

200 Special Problems (IND 1.0-6.0) (Variable) 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 Architectural Design I (LEC 1.0 and LAB 2.0) Introduction to the interaction between architecture and the engineering disciplines. Theories of building and site design, technology as an integral component of design, plan and spatial organization, structural clarity, formal composition, and environmental context are considered as principle form determinants. Prerequisite: Sophomore standing.

204 Architectural Design II (LEC 1.0 and LAB 2.0) A continuation of Architectural Engineering Design I with an increased focus on problems and models associated with detail development, principles of acoustic design and building construction as a form determinant. Prerequisite: ArchE 203.

205 Building Electrical and Lighting Systems (LEC 2.0) Design and specifications for interior and exterior building electrical and illumination systems, including electrical and lighting loads, branch circuits, grounding and switching. Work includes study of applicable NFPA 70 (NEC) and related building codes. Prerequisites: El Eng 281 and Arch Eng 204.

210 Senior Seminar: Engineering In A Global Society (RSD 1.0) Discussion of contemporary issues: public safety, health, and welfare; the principles of sustainable development; lifelong learning; impact of engineering solutions in a global and societal and political context; relationships with owners, contractors, and the public; public service; the Code of Ethics; and the Missouri licensing Statutes and Board Rules. Prerequisite: Senior standing. (Co-listed with Cv Eng and Env En 210)

217 Structural Analysis I (LEC 2.0 and LAB 1.0) Loads on Structures. Analysis of statically determinate and indeterminate beams, frames and trusses. Influence lines and moving loads. Computation of deflections. Development and use of theorems of displacement methods including slope-deflection and moment distribution to analyze statically indeterminate structures. Computer solutions. Prerequisites: IDE 50, IDE 110 each with a grade of "C" or better. (Co-listed with Civ Eng 217)

221 Structural Design In Metals (LEC 2.0 and LAB 1.0) The analysis and design of structural elements and connections for buildings, bridges and specialized structures utilizing structural metals. Both elastic and plastic designs are considered. Prerequisite: Arch Eng 217 with grade of "C" or better. (Co-listed with Cv Eng 221)

223 Reinforced Concrete Design (LEC 2.0 and LAB 1.0) The analysis and design of reinforced concrete beams, slabs, columns, retaining walls and footings by the elastic and ultimate strength methods including and introduction to the design of prestressed concrete. Introduction to use of computers as a design aid tool. Prerequisite: Arch Eng 217 with grade of "C" or better. (Co-listed with Cv Eng 223)

241 Economy Of Engineering Design (LEC 1.0 and LAB 1.0) Engineering decision-making procedures with emphasis on time value of money principles. Includes topics such as present, annual, and future worth analysis; rate of return and benefit/ cost ratio methods; effects of taxes, depreciation, and inflation on project viability; sensitivity analysis; design component optimization; project financing costs; and applications. Prerequisite: Preceded or accompanied by Stat 213. (Co-listed with Cv Eng 241)

247 Ethical, Legal And Professional Engineering Practice (LEC 2.0) Discussions of law concerning contracts, torts, agencies, real property, partnerships and corporations. The purposes and implications of the engineering registration law, the effect of legal, ethical and marketing considerations of the practice of Architectural Engineering. Prerequisite: Junior standing. (Co-listed with Cv Eng 247)

248 Fundamentals Of Contracts And Construction Engineering (LEC 3.0) A study of the concepts and techniques used in large construction projects for the preparation of engineer service contracts, the development of a project manuel, detailed and conceptual cost estimating, and construction scheduling analysis. Prerequisite: Senior Standing. (Co-listed with Cv Eng 248)

298 Senior Design Project (LEC 3.0) Open-ended building design project involving one or more areas of engineering. Planning design projects, philosophy of design, and the application of engineering principles to design problems. Prerequisite: Arch Eng 248 or Civ Eng 248. (Co-listed with Civ Eng 298 and Env Eng 298)

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.

319 Applied Mechanics In Structural Engineering (LEC 3.0) A study of basic relationships involved in the mechanics of structures. Topic include basic elasticity, failure criteria, fundamental theories of bending and buckling of plates and cylindrical shells for practical application in analysis and design of bridge building floors and shell roofs. Prerequisite: Cv Eng 217 with grade of "C" or better. (Co-listed with Cv Eng 319)

320 Structural Analysis II (LEC 3.0) Classical displacement and force methods applied to structures of advanced design. Analysis of indeterminate structures such as continuous beams, arches, cables, and two and three dimensional frames, and trusses. Analysis of indeterminate structures involving temperature and support settlements effects. Prerequisites: Civ Eng 217 or Arch Eng 217. (Co-listed with Civ Eng 320)

322 Analysis And Design Of Wood Structures (LEC 3.0) A critical review of theory and practice in design of modern wood structures. Effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design; development of design criteria and their application to plane and three dimensional structures. Prerequisite: Arch Eng 217 with a grade of "C" or better. (Co-listed with Cv Eng 322)

323 Computer Methods of Structural Analysis (LEC 3.0) Force and displacement matrix methods and computer methods applied to structural analysis. Analysis of indeterminate structures such as continuous beams, and two and three dimensional frames and trusses. Analysis of indeterminate structures involving temperature and support settlements effects using computer methods formulation. Prerequisite: Cv Eng 217 with grade of "C" or better. (Co-listed with Civ Eng 323)

326 Advanced Steel Structures Design (LEC 3.0) The design of structural steel systems into a final integrated structure. Plate girders, composite systems, stability, connections, rigid frames, single and multistory buildings, and similar type problems of interest to the student. Use of the

computer as a tool aid in the design will be emphasized. Prerequisite: Arch Eng 221 with a grade of "C" or better. (Co-listed with Cv Eng 326)

327 Advanced Concrete Structures Design (LEC 3.0) The design of structural concrete systems into a final integrated structure. Two-way slabs, long columns, connections, and discontinuity regions, deflections and cracking of beams and slabs, ACI design criteria, and similar type problems of interest to the student. Use of the computer as a tool to aid in the design will be emphasized. Prerequisite: Arch Eng 223 with a grade of "C" or better. (Co-listed with Cv Eng 327)

328 Prestressed Concrete Design (LEC 3.0) Behavior of steel and concrete under sustained load. Analysis and design of pre-tensioned and post-tensioned reinforced concrete members and the combining of such members into an integral structure. Prerequisite: Arch Eng 223 with a grade of "C" or better. (Co-listed with Cv Eng 328)

329 Foundation Engineering II (LEC 3.0) Classical earth pressure theories. Analysis of shallow and deep foundations to include bearing capacity and settlement of footings, rafts, piles and drilled piers. Analysis of stability and design of retaining walls and anchored bulkheads. Prerequisite: Arch Eng 229 with a grade of "C" or better. (Co-listed with Cv Eng 329)

345 Construction Methods (LEC 3.0) Introduction to construction planning selection of equipment and familiarization with standard methods for horizontal and vertical construction. Application of network analysis and schedules to project control. Prerequisite: Arch Eng 248 with a grade of "C" or better. (Co-listed with Cv Eng 345)

346 Management Of Construction Costs (LEC 3.0) Management of construction projects from inception to completion: estimates, role of network preplanning, project monitoring and control. Prerequisite: Arch Eng 248 with a grade of "C" or better. (Co-listed with Cv Eng 346)

349 Engineering And Construction Contract Specifications (LEC 3.0) Legal and business aspects of contracts and contracting procedure in the construction industry. Topics include formulation of contracts in common law, engineering services contracts, and construction project contract documents and contract administration issues. Prerequisite: Arch Eng 248 with a grade of "C" or better. (Co-listed with Cv Eng 349)

374 Infrastructure Strengthening With Composites (LEC 3.0) The course presents composite materials and includes principles of reinforcing and strengthening for flexure, shear, and ductility enhancement in buildings and bridges. It covers the design of existing members strengthened with externally bonded laminates and near surface mounted composites. Case studies are discussed. Prerequisites: Arch Eng/Civ Eng 217, Arch Eng/Civ Eng 223. (Co-listed with Cv Eng 374)

375 Low-Rise Building Analysis And Design (LEC 3.0) Characterization of various design loads, load combinations, general methodology of structural designs against lateral loads, code-oriented design procedures, distribution of lateral loads in structural systems, application of the International Building Code in design of loadbearing wall systems, building frame system and moment-resisting frame systems. Prerequisite: Preceded and/or accompanied by Civ -Arch Eng 221 or Civ-Arch Eng 223. (Co-listed with Civ Eng 375)

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 by instructor.

Art

The study of art can broaden and intensify your experiences and help you gain a better perspective on the world.

UMR offers courses in art appreciation, art history, study of film, and applied courses in design, painting, and photography. Non-credit courses are available from time to time in other applied art or special interest courses.

Faculty

Professor:
James Bogan, Ph.D., Kansas
Lecturer:
Leo Soisson, M.F.A., Southern Illinois
Instructor:
Luce Myers, B.S., Bradley University

Art Minor

The Art Minor offers students the opportunity to pursue an area of focus in studio art, art history, and film studies.

Requirements: The minor requires 15 hours, including Art 80: Art Appreciation, which is a required course. Students may take additional hours from these offerings: Art 85: Study of film; Art 222: Revolution and Romanticism; Art 255: Script to Screen; Philosophy 330: Aesthetics, and topics course from the Art 101, 201, 301 series. In addition, students may take up to six hours of Studio classes.

Film and Literature Minor

The Film and Literature Minor is an interdisciplinary and inter-textual course of study in which students will explore the connections between different mediums, increasing the pleasure and understanding of each.

Requirements:

The minor requires 12 hours, including the following required courses: Art 85: Study of Film (3 hours) and the core course English 177: Literature and Film (3 hours).

In addition, students will take 6 hours of electives in the field of literature and film studies. These electives can include but are not limited to:

- Art 255: Script to Screen (3)
- English 278: Thematic Studies in Lit & Film (3)
- English 279: Genre Studies in Lit & Film (3)

- Art 250: Thematic Studies in Film & Lit (3)
- Art 251: Genre Studies in Film & Lit (3)

Art Courses

20 Drawing I (LEC 3.0) Principles of drawing: placement, proportion, perspective, chiaroscuro, values, line, form, texture, and techniques. Applied problems to develop perceptual observation.

30 Drawing II (LEC 3.0) Application of drawing principles: cast and life drawing. Exercises in representational rendering. Prerequisite: Art 20.

40 Painting I (LEC 3.0) Basic Exploration of oil painting techniques and methods. Still life, landscape and figure.

50 Painting II (LEC 3.0) Continuation of Art 40. Prerequisite: Art 40.

64 Sculpture (LAB 3.0) Solving problems in shallow and BAS relief and small clay sculpture, study of contemporary and classical proportion, faux bronze and plaster casting.

80 Art Appreciation (LEC 3.0) A basic introductory course designed to familiarize students who have little or no knowledge of the arts with fundamental knowledge necessary for intelligent approach to experiencing the visual arts; painting, sculpture, and architecture.

85 Study Of Film (LEC 2.0 and LAB 1.0) A study of classic and contemporary films with emphasis on director's technique and philosophy. Films by Fellini, Antonioni plus Bergman, Chaplin, etc. will be viewed and discussed.

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.

203 Architectural Design I (LEC 1.0 and LAB 2.0) Introduction to the interaction between architecture and art. A series focused on the history of architecture as it relates to styles and functions. Theories of building and site design, plan and spatial organization, formal composition, and environmental context are considered as principle form determinants. Prerequisite: Sophomore standing.

219 Art For Elementary Teachers (LEC 3.0) Considers the vital role of art activities and creative experiences in the growth and development of children at their level. Prerequisite: Educ 40. (Co-listed with Educ 219)

222 Revolution And Romanticism In The Arts 1785 - 1832 (LEC 3.0) This course will investigate the great revolution of thought, perception, language, through art during the period between 1785 and 1832. Artists, writers, and musicians to be studied include: Blake, David, Wordsworth, and Beethoven. The role of art and artists to the French Revolution will be stressed. Prerequisite: Introductory level Art or History course.

245 Thomas Hart Benton And The Tradition Of American Art (LEC 3.0) Missouri artist Tom Benton lived amidst controversy and acclaim from the 1920's to the 1970's. The American tradition from which Benton grew will be studied, then his own work and his subsequent influence. Prerequisite: Art 85 or Art 80.

250 Thematic Studies In Film & Literature (LEC 3.0) Different thematic relationships between film & literature (e.g., Poe & Hitchcock, Shakespeare on Film, etc.) will be studied. Prerequisite: Art 85.

251 Genre Studies In Film & Literature (LEC 3.0) Topics examine various generic relationships between film & literature. (e.g., comedy, film noir, western film/literature) Prerequisite: Art 85.

255 Script To Screen: How Books Become Films (LEC 3.0) This course will focus on how words are transmuted into film images. By comparing the tests of poems, stories, and novels with the finished film, a double appreciation of both film and literature is gained. Prerequisite: Introductory level Art or Literature course.

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.

Arts and Sciences

Bioinformatics Minor Curriculum

Bioinformatics is the rapidly-developing field that applies computational methods to address biological questions, and includes new advances in computer science, mathematics, and biology. Students entering the field of bioinformatics should have some training in each of these fields.

The minor is designed for students pursuing a BS who would have the necessary prerequisites for the required courses. Students pursuing a BA may participate if the prerequisites for the required courses are fulfilled. Each department (Biological Sciences, Computer Science, Mathematics) will designate a minor advisor. The student's minor advisor will be chosen from outside of their major area of study.

Required courses:

- BIO 110 General Biology (3 hrs)
- BIO 211 Cellular Biology (4 hrs) or BIO 231 General Genetics (3 hrs)
- BIO 331 Molecular Genetics (3 hrs)
- CMP SC 53, 54 Introductory Programming, Introductory Programming Lab (4 hrs)
- CMP SC 153 Data Structures I (3 hrs)
- CMP SC 238 File Structure and Introduction to Database Systems (3 hrs)
- BIO 311/CMP SC 311 Bioinformatics (3 hrs) (It is strongly recommended that this course be taken after the other BIO and CMP SC requirements)

- STAT 301 Biostatistics (4 hrs) or STAT 346 Regression Analysis (3 hrs) or STAT 353 Statistical Data Analysis (3 hrs)

One additional course, 200 or above in MATH, or 300 or above in BIO or CMP SC, outside of the major area of study, and as agreed upon by the minor advisor (3+ hrs)

Arts and Sciences 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.

110 Hit The Ground Running (LEC 3.0) An introductory, multi-faceted lecture including a coordinated presentation of mathematics principles, chemical principles, academic skills development, and the elements of academic leadership. Objectives are to provide students with a positive and realistic experience that supports establishment of valid academic expectations and provides knowledge of the resources and strategies necessary to begin a strong academic career.

111 Women as Global Leaders (LEC 0.5) The class will encourage the development of the skills necessary for strong leadership. It will begin with skills assessment, progress through seminars and workshops led by women alumni, and culminate in the project and team-building exercises. Course may be repeated for credit.

Biological Sciences

Bachelor of Arts
Bachelor of Sciences

Biological sciences or biology is the study of life and living organisms. Biological Sciences embraces a vast and rapidly expanding body of knowledge and inquiry. Including

- biochemistry, sub-cellular and molecular biology,
- the anatomy and physiology of cells, tissues, organs and organ systems, whole multi-cellular plants, animals, and fungi,
- the complex structure, function, behavior, and interactions of individuals, populations, communities, ecosystems, and the entire biosphere.

Biology also draws on the physical sciences (chemistry, physics, mathematics, and earth sciences) as well as the behavioral sciences for analysis and interpretation of life processes and interrelationships.

The study of biology provides an academic foundation for career and postgraduate opportunities in:

- Industry and government (chemical, food, agriculture, pharmaceutical, environmental, research)
- Education (teaching and graduate study)
- Health professions (human medicine, dentistry, pharmacy, vetinary medicine, physical therapy, etc.)

The core curriculum required of all biological sciences majors consists of basic course work in introductory biology, zoology, plant biology, cellular biology, microbiology, genetics, and ecology. A variety of advanced courses offer greater depth, detail and specific information leading to proficiency and preparation for employment and other postgraduate activities.

At UMR faculty members active in research teach all biological sciences courses. Classes are small, providing exceptional opportunity for discussion and individual attention. Most undergraduate students participate in research, learning techniques and developing skills that will prepare them for many exciting postgraduate opportunities. A background in mathematics and physical sciences, together with outstanding supporting course work in the humanities and social sciences provide a well-rounded educational experience and enhanced understanding. UMR students who have received their B.S. degrees in biological sciences have an excellent record of success. Average performance on nationally normed achievement examinations has been very high. Acceptance of UMR students in professional schools of medicine, dentistry and pharmacy, and subsequent performance of our students in these professional schools, remains exceptionally high. Many UMR biological sciences graduates have been accepted into prestigious graduate study programs in a variety of areas, including biochemistry, microbiology, immunology, molecular genetics and genetic engineering, marine biology, cell and mammalian physiology, human physiology, environmental science, plant physiology, and evolution. Employment opportunities are varied, and future prospects for graduates in the biological sciences remain promising. The broad educational resources and depth of understanding available to the UMR student of biology offer preparation and a competitive edge for a broad variety of jobs and graduate study programs.

Faculty

Professor:

Robert S. Aronstam, (Chair), Ph.D., University of Rochester

Roger Brown, Ph.D., Colorado State

Nord Gale (Curators' Teaching Professor Emeritus), Ph.D., Brigham Young

Associate Professor:

Ronald L. Frank, Ph.D.,Ohio State

Melanie Mormile, Ph.D., Oklahoma

Yue-Wern Huang, Ph.D., Wisconsin-Madison

David Westenberg, Ph.D., UCLA

Assistant Professor:

Ching-Nen Nathan Chen, Ph.D., National Taiwan University, Taiwan

Anne Maglia, Ph.D., University of Kansas

Dev Niyogi, Ph.D., University of Colorado

Katie Shannon, Ph.D., Harvard Medical School

Lecturer:

Tonye Numbere, Ph.D., Kansas State

Terry Wilson, M.S., Southwest Missouri State

Bachelor of Arts Biological Sciences Degree Requirements

Specific requirements for the B.A. degree in biological sciences include a minimum of 120 semester hours of credit.

Core Courses	Credit
Bio Sc 102-Intro to Bio Sc	1
Bio Sc 110-Gen Bio or Bio Sc 111-Princ Bio	3
Bio Sc 112-Gen Bio Lab	2
Bio Sc 115 & 116-Zoology or Bio Sc 118 & 119-Plant Bio	4
Bio Sc 211-Cell Biology	3
Bio Sc 212-Cell Biology Lab	1
Bio Sc 231-Gen Genetics	3
Bio Sc 251-Ecology	3
Bio Sc 310-Seminar	1
Advanced courses, 200 level or higher (at least one with laboratory and one 300 level)	9
Chemistry	
Chem 1,2,3, & 4-General Chem	9
Chem 221 & 223-Org Chem	6
Mathematics & Physical Science	
Various courses in mathematics, physics, and/or geology chosen in consultation with academic adviser. (Note: Proficiency in College Algebra must be demonstrated by a grade of "C" or better in a College Algebra course or by examination.	9
Computer Science/Statistics (One of the following)	
Cmp Sc 053-Intro to Prog	3
Stat 115-Stat for Soc Sci	3
Stat 211-Stat Tools for Decision Making	3
CAS General Requirements for BA (Basic skills/concepts)	
English Composition	6
Western Civilizations	6
Foreign Language	11
General Education	
Humanities	12
Social Sciences	12
Electives	16
	Total 120 hours

Bachelor of Arts Biological Sciences Pre-Medicine Emphasis Area Degree Requirements

The student will fulfill the requirements for a Bachelor of Arts in Biological Sciences as outlined above. The following classes are also required: Chem 226 & 228 (Org Chem labs), 2 semester of College (General) Physics and labs (Phy 31 (21), 22, 35 (25), 26), 8 (10), other classes (Bio Sc 241, 242 & 243, Chem 361) are highly recommended.

Bachelor of Arts Biological Sciences Teacher Certification Degree Requirements

The student will fulfill the requirements for:
1) the Bachelor of Arts in Biological Sciences (except for eign language) and
2) the requirements for Missouri certification in teaching Biology (See Education) Contact the UMR Biological Sciences Department for advising.

Bachelor of Science Biological Sciences Degree Requirements

A minimum of 130 credit hours is required for a Bachelor of Science degree in Biological Science and an average of at least two grade points per credit hour must be obtained. These requirements for the B.S. degree are in addition to credit received for basic ROTC.

The Biological Science 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.

The Biological Science B.S. degree must include 46 semester hours of biological sciences course work, to include:

	Credit
Bio Sc 102-Intro to Bio Sc	1
Bio 110-Gen Bio or Bio Sc 111-Princ Bio	3
Bio Sc 112-Gen Bio Lab	2
Bio Sc 115-Zoology	3
Bio Sc 116-Zoology Lab	1
Bio Sc 118-Plant Biology	3
Bio Sc 119-Plant Biology Lab	1
Bio Sc 211-Cellular Biology	3
Bio Sc 212-Cellular Biology Lab	1
Bio Sc 221-Microbiology	3
Bio Sc 222-Microbiology Lab	2
Bio Sc 231-General Genetics	3
Bio Sc 251-Ecology	3
Bio Sc 310-Seminar	1
Advanced biological sciences or approved advanced course work in other science or eng disciplines	18
20 semester hours of chemistry to include general chemistry (Chem 1,2,3, & 4)	9
Chem 361 General Biochemistry	3
Chem 221, 226, 223, 228-Org Chem	8
Physics 21 or 31, 25 or 35 (two semesters of physics)	6
Physics 22 & 26 (two semesters of labs)	2

The Math/Statistics requirement will be a minimum of 10 credit hours with a requirement for Math 8, Math 21 or an approved statistical course may be used to meet 10 hr Math requirement for students entering at 6 or 8.

12 semester hours of humanities, excluding foreign language, and to include: English 20 (entering students will normally take English 20 either semester of the first year) and English 60.....12

9 semesters hours of social sciences, (to include Hist 112 or 175 or 176 or Pol Sc 90, or equivalent.....9

Elective credits: In consultation with his or her advisor, each student will elect sufficient additional courses to complete a minimum of 130 credit hours.

A minimum grade of "C" is required for each Biological Science course used to fulfill the B.S. degree requirements.

Minor Curriculum

A student wishing to minor in biological sciences must take a minimum of 20 hours of biological sciences course work which should include Bio Sc 110, 112, 115, or (211) and at least seven hours of advanced Bio Sc to be selected upon consultation with a Bio Sc department advisor. Students minoring in biological sciences should declare these intentions prior to the junior year.

Bioinformatics Minor

Students majoring in biological sciences are eligible to pursue a minor in bioinformatics. See the description of the bioinformatics minor under the heading.

Biological Sciences 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.

102 **Introduction To Biological Science** (LEC 1.0) An introduction to the study of biology at UMR. Students will consider personal and professional opportunities within the various areas of biology and become acquainted with Biological Sciences faculty and departmental and campus facilities. Required of freshman Biological Sciences majors.

110 **General Biology** (LEC 3.0) A comprehensive study of the general principles of the biology of plants, animals, and protists including population biology and regulation mechanisms. Prerequisite: Entrance requirements.

111 **Principles of Biology** (LEC 3.0) A comprehensive study of the general principles of the biology of plants, animals, and protists including population biology and regulation mechanisms. An in-depth study of the fundamental principles governing all living organisms from the molecular to the population level. Required for Biological Sciences majors. Cannot also receive credit for Bio 110. Prerequisite: Entrance requirements.

112 **General Biology Lab** (LEC 1.0 and LAB 1.0) The laboratory work accompanying general biology consists of experiments designed to supplement and extend lectures in course Bio 1. Prerequisite: Preceded or accompanied by Bio 110.

115 **Zoology** (LEC 3.0) Survey class that explores the diversity of animal life. Emphasis on the morphology, physiology, development, ecology, and phylogeny of animals and protozoans.

116 **Zoology Laboratory** (LAB 1.0) Bio Sci 116 is designed to accompany Bio Sci 115 and consists of laboratory and field explorations of the diversity of animal life. Prerequisite: Preceded or accompanied by Bio Sci 115.

118 **Plant Biology** (LEC 3.0) A survey course covering the cellular structures unique to plants, their bizarre life cycles, and the mechanisms they use to survive, reproduce, and convert solar energy into a form usable by all other organisms. Prerequisite: Bio Sci 110 or Bio Sci 111.

119 **Plant Biology Laboratory** (LAB 1.0) Bio 119 is designed to accompany Bio 118 and consists of experiments that will supplement and extend the lectures in Bio 118. Among the topics to be covered are photosynthesis, diversity, respiration, anatomy and development, hormones, and transpiration. Prerequisites: Bio 112, preceded or accompanied by Bio 118.

121 **Microbes And Man -- Introductory Microbiology** (LEC 3.0) An introduction to the study of microorganisms in nature, especially as they affect humans. Consideration of the involvement of microorganisms in disease, decomposition, nutrition, agriculture, food processing and preservation, industrial applications and waste treatment.

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 **Cell Biology** (LEC 3.0) The structure and function of eukaryotic and prokaryotic cells. Emphasis on macromolecules, organelles, metabolic pathways, bioenergetics, cell signaling, the cell cycle, and information processing. Prerequisite: Preceded or accompanied by Chem 3.

212 **Cell Biology Laboratory** (LAB 1.0) Laboratory course to accompany Cell Biology (Bio Sci 211). Laboratory work includes microscopy, biochemical assays, enzymology, and genetic analysis (PCR, mapping, electrophoresis, transfection, sequencing). Prerequisite: Preceded or accompanied by Bio Sci 211.

221 **Microbiology** (LEC 3.0) General introduction to the culture and study of microorganisms, their physiology, structure, and contribution to biology. Prerequisite: Bio 211.

222 **Microbiology Lab** (LAB 2.0) General introduction to the techniques used for the culture and identification of microorganisms, their physiology, structure, and contribution to biology. Prerequisite: Preceded or accompanied by Bio Sci 221.

231 **General Genetics** (LEC 3.0) The study of the principles of heredity and reasons for variation in plants and animals. A study of Mendelian principles and population genetics with emphasis on the human.

235 Evolution (LEC 3.0) A survey of the genetic and environmental mechanisms associated with organic evolution.

241 Human Anatomy (LEC 3.0 and LAB 2.0) Study of gross anatomy and microscopic anatomy of the human organ systems. Laboratory work includes dissection of the cat. Prerequisite: Bio Sci 110 or Bio Sci 111.

242 Human Physiology (LEC 3.0) Study of the function of the organ systems of the human body with emphasis on organ systems interactions. Prerequisites: Bio Sci 110, Bio Sci 111, or Bio Sci 211.

243 Human Physiology Laboratory (LAB 1.0) Laboratory activities and demonstrations of basic physiology of human organ systems. Prerequisite: Accompanied or preceded by Bio Sci 242.

251 Ecology (LEC 3.0) Relationships between organisms and the environment. Topics include the influence of environmental factors on individual organisms, population dynamics, interspecific associations, and entire ecosystems. Prerequisite: Bio Sci 110 or Bio Sci 111.

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 (RSD 0.0) Presentation of a scientific paper concerned with current topics in biological sciences. Prerequisite: Senior standing.

311 Bioinformatics (LEC 3.0) The course will familiarize students with the application of computational methods to biology, as viewed from both perspectives. It will introduce problems in molecular, structural, morphological, and biodiversity informatics, and will discuss principles, algorithms, and software to address them. Prerequisites: Bio Sci 110 or 111 and Comp Sci 53/54 or 74/78. (Co-listed with Comp Sci 311)

315 Developmental Biology (LEC 3.0) Study of the patterns of development of the vertebrate embryo, the molecular mechanisms of tissue induction, and interactions among developing tissues. Prerequisites: Bio 115 and Bio 211.

321 Pathogenic Microbiology (LEC 3.0) A study of medically important microorganisms. Students will learn about the properties that enable organisms to cause disease as well as the disease process within the host. Special emphasis will be placed on recent advances in the molecular genetics of host pathogen interaction. Prerequisite: Bio 221 or Cv Eng 261.

322 Pathogenic Microbiology Laboratory (LAB 2.0) An investigation of techniques for the isolation and identification of pathogenic microorganisms. Prerequisite: Preceded or accompanied by Bio 321.

325 Microbiology In Bioengineering (LEC 3.0) General introduction to prokaryotic and eukaryotic microorganisms and viruses. Consideration of various parameters affecting the growth, basic techniques of culture, and industrial applications of microorganisms. Prerequisite: Bio 211.

327 Plant Physiology (LEC 3.0) This course will cover structures and functions of plants from the cellular to the whole plant levels. Topics covered include absorption and transport of water and mineral nutrients, photosysnthesis, metabolism of starch and lipids, secondary metabolism, plant stress physiology, and plant hormones. Prerequisites: Bio Sci 111, 110; Bio Sci 118, 119.

328 Nutritional And Medicinal Properties Of Plants (LEC 3.0) A survey of the biochemical and physiological functions of mineral elements, vitamins, and other organic compounds from plants necessary in human nutrition; and an overview of the medicinal derivatives of various plants, their effects and uses. Prerequisites: Bio Sci 110 or Bio Sci 111; and Bio Sci 211.

331 Molecular Genetics (LEC 3.0) A study of the properties and functions of DNA that make this macromolecule unique in the universe. Examples of replication, transcription, translation, repair, and regulation will be examined in viruses, prokaryotes, and eukaryotes. Prerequisites: Bio 231 and Bio 211.

332 Molecular Genetics Laboratory (LAB 2.0) This course provides experience in the use of a variety of DNA manipulation techniques that are common to molecular studies. These include DNA extraction, restriction mapping, Southern blotting, recombinant plasmid construction, DNA sequencing and analysis, and polymerase chain reaction. Prerequisite: Preceded or accompanied by Bio 331.

340 Biomaterials I (LEC 3.0) This course will introduce senior undergraduate students to a broad array of topics in biomaterials, including ceramic, metallic, and polymeric biomaterials for in vivo use, basic concepts related to cells and tissues, host reactions to biomaterials, biomaterials-tissue compatibility, and degradation of biomaterials. Prerequisite: Senior undergraduate standing. (Co-listed with Cer Eng 340, Met Eng 340, Chem Eng 340)

342 Exercise Physiology (LEC 3.0) Covers cardiovascular, pulmonary, and metabolic responses to aerobic and anaerobic muscular activities, work capacities, nutritional factors in performance, and role of exercise in health. Prerequisite: Bio Sci 110 or Bio Sci 111.

345 Comparative Chordate Anatomy (LEC 2.0 and LAB 2.0) An integrated, comparative study of chordate structures and systems, with emphasis on evolution, development and function. Includes examination of gross anatomy and histology of selected forms. Prerequisites: Bio Sci 110 or 111, and Bio Sci 115 and 116.

352 Biological Effects Of Radiation (LEC 3.0) Introduction to biological effects of ionizing radiation including mode of induction of mutations, effects on the developing fetus and specific tissues plus therapeutic applications of various types of

radiation. Prerequisites: Bio Sci 110 or Bio Sci 111; and Chem 3.

354 Freshwater Ecology (LEC 3.0) The ecology of streams, lakes, and wetlands. The course will cover the physical and chemical characteristics of freshwater environments, the diversity of life in freshwaters, biogeochemical processes, and threats to freshwater systems. Prerequisite: Bio Sci 251.

361 Cell Physiology (LEC 3.0) Consideration of the physiochemical nature of the cell, its relationship with environment, and its metabolic pathways. Prerequisite: Bio 211.

365 Comparative Animal Physiology (LEC 3.0) A comparative study of functional relationships, physiological adaptations, and survival strategies which are observed among various groups of animals as they respond to natural environmental conditions. Emphasis is placed on relating biochemical function and phylogenetic relationships. Prerequisites: Bio 215, Chem 223, and Bio 211 or Chem 361.

370 Toxicology (LEC 3.0) A study of natural and man-made toxicants, various possible routes of exposure, absorption, distribution, biotransformation, specific target sites, and mechanisms involved in elicitation of toxic effects, as well as detoxification and excretion. Prerequisites: Bio 211 plus either Bio 215 or 242.

375 Advanced Biology Lab Techniques I (IND 1.0-3.0) Advanced level laboratory designed to acquaint students of cellular and molecular biology with techniques employed in current research. Students select one to three miniprojects, each designed to involve 40 to 45 hours of library and laboratory work. Prerequisite: Junior or senior standing in Biological Sciences or related field plus consent of instructor.

376 Advanced Biology Lab Techniques II (IND 1.0-3.0) Continued laboratory study of current bioresearch techniques. Further work with miniprojects. Prerequisite: Junior or senior standing in Biological Sciences or related field plus consent of instructor.

381 Immunology (LEC 3.0) A study of the principles of immunology, including biological and biochemical aspects of the immune response, immunochemistry, serology, immunoglobulin and T-cell mediated allergies, tumor and transplantation immunology, autoimmune diseases, and the role of immunity in host defense. Prerequisites: Chem 223 or Chem 363 and Bio 211.

390 Undergraduate Research (IND 1.0-3.0) Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours for graduation credit. Subject and credit to be arranged with the instructor. Prerequisite: Consent of instructor.

391 General Virology (LEC 3.0) An overview of the field of virology, including plant, animal, and bacterial viruses. Discussions will include morphology, classification, virus-host interactions, genetics, clinical and industrial aspects of viruses, and viruses as model systems for basic biological studies. Prerequisites: Bio Sci 110 or 111; Bio Sci 211, 221, Chem 1, 3, 221.

Business and Management Systems

Bachelor of Science

Business and Management Systems is an undergraduate degree that emphasizes the role of technology in business. It is based on broad, foundational core courses. Students in business are preparing for careers in the expanding fields of business administration and management information systems. Professionals in these fields analyze organizational needs to provide technology-enabled management and operations.

Today's business environments have a critical need for professionals who have an understanding of information technologies; who feel comfortable in an electronic environment; and who are able to synthesize, analyze, and learn from vast amounts of information. These individuals are needed to realize technology's great potential to support business processes, decision-making, and communication.

As a business and management systems major, you will take courses that are rigorous and oriented toward building the foundation necessary for lifetime learning. Studying at Missouri's technological university, you will benefit from the world-class computer environment and your association with excellent students from around the country and the world. Students in the program are strongly encouraged to participate in summer internships or co-ops with companies before they graduate. There are many rich opportunities and students benefit greatly in terms of their education and the edge they have seeking full-time employment once they graduate.

Faculty

Professor

Caroline Fisher (Chair), Ph.D., Bowling Green State University

Associate Professor:

Ray Kluczny (Emeritus), Ph.D., Arizona State University

Assistant Professor:

Joseph Bradley, Ph.D., Claremont Graduate University
Lance Gentry, Ph.D., Michigan State University
Chihmao Hsieh, Ph.D., Washington University in St. Louis
Morris Kalliny, Ph.D., University of Texas-Pan American
Bih-Ru Lea, Ph.D., Clemson University
Julie Patock-Peckham, Ph.D., Arizona State University
Lian Qi, Ph.D., University of Florida
Hong Sheng, Ph.D., University of Nebraska, Lincoln

Instructor:

Yu-Hsien Chiu, M.S., University of Wisconsin-Milwaukee

Stephanie Fitch, M.A., University of Texas at Austin

Bachelor of Science
Business and Management Systems

In Business and Management Systems, the Bachelor of Science degrees consist of 120 credit hours. First, all undergraduate students in Business and Management Systems are required to complete a prescribed General Education Requirements Core that corresponds to the recommendations of the Missouri State Coordinating Board for Higher Education and consists of 41 credit hours in the areas of Individual Expression, Natural Systems, and Human Institutions. In addition, all undergraduate students are required to complete a 40 credit hour core consisting of courses in Information Technology, Management, Quantitative Skills, and Communication Skills. A minimum grade of "C" is required for courses in both the Information Technology and the Management areas. Finally, each degree includes 12 credit hours of free electives.

The remaining 27 credit hours of the required 120 credit hours for the Business and Management Systems degree are divided into a prescribed 18 credit hour degree core and 9 credit hours of specific degree electives. A minimum grade of "C" is required in these courses. The Business and Management Systems Degree requires courses in Marketing, Finance, Operations, Managerial Accounting, Strategic Management, and Statistics. The electives for this degree are then chosen from business related upper-level courses.

FRESHMAN YEAR

First Semester	Credit
Psych 50 General Psychology	3
MIS 10 Introduction to Mgt & Inf Systems I[1]	0.5
English 20 Exposition & Argumentation	3
Math 4 College Algebra	3
Biology 110, 231, 235, or 251	3
Laboratory w/ Biology or Physical Science Course	1
	13.5
Second Semester	
MIS 11 Introduction to Mgt & Inf Systems II[1]	0.5
Bus 110 Mgt & Org Behavior	3
Math 12-Business Calculus	4
History	3
IST 51 Visual Basic	3
Econ 121 Microeconomics	3
	16.5

SOPHOMORE YEAR

First Semester	Credit
English 65 Tech Writing	3
Speech 85 Princ of Speech	3
Stat 211 Stat Tools for Decision Making	3
IST 151 Java	3
English 75, 80, 102, 105, 106, 177, or 178 Lit	3
	15
Second Semester	
BUS 120 Essentials of Accounting	3
Econ 122 Macroeconomics	3
Chemistry, Geol, Ge Eng, or Physics	3
Art 80, 85; Music 50; Theater 90	3
IST 141 Info Systems	3
	15

JUNIOR YEAR

First Semester	Credit
IST 246 Introduction to ERP	3
BUS 230 Business Law	3
BUS 240 Basic Marketing	3
Finance 250 Corporate Finance I	3
Econ 211 Intro to Econ Stat	3
	15
Second Semester	
Speech 181 Communication Theory	3
Political Science 90 American Government	3
BUS 260 Business Operations	3
BUS 220 Managerial Accounting	3
Area of Concentration	3
	15

SENIOR YEAR

First Semester	Credit
English 260 Practicum in Technical Writing	3
Culture, Sociology, Religion[2]	3
BUS 280 Strategic Management	3
Area of Concentration	6
	15
Second Semester	
SMIS 397 Capstone Seminar in Bus & Mgt Sys[1]	3
Free Electives	12
	15

A grade of “C” or better is required in the following courses for graduation; MIS 10, MIS 11, MIS 397, IST 51, IST 141, IST 151, IST 246, Bus 110, Bus 120, Bus 230, Econ 121, Bus 240, Fin 250, Bus 260, Bus 220, Bus 280, and Econ 211.

[1]Writing Intensive Course
[2]Economics 220; English 215, 230, 281, 345, 350; Foreign Language Beyond Second Semester; History 340, 355; Philosophy 25, 235, 75, 212, 340, 355; Any Political Science; Psychology 270, 380; Any Sociology; Speech 235

Areas of Concentration

All students are required to complete nine credit hours chosen from 200 or 300 level courses in business, economics, finance, or information science & technology. If the student chooses to designate an area of concentration for these courses, he or she may do so. Students are not required to choose a concentration area. A “C” or better is required in all nine credit hours. Areas of concentration are as follows:

E-Commerce

IST	221 - Internet Concepts and Applications
IST	241 - E-Commerce
IST	286 - Web Development and Design
IST	336 - Internet Computing
IST	342 - E-Commerce Architecture
IST	357 - Network Economy
IST	368 - Law and Ethics in E-Commerce

Enterprise Resource Planning

BUS 326/IST 346 - ERP Systems Design and Implementation
BUS 366/IST 347 - Supply Chain Management
BUS 386/IST 348 - Strategic Engerprise Management Systems

Finance

Fin 250 - Corporate Finance I
Fin 350 - Corporate Finance II
Econ 323 - International Finance
Econ 330 - Public Finance
Fin 201 - Investments I
Fin 301 - Investments II
Fin 301 - Introduction to Derivatives

Human-Computer Interaction

IST 385 - Human Computer Interaction
IST 386 - Human-Computer Interaction Prototyping
IST 387 - Human-Computer Interaction Evaluation

Management Information Systems

IST 223 - Database Management
IST 233 - Networks and Communications
IST 243 - Systems Analysis

Marketing

Bus 341 - Marketing Strategy
Bus 301 - International Business
Bus 301 - New Product Development
Bus 311 - Business Negotiations
Bus 301 - Other courses in the marketing area as approved by the Chair
Eng Mg 351 - Industrial Marketing Systems Analysis
Eng Mg 354 - Integrated Product and Process Design

Minor in Business

A minor in Business and Management Systems* requires the following 15 hours of course work:
1) Psych 50-General Psychology
2) Econ 121-Princples of Microeconomics or Econ 122-Principles of Macroeconomics
3) Bus 110-Management & Organizational Behavior
4) Bus 120-Essentials of Accounting
5) Bus 240-Basic Marketing

*At least 6 hours of the minor course work must be taken in residence at UMR.

Minor in Marketing

A minor in Marketing* requires the following 18 hours of course work:
1) Psych 50-General Psychology
2) Econ 121-Princples of Microeconomics or Econ 122-Principles of Macroeconomics
3) Bus 240-Basic Marketing
4) 9 hours of electives in Marketing approved by the department

*At least 6 hours of the minor course work must be taken in residence at UMR.

Pre MBA Minor

A minor in Pre MBA* will prepare students to enter an accredited MBA program at UMR or elsewhere. This minor requires the following 39 hours of course work:
1) Psych 50-General Psychology
2) Math 8-Calculus with Analytic Geometry I, Math 12-Business Calculus, or Math 14-Calculus for Engineers I
3) Econ/Stat 111-Business and Economic Statistics I, Stat 115-Statistics for the Social Sciences I, Stat 211-Statistical Tools for Decision-Making, Stat 213-Applied Engineering Statistics, Stat 215-Engineering Statistics, or Stat 217-Introduction to Probability and Statistics
4) Econ 121-Principles of Microeconomics
5) Econ 122-Principles of Macroeconomics
6) Bus 110-Management and Organizational Behavior
7) Bus 120-Essentials of Accounting or Eng Mg 322-Accounting for Engineering Management
8) Bus 220-Managerial Accounting
9)Bus 230-Business Law or Eng Mg 327-Legal Environment
10) Bus 240-Basic Marketing or Eng Mg 251-Marketing Management
11) Fin 250-Corporate Finance I or Eng Mg 252-Financial Management
12) Bus 260-Business Operations or Eng Mg 282-Operations and Production Management
13) IST 141-Information Systems or Eng Mg 333-Management Information Systems

*At least 6 hours of the minor course work must be taken in residence at UMR.

Business Courses

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

110 Management And Organizational Behavior (LEC 3.0) The course provides coverage of classic and current management principles, as well as the study of the behavior of individuals and groups in an organizational setting. Topics include motivation, leadership, organizational design, and conflict resolution. Prerequisite: Psych 50.

120 Essentials Of Accounting (LEC 3.0) This course is an introduction to accounting and its significant role in making sound business decisions. Emphasis is in financial accounting, what accounting information is, it's importance, and how it is used to facilitate business processes. Prerequisite: Math 4.

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

202 Cooperative Training in Business (IND 0.0-6.0) On-the-job experience gained through cooperative education with industry with credit arranged through departmental co-op advisor. Grade received depends on quality of reports submitted and work supervisors's evaluation. Prerequisite: Completed 30 hours toward degree.

220 Managerial Accounting (LEC 3.0) Emphasizes internal use of accounting information in establishing plans and objectives, controlling operations, and making decisions involved with management of an enterprise (the determination of costs relevant to a specific purpose such as inventory valuation, control of current operation, or special decisions). Prerequisite: Bus 120.

230 Business Law (LEC 3.0) This course is an introduction to the nature and meaning of law and the legal environment of business. Topics include the legal process, sources of law, and institutions. Prerequisites: Bus 110 and Econ 121.

240 Basic Marketing (LEC 3.0) The course examines the distribution, product, price, and promotion policies that underlie the activities of marketing institutions and the managerial, economic, and societal implications of such policies.

260 Business Operations (LEC 3.0) This course examines the concepts, processes, and institutions that are fundamental to an understanding of business operations within organizations. Emphasis is on the management and organization of manufacturing and service operations and the application of quantitative methods to the solution of strategic, tactical and operational problems Prerequisites: Bus 120, Math 12, Econ 121.

270 Human Resource Management (LEC 3.0) The course examines employee selection, performance appraisal, training and development, compensation, legal issues, and labor relations. Prerequisite: Bus 110.

280 Strategic Management (LEC 3.0) Study of the formulation and implementation of corporative, business and functional strategies designed to achieve organizational objectives. Case studies and research reports may be used extensively. (It is preferred that this course be taken during the student's senior year.) Prerequisites: Bus 240 and 250.

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 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: Completed 30 hours toward degree.

311 Business Negotiations (LEC 3.0) The purpose of this course is to understand the practices and processes of negotiation so that you can negotiate successfully in a variety of settings. The course is designed to be relevant to the broad spectrum of negotiation problems faced by managers, consultants, etc. Because almost everyone negotiates all the time, this course is relevant to almost any student. Prerequisite: Upperclassmen or graduate status.

326 Enterprise Resource Planning Systems Design and Implementation (LEC 3.0) This course provides a technical overview of Enterprise Resource Planning Systems and their impact on organizations. SAP is introduced to illustrate the concepts, fundamentals, framework, general information technology context, the technological infrastructure, and integration of business enterprise-wide applications. Prerequisite: IST 141 (Co-listed with IST 346)

341 Marketing Strategy (LEC 3.0) Identification and analysis of strategic managerial marketing issues. Integration of marketing concepts through theoretical overview and practical analysis, including extensive use of simulation. Prerequisite: Bus 240 or Eng Mgt 251.

366 Supply Chain Management Systems (LEC 3.0) The course studies the need for supply chain integration and the challenges of managing complex interfaces. This course focuses on the systems approach to the planning, analysis, design, development, and evaluation of supply chain. The course discusses activities that lead to integration of information and material flows across multiple organizations. Prerequisite: IST 346 or Bus 326 or Bus 420 or (IST 246 previously, and IST 346 or Bus 326 concurrently) (Co-listed with IST 347

386 Strategic Enterprise Management Systems (LEC 3.0) This course will study the use of information technology for the formulation and implementation of strategy in the organization. SAP's Strategic Enterprise Management (SEM) will be used to study the development of business plans, definition of key performance indicators, and evaluation of business. Prerequisite: IST 346 or Bus 326 or Bus 420 or (IST 246 previously, and IST 346 or Bus 326 concurrently) (Co-listed with IST 348)

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.

Ceramic Engineering

Bachelor of Science
Master of Science
Doctor of Philosophy

The Ceramic Engineering program is offered under the Department of Materials Science and Engineering.

Ceramic engineers produce materials vital to many advanced and traditional technologies: electronic and optical assemblies, aerospace parts, biomedical components, nuclear components, high temperature, corrosion resistant assemblies, fuel cells, electronic packaging. Ceramic engineers generally work with inorganic, nonmetallic materials processed at high temperatures. In the classroom, ceramic engineering students learn the relationships between engineering properties and the chemistry and structure of ceramic materials and go on to apply these scientific principles to the design of new formulations and manufacturing processes. If you are interested in the "why" of things, ceramic engineering will definitely interest you.

Ceramic engineering usually appeals to those who have a strong interest in finding practical applications of the basic sciences, especially chemistry and physics, and can be described as one of the disciplines where 'science and engineering intersect'. Design occurs at the atomic or microstructural level of solid materials. The UMR department of ceramic engineering specializes in glass and optical materials, electronic materials, and high temperature materials, but the same scientific and engineering principles that are learned can be applied to the design of new materials for other applications, including biomaterials, high strength materials, materials for energy generation, etc.

Most ceramic engineering classes and laboratories are held in McNutt Hall, but other research laboratories on campus are available to our students. Equipment exists for X-ray investigation of materials, for detection of thermally induced changes in chemistry and structure, for high temperature processing, and for measuring a wide variety of electronic, optical, magnetic, mechanical and thermal properties. The Graduate Center for Materials Research makes additional research equipment available to ceramic engineers, including electron microscopes, optical, infrared, and X-ray spectrometers, thermal analyzers, and high temperature/controlled atmosphere furnaces. Students may broaden their experience by assisting faculty in research projects, either for academic credit or for pay.

Undergraduate student organizations are very active and participation in local and national activities is encouraged. Cooperative education and internships are available with companies and research agencies around the country. Additional information about the department is available at http://mse.umr.edu/.

Mission Statement

The department will train the future industrial and academic leaders in ceramic engineering by providing a comprehensive, forward-looking and broad-based curriculum, which emphasizes fundamental principles, practical applications, oral and written communication skills, and professional practice and ethics. The department is distinguished by a nationally recognized graduate program that emphasizes research of significance to the State of Missouri and the nation while providing a stimulating educational environment.

The specific objectives of the ceramic engineering program are to:

- Provide a comprehensive, modern ceramic engineering curriculum that emphasizes the application of fundamental knowledge and design principles to solve practical problems;
- Maintain modern facilities for safe, hands-on laboratory exercises;
- Develop oral, written, and electronic communication skills in all students;
- Coordinate leadership and team-building exercises that are needed for success in industrial, research, or academic careers;
- Supplement formal academic training with co-op, summer intern, and department research experience to enhance student preparation for graduate school or careers in industry, research, or academics.
- Promote a dynamic and interactive learning environment in the classrooms and laboratories and enhance student-faculty communications through extra-curricular activities.

Faculty

Professors:

Harlan Anderson (Curators' Professor Emeritus), Ph.D., University of California-Berkeley
Richard Brow, Ph.D., Pennsylvania State University
Delbert Day[1], (Curators' Professor Emeritus), Ph.D., Pennsylvania State University
Fatih Dogan, Ph.D., Technical University of Berlin, Germany
Gregory Hilmas, Ph.D., University of Michigan
Wayne Huebner, Ph.D., (Department Chair of Materials, Science, and Engineering) University of Missouri-Rolla
P. Darrell Ownby[1], (Emeritus), Ph.D., Ohio State
Mohamed N. Rahaman, Ph.D., Sheffield, England
Robert Schwartz, Ph.D., University of Illinois-Urbana Champaign

Associate Professors:

William Fahrenholtz, Ph.D., University of New Mexico
Jeffrey D. Smith, Ph.D., University of Missouri-Rolla

[1]Registered Professional Engineer

Bachelor of Science
Ceramic Engineering

Entering freshmen desiring to study Ceramic Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Ceramic Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshmen Engi-

neering program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major.

For the Bachelor of Science degree in Ceramic Engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. A student must maintain 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 Ceramic Engineering.

The Ceramic Engineering curriculum contains a required number of hours in humanities and social sciences as specified by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. Each student's program of study must contain a minimum of 18 credit hours of course work from the humanities and the social sciences areas and should be chosen according to the following rules:

1) All students are required to take one American history course and one economics course. The history course is to be selected from History 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.

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 chairman.

The Ceramic Engineering program at UMR 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
Fr Eng 10-Study & Careers in Engr.	1
Chem 1-General Chemistry	4
Chem 2-General Chemistry Lab	1
Math 14-Calculus For Engineers I	4
Engl 20-Exposition & Argumentation	3
H/SS Elective[1]	3
	16
Second Semester	
Met 125-Chem of Materials	3
Math 15-Calculus For Engineers II	4
Phys 23-Engineering Physics I	4
H/SS Elective[1]	3
IDE 20-Eng Design & Computer Appls	3
	17

SOPHOMORE YEAR

First Semester	Credit
Cr Eng 102-Atomic Structure Cryst	3
Cr Eng 104-Cer in the Modern World	2
Cr Eng 111-Cer Mat Lab I, Char	2
Math 22-Calc w/Analy Geo III	4
Physics 24-Eng Physics II	4
	15
Second Semester	
Cr Eng 103-Intro to Glass Sci & Tech	3
Cr Eng 122-Cer Mat Lab II-Glass & Trad Cr	2
Cer 259-Thermodynamics of Materials	3
Math 204-Diff Equa or Statistics Elective[3]	3
H/SS Elective[1]	3
IDE 50-Engr Mechanics Statics	3
	17

JUNIOR YEAR

First Semester	Credit
Cr Eng 231-Cer Proc Lab I	2
Cr Eng 251-Phase Equilibria	3
IDE 110-Mechanics of Materials	3
Cr Eng 203-Thermal Proc in Cer	3
Cr Eng 291-Characterization of Inorganic Solids	3
	14
Second Semester	
Cr Eng 242-Cer Proc Lab II	2
Cr Eng 291-Materials Characterization	3
Physics 107-Intro to Modern Physics	3
H/SS Elective[1]	3
Technical Elective[2]	3
Advanced Chemistry Elective[5]	3
	17

SENIOR YEAR

First Semester	Credit
Cr Eng 261-Materials Senior Design I	1
Cr Eng 284-Elect Prop of Ceramics w/lab	4
Cr Eng 331-Ceramics Processing	3
Cr Eng 338-Thermal Properties of Ceramics	3
EMgt 209-Engineering Economy and Mgmt	3
Technical Elective[2]	3
	17
Second Semester	
Cr Eng 262-Materials Senior Design II	2
Cr Eng 306-Mech. Prop. of Ceramics w/lab	4
H/SS Elective[1]	3
Statistics Elective[3]	3

Technical Electives[2] 3
15

Note 1: Students may replace Chem 1, 2, and 3 with Chem 5, but will need to also take an additional technical elective (with advisor's approval) to reach the 128 hour requirement.

Note 2: Students may substitute Math 8 and 21 for Math 14 and 15, respectively.

Note 3: Students may substitute Chem 3 for Met 125.

1) Eighteen hours of H/SS electives to be taken
2) Technical electives must be selected from 200 and 300 level engineering and science courses with the advisor's approval.
3) All Ceramic Engineering students must either take Math 204 and one statistics course (200-level or higher) or an introductory statistics course (200-level) plus an advanced statistics elective (EMAN 385, Stat 320, Stat 343, Stat 344, Stat 346, or Stat 353).
4) All Ceramic Engineering students must take the Fundamentals of Engineering Examination (FE) 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 UMR assessment process as described in Assessment Requirements found in the Undergraduate catalog. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.
5) All Ceramic Engineering students must select an advanced chemistry elective with the advisor's approval. The courses that can be considered are Chem 221, Chem 225, Chem 237, Chem 241, Chem 331, or Chem 343.

Specific Degree Requirements

1) Total number of hours required for a degree in Ceramic Engineering is 128.

2) The assumption is made that a student admitted in the department has completed 34 hours credit towards graduation. The academic program of students transferring from colleges outside UMR will be decided on a case-by-case basis.

3) The department requires a total of 18 credit hours of humanities and social science.

Ceramic Engineering Courses

102 Atomic Structure Of Crystalline Ceramics (LEC 3.0) The crystal-chemical principles used to design and manufacture materials with specified properties are developed and applied to oxides, clays, silicates and other nonmetallic compounds.

103 Introduction To Glass Science And Technology (LEC 3.0) A study of the atomic-level structure of oxide glasses and the relationships between composition, properties and structure of glass-forming systems. Simple rate processes will be introduced to explain temperature-dependent properties. Prerequisite: Cr Eng 102.

104 Ceramics In The Modern World (LEC 2.0) An introduction to traditional and modern applications of ceramics providing a broad overview of all aspects of current ceramic technology.

111 Ceramic Materials Laboratory I-Characterization Of Materials (LAB 2.0) Laboratory experience in collection, beneficiation, and characterization of ceramic raw materials; granulation, compaction, and sintering of particulate materials; and characterization at an introductory level. Standard laboratory practice including safety, report writing, and error analysis are also emphasized. Prerequisite: Sophomore standing.

122 Ceramic Materials Laboratory IIGlass And Ceramic Processing (LAB 2.0) Laboratory experience in design, processing, and characterization of glasses and ceramics. Glasses are formulated, melted and characterized to correlate composition and properties. Clay-based ceramics are formulated to meet performance specifications, prepared by slip casting/extrusion, and fired. Prerequisite: Cr Eng 111.

202 Cooperative Training (IND 1.0-3.0) On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted at work supervisor's evaluation.

203 Thermal Processes In Ceramics (LEC 3.0) Considerations in rate controlled processes in the fabrication of ceramics, packing of powders, comminution and calcination, drying and firing of ceramic ware, polymorphic transformations, sintering, grain growth and hot pressing, relationships of fabrication techniques to physical properties.

205 The Engineering Design Process (LEC 2.0) Introduction to elements of design process including strategic, planning, project, management, modelling, materials selection, engineering economics, safety, environmental issues and ethics. Prerequisite: Junior standing.

231 Ceramic Processing Lab I (LAB 2.0) The first half of a two-semester sequence that gives students practical knowledge of the methods and techniques used in the fabrication of ceramics. Prerequisite: Cr Eng 122.

242 Ceramic Processing Lab II (LAB 2.0) The second half of a two-semester sequence that gives students practical knowledge of the methods and techniques used in the fabrication of ceramics. Prerequisite: Cr Eng 231.

251 Phase Equilibria (LEC 3.0) The study of unary, binary and ternary inorganic, phase equilibrium systems with examples for solving practical engineering problems. Prerequisite: Chem 3.

259 Thermodynamics of Materials (LEC 3.0) Basic thermodynamic concepts are applied to materials. Calculations involving enthalpy, entropy, and Gibbs' free energy are studied. Inter-relationships among properties are emphasized. Fundamental concepts of phase equilibira are presented. Prerequisite: Met Eng 125 or Chem 3.

261 Materials Senior Design I (LAB 1.0) Students working in groups will be assigned a capstone de-

sign project related to a specific materials technology. This course will focus on project plan and all aspects of product and process design. Prerequisite: Senior standing. (Co-listed with Met Eng 261)

262 Materials Senior Design II (LAB 1.0) A continuation of the Materials Senior Design I. Students working in groups will complete a capstone design project including process and product simulation and/or fabrication, safety aspects, environmental impact and capital and operating economics. Prerequisite: Cer Eng 261 or Met Eng 261. (Co-listed with Met Eng 262)

284 Electrical Properties Of Ceramics (LEC 3.0 and LAB 1.0) The application of ceramic chemistry and physics to the development and evaluation of electronic, dielectric, magnetic, and optical properties. Emphasis is placed on the relationships between properties and crystal structure, defects, grain boundary nature, and microstructure. Prerequisite: Physics 107.

291 Characterization Of Inorganic Solids (LEC 3.0) X-ray diffraction analysis is emphasized including lattice parameter determination, qualitative and quantitative analysis methods, and sources of error. In addition, the basic principles of other common characterization techniques including electron microscopy, thermal analysis, and energy dispersive spectroscopy are discussed. Prerequisite: Cr Eng 102 or Mt Eng 121 or a similar introductory course on structure of solids.

292 Characterization Of Inorganic Solids Laboratory (LAB 1.0) Practical aspects of x-ray diffraction analysis will be emphasized; students will gain hands-on experience in qualitative and quantitative analysis techniques, use of electronic databases, and operation of modern powder diffractometers. Prerequisite: Preceded or accompanied by Cr Eng 291.

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.

306 Mechanical Properties Of Ceramics (LEC 3.0 and LAB 1.0) This course will treat the theory and testing practice related to design based on the mechanical properties of ceramics. The course also includes a laboratory consisting of experiments for the characterization of the mechanical properties of ceramics. Prerequisite: IDE 110.

308 Electrical Ceramics (LEC 2.0 and LAB 1.0) The application and design of ceramics for the electrical industry is discussed. Particular emphasis is placed on how ceramic materials are altered to meet the needs of a specific application. The laboratory acquaints the student with measurements which are used for electrical property evaluation. Prerequisite: Cr Eng 284.

315 Organic Additives In Ceramic Processing (LEC 2.0) Basic chemistry, structure and properties or organic additives used in the ceramics industry; solvents, binders, plasticizers, dispersants. Use of organic additives in ceramic processing. Prerequisites: Cr Eng 203 and 231.

331 Ceramic Processing (LEC 3.0) Powder, colloidal and sol-gel processing, forming methods, drying, sintering and grain growth. Relation of processing steps to densification and microstructure development. Prerequisite: Senior standing.

333 Microelectronic Ceramic Processing (LEC 3.0) Materials, processing and design of microelectronic ceramics are covered. Introduction to devices, triaxial ceramics, high aluminas, tape fabrication, metallizations, thick film processing and glass-to-metal seals. Prerequisites: Cr Eng 203 & 242.

338 Thermal Properties Of Ceramics (LEC 3.0) This course will teach the crystal physics underlying heat capacity, internal energy, phonon and photon conduction, and thermal expansion. These properties will be used to rationalize the behavior of a wide variety of ceramic materials in severe thermal environments. Prerequisite: Senior Standing.

340 Biomaterials I (LEC 3.0) This course will introduce senior undergraduate students to a broad array of topics in biomaterials, including ceramic, metallic, and polymeric biomaterials for in vivo use, basic concepts related to cells and tissues, host reactions to biomaterials, biomaterials-tissue compatibility, and degradation of biomaterials. Prerequisite: Senior undergraduate standing. (Co-listed with Bio Sci 340, Met Eng 340, Chem Eng 340)

352 International Engineering and Design (LEC 2.0 and LAB 1.0) A multi-disciplinary engineering course focused on sustainable design and technology transfer to developing countries. Course includes elements of traditional capstone design classes. Experiential learning through competitions and/or field work is a major component of the class. Prerequisite: Senior standing, instructor approval. (Co-listed with Geo Eng 352 and Met Eng 352)

362 Thermomechanical/Electrical/Optical Properties Lab (LAB 1.0) Laboratory consisting of three separate modules of experiments for the characterization of the thermomechanical, electrical and optical properties of ceramics. The student will choose one of the three modules. Prerequisite: IDE 110 or Cer Eng 284.

364 Refractories (LEC 3.0) The manufacture, properties, uses, performance, and testing of basic, neutral and acid refractories.

369 Glass Science And Engineering (LEC 3.0) The development, manufacturing methods, applications, and properties of flat, fiber, container, chemical, and special purpose glasses. Composition/property relationships for glasses and nucle-

ation-crystallization processes for glass-ceramics are also covered. Prerequisite: Cr Eng 103.

371 Dielectric And Electrical Properties Of Oxides (LEC 3.0) The processes occurring in inorganic materials under the influence of an electric field are considered from basic principles. Emphasis is placed on application to real systems. Prerequisite: Cr Eng 284.

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, Physics 377, Mt Eng 377)

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.

392 X-Ray Diffraction Laboratory (LAB 1.0) Practical aspects of sample preparation, instrument setup, data collection, and analysis are covered. Students cannot receive credit for Cr Eng 292 and Cr Eng 392. Prerequisite: Preceded or accompanied by Cr Eng 291, or Cr Eng 477, or an advanced crystallography course.

Chemical & Biological Engineering

Bachelor of Science in Chem. Eng.
Master of Science in Chem. Eng.
Doctor of Philosophy in Chem. Eng.
Doctor of Engineering in Chem. Eng.

Emphasis area at bachelor of science level in biochemical engineering

Chemical engineering is the branch of engineering which deals with changing the composition, energy content, and state of aggregation of materials. As a chemical engineering student, you will consider the fundamental properties and nature of matter (chemistry), the forces that act on matter (physics), and the precise expressions of the relationships between them (mathematics). Extensive use is made of computers in the application of these sciences to engineering problems.

As a chemical engineer, you may study ways in which pure water can be obtained from the sea; design processes to provide fertilizers, rubber, fibers, and fuels; or team up with other engineers and scientists in biomedical engineering to develop specialized polymeric materials for use in artificial arms, legs, and other human organs. You may be instrumental in finding supplemental food sources for man-such as protein from petroleum, wood, or the sea. You might help develop new processes for the application of biochemistry, energy conservation, or environmental control-such as reducing undesirable substances in the air. Or, you might have a hand in the creation of strong lightweight materials to be used in aircraft construction. Your opportunities will be unlimited.

At UMR, you will have laboratories available which offer training in qualitative and quantitative analysis, organic and physical chemistry, physics, unit operations, biochemical engineering, design, and automatic process control.

Your studies will give you a broad technical basis with an emphasis on material balances, energy balances, separation processes, rate processes, unit operations, and process economics and design.

Among its facilities, the department features digital data acquisition and control equipment for research and instruction which allows simultaneous utilization of the system by several people. A full complement of hardware exists for input and output of signals to and from process equipment and instrumentation. The departmental computer network makes available a wide variety of professional software. Also included is equipment to measure thermodynamic and physical properties, study biochemical engineering processes, polymers, surface phenomena, fluid mechanics, membranes, chemical kinetics, and diffusion.

Mission Statement

The department prepares chemical engineers for successful careers of leadership and innovation in chemical engineering and related fields; expands the knowledge base of chemical engineering through its scholarly pursuits; develops technology to serve societal needs; and benefits the public welfare through service to the chemical engineering profession.

BSChE Program Objectives: Graduates Will Have:

1) A strong fundamental scientific and technical knowledge base and critical thinking skills which provide the foundation for design, experimentation, interpretation, and analysis, and for life-long learning.
2) The ability to apply science, mathematics and engineering skills and work in multi-functional teams to identify and formulate solutions for problems faced by practicing chemical engineers, and to design and analyze chemical engineering systems and processes.
3) The ability to effectively communicate technical and professional information in written oral, visual and graphical formats.
4) Awareness and understanding of the moral, ethical, legal and professional obligations needed to function as part of a professional enterprise, and to protect human health and welfare, and the environment in a global society.

Faculty

Professors:

Craig D. Adams, Ph.D., University of Kansas
(joint appointment with Civil, Architectural and Environmental Engineering)
Orrin Crosser[1], (Emeritus), Ph.D., Rice
Daniel Forcinti, Ph.D., North Carolina State University
Sunggyu "KB" Lee, Ph.D., Case Western Reserve University (joint appointment with Chemical Engineering, UMC)
Athanasios Liapis[1], Ph.D., Swiss Federal Institute of Technology
Douglas K. Ludlow, (Acting Chair), Ph.D., Arizona State University
David Manley (Emeritus), Ph.D., University of Kansas
Nicholas Morosoff (Emeritus), Ph.D., Polytechnic Institute of Brooklyn
Partho Neogi, Ph.D., Carnegie-Mellon
Gary Patterson[1], (Emeritus), Ph.D., University of Missouri-Rolla
X B Reed, Jr. (Emeritus), Ph.D., Minnesota
Judy A. Raper[1], (Department Chair), Ph.D., UNSW
Stephen L. Rosen, (Emeritus) Ph.D., Cornell
Mailand Strunk (Emeritus), Sc.D., Washington University
Raymond Waggoner[1], (Emeritus), Ph.D.,Texas A & M

Associate Professors:

Neil Book, Ph.D., Colorado
Oliver Sitton, Ph.D., University of Missouri-Rolla
Jee-Ching Wang, Ph.D., Pennsylvania State University

Assistant Professors:

David B Henthorn, Ph.D., Purdue University
Kimberly H. Henthorn, Ph.D., Purdue University
Kai-tak Wan, Ph.D., University of Maryland
(joint appointment with Mechanical and Aerospace Engineering)
Yangchuan Xing, Ph.D., Yale

[1]Registered Professional Engineer

Bachelor of Science Chemical Engineering

Entering freshmen desiring to study Chemical Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Chemical Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the 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 Chemical Engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in Chemical Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1) All students are required to take one American history course, one economics course, one humanities course, and English 20. The history course is to be selected from History 112, History 175, History 176, or Political Science 90. The economics course may be either Economics 121 or 122. The humanities course must be selected from the approved lists for Art, English, Foreign Languages, Music, Philosophy, Speech and Media Studies, or Theater.

2) Depth requirement. Three credit hours must be taken in humanities or social sciences at the 100 level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 70 or 80 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 300 level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.

3) The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to English 20.

4) Any specific departmental requirements in the general studies area must be satisfied.

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

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

FREE ELECTIVES FOOTNOTE:

Free electives. Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.

FRESHMAN YEAR

First Semester	Credit
FE 10-Study & Careers in Eng	1
Chem 1 - General Chemistry	4
Chem 2 - General Chemistry Lab	1
Engl 20 - Exposition & Argumentation	3
Hist - 112, 175, 176 or Pol Sci 90	3
Math 14 - Calculus I for Engineers	4
	16

Second Semester
IDE 20-Eng Design w/Comp App 3
Ch Eng 20-Comp & Chem Eng or CmpSc73/77 or CmpSc74/78 or CmpSc 53/54 3
Chem 3-General Chemistry II 3
Math 15-Calculus II for Engineers 4
Physics 23-Engineering Physics I 4
17

SOPHOMORE YEAR

First Semester	Credit
Ch Eng 120-Chem Eng Mat Balances[1]	3
Chem 221-Organic Chemistry I	3
Econ 121 or 122-Prin of Micro/Macro	3
Math 22-Calculus w/Analytic Geometry III	4
Physics 24-Eng Physics II	4
	17

Second Semester	
Ch Eng 211-Prof Prac & Ethics[4]	1
Ch Eng 141-Chemical Eng Thermodynamics I[1]	3
Ch Eng 145-Chem Process Materials	3
Humanities Electives[2]	3
Humanities or Social Science Elective[2]	3
Math 204-Elem Differential Equa	3
	16

JUNIOR YEAR

First Semester	Credit
Ch Eng 231-Chem Eng Fluid Flow	3
Ch Eng 233-Chem Eng Heat Transfer	2
Ch Eng 245-Chem Eng Thermo II[1]	3
Chem 241-Physical Chemistry I	3
General Ed Upper Level Elective[3]	3
Humanities or Social Science Upper Level Elective[2]	3
	17

Second Semester	
Ch Eng 234-Chem Eng Lab I[4]	2
Ch Eng 235-Staged Mass Transfer	3
Ch Eng 237-Cont Mass Transfer	3
Ch eng 247-Molecular Chem Eng	3
Chem & Lab Elective[5]	4
	15

SENIOR YEAR[6]

First Semester	Credit
Ch Eng 236-Chem Eng Lab II[4]	3
Ch Eng 251-Chem Eng Proc Dyn & Cont	3
Ch Eng 252-Proc Dyn & Contr Lab	1
Ch Eng 281-Chem Eng Reactor Design	3
Ch Eng 3xx-Chem Eng Elective[7]	3
Free Electives[8]	3
	16

Second Semester	
Ch Eng 283-Chem Eng Econ[4]	2
Ch Eng 285-Chem Proc Safety[4]	3
Ch Eng 288-Chem Process Design[4]	3
Ch Eng 3xx-Chem Eng Elective[7]	3
Free Electives[8]	3
	14

Note: The minimum number of hours required for a degree in Chemical Engineering is 128.

1) A grade of "C" or better is required in Ch Eng 120 and in Ch Eng 141 to enroll in Ch Eng 245
2) From approved list
3) General Education Upper Level Elective -all Hu/SS upper level electives and also: Engl 60, Engl 160, Sp&M 85, and Sp&M 181
4) Writing emphasized course
5) Chemistry & Laboratory Electives:Chem 151(4), or Chem 223(3), 224(1) or Chem 243(3), 242(1) or Chem 361(3), 362(1) or BioSci 211(4)
6) All Chemical Engineering students must take the Fundamentals of Engineering Exam prior to graduation. This requirement is part of the UMR assessment process as described in Assessment Requirements found elsewhere in this undergraduate catalog. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.
7) Chemical Engineering Elective: Any Ch Eng 3xx class. But only one of Ch Eng 300, 390 or 390H can be used to fulfill this requirement.
8) Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours. ECE 281 recommended for preparation for FE exam.

Chemical Engineering Biochemical Engineering Emphasis

FRESHMAN YEAR

First Semester	Credit
FE 10-Study & Careers in Eng	1
Chem 1-General Chemistry	4
Chem 2-General Chemistry Lab	1
Engl 20-Exposition & Argumentation	3
Hist-112, 175, 176 or Pol Sci-90	3
Math 14-Calculus I for Engineers	4
	16

Second Semester	
IDE 20-Eng Design w/ Comp Appl	3
Ch Eng 20-Comp & Ch Eng or CmpSc 73/77 or CmpSc 74/78 or CmpSc 53/54	3
Chem 3-General Chemistry II	3
Math 15-Calculus II for Engineers	4
Physics 23 - Engineering Physics I	4
	17

SOPHOMORE YEAR

First Semester	Credit
Bio 211-Cellular Biology	4
Ch Eng 120-Chem Eng Mat Bal[1]	3
Chem 221-Organic Chemistry I	3
Math 22-Calculus w/Analytic Geometry III	4
Physics 24-Eng Physics II	4
	18

Second Semester	
Bio Sc 221-Microbiology	5
Ch Eng 141-Chem Eng Thermo[1]	3
Ch Eng 145-Chem Process Mat	3
Chem 223-Organic Chemistry II	3
Chem 224-Organic Chemistry Lab	1
Math 204-Elem Differential Equations	3
	18

JUNIOR YEAR

First Semester	Credit
Bio Sc 331-Molecular Genetics	3
Bio Sc 332-Molecular Genetics Lab	2
Ch Eng 231-Chem Eng Fluid Flow	3
Ch Eng 233-Chem Eng Heat Transfer	2
Ch Eng 245-Chem Eng Thermodynamics II[1]	3
Chem 241-Physical Chemistry	3
	16
Second Semester	
Ch Eng 211-Prof Prac & Ethics[4]	1
Ch Eng 235-Staged Mass Transfer	3
Ch eng 247-Molecular Chem Eng	3
Ch Eng 263-Biochem Separations	3
Econ 121 or 122-Prin of Micro/Macro	3
Humanities Elective[2]	3
	16

SENIOR YEAR[3]

First Semester	Credit
Ch Eng 251-Proc Dyn & Control	3
Ch Eng 252-Proc Dyn & Contr Lab	1
Ch Eng 264-Biochemical Separations Lab[4]	2
Ch Eng 281-Chem Eng Reactor Design	3
General Ed Upper Level Electivies[5]	3
Humanities or Social Science Elective[2]	3
	15
Second Semester	
Cheng 283-Chem Eng Econ[4]	2
Ch Eng 365-Biochemical Reactors	3
Ch Eng 266-Bioreactor Lab[4]	3
Ch Eng 288-Chem Process Design[4]	3
Humanities or Social Science Upper Level Elective[2]	3
	14

NOTE: The minimum number of hours required for a degree in Chemical Engineering is 130.

1) A grade of "C" or better is required in Ch Eng 120 and in Ch Eng 141 to enroll in Ch Eng 245
2) From approved list
3) All Biochemical Engineering Emphasis students must take the Fundamentals of Engineering Exam prior to graduation. This requirement is part of the UMR assessment process as described in Assessment Requirements found elsewhere in this undergraduate catalog. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.
4) Writing emphasized course
5) General Education Upper Level Elective-all Hum/SS upper level electives and also: Engl 60, Engl 160, Sp&M 85, and Sp&M 181

Honors in Chemical and Biological Engineering

CBE has rewritten its rules for the honors program effective as of 2005. The Honors Program requires candidates to maintain a GPA of 3.5 at all times, take 3 credit hours of ChE 390H and submit a report to the honors advisor. When the honors advisor lets the department chair know that all requirements have been met that the candidate gets his/her diploma with honors.

CBE requires the student to complete a three semester long project with 6 or 9 credit hours of ChE 390H, three hours counting towards the technical elective and up to 6 towards free electives. ChE 390H cannot be taken without a GPA of 3.5. It is necessary to start and finish with the same advisor. The report has to be validated by a committee consisting of at least the project advisor and the CBE honors program advisor. A form has to be sent to the department chair to start and another to complete the process.

Honors projects have no known solutions and in that, the successful completion of the project shows the ability of the candidates to solve problems. The three semesters make the study in-depth. And the report will contribute towards building good technical writing abilities. This report can be shown to all technical people to make a point about the lasting skills that have been achieved along with the B.S. degree.

Chemical Engineering Courses

20 Computers And Chemical Engineering (LEC 2.0 and LAB 1.0) Introduction to chemical engineering, both its intellectual and professional opportunities. Students are introduced to computer programming and software packages while performing meaningful chemical engineering calculations.

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

120 Chemical Engineering Material & Energy Balances (LEC 2.0 and LAB 1.0) The application of mathematics, physics and chemistry to industrial chemical processes. The use of equations of state, chemical reaction stoichiometry, and the conservation of mass and energy to solve chemical engineering problems. Prerequisites: Chem 3; preceded or accompanied by Math 15 (or 21); preceded or accompanied by Chem Eng 20, or Comp Sci 73 & 77, or Comp Sci 74 & 78; or Comp Sci 53 & 54.

141 Chemical Engineering Thermodynamics I (LEC 3.0) Development and application of the laws and fundamental relationships of thermodynamics to industrial chemical processes. Emphasis is placed on the estimation of thermophysical property values for applications in chemical process engineering. Prerequisites: Preceded or accompanied by Chem Eng 120, Math 22; and Chem Eng 20, or Comp Sci 73 & 77, or Comp Sci 74 & 78, or Comp Sci 53 & 54.

145 Chemical Process Materials (LEC 3.0) Fundamentals of the chemistry of materials. Classification, properties, selection, and processing of engineering materials. Introduction to polymers, electronic materials, biomaterials, and nanomaterials. Prerequisites: Math 15(21), Physics 23.

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.

202 Co-Operative Engineering Training (IND 0.0-6.0) On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative adivsor. Grade received depends on quality of reports submitted and work supervisors evaluation.

211 Professional Practice And Ethics (LEC 1.0) Preparation for post-graduate activities including resume writing and job searching. Professional attitudes, practice, licensure, and ethics in the chemical engineering profession. Discussions led by visiting industrialists and other invited speakers. Discussion of professional development including professional and graduate programs. Generally offered fall semester only. Prerequisite: At least sophomore standing.

231 Chemical Engineering Fluid Flow (LEC 3.0) Mass, energy, and momentum balance concepts in fluid flow are studied to provide a basis for study of flow measurement, fluid behavior, turbulent flow, dimensional analysis of fluid flows, and the study of some practical flow processes such as : filtration, fluidization, compressible flow, pipe networks. Prerequisites: Chem Eng 120, Math 204, and Physics 23.

233 Chemical Engineering Heat Transfer (LEC 2.0) Process principles of heat transfer in the chemical process industry. Steady and unsteady state heat conduction and radiation heat transfer. Free and forced convection and condensation and boiling heat transfer. Practical heat exchanger design. Prerequisite: Accompanied or preceded by Ch Eng 231.

234 Chemical Engineering Laboratory I (LEC 1.0 and LAB 1.0) Experiments associated with the unit operations with fluid flow and heat transfer. Design of experiments and uncertainty analysis are introduced. Process equipment designs based on laboratory data stress the importance of creativity as well as the need for effective communication. This is a communication emphasized course. Generally offered winter semester only. Prerequisites: Chem Eng 231 and Chem Eng 233.

235 Staged Mass Transfer (LEC 3.0) Principles of equilibrium stage operations applied to distillation, liquid-liquid extraction, absorption, and leaching. Crystallization, fluidization, mechanical separations are also studied. Quantitative solutions to practical problems are stressed. Prerequisites: Chem Eng 245 and preceded or accompanied by Chem Eng 237 or Chem Eng 263.

236 Chemical Engineering Laboratory II (LEC 1.0 and LAB 2.0) Experiments illustrating the unit operations of continuous and staged separation. Experimental design methods are extended to include the principles of regression and model building. Communication skills are stressed. This is a communication emphasized course. Prerequisites: Chem Eng 234, Chem Eng 235, Chem Eng 237; preceded or accompanied by Chem Eng 281.

237 Continuous Mass Transfer (LEC 3.0) Fundamentals of diffusion and mass transfer applied to absorption, extraction, humidification, drying and filtration. Design and rating of continuous chemical separators. Prerequisites: Ch Eng 233, 245 and preceded or accompanied by Chem 241.

245 Chemical Engineering Thermodynamics II (LEC 3.0) Physical, chemical and reaction equilibrium. Study of the thermophysical relationships of multicomponent, multiphase equilibrium. Application of equilibrium relationships to the design and operation of chemical mixers, separators and reactors. Prerequisites: Grade of "C" or better in Ch Eng 120 and 141, accompanied or preceded by Math 204.

247 Molecular Chemical Engineering (LEC 3.0) Introduction to the molecular aspects of chemical thermodynamics, transport processes, reaction dynamics, and statistical and quantum mechanics. Prerequisite: Ch Eng 245.

251 Chemical Engineering Process Dynamics And Control (LEC 3.0) Study of the dynamics of chemical processes and the instruments and software used to measure and control temperature, pressure, liquid level, flow, and composition. Generally offered fall semester only. Prerequisites: Preceded or accompanied by Chem Eng 236 or Chem Eng 264; accompanied by Chem Eng 252.

252 Process Dynamics And Control Laboratory (LAB 1.0) Application of the concepts of industrial process dynamics and control using experiments that demonstrate different control and sensing devices and software. Generally offered fall semester only. Prerequisites: Preceded or accompanied by Ch Eng 236, or Ch Eng 264; accompanied by Ch Eng 251.

263 Biochemical Separations (LEC 3.0) The fundamentals of mass transfer are introduced and applied to various unit operations employed in the separation of chemical and biochemical compounds. Prerequisites: Chem Eng 245 and preceded or accompanied by Chem Eng 235.

264 Biochemical Separations Laboratory (LAB 2.0) Introduction to the unit operations employed in the separation of chemicals and biochemicals. The experiments illustrate the stage and continuous separation systems are involved. This is a communication emphasized course. Prerequisite: Ch Eng 263.

266 Biochemical Reactor Laboratory (LAB 3.0) Introduction to the unit operations involved with the production of biochemicals. The experiments emphasize the isolation of proteins and enzymes from tissue and bacteria cells. Prerequisites: Chem Eng 263 and preceded or accompanied by Chem Eng 365.

281 Chemical Engineering Reactor Design (LEC 3.0) The study of chemical reaction kinetics and their application to the design and operation of

chemical and catalytic reactors. Prerequisite: Chem Eng 237 or Chem Eng 263.

283 Chemical Engineering Economics (LEC 2.0) Economic analysis of a chemical process including capital requirements, operating costs, earnings, and profits. The economic balance is applied to chemical engineering operations and processes. Optimization and scheduling techniques are applied to process evaluation. This is a communication emphasized course. Prerequisite: Ch Eng 235.

285 Chemical Process Safety (LEC 3.0) The identification and quantification of risks involved in the processing of hazardous and/or toxic materials are studied. Generally offered winter semester only. Prerequisite: Preceded or accompanied by Ch Eng 145 and Ch Eng 281.

288 Chemical Process Design (LEC 1.0 and LAB 2.0) Engineering principles involved in the design and layout of chemical process equipment. Material and energy balances, equipment selection and design, and preconstruction cost estimation are performed for a capstone design project. Communication emphasized course. Prerequisites: Chem Eng 235 and Chem Eng 281; preceded or accompanied by Chem Eng 251, Chem Eng 252, and Chem Eng 283.

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.

320 Chemical Process Flowsheeting (LEC 2.0 and LAB 1.0) The development, implementation, and evaluation of methods for determining the mathematical model of a chemical process, ordering the equations in the mathematical model, and solving the model. Prerequisite: Math 204 or graduate standing.

333 Intermediate Separation Processes (LEC 3.0) Fundamentals of separation operations such as extraction and distillation; rates of diffusion in equilibrium stages and continuous contactors; efficiencies; multistage contactors; performance of equipment; phase equilibrium data; multicomponent separation. Prerequisite: Ch Eng 235 or graduate standing.

335 Intermediate Transport Phenomena (LEC 3.0) The similarities of flow of momentum, heat and mass transfer and the applications of these underlying principles are stressed. Course is primarily for seniors and beginning graduate students. Prerequisite: Chem Eng 237 or Chem Eng 263 or graduate standing.

340 Biomaterials I (LEC 3.0) This course will introduce senior undergraduate students to a broad array of topics in biomaterials, including ceramic, metallic, and polymeric biomaterials for in vivo use, basic concepts related to cells and tissues, host reactions to biomaterials, biomaterials-tissue compatibility, and degradation of biomaterials. Prerequisite: Senior undergraduate standing. (Co-listed with Cer Eng 340, Bio Sci 340, Met Eng 340)

341 Physical Property Estimation (LEC 3.0) Study of techniques for estimating and correlating thermodynamic and transport properties of gases and liquids. Prerequisite: Ch Eng 235 or graduate standing.

347 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, Physics 377, Mt Eng 377, Cr Eng 377)

349 Structure And Properties Of Polymers (LEC 3.0) A study of the parameters affecting structure and properties of polymers. Syntheses, mechanisms, and kinetic factors are emphasized from the standpoint of structural properties. Prerequisite: Ch Eng 235 or graduate standing.

351 Principles Of Environmental Monitoring (LEC 3.0) This course introduces the fundamentals of particle technology, including particle characterization, transport, sampling, and processing. In addition, students will learn about the basic design of some industrial particulate systems and environmental and safety issues related to particulate handling. Prerequisites: Chem Eng 231 and Physics 24, or graduate standing.

355 Intermediate Process Dynamics And Control (LEC 3.0) A study of the dynamic properties of engineering operations and the interrelationships which result when these operations are combined into processes. Formulation of equations to describe open-loop and closed-loop systems. Prerequisite: Chem Eng 235 or graduate standing.

359 Plantwide Process Control (LEC 3.0) Synthesis of control schemes for continuous and batch chemical plants from concept to implementation. Multiloop control, RGA, SVD, constraint control, multivariable model predictive control, control sequence descriptions. Design project involving a moderately complicated multivariable control problem. Prerequisites: Chem Eng 251, Elec Eng 231, Elec Eng 235 or graduate standing. (Co-listed with El Eng 332)

365 Biochemical Reactors (LEC 3.0) Application of chemical engineering principles to biochemical reactors, and human physiology. Emphasis on cells as chemical reactors, enzyme catalysis and biological transport phenomena. Prerequisite: Preceded or accompanied by Chem Eng 281 or graduate standing.

366 Chemical Process Simulation (LAB 1.0) Simulation of Engineering and chemical processes on digital and/or analog devices with application to pilot scale processes. Prerequisite: Chem Eng 235 or graduate standing.

371 Environmental Chemodynamics (LEC 3.0) Interphase transport of chemicals and energy in the environment. Application of the process oriented aspects of chemical engineering and science to situations found in the environment. Prerequisite: Chem Eng 237 or Chem Eng 263 or graduate standing.

373 Pollution Prevention Via Process Engineering (LEC 3.0) To arrive at environmentally benign process design, each processing system will be considered as an inter-connection of elementary units. Systematic methods capitalizing on synergistic process integrations will be employed. Linear, nonlinear and integer optimization, mass/heat exchange networks, and reactor and reaction networks will be used. Prerequisite: Ch Eng 235 or graduate standing.

379 Industrial Pollution Control (LEC 3.0) The study of water, air, and thermal pollution control methods and the application of these methods to the solution of pollution problems in the chemical industry. Prerequisite: Ch Eng 235 or graduate standing.

381 Corrosion And Its Prevention (LEC 3.0) A study of the theories of corrosion and its application to corrosion and its prevention. Prerequisite: Chem 243 or Mt Eng 281. (Co-listed with Mt Eng 381)

383 Intermediate Chemical Reactor Design (LEC 3.0) A study of homogeneous and heterogeneous catalyzed and noncatalyzed reaction kinetics for flow and batch chemical reactors. Application to reactor design is stressed. Prerequisite: Ch Eng 281 or graduate standing.

384 Interdisciplinary Problems In Manufacturing Automation (LEC 2.0 and LAB 1.0) The course will cover material necessary to design a product and the fixtures required to manufacture the product. Participants will gain experience with CAD/CAM software while carrying out an actual manufacturing design project. (Co-listed with Mc Eng 344, Eng Mg 344)

385 Patent Law (LEC 3.0) A presentation of the relationship between patent law and technology for students involved with developing and protecting new technology or pursuing a career in patent law. Course includes an intense study of patentability and preparation and prosecution of patent applications. Prerequisite: Senior or graduate standing. (Co-listed with Civ Eng 385, Eng Mgt 369)

387 Interfacial Phenomena In Chemical Engineering (LEC 3.0) The course deals with the effects of surfaces on transport phenomena and on the role of surface active agents. Topics include fundamentals of thermodynamics, momentum, heat and mass transfer at interfaces and of surfactants. Some applications are included. Prerequisite: Chem Eng 237 or Chem Eng 263 or graduate standing.

388 Intermediate Process Design (LEC 3.0) Study of newer unit operations, fluidization, chromatographic absorption, new developments in operations previously studied. Comparison of operations which might be selected for the same end result in an industrial process. Prerequisite: Ch Eng 235 or graduate standing.

389 Industrial Chemical Processes (LEC 3.0) Detailed study of various industrial chemical manufacturing processes including underlying chemistry, reaction pathways and separation processes. Prerequisite: Ch Eng 235 or Chem 221, or graduate standing. (Co-listed with Chem 325)

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 hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

Chemistry

Bachelor of Arts
Bachelor of Science
Bachelor of Science(non-ACS Certified)
Master of Science
Master of Science for Teachers
Doctor of Philosophy

Emphasis areas at Bachelor of Science level in biochemistry, polymer and coatings science, and premedicine chemistry.

Chemistry is the study of the elements, the compounds they form and the reactions they undergo.

The program of study encompasses the full range of the subject plus mathematics, physics, and, if desired, biology. Students may also pursue special interests such as analytical, biological, electrochemical, environmental, inorganic, nuclear, organic, physical or polymer chemistry.

The B.A. offers a general education degree with a chemistry focus. The B.A. degree may be appropriate for students in pre-professional programs (pre-medicine, pre-veterinary, pre-dentistry, pre-pharmacy, chemical sales and marketing).

Chemists tackle a broad range of challenges, from environmental cleanup and pollution prevention to creating the materials that will take humans to Mars. A Bachelor's degree in Chemistry will provide many career possibilities. It has been called the central science because it occupies a pivotal place in many disciplines. As such it serves as the foundation for many other professions such as medicine, biotechnology, ceramics, chemical engineering, polymers, materials, metallurgy and environmental sciences.

All students are encouraged to participate in research programs during their undergraduate career. Such participation can lead to valuable experience and the possibility of publications, awards and recognition in the chemistry work place. Students may opt to participate in the campus wide "Opportunities in Research Experience"

(OURE). Through OURE they can receive academic credit and a stipend for conducting a research project of mutual interest to the student and a faculty member.

Schrenk Hall is home to the department and where most chemistry classes and laboratories are held. The department has a broad range of modern instrumentation and equipment to prepare the student for the future.

Faculty

Professors:

Philip Whitefield (Department Chair), Ph.D., University of London Queen-Mary College, London, England
Frank Blum (Curators'), Ph.D., Minnesota
Harvest Collier (Vice Provost, Office of Undergraduate Studies), Ph.D., Mississippi State
Nuran Ercal, Ph.D., Hacettepe University
Shubhender Kapila, Ph.D., Dalhousie University
Nicholas Leventis, Ph.D., Michigan State University
Gary Long, Ph.D., Syracuse
Yinfa Ma, Ph.D., Iowa State University
Ekkehard Sinn, Ph.D., University of New South Wales
Chariklia Sotiriou-Leventis, Ph.D., Michigan State University
Jay A. Switzer (Donald L. Castleman/FCR Missouri Endowed Professor of Discovery in Chemistry), Ph.D., Wayne State University

Associate Professors:

V. Prakash Reddy, Ph.D., Case Western Reserve University
Thomas Schuman, Ph.D., University of Alabama in Huntsville
Pericles Stavropoulos, Ph.D., Imperial College of Science, Tech. & Medicine, London, U.K.
Michael R. Van De Mark, Ph.D., Texas A&M
Klaus Woelk, Ph.D., University of Bonn, Germany

Assistant Professors:

Charles C. Chusuei, Ph.D., George Mason University
Paul K.S. Nam, Ph.D., University of Missouri-Columbia
Jeffrey Winiarz, Ph.D., State University of New York at Buffalo

Lecturers:

Terry Bone, Ph.D., University of Missouri-Rolla
David Hoiness, Ph.D., Baylor University

Adjunct Professors:

Tadashi Tokuhiro, Ph.D., Tokyo Institute of Technology

Emeritus Faculty

Donald Beistel, Ph.D., Delaware
Gary Bertrand, Ph.D., Tulane
Louis Biolsi, Ph.D., Rensselaer
Samir Hanna, Ph.D., MIT
Fred Hardtke, Ph.D., Oregon State
William James, Ph.D., Iowa State
Oliver Manuel, Ph.D., Arkansas
Hector McDonald, Ph.D., Arkansas
B. Ken Robertson, Ph.D., Texas A&M
D. Vincent Roach, Ph.D., University of Missouri-Columbia
Robert Russell, Ph.D., Kansas
Donald Siehr, Ph.D., Wisconsin
James Stoffer (Curators'), Ph.D., Purdue
Wilbur Tappmeyer, Ph.D., University of Missouri-Columbia
Raymond Venable, Ph.D., Louisiana State
David Wulfman, Ph.D., Stanford

Bachelor of Arts Chemistry

FRESHMAN YEAR

First Semester	Credit
Chem 1-General Chemistry	4
Chem 2-General Chemistry Lab	1
Chem 4-Intro to Lab Safety	1
Math 8-Calculus with Analytic Geometry I	5
English 20-Exposition & Argumentation	3
	14
Second Semester	
Chem 3-General Chemistry	3
Chem 8-Qualitative Analysis	2
History 111-Early Western Civ	3
Math 21-Calc w/Analytic Geometry II	5
Humanities Electives	3
	16

SOPHOMORE YEAR

First Semester	Credit
Chem 221-Organic Chemistry I	4
Chem 226-Organic Chemistry I Lab	1
Electives	5
History 112-Modern Western Civ	3
Humanities Elective	3
	16
Second Semester	
Chem 223-Organic Chemistry II	4
Chem 228-Organic Chemistry II Lab	1
Elective	4
English 60-Writing & Research	3
Social Elective	3
	15

JUNIOR YEAR

First Semester	Credit
Chem 151-Anal Chem I	4
Physics 21-General Physics I	4
Physics 22-General Physics Lab I	1
Stat 213-Applied Engineering Stat	3
Elective	3
	15
Second Semester	
Chem Electives (see list below)	4
Physics 25-General Physics II	4
Physics 26-General Physics Lab II	1
Electives	6
	15

SENIOR YEAR

First Semester	Credit
Chem 241, 243 or 343-Phy Chem	3
Chem 242 or 244-Phy Chem Lab	1
Humanities Elective Literature	3
Social Electives	6
Elective	3
	16
Second Semester	
Chem 310-Seminar	1
Humanities Elective	3
Social Sciences Elective	3

Electives 6
13

Students must complete a minimum of 120 credit hours for the Bachelor of Arts in Chemistry degree. Students may have to take more than the minimum number of coursework hours to comply with the BA requirements due to variations in minor degree and foreign language requirements within an individual's program of study.

Elective credits include a required minor in one of the following areas: English, Economics, History, Philosophy, Psychology, Sociology, Communications, Speech, Media, Political Science, Music, Mathematics, Statistics, Foreign language, Computer Science, Biology, or Art. See Undergraduate catalog for courses required for specific minor. All chemistry majors are encouraged to do research through Chem 390. A total of 9 credits of a modern foreign language must also be taken as part of the electives above.

Chem Elective must be from one or more of the following:Chem 321, 328, 342, 346, 349, 351, 355, 361, 362, 363, 371, 375, 381, 384, 385. This program of study allows students to design, in conjunction with their chemistry advisor, a program for many disciplines including pre-law, business, pre-dentistry, pre-veterinary medicine, as well as pre-medicine. An example of such a program is shown for pre-medical studies:

Bio Sc 110-Gen Bio 4
Bio Sc 112-Bio Lab 1
Bio Sc 211-Cellular Bio 4
Chem 361-Biochem 3
Chem 362-Biochem Lab 2

A grade of "C" or better is required for each Chemistry course counted towards the degree.

Bachelor of Science Chemistry

A minimum of 131 credit hours is required for a Bachelor of Science degree in Chemistry and an average of at least two grade points per credit hour must be obtained. These requirements for the B.S. degree are in addition to credit received for algebra, trigonometry, and basic ROTC.

The Chemistry science curriculum requires 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 Lab 1
Chem 4-Intro to Lab Safety Haz Mat 1
Chem 11-Intro to Chemistry 1
Math 8-Calculus with Analytic Geometry I 5
English 20-Exposition & Argumentation 3
History 112,175,176 or Pol Sc 90 3
18

Second Semester
Chem 3-General Chemistry 3
Chem 8-Qualitative Analysis 2
Math 21-Calculus with Analytic Geometry II 5
Electives 6
16

SOPHOMORE YEAR

First Semester — Credit
Chem 221-Organic Chemistry I 4
Chem 226-Organic Chemistry I Lab 1
Math 22-Calculus with Analytic Geometry III 4
Physics 21-General Physics I 4
Physics 22-General Physics Lab 1
Elective 3
17

Second Semester
Chem 223-Organic Chemistry II 4
Chem 228-Organic Chemistry II Lab 1
Physics 25-General Physics II 4
Physics 26-General Physics II Lab 1
Cmp Sc 53 or Cmp Sc 74 & 78-Intro to Prog 3
Stat 213-Applied Eng Stat 3
16

JUNIOR YEAR

First Semester . . . . . .Credit
Chem 343-Intro to Quantum Chemistry 3
English 60-Writing & Research 3
Chem 361-Biochemistry 3
Electives 7
16

Second Semester
Chem 151-Anal Chem I 4
Chem 237-Inorganic Chemistry 3
Chem 238-Inorganic Chemistry Lab 1
Chem 241-Physical Chemistry 3
Chem 242-Physical Chem Lab 1
Chem 328-Organic Synthesis & Spec. Analysis 3
15

SENIOR YEAR

First Semester — Credit
Chem 243-Physical Chemistry 3
Chem 244-Physical Chem Lab 1
Chem 251-Anal Chem II 4
Chem 310-Undergraduate Seminar or
Chem 390-Undergraduate Research 1
Chemistry Electives 6
Electives 2
17

Second Semester
Chem 310-Undergraduate Seminar or
Chem 390-Undergraduate Research 1
Chemistry Electives 7
Electives 9
17

Notes:

Grade Requirements: Students must complete a minimum of 131 credit hours for a Bachelor of Science in Chemistry degree. A minimum grade of "C" is required for each chemistry course counted towards the degree.

ROTC: Basic ROTC may be taken in the freshman and sophomore year, but is not countable towards a degree.

Chemistry Electives: Of these thirteen (13) hours of chemistry electives, three (3) must be chosen from 300 (or 400 with permission) level chemistry courses, and ten (10) hours must be 200 level or higher in chemistry or another technical area with permission of department chairperson.

Electives: There are twenty-eight (26) hours of electives. Six (6) elective hours must be completed in the social sciences. Nine (9) elective hours are required in the humanities, exclusive of foreign language. Three of the humanities hours must be literature. Three (3) of the humanities hours are to be at the 100 level or higher.

Students planning to attend graduate school are encouraged to incorporate additional higher level chemistry electives, math, and foreign language, including scientific literature course. Recommended courses include but are not limited to the following:

Biology, 200 and 300 level, especially 211
Math 200 and 300 level, especially 204, 208 & 325
Physics 200 and 300 level, especially 208, 221, 323 & 341
Statistics, 200 & 300 level, especially 343, 346 & 353
Also, Ceramic Engineering 391 and 392, or Geology 381
A foreign language series.

Students who plan to teach high school chemistry should consult the Education section of this catalog.

Bachelor of Science Chemistry (non-ACS certified)

A minimum of 130 credit hours is required for a Bachelor of Science degree in Chemistry and an average of at least two grade points per credit hour must be obtained. These requirements for the B.S. degree are in addition to credit received for algebra, trigonometry, and basic ROTC.

The Chemistry science curriculum requires 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 Lab	1
Chem 4-Intro to Lab Safety Haz Mat	1
Math 8-Calc w/ Analytic Geometry I	5
Electives	3
English 20-Exposition & Argumentation	3
	17
Second Semester	
Chem 3-General Chemistry	3
Chem 8-Qualitative Analysis	2
Math 21-Calculus with Analytic Geometry II	5
History 112,175,176, or Pol Sc 90	3
Electives	3
	16

SOPHOMORE YEAR

First Semester	Credit
Chem 221-Organic Chemistry I	4
Chem 226-Organic Chemistry I Lab	1
Math 22-Calculus with Analytic Geometry III	4
Electives	5
Social Sciences Elective	3
	17
Second Semester	
Chem 223-Organic Chemistry II	4
Chem 228-Organic Chemistry II Lab	1
English 60-Writing & Research	3
Social Sciences Elective	3
Electives	6
	17

JUNIOR YEAR

First Semester	Credit
Chem 151-Anal Chem I	4
Physics 21-Gen Physics I	4
Physics 22-Gen Physics Lab I	1
Stat 213-Applied Eng Stat	3
Electives	6
	18
Second Semester	
Chem 251-Anal Chem II	4
Chem Elective-3xx Lecture	3
Chem Elective 3xx Lab	1
Physics 25-Gen Physics II	4
Physics 26-Gen Physics Lab II	1
Humanities Elective	3
	16

SENIOR YEAR

First Semester	Credit
Chem 343-Physical Chem	3
Humanities Elective Literature	3
Electives	9
	15
Second Semester	
Chem 241 or Chem 243-Physical Chem	3
Chem 242 or Chem 244-Physical Chem Lab	1
Chem 310-Seminar	1
Electives	9
	14

Students must complete a minimum of 130 credit hours for the Bachelor of Science in Chemistry (non-ACS certified) degree. A minimum grade of "C" is required for each Chemistry course counted towards the degree.

A minor in either Mathematics, Physics, Biology, Psychology, or Computer Science must be met. See Undergraduate catalog for courses required for specific minor. Chem 3xx Elective must be from one or more of the following: Chem 321, 328, 342, 346, 351, 355, 361, 362, 363, 371, 373, 375, 381, 384, 385.

This program of study allows students to design, in conjunction with their chemistry advisor, a program for many disciplines including pre-law, business, pre-dentistry, pre-veterinary medicine, as well as pre-medicine. An example of such a program is shown for pre-medical

studies. Pre-Medical Chemistry Majors Options. Electives must include:
Bio Sci 110-Gen Bio 4
Bio Sc 112-Bio Lab 1
Bio Sc 211-Cellular Bio 4
Chemistry 3xx Electives:
Chem 361-Biochem 3
Chem 362-Biochem Lab 2

Minor in Chemistry

A minor in chemistry requires a minimum of 19 hours of chemistry course work selected in conjunction with a chemistry faculty advisor. The required courses are Chem 1, 2, 3, 4, 8, 221 and either 224 or 226. Three additional hours of chemistry are to be selected from Chem 151, or other Chem 200 and 300 level courses.

Chemistry Biochemistry Emphasis Area

FRESHMAN YEAR

First Semester — Credit
Chem 1-General Chemistry 4
Chem 2-General Chemistry Lab 1
Chem 4-Intro to Lab Safety Hazardous Materials 1
Chem 11-Intro to Chemistry 1
Math 8-Calculus with Analytic Geometry I 5
English 20-Exposition & Argumentation 3
History 112,175,176 or Pol Sc 90 3
18

Second Semester
Chem 3-General Chemistry 3
Chem 8-Qualitative Analysis 2
Math 21-Calculus with Analytic Geometry II 5
Bio Sc 211-Cellular Biology 4
Humanities Elective 3
17

SOPHOMORE YEAR

First Semester . . . . . .Credit
Chem 221-Organic Chemistry I 4
Chem 226-Organic Chemistry I Lab 1
Math 22-Calculus with Analytic Geometry III 4
Physics 21-General Physics I 4
Physics 22-General Physics Lab 1
Literature Elective 3
17

Second Semester
Chem 223-Organic Chemistry II 4
Chem 228-Organic Chemistry II Lab 1
Physics 25-General Physics II 4
Physics 26-General Physics II Lab 1
Cmp Sc 53 or Cmp Sc 74 & 78-Intro to Prog 3
Stat 213-Applied Eng Stat 3
16

JUNIOR YEAR

First Semester — Credit
Chem 343-Intro to Quantum Chemistry 3
Chem 361-Biochemistry 3
Chem 362-Biochemistry Lab 2
English 60-Writing & Research 3
Social Sciences Elective 3
Electives 3
17

Second Semester
Chem 151-Anal Chem I 4
Chem 241-Physical Chemistry 3
Chem 242-Physical Chem Lab 1
Chem 363-Intermediary Metabolism 3
Humanities Elective 3
Electives 2
16

SENIOR YEAR

First Semester — Credit
Chem 243-Physical Chemistry 3
Chem 244-Physical Chem Lab 1
Chem 251-Anal Chem II 4
Chem 310-Undergraduate Seminar or
Chem 390-Undergraduate Research 1
Bio Sc 331-Molecular Genetics 3
Elective 3
15

Second Semester
Chem 237-Inorganic Chemistry 3
Chem 238-Inorganic Chem Lab 1
Chem 300-Special Problems 1
Chem 310-Undergraduate Undergraduate Seminar or
Chem 390-Undergraduate Research 1
Chem 328-Organic Syn & Spec Analy 3
Social Sciences Elective 3
Elective 3
15

Notes:

Grade Requirements: Students must complete a minimum of 131 credit hours for the Bachelor of Science in Chemistry degree. A minimum grade of "C" is required for each Chemistry course counted towards the degree.

ROTC: Basic ROTC may be taken in the freshman and sophomore years, but is not countable towards a degree.

Electives: There are thirteen (11) hours of electives. Students planning to attend graduate school are encouraged to incorporate additional higher level chemistry electives, math, and foreign language, including a scientific literature course. Recommended courses include but are not limited to the following:
Biology, 200 and 300 level especially 211
Math 200 and 300 level, especially 204, 208 and 325
Physics 200 and 300 level, especially 208, 221, 323 & 341
Statistics, 200 & 300 level, especially 343, 346 & 353
Also Ceramic Engineering 391 and 392, or Geology 381
A foreign language series, French, German or Russian are recommended.

Chemistry
Polymer & Coatings Science
Emphasis Area

FRESHMAN YEAR

First Semester	Credit
Chem 1-General Chemistry	4
Chem 2-General Chemistry Lab	1
Chem 4-Intro to Lab Safety Hazardous Materials	1
Chem 11-Intro to Chemistry	1
Math 8-Calculus with Analytic Geometry I	5
English 20-Exposition & Argumentation	3
History 112,175,176 or Pol Sc 90	3
	18
Second Semester	
Chem 3-General Chemistry	3
Chem 8-Qualitative Analysis	2
Math 21-Calculus with Analytic Geometry II	5
Electives	6
	16

SOPHOMORE YEAR

First Semester	Credit
Chem 221-Organic Chemistry I	4
Chem 226-Organic Chemistry I Lab	1
Math 22-Calculus with Analytic Geometry III	4
Physics 21-General Physics I	4
Physics 22-General Physics Lab	1
Electives	3
	17
Second Semester	
Chem 223-Organic Chemistry II	4
Chem 228-Organic Chemistry II Lab	1
Physics 25-General Physics II	4
Physics 26-General Physics II Lab	1
Cmp Sc 53 or Cmp Sc 74 & 78-Intro to Programming	3
Stat 213-Applied Eng Stat	3
	16

JUNIOR YEAR

First Semester	Credit
Chem 343-Intro to Quantum Chemistry	3
Chem 381-Polymer Chemistry	3
Chem 361-Biochemistry	3
English 60-Writing & Research	3
Electives	4
	16
Second Semester	
Chem 151-Anal Chem I	4
Chem 241-Physical Chemistry	3
Chem 242-Physical Chem Lab	1
Chem 384-Polymer Science Lab	3
Chem 385-Fundamentals of Protective Coating I	3
Chem 390-Undergraduate Research	3
	17

SENIOR YEAR

First Semester	Credit
Chem 243-Physical Chemistry	3
Chem 244-Physical Chem Lab	1
Chem 251-Anal Chem II	4
Ch Eng 349-Structures & Properties of Polymers	3
Electives	6
	17
Second Semester	
Chem 237-Inorganic Chemistry	3
Chem 238-Inorganic Chem Lab	1
Chem 328-Organic Syn & Spec Analy	3
Chemistry Electives	3
Electives	4
	14

Notes:

Grade Requirements: Students must complete a minimum of 131 credit hours for a Bachelor of Science-Chemistry degree. A minimum grade of "C" is required for each Chemistry course counted towards the degree.

ROTC: Basic ROTC may be taken in the freshman and sophomore years, but is not countable towards a degree.

Chem 390 - Undergraduate Research: The undergraduate research must be done in Polymers and Coatings Science.

Electives: There are twenty-eight (26) hours of electives. Six (6) elective hours must be completed in the social sciences. Nine (9) elective hours are required in the humanities, exclusive of foreign language. Three of the humanities hours must be literature. Three of the humanities hours are to be at the 100 level or higher. Three (3) hours of elective may be chosen from Materials Science related courses numbered in the 300-series.

Students planning to attend graduate school are encouraged to incorporate additional higher level chemistry electives, math, and foreign language, including a scientific literature course. Recommended courses include but are not limited to the following:
Biology, 200 and 300 level, especially 211
Math 200 and 300 level, espeically 204, 208 and 325
Physics 200 and 300 level, especially 208, 221, 323 & 341
Statistics, 200 & 300 level, especially 343, 346 & 353
Also, Ceramic Engineering 391 and 392, or Geology 381
A foreign language series.

Chemistry
Pre-medicine Emphasis Area

FRESHMAN YEAR

First Semester	Credit
Chem 1-General Chemistry	4
Chem 2-General Chemistry Lab	1
Chem 4-Intro to Lab Safety & Hazardous Materials	1
Chem 11-Intro to Chemistry	1
Math 8-Calculus with Analytic Geometry I	5
English 20-Exposition & Argumentation	3
History 112,175,176 or Pol Sc 90	3
	18
Second Semester	
Chem 3-General Chemistry	3
Chem 8-Qualitative Analysis	2
Math 21-Calculus with Analytic Geometry II	5
Bio Sc 110-General Biology	3
Bio Sc 112-General Biology Lab	2
Humanities Elective	3
	18

SOPHOMORE YEAR

First Semester	Credit
Chem 221-Organic Chemistry I	4
Chem 226-Organic Chemistry I Lab	1
Math 22-Calculus with Analytic Geometry III	4
Physics 21-General Physics I	4
Physics 22-General Physics Lab	1
Bio Sc 211-Cellular Biology	4
	18
Second Semester	
Chem 223-Organic Chemistry II	4
Chem 228-Organic Chemistry II Lab	1
Physics 25-General Physics II	4
Physics 26-General Physics II Lab	1
Cmp Sc 53 or Cmp Sc 74 & 78-Intro to Programming	3
Stat 213-Applied Eng Stat	3
	16

JUNIOR YEAR

First Semester	Credit
Chem 343-Intro to Quantum Chemistry	3
Chem 361-Biochemistry	3
Chem 362-Biochemistry Lab	2
English 60-Writing & Research	3
Bio Sc 241-Human Anatomy	5
	16
Second Semester	
Chem 151-Anal Chem I	4
Chem 241-Physical Chemistry	3
Chem 242-Physical Chem Lab	1
Chem 363-Intermediary Metabolism	3
Bio Sc 242-Human Physiology	5
	16

SENIOR YEAR

First Semester	Credit
Chem 243-Physical Chemistry	3
Chem 244-Physical Chem Lab	1
Chem 251-Anal Chem II	4
Chem 310-Undergraduate Seminar or Chem 390-Undergraduate Research	1
Social Sciences Elective	3
Literature Elective	3
	15
Second Semester	
Chem 237-Inorganic Chemistry	3
Chem 238-Inorganic Chem Lab	1
Chem 310-Undergraduate Seminar or Chem 390-Undergraduate Research	1
Chem 328-Organic Synthesis & Spec. Analysis	3
Advanced Chemistry Electives	2
Social Sciences Elective	3
Humanities Elective	3
	16

Notes:

Grade Requirements: Students must complete a minimum of 131 credit hours for the Bachelor of Science in Chemistry degree. A minimum grade of "C" is required for each Chemistry course counted towards the degree.

ROTC: Basic ROTC may be taken in the freshman and sophomore years, bit is not countable towards a degree.

Chemistry Electives: The advanced Chemistry Elective is chosen from Chem 321, 331, 346, 351, 381, 385.

Electives: At least three hours of the humanities or literature electives are to be at the 100 level or higher.

Chemistry Courses

1 **General Chemistry** (LEC 3.0 and RSD 1.0) A comprehensive study of the general principles of chemistry with emphasis on the fundamental laws and their application in practical computations. The class is divided into smaller sections one day a week for recitation and discussion of problems. Prerequisite: Entrance requirements.

2 **General Chemistry Laboratory** (LAB 1.0) The laboratory work accompanying general chemistry consists of experiments designed to supplement lectures in Chem 1. Prerequisite: Preceded or accompanied by Chem 001 and Chem 004 or equivalent training program approved by UMR.

3 **General Chemistry** (LEC 3.0) Continuation of course Chem 1 with some emphasis on descriptive chemistry. The ionic theory and mass laws are introduced and applied at advantageous points in the lecture. Prerequisites: Chem 1 and 2.

4 **Introduction To Laboratory Safety & Hazardous Materials** (LEC 1.0) A systematic study of safe laboratory operations and pertinent regulations of state and federal agencies.

5 **Accelerated General Chemistry** (LEC 3.0, RSD 1.0, and LAB 1.0) An accelerated version of Chem 1, Chem 2, and Chem 3. Four lectures and three laboratory hours per week. Students who do not meet these entrance requirements must take Chem 1, 2, & 3. Prerequisite: Preceded or accompanied by Chem 4 or an equivalent training program approved by UMR. A minimum score of 60 for the sum of the MMPT and the ACT N. SCI. test scores with neither score below 27.

8 **Qualitative Analysis** (LAB 2.0) This course is to accompany the study of the metals in general chemistry and is devoted to the qualitative separation and detection of the metals. Prerequisite: Preceded or accompanied by Chem 3 and Chem 4 or an equivalent training program approved by UMR.

10 **General Chemistry For Non-Science Majors** (LEC 3.0) A one semester introduction to chemistry designed to acquaint the student with the philosophy of the chemist's approach to problem solving and the contribution of chemistry to society. Prerequisite: Entrance requirements.

11 **Introduction To Chemistry** (LEC 1.0) Introduction to chemistry, its intellectual and professional opportunities. Students will be acquainted with various areas of chemistry and with departmental and campus facilities useful to their future studies. Required of all freshman chemistry majors; encouraged for undergraduate transfer chemistry majors.

12 **Invitational Seminar** (LEC 1.0) This invitational seminar will introduce the student to research in

chemistry. A series of seminars will be presented by faculty and outside speakers on current topics in chemical research. Prerequisite: Chem 1 or Chem 5.

14 Elementary Analytical Chemistry (LEC 3.0 and LAB 2.0) A study of the general theories for separation and identification of metals. It also includes the fundamental principles of quantitative analysis. Prerequisite: Preceded or accompanied by Chem 3 and Chem 4 or an equivalent training program approved by UMR.

51 Elementary Quantitative Chemical Analysis (LEC 2.0) A treatise of the fundamental principles of analytical chemistry and their application in analytical methods. Prerequisite: Preceded or accompanied by Chem 3 or to be accompanied by Chem 52.

52 Elementary Quantitative Chemical Analysis (LAB 2.0) The application of the principles of analytical chemistry in gravimetric and volumetric determinations. Prerequisite: To be accompanied by Chem 51 and preceded or accompanied by Chem 4 or an equivalent training program approved by UMR.

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 Master Student (LEC 1.0) Master Student is an orientation course for new and transfer students that addresses transition needs.

151 Analytical Chemistry I (LEC 3.0 and LAB 1.0) A study of analytical chemistry including an introduction to experimental error, statistics, principles of gravimetric and combustion analysis, chemical equilibrium, acid - base titrations, and electro-analytical determinations. Prerequisites: Chem 3 and preceded or accompanied by Chem 4 or equivalent training program approved by UMR.

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 MST General Chemistry Lab (LAB 1.0) The laboratory work accompanying the MST chemistry courses consists of experiments designed to supplement the lecture work in chemistry. This course is primarily intended for secondary education science teachers. Credit will not be given for both Chemistry 2 and Chemistry 203. Prerequisite: Entrance requirements for the MST program. Preceded or accompanied by Chem 204 or equivalent training program approved by UMR.

204 Lab Safety and Environmental Safety (LEC 1.0) A systematic study of safe laboratory operations and pertinent regulations of state and federal agencies. This course is primarily intended for secondary education science teachers. Credit will not be given for both Chemistry 4 and Chemistry 204. Prerequisite: Entrance requirements for the MST program.

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

212 Science Teaching With In-Classroom Computers (LEC 2.0 and LAB 1.0) Lectures with laboratory sessions that provide student with indepth knowledge of computer hardware operation, software application and instructional methods. A computer is required for the course. Student full participation is expected as a partial measure of course completion. Prerequisite: Elementary or secondary science teacher certification.

221 Organic Chemistry I (LEC 3.0) A study of the theory and practice of the fundamental reactions of organic compounds. Prerequisite: Chem 3 or 8.

223 Organic Chemistry II (LEC 3.0) A continuation of Chem 221. Prerequisite: Chem 221.

224 Organic Chemistry Lab (LAB 1.0) The use of organic chemical laboratory procedures. For chemical engineering majors only. Prerequisite: Preceded or accompanied by Chem 223 and Chem 4 or an equivalent training program approved by UMR.

225 Bioorganic Chemistry I (LEC 4.0) This course consists of four parts: 1) Structure, bonding, and nomenclature; 2) hydrocarbons (alkanes, alkenes, and alkynes), conjugated systems, ultraviolet and visible spectroscopy, sterochemistry, resonance, and molecular orbital theory; 3) substitution and elimination reactions, and 4) identification of organic compounds via infrared and NMR spectroscopy. Prerequisites: Chem 1, 2, 3; or Chem 5.

226 Organic Chemistry I Lab (LAB 1.0) Laboratory involves purification techniques, simple and multistep synthesis and spectroscopic identification of organic functional groups. Prerequisites: Preceded or accompanied by Chem 221 and either Chem 4 or an equivalent training program approved by UMR.

227 Bioorganic Chemistry II (LEC 4.0) This course consists of three parts. The first part will cover aromaticity and reactions of aromatic compounds, the second part will cover carbonyl compounds, amines and their reactions, and the third part will cover bioorganic compounds that include carbohydrates, aminoacids, peptides, proteins, lipids, nucleosides, nucleotides, and nucleic acids. Prerequisite: Chem 225.

228 Organic Chemistry II Lab (LAB 1.0) Continuation of Chem 226. Prerequisites: Chem 226, preceded or accompanied by Chem 223 and Chem 4 or an equivalent training program approved by UMR.

237 Inorganic Chemistry (LEC 3.0) A study of modern concepts of atomic structure, chemical bonding, thermodynamics and kinetics as related to the periodic relationship of the elements. Reference to topics of current interests as applied to the above areas.

238 Inorganic Chemistry Laboratory (LAB 1.0) Synthesis and characterization of inorganic chemicals, high and low temperature syntheses, inert atmosphere and vacuum manipulations, electrochemistry, magnetochemistry, spectroscopy (NMR, IR, UV/VIS), superconductivity. Prerequisites: Preceded or accompanied by Chem 237 and Chem 4 or an equivalent training program approved by UMR.

240 Physical Chemistry (LEC 3.0) A study of the laws of thermodynamics and their applications to chemical systems. Prerequisites: Chem 51 and 52, Math 22, Physics 25.

241 Physical Chemistry (LEC 3.0) A study of the laws of thermodynamics and their applications to the states of matter, solutions, and equilibria. Prerequisites: Math 22, Physics 25.

242 Physical Chemistry Laboratory (LAB 1.0) Some typical operations of experimental physical chemistry. Prerequisites: Preceded or accompanied by Chem 241 and Chem 4 or an equivalent training program approved by UMR.

243 Physical Chemistry (LEC 3.0) A study of kinetic theory, chemical kinetics, electromotive force and ionic equilibria. Prerequisite: Chem 241 or consent of department.

244 Physical Chemistry Laboratory (LAB 1.0) A continuation of Chem 242. Prerequisite: Preceded or accompanied by Chem 243 or 240 and Chem 4 or an equivalent training program approved by UMR.

251 Analytical Chemistry II (LEC 3.0 and LAB 1.0) A study of analytical chemistry including separation techniques for chemical and biochemical analysis, atomic - molecular mass spectrometry, atomic - molecular spectroscopy, surface analysis with electron spectroscopy, X-ray and mass spectrometry. Prerequisites: Chem 4, Chem 151, Chem 223 and Chem 241.

300 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Prerequisite: Preceded or accompanied by Chem 4 or an equivalent training program approved by UMR. 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 Advanced Chemical Preparations And Techniques (LEC 1.0 and LAB 2.0) A course designed to develop facility in the use of equipment and techniques commonly used in advanced work in experimental chemistry. Prerequisite: Preceded or accompanied by Chem 4 or an equivalent training program approved by UMR.

310 Undergraduate Seminar (RSD 1.0) Written and oral presentations of current topics in chemistry. This course may serve as part of the capstone requirement for chemistry majors.

321 Intermediate Organic Chemistry I (LEC 3.0) An advanced course designed to give the student a mastery of the fundamentals of organic chemical reactions and theory. Prerequisite: Chem 223.

323 Intermediate Organic Chemistry II (LEC 3.0) A systematic study of organic reactions, their mechanisms and synthetic applications. Prerequisites: Chem 223.

325 Industrial Chemical Processes (LEC 3.0) Detailed study of various industrial chemical manufacturing processes including underlying chemistry, reaction pathways and separation processes. Prerequisite: Ch Eng 235 or Chem 221, or graduate standing. (Co-listed with Ch Eng 389)

328 Organic Synthesis And Spectroscopic Analysis (LEC 1.0 and LAB 2.0) Advanced methods for the multistep synthesis and characterization of organic compounds. Modern instrumental methods of identification of organic compounds. Prerequisites: Chem 4, Chem 223, Chem 228.

331 Selected Topics In Inorganic Chemistry (LEC 3.0) A study of inorganic chemistry with emphasis on physical methods. General subjects covered include: molecular structure, bonding, complexes, spectroscopy, and reaction rates.

338 Advanced General Chemistry For Secondary Teachers (LEC 3.0 and LAB 1.0) A study of the general principles of chemistry with emphasis on the fundamental laws and their application in practical applications. The laboratory experiments are designed to support lectures and to be used as teaching demonstrations in high schools. Prerequisite: One year of college chemistry.

343 Introduction To Quantum Chemistry (LEC 3.0) A study of molecular structures and spectroscopy, statistical thermodynamics, kinetic theory, chemical kinetics, crystals, and liquids. Prerequisites: Math 22 & Physics 25 or equivalents.

344 Advanced Physical Chemistry (LEC 3.0) Advanced undergraduate treatments of special topics of physical chemistry, which may include statistical mechanics, kinetics, group theory, or spectroscopy. Prerequisite: Chem 343.

346 Chemical Thermodynamics (LEC 3.0) A study of the laws of thermodynamics with application to chemical systems. Emphasis is placed on partial molal functions. Prerequisite: Chem 243.

349 The Physical Chemistry Of Colloidal Dispersions (LEC 3.0) The stability of colloidal systems is treated using the kinetic approach with interparticle potentials. The results are extended to practical systems of microemulsions, emulsions and foams. Prerequisite: Chem 343.

351 Advanced Analytical Chemistry (LEC 3.0) Theoretical and practical aspects of modern analytical chemistry. Prerequisite: Chem 251.

355 Instrumental Methods Of Chemical Analysis (LEC 3.0 and LAB 1.0) Principles and analytical applications of molecular spectroscopy, chromatographic separations, mass spectrometry, and radiochemistry. A brief overview of instrument electronics, signal generation and processing, and automated analysis is also provided. Prerequisites: Chem 4, Chem 52, Chem 223, Chem 243.

361 General Biochemistry (LEC 3.0) A resume of the important aspects of quantitative and physical

chemistry in biochemical processes. General subjects covered include: proteins, nucleic acids, enzymes, carbohydrates and lipids. Prerequisites: Chem 223 and Bio 211.

362 General Biochemistry Laboratory (LAB 2.0) Experiments are integrated with the lectures and cover the chemical and physical properties of proteins, enzymes, nucleic acids, carbohydrates and lipids. Prerequisites: Preceded or accompanied by Chem 361 and Chem 4 or an equivalent training program approved by UMR.

363 Metabolism (LEC 3.0) A continuation of Chem 361. Catabolism and anabolism of carbohydrates, lipids, proteins, and nucleic acids. Photosynthesis, oxidative phosphorylation and membranes. Prerequisite: Chem 361 or Chem 225; Chem 227.

367 Industrial Biochemistry (LEC 3.0) A study of the problems involved in the utilization of biological systems for the production of bulk chemicals, the preparation of biologicals and the treatment of waste from plants producing biologicals and foodstuffs. Prerequisite: Junior standing.

371 Nuclear And Radiochemistry (LEC 3.0 and LAB 1.0) A study of the fundamentals of nuclear and radiochemistry including properties of radiations; effect of radiation on materials, production, measurement and use of radioactive tracers; and the chemistry of reactor materials. Laboratory training includes radiochemistry technology. Prerequisites: Physics 107 or 207 and preceded or accompanied by Chem 4 or an equivalent training program approved by UMR.

373 Atmospheric Chemistry (LEC 3.0) A chemical study of the troposphere including composition; nucleation, growth stability, distribution, diffusion, and fallout of aerosols; and meteorological aspect. Prerequisite: Chem 243.

375 Principles Of Environmental Monitoring (LEC 3.0) This course provides an overview of environmental monitoring methodologies. Discussion covers thermodynamic and kinetic processes that affect chemical transport and fate in the environment. Federal environmental regulations and remediation technologies are also covered with specific examples. Prerequisites: Chem 221, Physics 25.

381 Chemistry And Inherent Properties Of Polymers (LEC 3.0) A basic study of the organic chemistry of natural and synthetic high polymers, their inherent properties and their uses in plastic, fiber, rubber, resin, food, paper and soap industries. Prerequisite: Chem 223.

384 Polymer Science Laboratory (LEC 1.0 and LAB 2.0) Lectures and laboratory experiments dealing with polymerization reactions, solution properties and bulk or solid properties will be presented. Each student will prepare polymers and carry out all characterization experiments on actual samples. Prerequisite: Chem 381 or Ch Eng 375, preceded or accompanied by Chem 4 or an equivalent training program approved by UMR.

385 Fundamentals Of Protective Coating I (LEC 3.0) Study of the basic principles of protective coatings with particular reference to the paint and varnish industry. Classifications, manufacture, properties and uses of protective coatings. Prerequisite: Chem 223.

390 Undergraduate Research (IND 0.0-6.0) Designed for the undergraduate student who wishes to engage in research. Does not lead to the preparation of a thesis. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Preparation of a written, detailed report is required of the student. Prerequisite: Must meet departmental requirements for instruction in laboratory safety. Consent of instructor required.

Civil Engineering

Bachelor of Science
Master of Science
Doctor of Philosophy
Doctor of Engineering

Emphasis areas at all levels in construction engineering, environmental engineering, water resources engineering, geotechnical engineering, structural engineering, materials engineering and transportation engineering.

Civil engineers plan, design, and supervise construction of many essential facilities and structures such as bridges, dams, interstate highways, and buildings. Service to the community, its development and improvement are fundamental aspects of a civil engineering career. Civil engineers are problem solvers...applying the latest in high-tech equipment and sophisticated procedures to address challenges concerning our environment and infrastructure.

Included in the study of civil engineering are courses in environmental engineering that are directly related to the solution of hazardous waste and pollution problems, to providing potable and economical water supply systems, and to maintaining a safe environment. Water resources engineering is related to hydraulic and hydrologic engineering, flood control, rainfall, and runoff prediction and the transport in flows. Studies in geotechnical engineering address the bearing capacities of soils, settlement of foundations, and the design of both deep and shallow foundations. Courses in structural analysis and design are directed toward providing reliable and economical structures such as bridges, buildings, port facilities, and intricate lock and dam facilities. The principles involved in this sequence of courses are also applicable to the design of automobiles, aircraft, spacecraft, and future space structures. Transportation engineering involves the movement of people and cargo from place to place, the design of airports and highways, and traffic studies to maintain efficient flows. Courses in construction engineering include studies in construction techniques, cost estimating, quality con-

trol/quality assurance, and contract administration. Materials engineering involves the production, quality control, use, and property analysis of construction materials such as asphalt, concrete, aggregate, wood, masonry, and steel.

Civil engineering is a broad field of endeavor. Because of this breadth, courses are required in each of the above areas. Although you, as a civil engineer, may specialize within a given area, by the very nature of the profession you will be required to interact with specialists in the other areas. You also may find that you will work with engineers in other disciplines such as mechanical, electrical, or geological engineering in the planning, design, and construction of complex facilities.

Civil engineers also must be effective in communicating with the public. You may be expected to work with property owners, concerned citizens, city officials, attorneys, and even medical doctors for concerns related to public health measures.

The results of your work as a civil engineer will be seen everywhere. Projects in which you will become involved must be economical, provide an adequate factor of safety for the particular use, and provide a reasonable life expectancy. To do this adequately and within a reasonable time frame, you will find that, with the exception of your engineering training, the computer is one of the most important and valuable tools you will use to produce a proper design or to complete a specific project. You may expect that your courses taken in civil engineering will require the use of computer hardware and software related to the different areas of study.

Mission Statement

The Civil Engineering Program will prepare students for professional performance in the global society and for life-long learning and continued professional development in the civil engineering profession through a comprehensive, forward-looking and broad-based curriculum in civil engineering emphasizing fundamentals and practical applications, oral and written communication skills, computer applications skills, and professional practice issues and ethics.

Civil Engineering Program Objectives

Consistent with the mission of the Civil Engineering Program, graduates of the program will have:

1) a strong and broad fundamental scientific and technical knowledge base that will provide the necessary tools to begin a career in civil engineering, and,

2) the ability to identify, formulate, develop, and execute practical, innovative, high quality, and cost efficient solutions for civil engineering problems, and,

3) an awareness and understanding of the moral, ethical, legal, and professional obligations needed to function as part of a professional enterprise while protecting human health and welfare and the environment in a global society, and,

4) an awareness and understanding of the need for personal and professional growth through continuing education, professional development, professional licensure, and increased community, and the global marketplace, and,

5) an awareness and understanding of the need to develop leadership and team building skills to maximize the benefits of an engineering education and its application to solving world problems.

Program Outcomes - An Overview

Consistent with the program educational objectives listed above, the UMR civil engineering program graduate will have:

1. knowledge of contemporary issues, through broad education, which allows them to appreciate the impact of engineering solutions on humankind, and to be enthusiastic about and have the ability to engage in continued education throughout their lives;
2. knowledge of mathematics, science, and engineering, an ability to apply it with proficiency in at least four civil engineering areas, and an understanding of the need for up to date engineering tools acquired through life-long learning;
3. ability to design and conduct experiments in more than one CE area and communicate effectively in multi-disciplinary environments to analyze and interpret data and provide the results;
4. ability to carry out the design of an integrated system and its various components and processes for a CE project;
5. opportunity to provide leadership and ability to effectively communicate among engineers and non-engineers when working in multiple disciplinary teams;
6. ability to define and state engineering problems in technical and non-technical language and to apply basic engineering principles to solve problems;
7. understanding of the responsibility of civil engineers to practice in a professional and ethical manner at all times, including procurement of work, qualifications based selection processes, and interaction of design professionals and construction professionals;
8. ability to communicate effectively using written, oral, visual and graphic forms;
9. knowledge of the interactions of technology and society and their possible impacts on the practice of Civil Engineering;
10. ability to utilize their background in science, humanities and engineering, and analytical and design skills, when approaching ever changing engineering practice; and,
11. a sense of responsibility for the continued well-being of their alma mater and their profession.

Faculty

Professors:

Craig D. Adams[1] (John and Susan Mathes Professor), Ph.D., Kansas

William Andrews[1] (Emeritus), D.Sc., Washington

Abdeldjelil Belarbi, (Distinguished Teaching Professor) Ph.D., Houston

John Best[1] (Emeritus), Ph.D., Vanderbilt

Genda Chen[1], Ph.D., SUNY-Buffalo
Franklin Cheng[1] (Curators' Emeritus), Ph.D., Wisconsin
Charles Dare[1] (Emeritus), Ph.D., Iowa
Ju-Chang Huang[1] (Emeritus), Ph.D., Texas-Austin
Roger LaBoube[1] (Distinguished Teaching Professor), Ph.D., Missouri-Rolla
Paul Munger[1] (Emeritus), Ph.D., Arkansas
Thomas M. Petry[1], (Emeritus) Ph.D., Oklahoma State
Shamsher Prakash[1] (Emeritus), Ph.D., Illinois
J. Kent Roberts[1] (Emeritus), M.S., Missouri-Rolla
Norbert Schmidt[1] (Emeritus), Ph.D., Illinois
William Schonberg[1] (Department Chair), Ph.D., Northwestern
Joseph Senne[1] (Emeritus), Ph.D., Iowa State
Richard Stephenson[1], Ph.D., Oklahoma State
Jerome Westphal[1] (Emeritus), Ph.D., Nevada
Bobby Wixson (Emeritus), Ph.D., Texas A&M
Wei-Wen Yu[1] (Curators' Emeritus), Ph.D., Cornell

Associate Professors:
Jerry Bayless[1] , M.S., Missouri-Rolla
Joel Burken, Ph.D., Iowa
Mark Fitch, Ph.D., Texas-Austin
Rodney Lentz[1], (Emeritus), Ph.D., Michigan State
Ronaldo Luna[1], Ph.D., Georgia Tech.
Cesar Mendoza, Ph.D., Colorado State University
Donald Modesitt[1] (Emeritus), Ph.D., Oklahoma State
Charles Morris[1], Ph.D., Illinois
Glenn Morrison, Ph.D., California-Berkeley
John Myers[1], Ph.D., Texas-Austin
David Richardson[1], Ph.D., Missouri-Rolla
Purush TerKonda (Emeritus), Ph.D., Texas-Austin

Assistant Professors:
Ashraf Ayoub, Ph.D., California-Berkeley
Ghulam Bham, Ph.D., University of Illinois
Louis GE, Ph.D., University of Colorado at Boulder
Jianmin Wang[1], Ph.D., Delaware

Lecturer:
William Eric Showalter[1], Ph.D., Purdue
Harold Wagner[1], M.S., University of Missouri-Rolla

[1] Registered Professional Engineer

Bachelor of Science Civil Engineering

Entering freshmen desiring to study Civil Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Civil Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the 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 Civil Engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in Civil Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1) All students are required to take one American history course, one economics course, one humanities course, and English 20. The history course is to be selected from History 112, History 175, History 176, or Political Science 90. The economics course may be either Economics 121 or 122. The humanities course must be selected from the approved lists for Art, English, Foreign Languages, Music, Philosophy, Speech and Media Studies, or Theater.

2) Depth requirement. Three credit hours must be taken in humanities or social sciences at the 100 level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 70 or 80 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 300 level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.

3) The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to English 20.

4) Any specific departmental requirements in the general studies area must be satisfied.

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

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

FREE ELECTIVES FOOTNOTE:

Free electives. Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.

FRESHMAN YEAR

First Semester	Credit
FE 10-Study & Careers in Eng[2]	1
Chem 1 & 2-Gen Chem	5
Math 14-Calc for Engineers I	4

English 20-Expos & Argumentation 3
General Ed Elective[1] 3
16

Second Semester
IDE 20-Eng Design/Comp Appl 3
Math 15-Calc for Engineers II 4
Physics 23-Eng Physics I 4
General Ed Elective[1] 3
General Ed Elective[1] 3
17

SOPHOMORE YEAR

First Semester — Credit
CE 1-Fund of Surveying[2] 3
CE 3-Eng Communications 2
IDE 50-Eng Mech-Statics[2] 3
Math 22-Calc w/Analytic Geometry III 4
Physics 24-Eng Physics II 4
16

Second Semester
IDE 150-Eng Mech/Dynamics 2
Stat 213-Applied Eng Statistics 3
GE 50-Geology for Engineers 3
IDE 110-Mechanics of Materials[2] 3
IDE 120-Materials Test Lab 1
Math 204-Differential Equations 3
15

JUNIOR YEAR

First Semester — Credit
CE 241-Economy of Eng Design[2] 2
CE 217-Structural Analysis I[2] 3
CE 215-Elementary Soil Mech 3
CE 230-Elementary Fluid Mech[2] 3
CE 261-Fund of Environmental 3
General Ed Elective[1] 3
17

Second Semester
CE 216-Construction Mat 3
CE 242-Building Systems 3
CE 211-Transportation Engineering 3
CE 234-Water Resources Eng 4
Free Elective[5] 3
16

SENIOR YEAR

First Semester — Credit
CE 210-Senior Seminar 1
(2) CE Depth Electives[3,4] 6
CE 248-Contracts & Const Eng 3

CE 221-Structural Design Metals or
CE 223-Reinf Conc Des 3
General Ed Elective[1] 3
16

Second Semester
CE 298-Civil Eng Design Project 3
CE Tech Elective[3,6] 3
CE Depth Elective[3,4] 3
General Ed Elective[1] 3
Free Elective[5] 3
15

1) All general education electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog. One general education elective must be from Engl 60, Engl 160, or SP&MS 85.
2) A grade of 'C' or better required to satisfy graduation requirements
3) A grade of 'C' or better may be required in CE technical and depth elective prerequisite courses. Refer to the UMR undergraduate catalog for this prerequisite information.
4) Choose depth electives using Guidelines for Depth and Technical Electives
5) Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.
6) Choose technical electives using Guidelines for Depth and Technical Electives

NOTE: All Civil Engineering students must take the Fundamentals of Engineering examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree, however, it is the first step toward becoming a registered professional engineer. This requirement is part of the UMR assessment process as described in Assessment Requirements found elsewhere in this catalog. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.

Guidelines for Depth and Technical Electives

Please consult the Department's Advising Center or your academic advisor for guidelines regarding the selection of depth and technical electives.

Course Listings by Area

Construction Engineering

345 Construction Methods
346 Management of Construction Costs
349 Engineering and Construction Contract Specifications

Materials Engineering

312 Bituminous Materials
313 Composition and Properties of Concrete
317 Pavement Design

Environmental Engineering

265 Water/Wastewater
360 Environmental Law and Regulations
361 Remediation of Contaminated Groundwater and Soil
362 Public Health Engineering
363 Solid Waste Management
365 Environmental Engineering Analysis Laboratory

367 Introduction to Air Pollution
368 Air Pollution Control Methods
369 Sanitary Engineering Design

Geotechnical Engineering

229 Foundation Engineering
314 Geosynthetics in Engineering
315 Intermediate Soil Mechanics
316 Geotechnical Earthquake Engineering
329 Foundation Engineering II

Water Resources Engineering

330 Hydraulic Transients
331 Hydraulics of Open Channels
335 Water Infrastructure Engineering
337 River and Harbor Engineering
338 Hydrologic Techniques

Structural Engineering

221 Structural Design Metals
223 Reinforced Concrete
318 Smart Materials and Sensors
319 Applied Mechanics in Structural Engineering
322 Analysis and Design of Wood Structures
323 Classical and Matrix Methods of Structural Analysis
326 Advanced Steel Structures Design
327 Advanced Concrete Structures Design
328 Prestressed Concrete Design
374 Infrastructure Strengthening with Composites
375 Low-Rise Building Analysis and Design

Transportation Engineering

311 Geometric Design of Highways
353 Traffic Engineering
373 Air Transportation

Civil Engineering Courses

1 Fundamentals Of Surveying (LEC 2.0 and LAB 1.0) Surveying fundamentals: leveling, directions, angles, distances, errors, traverse calculations and basic adjustments. Fundamentals of horizontal curves. Lab exercises include leveling, traversing, horizontal circular curve layout and building layout. Prerequisite: Preceded or accompanied by Math 14 (or 8).

3 Engineering Communications (LEC 1.0 and LAB 1.0) Introduction to programming concepts and software tools (computer aided design drafting, computer mathematics, word processing, spreadsheets, and presentation software) with application to written and oral communication in professional civil and architectural engineering practice. Prerequisite: Sophomore standing. (Co-listed with Arch Eng 003)

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.

202 Co-Operative Engineering Training (IND 1.0-3.0) On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation.

210 Senior Seminar: Engineering In A Global Society (RSD 1.0) Discussion of contemporary issues: public safety, health, and welfare; the principles of sustainable development; lifelong learning; impact of engineering solutions in a global and societal and political context; relationships with owners, contractors, and the public; public service; the Code of Ethics; and the Missouri licensing Statutes and Board Rules. Prerequisite: Senior standing. (Co-listed with Arch E and Env En 210)

211 Transportation Engineering (LEC 2.0 and LAB 1.0) A study of operating characteristics of transportation modes including highways, railways, inland waterways, airways, and pipelines. Consideration of traffic control devices, safety, system capacity, design of routes, planning of urban transportation systems, and economic evaluation of transportation alternatives. Prerequisites: Civ Eng 1, IDE 50 with a grade of "C" or better.

215 Fundamentals of Geotechnical Engineering (LEC 2.0 and LAB 1.0) Analysis of geotechnical systems including soil classification, index properties, permeability, compressibility and shear strength. Basic geotechnical engineering design principles as they apply to civil constructed facilities, such as analysis of foundations and earth structures. Laboratory determination of the basic properties of soils. Prerequisite: Geo Eng 50 preceded or accompanied by IDE 110; or Arch Eng 103.

216 Construction Materials, Properties And Testing (LEC 2.0 and LAB 1.0) A study of the origin, production, uses and general properties of construction materials accompanied by selected laboratory tests and demonstrations. Prerequisites: IDE 120, Civ Eng 215.

217 Structural Analysis I (LEC 2.0 and LAB 1.0) Loads on Structures. Analysis of statically determinate and indeterminate beams, frames and trusses. Influence lines and moving loads. Computation of deflections. Development and use of theorems of displacement methods including slope-deflection and moment distribution to analyze statically indeterminate structures. Computer solutions. Prerequisites: IDE 50, 110 each with a grade of "C" or better. (Co-listed with Arch Eng 217)

218 Structural Analysis (LEC 4.0 and LAB 1.0) Analysis of statically determinate and indeterminate beams, frames and trusses. Moving loads. Influence lines. Development and use of theorems of moment area, virtual work, slope deflection,

moment distribution, matrix displacement. Formulation by students of several computer programs. Prerequisites: IDE 50, 110 each with grade of "C" or better.

221 Structural Design In Metals (LEC 2.0 and LAB 1.0) The analysis and design of structural elements and connections for buildings, bridges and specialized structures utilizing structural metals. Both elastic and plastic designs are considered. Prerequisite: Cv Eng 217 with grade of "C" or better. (Co-listed with Arch Eng 221)

223 Reinforced Concrete Design (LEC 2.0 and LAB 1.0) The analysis and design of reinforced concrete beams, slabs, columns, retaining walls and footings by the elastic and ultimate strength methods, including an introduction to the design of prestressed concrete. Introduction to use of computers as a design aid tool. Prerequisite: Cv Eng 217 with grade of "C" or better. (Co-listed with Arch Eng 223)

229 Foundation Engineering (LEC 3.0) The effect of subsoil conditions on the behavior and choice of foundations. Topics include geotechnical explorations and the design of foundations, which includes the selection of foundation types, the analysis of bearing capacity and settlement of shallow/deep foundations, and retaining walls. Prerequisite: Cv Eng 215.

230 Elementary Fluid Mechanics (LEC 3.0) A study of the principles governing the behavior of fluids at rest and in motion. Emphasizes methods employed in the development of general relationships in the statics, kinematics, and kinetics of fluids. An introduction to similitude and dimensional analysis. Prerequisite: IDE 150 or IDE 140 with a grade of "C" or better.

233 Engineering Hydrology (LEC 2.0 and LAB 1.0) A study of hydrologic processes as they relate to design of structures for control and management of water. Emphasizes characterization of precipitation processes, development of design hydrographs, rainfall/runoff frequency analysis, ground-water and wells. Prerequisites: Cv Eng 230 with grade of "C" or better.

234 Water Resources Engineering (LEC 3.0 and LAB 1.0) An introduction to the engineering of water resources; flow in closed conduits, pumps, flow in open channels, surface water hydrology, rainfall analysis, hydrograph analysis, flow routing; and ground-water hydrology. Prerequisites: Cv Eng 230 and Stat 213 with grades of "C" or better.

235 Hydraulic Engineering (LEC 2.0 and LAB 1.0) A study of applied hydraulics to design of systems used for collection or distribution of water. Emphasis on open channel flow, hydraulic machinery, design of supply systems, drainage systems, and hydraulic transients. Prerequisites: Cv Eng 230 with grade of "C" or better.

241 Economy Of Engineering Design (LEC 1.0 and LAB 1.0) Engineering decision-making procedures with emphasis on time value of money principles. Includes topics such as present, annual, and future worth analysis; rate of return and benefit/cost ratio methods; effects of taxes, depreciation, and inflation on project viability; sensitivity analysis; design component optimization; project financing costs; and applications. Prerequisite: Preceded or accompanied by Stat 213. (Co-listed with Arch E 241)

242 Fundamentals of Building Systems (LEC 3.0) An examination of building life support systems and technology of interest to civil engineers in the planning, operation, and maintenance of buildings. Topics include human comfort, electrical, mechanical, water and waste, transportation, lighting, and other systems necessary for building utilization. Prerequisites: Physics 24, Math 204 and Junior Standing.

247 Ethical, Legal And Professional Engineering Practice (LEC 2.0) Discussions of laws concerning contracts, torts, agencies, real property, partnerships, and corporations. The purposes and implications of the engineering registration law, the effect of legal, ethical and marketing considerations of the practice of Civil Engineering. Prerequisite: Junior standing. (Co-listed with Arch Eng 247)

248 Fundamentals Of Contracts And Construction Engineering (LEC 3.0) A study of the concepts and techniques used in large construction projects for the preparation of engineer service contracts, the development of a project manual, detailed and conceptual cost estimating, and construction scheduling analysis. Prerequisite: Senior Standing. (Co-listed with Arch Eng 248)

261 Fundamentals Of Environmental Engineering And Science (LEC 2.0 and LAB 1.0) Course discusses fundamental chemical, physical, and biological principles in environmental engineering and science. Topics include environmental phenomena, aquatic pollution and control, solid-waste management, air pollution and control, radiological health, and water and wastewater treatment systems.

262 Biological Fundamentals Of Environmental Engineering (LEC 3.0) Introduction to the function of organisms related to environmental engineering. The course focuses on both the application of organisms to removing contaminants and the effects of contaminants on organisms. Prerequisites: Bio Sci 110 and preceded or accompanied by Civ/Env Eng 261. (Co-listed with Env Eng 262)

263 Chemical Fundamentals Of Environmental Engineering (LEC 2.0 and LAB 1.0) Introduction to the key chemical and physical concepts integral to environmental systems and processes. This course provides a fundamental background in those chemical and environmental engineering principles that are common to all environmental engineering disciplines. Prerequisites: Chem 3, Physics 23, Math 22. (Co-listed with Env En 263)

265 Water And Wastewater Engineering (LEC 3.0) A study of the engineering design principles deal-

ing with the quantity, quality and treatment of water, and the quantity, characteristics, treatment and disposal of wastewater. Prerequisites: Civ Eng 230 with grade of "C" or better, Civ Eng 261. (Co-listed with Env Eng 265)

298 Senior Design Project (LEC 3.0) Open-ended design projects involving one or more areas of engineering. Planning design projects, philosophy of design, and application of engineering principles to design problems. Prerequisite: Civ Eng 248 or Arch Eng 248. (Co-listed with Arch Eng 298 and Env Eng 298)

299 Civil Engineering Design (LAB 2.0-4.0) Design projects, open-ended in nature, which involve one or more areas of civil engineering. Planning design projects; philosophy of design, application of the principles of civil engineering to design problems. Prerequisite: To be taken in final semester.

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 Geomatics (LEC 3.0) Horizontal and vertical geodetic datums and networks. Theory, calculations and applications of State Plane Coordinate Systems. Introduction to Geographic and Land Information Systems: hardware and software issues; data quality and accuracy; resource, environmental, cadastral and governmental applications; databases; GIS/LIS trends. Introduction to Global Positioning Systems (GPS): Project planning, data collection, data processing and network adjustment applications, Kinematic and RealTime GPS applications, hardware and software options and costs. Prerequisite: Cv Eng 1 with grade of "C" or better

304 Legal Aspects Of Boundary Surveying (LEC 3.0) The U.S. Public Land Survey System (USPLSS): original GLO survey instructions and procedures. Resurveys on the USPLSS law, standards, procedures with emphasis on Missouri. Rights in real property; statute, case and administrative law applied to boundaries. Simultaneous and sequence conveyances. Unwritten rights in real property. Riparian boundaries. Writing and interpreting boundary descriptions. Land surveyor duties and responsibilities. Prerequisite: Cv Eng 1 with grade of "C" or better.

306 Surveying Systems (LEC 3.0) Celestial observations for azimuths. Introduction to State Plane Coordinate systems. Theory and calculations. Route surveying and geometrics, horizontal, spiral and vertical curves. Surveying aspects of residential and commercial subdivision design: lot layout, rights of way, easements, setbacks, platting, planning and zoning constraints, application of surveying software. Instrumentation: total stations, electronic levels, instrument calibrations. Prerequisite: Cv Eng 1 with grade of "C" or better.

310 Seminar (LEC 1.0) Discussion of current topics. Prerequisite: Senior standing.

311 Geometric Design Of Highways (LEC 2.0 and LAB 1.0) Development and applications of concepts of geometric design for rural and urban highways. Design controls and criteria; elements of design, including sight distance, horizontal and vertical alignment; cross-section elements; highway types; intersection design elements; types of interchanges and interchange design elements; grade separations and clearance; development of visual elements. Prerequisites: Cv Eng 211 with grade of "C" or better.

312 Bituminous Materials (LEC 2.0 and LAB 1.0) Properties, types, and grades of bituminous materials are presented. Emphasis is placed on usage, distress, surface treatment design, and asphalt concrete mix properties, behavior, design manufacture, and construction. Prerequisite: Preceded or accompanied by Cv Eng 216.

313 Composition And Properties Of Concrete (LEC 3.0) Properties of plastic and hardened concrete and the influence of cements, aggregates, water and admixtures upon these properties. The microstructure of cement gel and other factors are related to the behavior of hardened concrete under various types of loading and environments, drying shrinkage, creep and relaxation, fatigue, fracture, and durability. Introduction to statistical quality control of concrete production. Prerequisite: Preceded or accompanied by Cv Eng 216.

314 Geosynthetics In Engineering (LEC 3.0) Geotechnical principles are applied to design of geosynthetic systems for foundation support, earth retention, drainage, and disposal of hazardous conventional wastes. Geosynthetic testing and identification. Emphasis is on design of geosynthetic earth reinforcement, roadway stabilization, filters, and waste containment systems. Prerequisites: Cv Eng 215 with grade of "C" or better.

315 Intermediate Soil Mechanics (LEC 3.0) General principles of soil mechanics and their applications, including mineralogy, soil structure, flow through porous media, shear strength, slope stability and consolidation. Prerequisites: Cv Eng 215 with grade of "C" or better.

316 Geotechnical Earthquake Engineering (LEC 3.0) Geotechnical earthquake hazards and mitigations, damage to structures, plate tectonics, seismicity, wave propagation, characterization of ground motions, theory of vibrations (1-DOF), effect of local soil conditions on ground response, development of design ground motions, liquefaction, dynamic lateral earth pressures and slope stability/deformation. Prerequisites: Cv Eng 215 with a grade of "C" or better.

318 Smart Materials And Sensors (LEC 2.0 and LAB 1.0) Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multidisciplinary topics include characterization, performance, and fabrication of composite struc-

tures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior Standing and Math 204. (Co-listed with Ae Eng, E Mech, Mc Eng and El Eng 329)

319 Applied Mechanics In Structural Engineering (LEC 3.0) A study of the basic relationships involved in the mechanics of structures. Topics include basic elasticity, failure criteria, fundamental theories of bending and buckling of plates and cylindrical shells for practical application in analysis and design of bridge, building floors, and shell roofs. Prerequisite: Cv Eng 217 with grade of "C" or better. (Co-listed with Arch Eng 319)

320 Structural Analysis II (LEC 3.0) Classical displacement and force methods applied to structures of advanced design. Analysis of indeterminate structures such as continuous beams, arches, cables, and two and three dimensional frames, and trusses. Analysis of indeterminate structures involving temperature and support settlements effects. Prerequisites: Civ Eng 217 or Arch Eng 217. (Co-listed with Arch Eng 320)

322 Analysis And Design Of Wood Structures (LEC 3.0) A critical review of theory and practice in design of modern wood structures. Effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design; development of design criteria and their application to plane and three dimensional structures. Prerequisite: Cv Eng 217 with grade of "C" or better. (Co-listed with Arch Eng 322)

323 Computer Methods of Structural Analysis (LEC 3.0) Force and displacement matrix methods and computer methods applied to structural analysis. Analysis of indeterminate structures such as continuous beams, and two and three dimensional frames and trusses. Analysis of indeterminate structures involving temperature and support settlements effects using computer methods formulation. Prerequisite: Cv Eng 217 with grade of "C" or better. (Co-listed with Arch Eng 323)

324 Numerical Methods Of Structural Analysis (LEC 3.0) The application of numerical integration techniques for determining shears, moments, slopes and deflections of beams and frames. Numerical techniques for structural element stability. Application of finite difference methods on one and two dimensional structural systems. Prerequisite: Cv Eng 217 with grade of "C" or better.

326 Advanced Steel Structures Design (LEC 3.0) The design of structural steel systems into a final integrated structure. Plate girders, composite systems, stability, connections, rigid frames, single and multistory buildings, and similar type problems of interest to the student. Use of the computer as a tool to aid in the design will be emphasized. Prerequisites: Cv Eng 221 with a grade of "C" or better. (Co-listed with Arch Eng 326)

327 Advanced Concrete Structures Design (LEC 3.0) The design of structural concrete systems into a final integrated structure. Two-way slabs, long columns, connections, and discontinuity regions, deflections and cracking of beams and slabs, ACI design criteria, and similar type problems of interest to the student. Use of the computer as a tool to aid in the design will be emphasized. Prerequisite: Cv Eng 223 with a grade of "C" or better. (Co-listed with Arch Eng 327)

328 Prestressed Concrete Design (LEC 3.0) Behavior of steel and concrete under sustained load. Analysis and design of pre-tensioned and post-tensioned reinforced concrete members and the combining of such members into an integral structure. Prerequisite: Cv Eng 223 with a grade of "C" or better. (Co-listed with Arch Eng 328)

329 Foundation Engineering II (LEC 3.0) Classical earth pressure theories. Analysis of shallow and deep foundations to include bearing capacity and settlement of footings, rafts, piles, and drilled piers. Analysis of stability and design of retaining walls and anchored bulkheads. Prerequisites: Cv Eng 229 with a grade of "C" or better. (Co-listed with Arch Eng 329)

330 Unsteady Flow Hydraulics (LEC 3.0) The study of unsteady flow and its effect on closed water systems and in open channels. Prerequisites: Cv Eng 230 with a grade of "C" or better.

331 Hydraulics Of Open Channels (LEC 3.0) The phenomena accompanying the flow of water in open channels, such as uniform and varied flow, critical conditions, backwater curves, hydraulic jump, hydraulic drop and applications are studied in detail. Prerequisites: Cv Eng 230 with a grade of "C" or better.

333 Intermediate Hydraulic Engineering (LEC 3.0) Application of fluid mechanics principles to the design. Kinematics of fluid motion, conservation of mass, linear and angular momentum, and energy. Requirements for similarity of fluid flow. Introduction to dynamics of fluid flows and viscous incompressible flows. Prerequisites: Cv Eng 230 with a grade of "C" or better.

335 Water Infrastructure Engineering (LEC 2.0 and LAB 1.0) Fundamental principles underlying comprehensive water infrastructure development; sanitary sewers, sanitary treatment facilities, stormwater sewers, stormwater detention, water power development, and hydraulic structures. The student is responsible for the planning and design of a water infrastructure development project. Prerequisite: Cv Eng 230 with a grade of "C" or better.

337 River Mechanics And Sediment Transport (LEC 3.0) Formation of rivers and the laws governing river regulation and improvements, including navigation and flood protection. Principles

governing sediment transport. Prerequisites: Cv Eng 230 with a grade of "C" or better.

338 Hydrologic Engineering (LEC 3.0) A study of current up-to-date hydrologic techniques involving design of hydrologic input for bridges, culverts, reservoirs. Techniques involve extreme value statistics, model hydrographs, routing, etc. Prerequisites: Cv Eng 234 with a grade of "C" or better.

341 Professional Aspects Of Engineering Practice (LEC 3.0) A study of engineering registration laws, regulations, rules of professional responsibility and standards of practice. Review of causative factors of selected failures and their relationship to professional responsibility. Prerequisite: Senior standing.

345 Construction Methods (LEC 3.0) Introduction to construction planning, selection of equipment and familiarization with standard methods for horizontal and vertical construction. Application of network analysis and schedules to project control. Prerequisite: Cv Eng 248 with a grade of "C" or better. (Co-listed with Arch Eng 345)

346 Management Of Construction Costs (LEC 3.0) Management of construction projects from inception to completion: estimates, role of network preplanning, project monitoring and control. Prerequisites: Cv Eng 248 with a grade of "C" or better. (Co-listed with Arch Eng 346)

349 Engineering And Construction Contract Specifications (LEC 3.0) Legal and business aspects of contracts and contracting procedure in the construction industry. Topics include formulation of contracts in common law, engineering services contracts, and construction project contract documents and contract administration issues. Prerequisite: Civ Eng 248 with a grade of "C" or better. (Co-listed with Arch Eng 349)

353 Traffic Engineering (LEC 3.0) Driver, vehicle, and roadway characteristics; traffic control devices; traffic studies; intersection capacity, intersection design, traffic safety, and evaluation of traffic improvements. Traffic laws and ordinances, traffic engineering, traffic circulation, parking design, and forecasting traffic impacts. Prerequisites: Cv Eng 211 with a grade of "C" or better.

360 Environmental Law And Regulations (LEC 3.0) This course provides comprehensive coverage of environmental laws and regulations dealing with air, water, wastewater, and other media. The primary focus is permitting, reporting, and compliance protocols. The course topics include U.S. and international legal systems and judicial processes, liability, enforcement, Clean Air Act, Clean Water Act (NPDES) permitting), Safe Drinking Water Act, OSGA, TSCA, RCRA, AND CERCLA. Case studies will be emphasized. (Co-listed with Env En 360)

361 Remediation Of Contaminated Groundwater And Soil (LEC 2.0 and LAB 1.0) Course covers current in-situ and ex-situ remediation technologies. Current literature and case studies are utilized to provide the focus for class discussions and projects. Prerequisites: Cv Eng 265, Ge Eng 337 or Graduate Standing. (Co-listed with Env En 361)

362 Public Health Engineering (LEC 3.0) A comprehensive course dealing with the environmental aspects of public health. Prerequisites: Cv Eng 261 with a grade of "C" or better. (Co-listed with Env En 362)

363 Solid Waste Management (LEC 3.0) A systematic study of the sources, amounts and characteristics of solid wastes and methods used for their collection, reclamation, and ultimate disposal. Prerequisites: Cv Eng 261 with grade of "C" or better; or graduate standing. (Co-listed with Env En 363)

364 Environmental Systems Modeling (LEC 3.0) Introductory course in modeling environmental systems. Course will focus on contaminant fate and transport in the environment. Models will be developed that will include physical, chemical and biological reactions and processes that impact this fate. Prerequisites: Env En/Cv Eng 261, Env En/Cv Eng 262 and Env En/ Cv Eng 263; or Graduate standing. (Co-listed with Env En 364)

367 Introduction To Air Pollution (LEC 3.0) Introduction to the field of air pollution dealing with sources, effects, federal legislation, transport and dispersion and principles of engineering control. Prerequisite: Cv Eng 230; or graduate standing. (Co-listed with Env En 367)

368 Air Pollution Control Methods (LEC 3.0) Study of the design principles and application of the state-ofthe-art control techniques to gaseous and particulate emissions from fossil fuel combustion, industrial and transportation sources. Prerequisite: Cv Eng 230; or graduate standing. (Co-listed with Env En 368)

369 Sanitary Engineering Design (LEC 2.0 and LAB 1.0) Functional design of water and waste water treatment facilities. Prerequisites: Cv Eng 265 with a grade of "C" or better. (Co-listed with Env En 369)

373 Air Transportation (LEC 2.0 and LAB 1.0) Runway configuration, airfield capacity, geometrics and terminal layout and design. Aircraft perfomance; navigation and air traffic control; airport planning and design; airline operations; aviation systems planning. Prerequisite: Cv Eng 211 with a grade of "C" or better.

374 Infrastructure Strengthening With Composites (LEC 3.0) The course presents composite materials and includes principles of reinforcing and strengthening for flexure, shear, and ductility enhancement in buildings and bridges. It covers the design of existing members strengthened with externally bonded laminates and near surface mounted composites. Case studies are discussed. Prerequisites: Civ Eng/Arch Eng 217, Civ Eng/Arch Eng 223. (Co-listed with Arch Eng 374)

375 Low-Rise Building Analysis And Design (LEC 3.0) Characterization of various design loads, load combinations, general methodology of structural

designs against lateral loads, code-oriented design procedures, distribution of lateral loads in structural systems, application of the International Building Code in design of loadbearing wall systems, building frame system and moment-resisting frame systems. Prerequisite: Preceded and/or accompanied by Civ -Arch Eng 221 or Civ-Arch Eng 223. (Co-listed with Arch Eng 375)

380 Water Resources And Wastewater Engineering (LEC 3.0) Application of engineering principles to the planning and design of multipurpose projects involving water resources development and wastewater collection/treatment/disposal/systems. Latest concepts in engineering analysis are applied to evaluation of alternative solutions. Prerequisites: Cv Eng 233, 235, 265. (Co-listed with Env En 380)

382 Teaching Engineering (LEC 3.0) Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mg 370, Env En 382, Cp Eng 382, El Eng 382)

385 Patent Law (LEC 3.0) A presentation of the relationship between patent law and technology for students involved with developing and protecting new technology or pursuing a career in patent law. Course includes an intense study of patentability and preparation and prosecution of patent applications. Prerequisite: Senior or graduate standing. (Co-listed with Eng Mgt 369, Chem Eng 385)

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.

Computer Engineering

Bachelor of Science
Master of Science
Doctor of Philosophy

Emphasis areas at bachelor of science level in Computers and Architecture, Integrated Circuits and Logic Design, Embedded Computer Systems, Computational Intelligence, Networking and Software Engineering, and Security and Reliability

The Computer Engineering Program is designed to prepare an engineer to work in both the abstract software world, where high level languages and complexity often provide a solution to a problem, and in the physical world where designs are often compromises between many opposing factors. The program prepares engineers to compete in today's rapidly changing marketplace by providing the fundamental concepts of computer engineering and the attributes of a professional.

The distinction between a computer engineer and the more traditional computer science major or electrical engineer specializing in computers may be their desire to understand and participate in the entire process of developing and using computers, from abstract algorithms and data structures to control changes in real physical devices.

There are many aspects to Computer Engineering. A Computer Engineer might work on the design of a new automobile brake system, where a knowledge of the electronic sensors and the dynamic nature of the brakes might be as important as the programming of an I/O handler interrupt subroutine in high level C or assembly language. They might also work on a project, design a distributed control system for a factory floor, that requires the engineer to have an extensive background in computer networks and programming as well as an understanding of the manufacturing process.

The major objective of the Bachelor of Science degree curriculum in Computer Engineering is to provide an in-depth education in both the hardware and software aspects of modern computer systems. At the same time it provides options that allow students to select courses in other science and engineering areas that will provide additional background for future positions where knowledge about a system may be as important for a particular task as computer skills.

The Bachelor of Science in Computer Engineering Degree Program is ABET- accredited. It provides training and technical skills through both lecture and laboratory courses. It develops communication techniques in courses such as technical writing and speech. It provides humanities and social science electives that help develop the perspective necessary to understand the social impact of engineering solutions. A two-semester senior project allows students to hone technical and communication skills while working as a team on a "real world" design or project.

The Computer Engineering Program follows the Electrical Engineering Program into the sophomore year and then branches into Computer Science courses in data structures, discrete mathematics, operating systems, and computer networks as well as additional core courses in electrical engineering. It includes computer design courses and hardware laboratories. Students will first complete the Freshman Engineering program thus obtaining basic science skills along with orientation about the various degree programs at UMR. This allows students time to consider different career options before they have to commit to a given degree program.

Students should work closely with their advisor to carefully plan each semester's class schedule in order to have the correct prerequisites for courses in the following semesters. They should also select electives in the program to provide the background in areas they wish to emphasize for a different career path.

Students in other disciplines working with their advisor should be able to plan a program that would allow them to graduate with a degree in the original discipline and a Computer Engineering degree by sharing some electives and taking additional course work. Students with a qualifying GPA should consider the alternative of working towards a MS degree in graduate school instead of a second B.S. degree.

Mission Statement

The mission of the Computer Engineering Program, consistent with the UMR campus mission statement, is the education of students to fully prepare them to provide leadership in the recognition and solution of society's problems in the area of Computer Engineering. Fundamental to the mission of the Department of Electrical and Computer Engineering is the operation of the B.S., M.S., and Ph.D., degree programs in Computer Engineering. The educational objectives for the undergraduate program are: First, you will obtain a broad education that crosses departmental boundaries while still attaining technical depth in areas impacted by computer engineering. Your skills will allow individual or team solutions to difficult, novel, multidisciplinary problems; effective balancing of multiple design issues; and lifelong adaptation to new technological developments. Secondly, you will obtain a solid understanding of professional and ethical responsibility and a recognition of the need for, and ability to engage in, a program of lifelong learning. Finally, you will experience an academic environment in which small classes are taught by full-time faculty and which fosters lifelong learning, leadership, scholarship, and an appreciation of the value of diversity.

Computer Engineering Faculty

Professors:

Ann Miller (The Cynthia Tang Missouri Distinguished Professor of Computer Engineering), Ph.D., St. Louis University

Paul D. Stigall[1] (Emeritus), Ph.D., University of Wyoming

Donald C. Wunsch II[1], (The Mary K. Finley Missouri Distinguished Professor of Computer Engineering), Ph.D., University of Washington

Associate Professors:

Daryl Beetner[1] (Associate Chair), D.Sc., Washington University

Hardy J. Pottinger (Emeritus), Ph.D., University of Missouri-Rolla

Ronald Joe Stanley, Ph.D., University of Missouri-Columbia

Ganesh Kumar Venayagamoorthy, Ph.D., University of Natal, South Africa

Assistant Professors:

Waleed Al-Assadi, Ph.D., Colorado State University

Minsu Choi, Ph.D., Oklahoma State University

Sahra Sedigh-Ali, Ph.D., Purdue University

Electrical Engineering Faculty

Professors:

David R. Cunningham[1] (Emeritus), Ph.D., Oklahoma State University

James Drewniak, (Director, MRC) Ph.D., University of Illinois at Urbana-Champaign

Kelvin T. Erickson[1], (Chair), Ph.D., Iowa State University

Randy H. Moss[1], Ph.D., University of Illinois

S. Vittal Rao (William A. Rutledge-Emerson Electric Co., Distinguished Professor) Ph.D., I.I.T., New Delhi

Steve E. Watkins, Ph.D., University of Texas at Austin

Cheng-Hsiao Wu, Ph.D., University Rochester

Associate Professors:

Levent Acar, Ph.D., Ohio State University

Norman R. Cox[1], Ph.D., University of Texas-Arlington

Kurt L. Kosbar, Ph.D., University of Southern California

[1] Registered Professional Engineer

Bachelor of Science Computer Engineering[1]

Entering freshmen desiring to study Computer Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Computer 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 Computer Engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in Computer Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1) All students are required to take one American history course, one economics course, one humanities course, and English 20. The history course is to be selected from History 112, History 175, History 176, or Political Science 90. The economics course may be either Economics 121 or 122. The humanities course must be selected from the approved lists for Art, English, Foreign Languages, Music, Philosophy, Speech and Media Studies, or Theater.

2) Depth requirement. Three credit hours must be taken in humanities or social sciences at the 100 level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 70 or 80 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 300 level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.

3) The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to English 20.

4) Any specific departmental requirements in the general studies area must be satisfied.

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

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

FREE ELECTIVES FOOTNOTE:

Free electives. Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.

FRESHMAN YEAR

First Semester	Credit
FE 10-Study & Careers in Eng[2]	1
Math 14-Calculus I for Engineers[3]	4
Chem 1-General Chemistry	4
Chem 2-General Chemistry Lab	1
Hist 112, 175, 176, or Pol Sc 90	3
English 20-Exposition & Argumentation	3
	16
Second Semester	
IDE 20-Eng Design with Comp Appl	3
Math 15-Calculus II for Engineers[3]	4
Physics 23-Engineering Physics I[3,4]	4
Econ 121 or 122	3
Elective-Hum[5]	3
	17

SOPHOMORE YEAR

First Semester	Credit
El Eng 151-Circuits I[3,6,7]	3
El Eng 152-Circuit Analysis Lab[3,6]	1
Math 22-Calculus w/Analytic Geometry III[3]	4
Cmp Sc 53-Intro to Programming[3]	3
Cmp Sc 54-Intro to Programming Lab[3]	1
Physics 24-Engineering Physics II[3,4]	4
	16
Second Semester	
Cp Eng 111-Intro to Computer Engineering [3,6,8]	3
Cp Eng 112-Computer Engineering Lab I [3,6]	1
El Eng 153-Circuits II [3,7,9]	3
Math 204-Elementary Differential Equations [3]	3
Cmp Sc 153-Data Structures I [3]	3
Cmp Sc 158-Discrete Mathematics[3]	3
	16

JUNIOR YEAR

First Semester	Credits
Cp Eng 213-Digital Systems Design[3,6,8]	3
Cp Eng 214-Digital Engineering Lab II[3,6,8]	1
Cp Eng 215-Computer Architecture[3,8]	3
El Eng 121-Introduction to Electronic Devices[3,6,7]	3
El Eng 122-Electronic Devices Lab[3,6,7]	1
Mathematics Elective[10]	3
Sp&M 85-Principles of Speech	3
	17
Second Semester	
Cp Eng Elective A[3,14]	3
El Eng 215-Discrete Linear Systems I[3,6,9]	3
El Eng 216-Discrete Linear Systems I Lab[3,6,9]	1
Cp Sc 284-Introduction to Operating Systems[3]	3
Stat 217-Prob & Stat for Eng and Scientists[12]	3
English 160-Technical Writing[13]	3
	16

SENIOR YEAR

First Semester	Credit
Cp Eng 319-Digital Network Design[3]	3
Cp Eng Elective B[3,15,16]	3
Cp Eng 391-El Eng Senior Project I[3,17]	1
Elective-Hum or Soc (any level)[5]	3
Free Elective[18]	2
Engineering Science Elective[11]	3
	15
Second Semester	
Cp Eng Elective C[3,15,16]	3
Cp Eng Elective D[3,15,16]	3
Cp Eng 392-El Eng Senior Project II[3,17]	3
Elective-Hum or Soc (upper level)[5]	3
Free Elective[18]	3
Assessment[19]	0
	15

NOTES: Student must satisfy the common engineering freshman year requirements and be admitted into the department.

1) The minimum number of hours required for a degree in Computer Engineering is 128.
2) Students that transfer to UMR after their freshman year are not required to enroll in Freshman Engineering Seminars.
3) A minimum grade of "C" must be attained in Math 14, 15, 22, and 204, Physics 23 and 24 (or their equivalents), Cp Sc 53, 54, 153, 158, and 284, Cp Eng 111, 112, 213, 214, 215, 319, 391, and 392, and El Eng 151, 152, 153, 121, 122, 261, and 262, and the Cp Eng electives A, B, C, and D. Also, students may not enroll in other courses that use these courses as prerequisites until the minimum grade of "C" is attained
4) Students may take Physics 21 and 22 or Physics 21 and 27 in place of Physics 23. Students may take Physics 25 and 26 or Physics 25 and 28 in place of Physics 24.
5) All electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog.

6) Students who drop a lecture prior to the last week to drop a class must also drop the corequisite lab.

7) Students must earn a passing grade on the El Eng Advancement Exam I (associated with El Eng 151) before they enroll in El Eng 153 or 121 and 122.

8) Students must earn a passing grade on the Cp Eng Advancement Exam (associated with Cp Eng 111) before they enroll in any course with Cp Eng 111 and 112 as prerequisites.

9) Students must earn a passing grade on the El Eng Advancement Exam II (associated with El Eng 153) before they enroll in El Eng 261 and 262.

10) Students must take Math 203, 208, 305, 307, 309, 315, 322, 325, 330, 351, 383, or Cp Sc 228.

11) Students must take IDE 140, Mc Eng 219, Mc Eng 227, Physics 207, Physics 208, Chem 221, Biology 211, or Biology 231. The following pairs of course are substitutions for any single course: IDE 50 and IDE 150, Physics 107 and Physics 311, Physics 107 and Cr Eng 284, Physics 107 and Nu Eng 205, or Eng Mt 211 and Eng Mt 282.

12) Students may replace Stat 217 with Stat 215 or Stat 343.

13) Students may replace English 160 with English 60.

14) Cp Eng Elective A must be a 300-level Cp Eng, El Eng, or Cp Sc course with at least a 3-hour lecture component. This normally includes all Cp Eng and El Eng 3xx courses except Cp Eng or El Eng 300, 390, 391, and 392 or Cp Sc 300, 310, 385, and 390.

15) Cp Eng Electives B, C, and D must be 200 or 300-level courses from an approved list of science, mathematics, and engineering courses. In particular, this list includes all 200 or 300-level Cp Eng, El Eng and Cp Sc courses except required courses in Cp Eng, El Eng, and Cp Sc and except Cp Eng 391 and 392, El Eng 281, 282, 283, 391, and 392, and Cp Sc 202, 285, and 385. Cp Eng Electives B, C, and D must include at least six hours of engineering or computer science courses.

16) Cp Eng Electives B, C, and D cannot include more than three hours of Cp Eng or El Eng 202, 300, or 390.

17) Students pursuing dual degrees in Cp Eng and El Eng may take either Cp Eng 391 or El Eng 391 and Cp Eng 392 or El Eng 392. Students may not receive credit for both Cp Eng 391 and El Eng 391 or Cp Eng 392 and El Eng 392 in the same degree program.

18) Students are required to take five hours of free elective in consultation with their academic advisors. Credits that do not count toward this requirement are deficiency courses (such as algebra and trigonometry) and extra credits from courses meeting other requirements. Any courses outside of engineering and science must be at least three credit hours.

19) All Computer 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 UMR assessment process as described in Assessment Requirements found elsewhere. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.

Emphasis Areas for Computer Engineering

Note: The following emphasis areas identify courses from which a student may opt to develop a specific emphasis. It is not required that students obtain an emphasis specialty within computer engineering.

Computers and Architecture

Highly Recommended
- Cp Eng 313-Microprocessor Systems Design
- Cp Eng 315-Digital Computer Design

Suggested
- Cp Eng 316-Advanced Microcomputer Sys Design

Integrated Circuits and Logic Design

Highly Recommended
- Cp Eng 311-Intro to VLSI Design
- Cp Eng 318-Digital Systems Modeling

Suggested
- EE 253-Electronics I
- Cp Eng 312-Digital Systems Design Lab
- Cp Eng 313-Microprocessor Systems Design
- Cp Eng 315-Digital Computer Design
- Cp Eng 316-Advanced Microcomputer Sys Design
- Cp Eng 317-Fault Tolerant Digital Systems
- Cp Eng 355-Analysis of Algorithms

Embedded Computer Systems

Highly Recommended
- Cp Eng 312-Digital Systems Design Lab
- Cp Eng 331-Real-Time Systems

Suggested
- Cp Eng 342-Real-Time Digital Signal Processing
- EE 231-Control Systems
- EE 253-Electronics I
- EE 265-Linear Systems I
- CS 306-Software Engineering I

Computational Intelligence

Highly Recommended
- EE 347-Machine Vision
- EE 368-Neural Networks
- Cp Eng 301-Computational Intelligence

Suggested
- EE 338-Fuzzy Logic Control

Networking and Software Engineering

Highly Recommended
- Cp Eng 319-Digital Network Design (or CS 285-Computer Network Concepts and Technology)
- Cp Eng 349-Trustworthy, Survivable Computer Networks

Suggested
- Cp Eng 317-Fault Tolerant Digital Systems
- CS 306-Software Engineering I
- CS 307-Software Engineering II

- IST 241-E-Commerce

Security and Reliability

Highly Recommended

- Cp Eng 317-Fault Tolerant Digital Systems
- Cp Eng 319-Digital Network Design (or CS 285-Computer Network Concepts and Technology)
- Cp Eng 349-Trustworthy, Survivable Computer Networks

Suggested

- Cp Eng 301-Computational Intelligence

Computer Engineering 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 Introduction To Computer Engineering (LEC 3.0) Binary arithmetic, Boolean algebra, logic and memory elements, computer organization. Prerequisite: Sophomore standing. Comp Eng 112 is also a co-requisite for Comp Eng and Elec Eng majors.

112 Computer Engineering Laboratory (LAB 1.0) Introduction to digital design techniques, logic gates, Medium Scale Integration (MSI) parts and flipflops, Timing analysis, Programming and use of Programmable Logic Devices (PLD). Prerequisite: Preceded or accompanied by Cp Eng 111.

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

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

202 Cooperative Engineering Training (IND 1.0-6.0) On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluations.

213 Digital Systems Design (LEC 3.0) Microcontroller-based digital system design methodology and techniques. Topics include basic machine organization, interface design, and C and assembly language programming for real-time embedded systems. Prerequisites: Comp Eng 111 and Comp Sci 53 (or programming equivalent) each with grade of "C" or better.

214 Digital Engineering Lab II (LAB 1.0) Advanced digital design techniques, Microcontroller based design, hardware and software codesign. Prerequisites: Comp Eng 111, Comp Eng 112, and Comp Sci 53 (or programming equivalent) each with grade of "C" or better. Preceded or accompanied by Comp Eng 213, Elec Eng 121 and Elec Eng 122.

215 Computer Organization and Design (LEC 3.0) Introduction to basic concepts of computer organization and design: metrics for computer performance, computer arithmetic, Von Neuman architecture, instruction implementation, control unit, pipelining, memory systems hierarchy, cache memories and basic I/O controllers. Prerequisites: Comp Eng 111. Should be preceded or accompanied by Comp Eng 213.

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.

311 Introduction To Vlsi Design (LEC 3.0) An introduction to the design and implementation of very large scale integrated systems. Procedures for designing and implementing digital integrated systems, structured design methodology, stick diagrams, scalable design rules, and use of computer aided design tools. Prerequisite: Cp Eng 213.

312 Digital Systems Design Laboratory (LEC 2.0 and LAB 1.0) Experimental studies of problems with high speed digital signals in circuits. Student designs, wires, tests, and programs a microprocessor based single board computer project. A FPGA design is programmed and tested. Prerequisite: Cp Eng 213 or 313.

313 Principles of Computer Architecture (LEC 3.0) Principles of performance measurement and instruction set design; advanced issues in pipelining; instruction level parallelism (dynamic scheduling, branch prediction, multi-issue processors); memory hierarchies for superscalar processors; multiprocessors; storage devices; and network technologies. Prerequisites: Cp Eng 213 and Cp Eng 214.

315 Digital Computer Design (LEC 3.0) Organization of modern digital computers; design of processors, memory systems and I/O units, hardware-software tradeoffs in different levels of computer system design. Prerequisites: Cp Eng 213 and Cp Eng 214.

316 Advanced Microcomputer System Design (LEC 3.0) The design of digital systems based on advanced microprocessors. Introduction to microcomputer logic development systems. I/0 interfaces. Assembly and high level language tradeoffs. Hardware and software laboratory projects required. Prerequisite: Cp Eng 313.

317 Fault-Tolerant Digital Systems (LEC 3.0) Design and analysis of fault-tolerant digital systems. Fault models, hardware redundancy, information redundancy, evaluation techniques, system design procedures. Prerequisites: Cp Eng 111 and Cp Eng 112.

318 Digital System Modeling (LEC 3.0) Digital system modeling for simulation, synthesis, and rapid system prototyping. Structural and behavioral models, concurrent and sequential language elements, resolved signals, generics, configuration, test benches, processes and case studies. Prerequisite: Comp Eng 111 with a grade of "C" or better.

319 Digital Network Design (LEC 3.0) Design of computer networks with emphasis on network architecture, protocols and standards, performance considerations, and network technologies. Topics

include: LAN, MAN, WAN, congestion/flow/error control, routing, addressing, broadcasting, multicasting, switching, and internetworking. A modeling tool is used for network design and simulation. Prerequisite: Comp Eng 213 or computer hardware competency.

325 Optical Computing (LEC 3.0) Introduction to the principles, subsystems, and architectures of optical computing. Topics include characteristics of optical devices; optical implementations of memory, logic elements, and processors; and computational structures. Prerequisite: Comp Eng 111 or equivalent. (Co-listed with Elec Eng 325)

325 Optical Computing (LEC 3.0) Introduction to the principles, subsystems, and architectures of optical computing. Topics include characteristics of optical devices; optical implementations of memory, logic elements, and processors; and computational structures. Prerequisite: Comp Eng 111 or equivalent. (Co-listed with Elec Eng 325)

331 Real-Time Systems (LEC 3.0) Introduction to real-time (R-T) systems and R-T kernels, also known as R-T operating systems, with an emphasis on scheduling algorithms. The course also includes specification, analysis, design and validation techniques for R-T systems. Course includes a team project to design an appropriate R-T operating system. Prerequisite: Cp Eng 213 or Cmp Sc 284.

342 Real-Time Digital Signal Processing (LEC 2.0 and LAB 1.0) Introduction to the use of programmable DSP chips. Includes real-time data acquisition, signal generation, interrupt-driven programs, high-level language, and assembly level routines. Applications to real-time systems are also presented. Prerequisites: Comp Eng 213 and Elec Eng 267.

345 Digital Image Processing (LEC 3.0) Fundamentals of human perception, sampling and quantization, image transforms, enhancement, restoration, channel and source coding. Prerequisite: El Eng 267 (Co-listed with El Eng 345)

347 Machine Vision (LEC 3.0) Image information, image filtering, template matching, histogram transformations, edge detection, boundary detection, region growing and pattern recognition. Complementary laboratory exercises are required. Prerequisites: Comp Eng 111 and preceded or accompanied by Elec Eng 267. (Co-listed with Elec Eng 347)

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 Elec Eng 348 and Sys Eng 348.

349 Trustworthy, Survivable Computer Networks (LEC 3.0) This course examines basic issues in network management, testing, and security; it also discusses key encryption, key management, authentication, intrusion detection, malicious attack, and insider threats. Security of electronic mail and electronic commerce systems is also presented. Prerequisite: Cp Eng 319 or Cmp Sc 285.

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 Sci 354, Philos 354 and Math 354)

358 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 Sys Eng 367)

372 Signal Integrity In High-Speed Digital & Mixed Signal Design (LEC 3.0) Signal integrity ensures signals transmitted over a propagation path maintain sufficient fidelity for proper receiver operation. Compromised signal integrity is often associated with parasitics (e.g. unintentional inductance, capacitance). Theory and CAD tools used for signal integrity analysis of functioning designs. Prerequisites: El Eng 271 or Cp Eng 213, and Senior standing. (Co-listed with El Eng 372)

382 Teaching Engineering (LEC 3.0) Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mg 370, Env En 382, El Eng 382, Cv Eng 382)

390 Undergraduate Research (IND 1.0-6.0) Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

391 Computer Engineering Senior Project I (RSD 0.5 and LAB 0.5) A complete design cycle. Working in small teams, students will design, document, analyze, implement, and test a product. Topics include: Iteraton in design, prototyping, group dynamics, design reviews, making effective presentations, concurrent design, designing for test, ethics and standards, testing and evaluation.

Prerequisites: Stat 217, Cp Eng 111, Econom 121 or 122, Sp&M S 85, English 160, Cp Eng 213, 214, and a computer organization elective.

392 Computer Engineering Senior Project II (LAB 3.0) A continuation of Cp Eng 391. Prerequisite: Cp Eng 391.

Computer Science

Bachelor of Science
Master of Science
Doctor of Philosophy

The Computer Science Department educates students in a broad range of areas. Students take courses in the design and implementation of software systems and the algorithms (problem solving techniques) used to solve "real world" problems in business, industry, and engineering or as preparation for graduate study. Students are given both the depth and breadth of computer science so necessary to keep them competitive in today's fast-changing world. While instruction and research are on the leading edge of computing, the Department endeavors to keep class sizes small to facilitate student and faculty interactions.

In addition to computer science courses, the Department's undergraduate program requires students to be educated in a broad range of general education courses. During their senior year, all computer science seniors take the capstone course. This course gives them "real world" experience working in teams composed of fellow students and practicing computer scientists. These teams design, implement, test, and maintain actual software systems. (The sample curriculum shown below provides more detail.)

The Computer Science faculty has a broad range of scholarly interests which include computer security, web databases and wireless systems, intelligent systems (artificial intelligence, machine learning, evolutionary computation), data mining, bioinformatics, parallel and distributed processing, software engineering, computer networks, scientific visualization, computational science, and algorithms. The research being done in these areas involves both undergraduates and graduates and supports the department's three major areas of excellence; software lifecycle, critical infrastructure protection, and bioinformatics. Faculty are not only actively doing research in these areas, they integrate their research experiences into the classroom.

Computer science graduates from UMR work in a variety of environments. Some work for large companies, others prefer smaller companies. Many of our graduates have started their own companies. Regardless of their choice of employment, UMR Computer Science graduates are in high demand as evidenced by the number of companies that specifically recruit our graduates.

The Computer Science Department at UMR makes use of both its own computer learning centers (CLCs) as well as university CLCs. The Department maintains several CLCs including the following instructional laboratories:

- Instructional Workstation Laboratory that provides Unix/Linux workstations,
- Instructional PC Laboratory consisting of PC computing platforms

Research laboratories provide support for both undergraduate and graduate students. These laboratories include:

- McDonnell Douglas Software Engineering Laboratory
- Bioinformatics Laboratory
- Experimental Computation Laboratory
- Data Mining & Knowledge Discovery Laboratory
- Web and Wireless Computing (W2C)
- Natural Computation Lab
- Algorithms & Complexity
- Network Research Lab

Wired and Wireless Network Access is available to all students, faculty and staff.

For further information, visit the Department's web page at http://www.cs.umr.edu or contact us at 573-341-4491 or at: csdept@umr.edu.

Faculty

Professors:
Fikret Ercal (Interim Department Chair), Ph.D., Ohio State
Thomas Weigert (Daniel C. St. Clair Endowed Chair), Ph.D., University of Illinois
Bruce McMillin, Ph.D., Michigan State
Chaman Sabharwal, Ph.D., UIUC
Ralph Wilkerson, Ph.D., SIU-Carbondale
Frank Liu, Ph.D., Texas A & M

Associate Professors:
Sanjay Madria, Ph.D., Indian Institute of Technology

Assistant Professors:
Maggie Cheng, Ph.D., University of Minnesota
Jennifer Leopold, Ph.D., University of Kansas
Daniel Tauritz, Ph.D., Leiden University
Sriram Chellappan, Ph.D., Ohio State University

Teaching Associate:
David M. Mentis, M.S., UMR
Matt Buechler, M.S., UMR

Undergraduate Coordinator/Freshman Advisor & Transfer Advisor:
Clayton Price, M.S., UMR

Emeritus Faculty:
Thomas Baird, M.S., UMR
Billy Gillett, Ph.D., Oklahoma State
Ralph E. Lee, M.A., Indiana
Howard D. Pyron, Ph.D., Iowa State
Kellam Rigler, Ph.D., Pittsburgh
Thomas J. Sager, Ph.D., New Mexico
Frank G. Walters, M.S., UMR
George W. Zobrist, Ph.D., Missouri-Columbia

Adjunct Faculty:
William E. Bond, Ph.D., Rensselaer
Randy Cannis, JD, UMC
Chris Merz, Ph.D., UC Irvine
William Van Stoecker, M.D., UMC

Bachelor of Science
Computer Science

A minimum of 128 credit hours is required for a Bachelor of Science degree in Computer Science and an average of at least two grade points per credit hour must be obtained. These requirements for the B.S. degree are in addition to credit received for algebra, trigonometry, and basic ROTC.

The Computer Science curriculum requires twelve semester hours in humanities, exclusive of foreign language, and must include English 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.

All computer science majors must earn a "C" or better grade in each of the following courses: Cmp Sc 53, Cmp Sc 54, Cmp Sc 153, Cmp Sc 158, and Cmp Sc 253.

All computer science majors must earn a minimum cumulative grade point average of 2.00 for all computer science courses presented to satisfy the required and elective computer science requirements.

All computer science majors must earn a minimum cumulative grade point average of 2.00 for all computer science courses taken at UMR which are presented to satisfy the required and elective graduation requirements.

Sample Course of Study

FRESHMAN YEAR

First Semester	Credit
Cmp Sc 1-Intro to Computer Science	1
Cmp Sc 53-Intro to Programming	3
Cmp Sc 54-Intro to Prog Lab	1
English 20-Exposition & Argumentation	3
Math 8-Calculus with Analytic Geometry I	5
Humanities Elective [5]	3
	16
Second Semester	
Cmp Sc 153-Data Structures I	3
Cmp Sc 158-Discrete Math for Cmp Sc	3
Math 21-Calculus with Analytic Geometry II	5
Laboratory science course(s) [1]	5
	16

SOPHOMORE YEAR

First Semester	Credit
Cmp Sc 253-Data Structures II	3
Math 22-Calculus with Analytic Geometry III	4
Literature Elective [5]	3
Physics Elective [3]	4
Sp&MS 85-Intro to Speech [4]	3
	17
Second Semester	
Cmp Sc 238-File Struct & Intro Database Sys	3
Cmp Eng 111-Intro to Cmp Eng[12]	3
Math 208-Linear Algebra I [7]	3
Physics Elective [3]	4
Stat 215-Engineering Statistics [6]	3
	16

JUNIOR YEAR

First Semester	Credit
History Elective [2]	3
Cmp Sc 284-Intro Operating Systems	3
Cmp Eng 213-Digital Systems Design[12]	3
Social Science Elective [2]	3
Free Elective [8]	3
	15
Second Semester	
Cmp Sc 236-Prog Languages & Translators	3
Social Science Elective [2]	3
Cmp Sc 228-Intro to Numerical Methods	3
English 60-Writing and Research[13]	3
Cmp Sc 206-Software Engineering I	3
	15

SENIOR YEAR

First Semester	Credit
Cmp Sc Electives [9]	6
Eng/Science Electives [10]	6
Humanities/Social Science Elective [11]	3
Cmp Sc 397-Software Systems Development I	3
	18
Second Semester	
Cmp Sc Electives [9]	6
Eng/Science Elective [10]	3
Humanities/Social Science Elective [11]	3
Free Elective [8]	3
	15

1) Any science lecture-laboratory course or course pair totaling at least four hours credit. The laboratory is mandatory in all cases. These course(s) may be selected from: Chem 1, 2 and 4 and 5; Bio Sc 110 and 112; Physics 9, 11 and 10; and Geology 51.
2) Any nine hours that include courses from at least two of the following areas: economics, history, political science, psychology, or sociology. One course must satisfy the Missouri and U.S. Constitution requirement. (see Cmp Sc web page)
3) Physics 23 and 24 or Physics 21-22/27 and Physics 25-26/28.
4) Sp & MS 85 or Sp & MS 283.
5) One literature and one humanities course in any of the humanities.
6) Stat 215 or 343.
7) Math 203 or 208.
8) Courses chosen from any field so that 128 hours are completed. These and only these courses may be taken pass/fail and only one course may be taken pass/fail each semester. Some courses such as algebra, trigonometry and the first two years of ROTC do not count toward the 128 hours.
9) Any twelve hours from computer science courses, at least six hours must be from 300 level. No X7X courses will be accepted.
10) Any nine hours chosen from departments that offer a B.S., (or Basic Engineering), excluding computer science.
11) Any six hours in humanities or social science.
12) Laboratory not required.
13) Or English 160 - Technical Writing.

Computer Science Minor Curriculum

A student with a minor in computer science must meet the following requirements:

A) Cmp Sc 153 and 12 elective hours in computer science beyond Cmp Sc 53, 54, 73 & 77 or 74 & 78.
B) A member of the computer science faculty will serve as the student's minor advisor. The student and his/her minor advisor will plan a course of study to meet the specific interests and needs of the student.
C) Students pursuing a minor in computer science must earn a "C" or better, in Cmp Sc 53, Cmp Sc 54, Cmp Sc 153, Cmp Sc 158, and Cmp Sc 253 if any of these courses are taken for the minor.

Bioinformatics Minor

Students majoring in computer science are eligible to pursue a minor in bioinformatics. See the description of the bioinformatics minor.

Computer Science Courses

1 Introduction To Computer Science (LEC 1.0) This course is devoted to an introduction of various areas of Computer Science, the faculty members, and lab equipment. Computer ethics will be discussed in several lectures.

53 Introduction To Programming (LEC 3.0) Programming design and development using C++. Emphasis placed on problem solving methods using good programming practices and algorithm design and development. Topics included are syntax/semantics, logical, relational and arithmetic operators, decision branching, loops, functions, file I/O, arrays, output formatting, C-strings, and an introduction to Object-Oriented Programming including the development and use of classes. Prerequisite: Accompanied by Cmp Sc 54.

54 Introduction To Programming Laboratory (LAB 1.0) Practical applications of concepts learned in Computer Science 53. Hands-on instruction in C++ developing, debugging, and testing programming projects. Prerequisite: Accompanied by Computer Science 53.

73 Basic Scientific Programming (LEC 2.0) Introduction to the structure of programs and programming techniques in Fortran to solve science and engineering problems. Topics include data representation, basic solutions of numerical problems and the debugging and verification of programs. Prerequisite: Entrance requirements.

74 Introduction To Programming Methodology (LEC 2.0) Basic structured programming and problem solving techniques using C++. Development, debugging, and testing of programs, data representation. Topics to include syntax/semantics, operators, loops, decision branching, arrays, file I/O. This course is a terminal course for nonmajors and is not sufficient for entry into Computer Science 153.

77 Computer Programming Laboratory (LAB 1.0) A laboratory to accompany Cmp Sc 73 which emphasizes the designing, writing and debugging of programs in Fortran. Prerequisite: Accompanied by Cmp Sc 73.

78 Programming Methodology Laboratory (LAB 1.0) A hands-on introduction to structured programming in C++. Development, coding, debugging, and execution of programming concepts discussed in Computer Science 74. Prerequisite: Accompanied by Computer Science 74.

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.

153 Data Structures I (LEC 3.0) A continuation of the development of structured programming concepts and their use in program development. Stacks, queues, linked list, arrays, trees, sorting and searching will be taught together with their use in implementations of a number of algorithms. Prerequisites: Grade of "C" or better in Cmp Sc 53.

158 Discrete Mathematics For Computer Science (LEC 3.0) A rigorous treatment of topics from discrete mathematics which are essential to computer science. Principal topics include: formal logic (propositional & predicate), proof techniques, mathematical induction, program correctness, sets, combinatorics, probability, relations, functions, matrices, graph theory and graph algorithms. Prerequisite: Comp Sci 53 or at least sophomore standing.

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.

202 Cooperative Work Training (IND 1.0-5.0) On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation.

206 Software Engineering I (LEC 3.0) Development of methodologies useful in the software engineering classical life cycle. This includes: requirements, design, implementation, and testing phases. These methodologies are reinforced through utilization of a CASE tool and a group project. Prerequisite: Cmp Sc 253.

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

228 Introduction To Numerical Methods (LEC 3.0) Finite difference interpolation, numerical differentiation and integration, linear systems of equations, solution of nonlinear equations, numerical solution of ordinary differential equations, computational techniques and the programming of a large number of problems on digital computers. Prerequisite: Math 22 and programming competency.

234 Introduction To Computer Organization And Assembly (LEC 3.0) A detailed study designed to teach the building blocks of a computer system, assembly language programming and the basic computer organization concepts. Subjects include

digital logic, performance issues, machine & assembly language, binary arithmetic, and the structure of an ALU. Prerequisites: Cmp Sc 153 and Cmp Sc 158.

235 Computer Organization (LEC 3.0) A detailed study of computer organization concepts and the components of a computer system including control unit, microprogrammming, pipelining, memory hierarchy, cache design, virtual memory, I\O devices, and a brief introduction to parallel processors. Prerequisite: Cmp Sc 234.

236 Programming Languages And Translators (LEC 3.0) Covers basic design of programming languages, compilers and interpreters. The concepts of syntax, variables, expressions, types, scope, functions, procedures, statements, I/O, exception handling and concurrency are introduced. The manner in which various programming languages handle these concepts is discussed. Prerequisite: Cmp Sc 253.

238 File Structures And Introduction To Database Systems (LEC 3.0) Course covers major topics in file structures and database systems including techniques for disk access and organization, record and file structures, index structures, sequential file, dense/sparse and secondary indexes, B-tress; range queries, insertion/detetion, hash tables, fundamentals of database systems, the ER model, relational model, algebra and SQL. Prerequisite: Cmp Sc 153.

253 Data Structures II (LEC 3.0) A continuation of the study of data structures and abstract data types with emphasis on complexity, performance, and correctness. Topics will include tree balancing algorithms, self-balancing trees, networks and graph algorithms, event simulation, and memory management. Prerequisites: Cmp Sc 158 and (Cmp Sc 153 or 274).

284 Introduction To Operating Systems (LEC 3.0) This course teaches the concepts, structure, and mechanisms of Operating Systems. Topics include process management, concurrency, synchronization, deadlock, multithreading, memory management, scheduling, and internetworking. Special emphasis is given to Unix and its modern-day derivatives. Prerequisites: Cmp Sc 153 and Cmp Sc 158 and Cp Eng 213.

285 Computer Network Concepts And Technology (LEC 3.0) This course will introduce computer network concepts and will survey the current and evolving technology for the construction, operation, and management of those networks. Both hardware and software issues will be addressed with a focus on local area networks. Prerequisite: Cmp Sc 284.

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 Multimedia Systems (LEC 3.0) This course introduces the concepts and components of Multimedia information systems. Topics include: Introduction to Multimedia Data, Multimedia Date Compression, Techniques and Standards, Indexing and Retrieval, Data Storage Organization, Communication and Synchronization, Applications-Media-OnDemand Systems, Video Conferencing, Digital Libraries. Prerequisite: Cmp Sc 153.

304 Database Systems (LEC 3.0) This course introduces the advanced database concepts of normalization and functional dependencies, transaction models, concurrency and locking, timestamping, serializability, recovery techniques, and query planning and optimization. Students will participate in programming projects. The course assumes students have an introductory course in database systems. Prerequisites: (Cmp Sc 238 or 274) and Cmp Sc 158.

307 Software Testing And Quality Assurance (LEC 3.0) It covers unit testing, subsystem testing, system testing, object-oriented testing, testing specification, test case management, software quality factors and criteria, software quality requirement analysis and specification, software process improvement, and software total quality management. Prerequisite: Cmp Sc 253.

308 Object-Oriented Analysis And Design (LEC 3.0) This course will explore principles, mechanisms, and methodologies in object-oriented analysis and design. An object-oriented programming language will be used as the vehicle for the exploration. Prerequisite: Cmp Sc 253.

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

311 Bioinformatics (LEC 3.0) The course will familiarize students with the application of computational methods to biology, as viewed from both perspectives. It will introduce problems in molecular, structural, morphological, and biodiversity informatics, and will discuss principles, algorithms, and software to address them. Prerequisites: Bio Sci 110 or 111 and Comp Sci 53/54 or 74/78. (Co-listed with Bio Sci 311)

317 Intellectual Property For Computer Scientists (LEC 3.0) A presentation of the relationship between the law of intellectual property and computer science. Topics include the application of copyright principles to computer programs, protection of computer programs through patents and trade secret law, and the effect of various agreements which are frequently encountered by the computer scientist. Prerequisite: Senior or graduate standing.

319 Security Operations & Program Management (LEC 3.0) An overview of information security operations, access control, risk management, systems and application life cycle management, physical security, business continuity planning, telecommunications security, disaster recovery, software piracy, investigations, ethics and more.

There will be extensive reporting, planning and policy writing. Prerequisite: Writing emphasized course AND Operating System course AND Computer Networking course.

328 Object-Oriented Numerical Modeling I (LEC 3.0) A study of object-oriented modeling of the scientific domain. Techniques and methodologies will be developed enabling the student to build a class library of reusable software appropriate for scientific application. Applications will be drawn from mechanics, finance, and engineering. Prerequisites: Comp Sci 228 and Comp Sci 153 and one of Math 208, 203, 229.

329 Object-Oriented Numerical Modeling II (LEC 3.0) A continued study of object-oriented modeling of the scientific domain. Advanced applications include models posed as balance laws, integral equations, and stochastic simulations. Prerequisite: Cmp Sc 328.

330 Automata Theory (LEC 3.0) Description of the extended Chomsky hierarchy and the relation of Chomsky language classes to grammars automata. Use of languages, grammars and automata in the compilation of programming languages. Introduction to decidability. Prerequisite: Cmp Sc 158.

332 Modular Software Systems (LEC 3.0) Introduction to Software Life Cycle pertaining to characteristics of large modular software systems. Exploration of software support for such systems, using Java, including use of GUI features, advanced I/O and String handling, Interfaces, Abstract classes, Generics and other modularity features. Program project included. Prerequisite: Comp Sci 253 or IST 231. (Co-listed with IST 353)

333 The Structure Of A Compiler (LEC 3.0) Review of Backus normal form language descriptors and basic parsing concepts. Polish and matrix notation as intermediate forms, and target code representation. Introduction to the basic building blocks of a compiler: syntax scanning, expression translation, symbol table manipulation, code generation, local optimization, and storage allocation. Prerequisites: Cmp Sc 236 or 274 and Cmp Sc 253 (or graduate standing).

342 Java Gui & Visualization (LEC 3.0) Fundamentals of Java Swing Foundation Classes, Java System Language Specifics, Graphical User Interfaces, Images, Audio, Animation, Networking, and Threading. Visualization of Algorithms. GUI Elements include Event Driven Programming, Interaction with Mouse and KeyBoard, Window Managers, Frames, Panels, Dialog Boxes, Borders. Prerequisite: Cmp Sc 253 or equivalent.

343 Interactive Computer Graphics (LEC 3.0) Applications and functional capabilities of current computer graphics systems. Interactive graphics programming including windowing, clipping, segmentation, mathematical modeling, two and three dimensional transformations, data structures, perspective views, antialiasing and software design. Prerequisites: Cmp Sc 228 and 253.

345 Introduction To Robotic Systems (LEC 3.0) Analysis of methods of the design and operation of robotic systems. Identification of three-dimensional objects using digitized images. Arm control: coordinate transformations, feedback control systems, and hardware components. Applications of distributed micro-computers to robotic control. command languages and job assignments. Prerequisites: Math 22, Physics 24, (Cmp Sc 158 or Cmp Sc 228).

347 Introduction To Artificial Intelligence (LEC 3.0) A modern introduction to AI, covering important topics of current interest such as search algorithms, heuristics, game trees, knowledge representation, reasoning, computational intelligence, and machine learning. Students will implement course concepts covering selected AI topics. Prerequisite: Cmp Sc 253.

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 and/or Computer Science. Prerequisite: Philos 15 with junior standing or Math 305 or Comp Sci 253. (Co-listed with Math 354 and Philos 354)

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, Philos 354 and Math 354)

355 Analysis Of Algorithms (LEC 3.0) The purpose of this course is to teach the techniques needed to analyze algorithms. The focus of the presentation is on the practical application of these techniques to such as sorting, backtracking, and graph algorithms. Prerequisite: Cmp Sc 253.

366 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 Stat 346)

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 229 or Math 204 or equivalent. (Co-listed with Sys Eng 378, El Eng 368)

381 The Structure Of Operating Systems (LEC 3.0) The hardware and software requirements for operating systems for uniprogramming, multiprogramming, multiprocessing, time sharing, real time and virtual systems. The concepts of supervisors, interrupt handlers, input/output control systems, and memory mapping are discussed in detail. Prerequisite: Cmp Sc 284.

384 Distributed Operating Systems (LEC 3.0) This is a study of modern operating systems, particularly distributed operating systems. Topics include a review of network systems and interprocess communication, causality, distributed state maintenance, failure detection, reconfiguration and recovery, load balancing, distributed file systems, distributed mutual exclusion, and stable property detection including deadlock detection. A group project in Distributed Systems programming will be required. Prerequisites: Cmp Sc 284 and 253.

385 Computer Communications And Networks (LEC 3.0) Network architecture model including physical protocols for data transmission and error detection/correction, data link concepts, LAN protocols, internetworking, reliable end to end service, security, and application services. Students will implement course concepts on an actual computer network. Prerequisites: Cmp Sc 284 and Cmp Sc 158.

387 Parallel Programming with MPI (LEC 3.0) Parallel computer architectures, network topologies, parallel algorithms, pipelining, message passing, process scheduling and synchronization. Parallel programming with MPI on workstation clusters. Multithreaded programming. Speedup and efficiency issues. Prerequisites: Cmp Sc 284 and Cmp Sc 253.

390 Undergraduate Research (IND 0.0-6.0) Designed for the undergraduate student who wishes to engage in research. Does not lead to the preparation of a thesis. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the faculty supervisor.

397 Software Systems Development I (LEC 3.0) Class members will work in small teams to develop a complete software system beginning with end-user interviews and concluding with end-user training. Prerequisites: Comp Sci 306 and 100 credit hours completed.

398 Software Systems Development II (LEC 3.0) This course is an optional continuation of Cmp Sc 397. Those interested in project management should take this course since participants become officers or group leaders in the class "corporation." This course is especially important for those going straight into industry upon graduation. Students with coop experience may find this course redundant. Prerequisite: Cmp Sc 397.

Economics

Bachelor of Arts in Economics
Bachelor of Science in Economics
Master of Arts in Economics

Master of Arts available as a cooperative degree program with the Economics Department of the University of Missouri-St. Louis. A maximum of 12 graduate semester hours may be taken at UMR.

Economics has been called the “science of scarcity.” It is the study of how individuals allocate scarce resources for production in order to satisfy their human needs and wants. This focus on the human condition places economics firmly into the social sciences area. However the application of economic principles to problems of choice in markets and in financial decision-making also gives economics a central role in the theory of business administration and management.

The UMR Economics Department offers a relevant business-oriented educational experience while maintaining the social science flavor of the traditional economics degree. The curriculum is based on a broad foundational core, Business Administration and Information Science and Technology. Students majoring in economics also take up to 33 hours of economics, finance, and management courses.

The Economics courses are taught rigorously and are technically-oriented. They also provide a solid social science education with studies of the social problems of market failure, monopoly, inflation, and the effectiveness of government economic and social policy. The department also offers a menu of finance courses for those students interested in an economics degree with a finance emphasis. Graduated students have an excellent education with job opportunities across the spectrum from business, finance, study of the law, government and public policy.

The economics program allows for the flexibility of selecting either the Bachelor of Arts or Bachelor of Science programs, depending on which best fits your goals and skills. Either degree will provide you with the necessary skills to compete effectively in the job market or succeed in graduate school.

Students wishing to minor in economics may select from a variety of courses tailored to their own needs. Specific tracks are available in energy/technology, international, financial, business economics, and accounting and finance.

Students majoring in an academic area at UMR other than economics can pursue a secondary B.A. or B.S. in economics to accompany their primary major. See the department chair of economics for more details on this academic option.

The UMR Economics Department has in place a cooperative Bachelor of Science/Master of Science in Accounting with the College of Business and Public Administration at the University of Missouri-Columbia. A student can take at UMR up to 90 hours of the 150 hours required for the BS/MS in accounting. The remaining 60 hours must be taken at Columbia. After completing the

90 hours at UMR the student must take the GRE exam and be admitted into the UMC graduate program.

Faculty

Professors:

Gregory Gelles (Chair), Ph.D., University of West Virginia

David Hentzel (Emeritus), Ph.D., Southern Illinois

Walter D. Johnson (Emeritus), Ph.D.,University of Oklahoma

Associate Professors:

Richard Bryant, Ph.D., University of California, Davis

Eun Soo Park, Ph.D., Northwestern University

Assistant Professors:

Michael Davis, Ph.D.,University of California, San Diego

Julie Gallaway, Ph.D., Colorado State University

Xuejing Xing, Ph.D., University of Missouri-Columbia

Duo Zhang, Ph.D., West Virginia University

Bachelor of Arts Economics

In addition to the general university requirements for a Bachelor of Arts degree, a student must complete:

1) Economics 121, 122, 221 and 222 with a minimum grade of “C” in each.

2) At least 18 additional hours of economics electives, above the 200 level, with a minimum grade of “C” in each.

3) Engineering Management 130 and 131; and Statistics 115; or Economics 111; and Economics 211.

Bachelor of Arts Economics (Preparation for Teacher Certification)

The student will fulfill the general requirements for the bachelor of arts degree, *except for foreign language;* the requirement for the Economics major *(teacher certification)*; and the requirements for Missouri certification in the teaching of Social Studies. See Economics. Contact the Economics Department for advising. Requirements for Teacher Certification as an Economics major are as follows:

1. Prerequisites for the Economics major are Econ 121, 122, 221, 222 with a minimum grade of “C” in each.

2. Econ 111 and 211 with a minimum grade of “C” in each. In addition, twelve hours of electives in economics with a minimum grade of “C”. Stat 115 or 211 can substitute for Econ 111.

3. Eng Mg 130 and 131. Eng Mg 230 can substitute for Eng Mg 130 and 131.

4. Thirty-seven hours of general education requirements to include English 20 and 60 and Speech 85; six hours of humanities and fine arts; twelve hours of social science to include History 175 or 176, Political Science 90, Psychology 50, and Geography; seven hours of natural science to include Physics or Geology and Biology 110 with one lab and three hours of mathematics to include Math 2 or 4 or higher.

Areas of Concentration

Students are encouraged to use their electives, both in economics and in general, to develop areas of concentration beyond the core requirements. Among the possibilities are business, finance, and international affairs. Faculty advisors will assist students in establishing these curricular tracks.

Bachelor of Science Economics

In Economics, the Bachelor of Science degrees consist of 120 credit hours. First, all undergraduate students in Economics are required to complete a prescribed General Education Requirements Core that corresponds to the recommendations of the Missouri State Coordinating Board for Higher Education and consists of 42 credit hours in the areas of Individual Expression, Natural Systems, and Human Institutions. In addition, all undergraduate students are required to complete a 39 credit hour core consisting of courses in Information Technology, Management, Quantitative Skills, and Communication Skills. A minimum grade of "C" is required for courses in both the Information Technology and the Management areas. Finally, each degree includes 12 credit hours of free electives.

The remaining 27 credit hours of the required 120 credit hours for the Economics degree are divided into a prescribed 18 credit hour degree core and 9 credit hours of specific degree electives. A minimum grade of "C" is required in these courses. The Business and Management Systems Degree requires courses in Marketing, Finance, Operations, Managerial Accounting, Strategic Management, and Statistics. The electives for this degree are then chosen from the two emphasis areas of Business Administration or Management Information Systems. The Economics Degree requires courses in advanced Micro, Macro and Statistics. The electives for this degree consist of courses from areas such as Law and Economics, Money and Banking, Energy Economics and E-Commerce. The Information Science and Technology Degree requires courses in Database Management, Systems Analysis, Internet Concepts, Computer Operations, Networks and Communications, and E-Commerce. The electives for this degree consist of advanced coursework in the areas introduced by the required courses.

FRESHMAN YEAR

First Semester	Credit
SMIS 10 Freshman Introduction[1]	1
English 20-Exposition & Argumentation[1]	3
Math 4 College Algebra	3
Biology 110, 231, 235, or 251	3
IST 51 Visual Basic	3
Lab w/Living or Physical Science Course	1
	14
Second Semester	
SMIS 11 Freshman Introduction	1
Psych 50 General Psychology	3
Survey of Calculus	3
History	3
IST 151 Java	3

Economics 121 or 122 3
16

SOPHOMORE YEAR

First Semester Credit
BUS 110 Mgt & Org. Behavior 3
Speech 85 Princ of Speech 3
Stat 211 Stat Tools for Decision Making 3
IST 141 Info Systems 3
English 75, 80, 102, 105, 106, 177, or 178 lit 3
15

Second Semester
BUS 120 Essentials of Accounting 3
Econ 121 or 122 3
Chemistry, Geol, Ge Eng, or Physics 3
Art 80, 85; Music 50; Theatre 90 3
IST 286 Web Design 3
15

JUNIOR YEAR

First Semester Credit
English 65 3
BUS 230 Business Law 3
Econ 221 Interm Micro 3
Econ 222 Interm Macro 3
Econ 211 Intro To Econ Stat 3
15

Second Semester

Speech 181 Communication Theory 3
Political Science 90 American Government 3
Emphasis Area Electives[2] 9
15

SENIOR YEAR

First Semester Credit
English 260 3
Culture, Sociology, Religion[3] 3
Emphasis Areas Electives[2] 9
15

Second Semester
SMIS 397 Capstone[1] 3
Free Electives 12
15

Economics students must earn the grade of "C" or better in all Economics and Finance courses to receive credit toward graduation.

[1]In-Major Writing Intensive
[2]Electives 18 hours of which 12 hours must be Economics to be selected from Econ, 223, Econ 230 or any 300 level Econ Lecture courses and accumulate 6 hours from the following Psych 212, Psych 372, Psych 374 or any 300 level Business Lecture courses.
[3]Economics 220; English 215, 230, 281, 345, 350; Foreign Language Beyond Second Semester; History 340, 355; Philosophy 25, 35, 75, 212, 340, 355; Any Political Science; Psychology 270, 380; Any Sociology; Speech 235

Minor in Economics

Students majoring in other disciplines are encouraged to develop a minor in economics. The formal minor in economics is designed to provide students with a solid understanding of economic principles and concepts and the ability to apply this knowledge to a host of economic, public policy and business problems. This program will be of particular benefit to those students whose major field of study may lead them to pursue a management position or later graduate studies in business.

The minor in economics requires the completion of a minimum of 15 hours of economics course work with a grade of "C" or better. Required courses in the minor program include both Economics 121 and 122 and at least one of the intermediate theory courses, Economics 221 and/or Economics 222. The choice of which intermediate theory course depends on which 300 level economic electives the student, in consultation with the department's minor advisor, selects for their program.

Energy/Technology Minor

(15 hours)

Required courses:
- Econ 121-Principles of Microeconomics
- Econ 122-principles of Macroeconomics
- Econ 221-Intermediate Microeconomics Theory

And 6 hours from:
- Econ 311-Econometrics
- Econ 335-Cost Benefit Analysis
- Econ 340-Environmental & Natural Resource Economics
- Econ 345-Energy Economics

International Economics Minor

(15 hours)

Required courses:
- Econ 121-Principles of Microeconomics
- Econ 122-Principles of Macroeconomics
- Econ 222-Intermediate Macroeconomics Theory

And 6 hours from:
- Econ 322-International Trade
- Econ 351-Economic Development
- Econ 360-Comparative Economic Systems

Financial Economics Minor

(15 hours)

Required courses:
- Econ 121-Principles of Microeconomics
- Econ 122-Principles of Macroeconomics
- Econ 221-Intermediate Microeconomic Theory
- Or Econ 222- intermediate Macroeconomic Theory

And 6 hours from:
- Econ 320-Money and Banking
- Econ 321-Finance
- Econ 322-International Trade

Business Economics Minor

(15 hours)

Required courses:
- Econ 121-Principles of Microeconomics
- Econ 122-Principles of Macroeconomics
- Econ 221-Intermediate Microeconomics Theory

And 6 hours from:
- Econ 321-Finance
- Econ 330-Public Finance
- Econ 335-Cost Benefit Analysis
- Econ 375-Labor Economics

Accounting and Finance Minor
(18 hours)

The Accounting and Finance Minor is an interdisciplinary course of study incorporating knowledge from Statistics, Engineering Management and Economics. Students pursuing this minor will be exposed to the interrelationships among statistics, accounting, economics, and finance, and will be introduced to a practical understanding of a number of accounting and business-related topics.

Required courses:

- Econ 211-Intro to Economics Statistics
- Or Stat 213-Stat Methodology in Eng or Stat 215-Eng Stat
- Or Stat 344-Mathematical Stat
- Econ 121-Principles of Microeconomics
- Econ 221-Intermediate Microeconomics
- Eng Mg 230-Managerial Accounting or
- Eng Mg 322-Accounting for Eng Mg

And 6 hours from:

- Eng Mg 252-Financial Management
- Econ 321-Finance
- Econ 323-International Finance
- Econ 330-Public Finance
- Eng Mg 332-Eng Cost Accounting

Economics Courses

100 Special Problems (IND 1.0-6.0) Problems or readings on specific subjects or projects in the department. Prerequisite: 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.

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 Stat 111)

121 Principles Of Microeconomics (LEC 3.0) An examination of how resources and products are priced and how income is distributed within various types of market structures.

122 Principles Of Macroeconomics (LEC 3.0) A study of alternative strategies for managing the U.S. economy within a global environment, to attain the goals of full employment, stability and growth.

200 Special Problems (IND 1.0-6.0) Problems or readings on specific subjects or projects in the department. Prerequisite: 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.

211 Introduction To Economic Statistics (LEC 2.0 and LAB 1.0) Introduction of econometric techniques for the analysis of economic data. Topics will include collection, manipulation, and presentation of economic and business data, linear, economic models, testing economic hypotheses, and forecasting. Application of all techniques using economic data and statistics software. Prerequisites: Econ 121 or 122, and Math 4 or higher and Stat 115 or Stat 211.

220 History Of Economic Thought (LEC 3.0) Contributions of the classical and modern economists to the development of economic thought. Course aims at establishing a synthesis of evolving doctrines which have become the basis of currently accepted economic theory. Prerequisites: Econ 121 and 122.

221 Intermediate Microeconomic Theory (LEC 3.0) Analysis of demand and supply in various market environments using the theories of production, resource pricing, and distribution of income. Emphasis on efficiency attainment and the rationale for market intervention. Prerequisites: Econ 121 and 122.

222 Intermediate Macroeconomic Theory (LEC 3.0) Examines the theoretical framework of national income and product generation, and the use of this theory to construct approaches such as, monetary and fiscal policy to attain economic, political and social goals. Prerequisites: Econ 121 and 122.

223 Managerial Economics (LEC 3.0) Business students who become managers of business enterprises should understand how market economic forces create opportunities for making profit. Business students need to be trained in managerial applications of microeconomic theory. Managerial Economics brings together those topics in micro theory that can be applied to business decision making. Prerequisites: Econ 121 & 122.

230 Law And Economics (LEC 3.0) Study of application of economics analysis to legal concepts, issues and reasoning. Emphasizes the use of microeconomic theory to examine questions of efficacy and efficiency of decisions emanating from three major areas of common law -property rights, contracts and torts. Prerequisite: Econom 121 or equivalent.

260 Introduction to Sports Economics (LEC 3.0) The course uses economics to analyze the business of sports. The course is designed for students with both an introductory or broader economics background, but who have not studied the economics of sports. Topics include labor relations, stadium financing, league structure, competitive balance, amateurism, sports gambling and in-game strategy. Prerequisite: Econ 121 or Econ 122.

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 Internship (IND 0.0-6.0) Internship will involve students applying critical thinking skills and discipline-specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisite: Senior status; must have completed 24 hours in major.

311 Econometrics (LEC 3.0) Applied statistical analysis of economic phenomena, including identification, least squares bias, and autocorrelation with emphasis on recent estimation procedures. Prerequisites: Stat 115 & 116, Econ 221 and 222.

315 Mathematical Economics (LEC 3.0) Marginal analysis, calculus, and linear algebraic systems are applied in selected advanced topics in economics such as price theory, general equilibrium theory, input-output analysis, activity analysis, and game theory. Prerequisite: Econ 221, 222, and Math 8.

320 Money And Banking (LEC 3.0) Study of the origin, principles, and functions of money, emphasizing the role of banks in the effectuation of monetary policies geared to achieve various economic and political goals. Prerequisite: Econ 222.

322 International Trade (LEC 3.0) Analysis of gains from trade; the effects of factor mobility; effects of trade restrictions on trade flow and income distribution; arguments for restricting trade; and effects of trade on economic development, employment and human capital development. Prerequisite: Econ 221.

323 International Finance (LEC 3.0) Examination of the international monetary system, the Balance of Payments, the foreign exchange market, futures and options markets; foreign exchange and other risk management for firms, financing from a global perspective and direct foreign investment. Prerequisite: Econ 222.

330 Public Finance (LEC 3.0) Study of government expenditures and sources of revenue. Particular emphasis is given to governmental decision making--how these decisions affect the economy and the behavior of individuals, firms, and families within the economy; and how these decisions may be evaluated. Prerequisite: Econ 221.

335 Cost-Benefit Analysis (LEC 3.0) Investigates the rationale for cost-benefit analysis within a free enterprise setting. Discussion of market efficiency and failure; determination of social costs and benefits; applications of cost-benefit analysis; and, problems remaining in theory and practice. Prerequisite: Econ 221.

340 Environmental And Natural Resource Economics (LEC 3.0) Optimum use of replenishable and non-replenishable resources, public goods and common resources, externalities, private vs. public costs, and quality of the environment; emphasis on public policy related to environmental and natural resource economics. Prerequisite: Econ 221.

345 Energy Economics (LEC 3.0) Market structure. World resource development. Supply and demand analysis on energy production and consumption within domestic and global settings. Prerequisite: Econ 221.

351 Economic Development (LEC 3.0) Theoretical analysis of the problem of economic development of the "poor" countries, where two-thirds of the world's population lives. Treatment of basic problem areas leading to a synthesis of theoretical approaches for the achievement of development. Prerequisite: Econ 221 or 222.

357 Network Economy (LEC 3.0) The course takes a look at the emerging Network/Internet economy, using traditional economic tools. Topics include production and reproduction cost of information, information as an "experience good," creation of different version of products, switching cost and lock-in affects, market adoption of dynamics, first-mover advantage, and intellectual property rights. Prerequisite: Econom 221. (Co-listed with IST 357)

375 Labor Economics (LEC 3.0) Labor as a factor of production, collective bargaining, trade unionism, labor legislation, from the viewpoint of public policy. Prerequisite: Econ 221 or Econ 222.

389 Problems In Economic Policy (LEC 3.0) Advanced course designed for students majoring within the department. Appraisal and analysis of major problems of economic policy. Research and reports. Topics covered vary from year to year. Offered jointly by members of the department. Prerequisite: Seniors with 24 or more hours in Econ.

Education

If you are interested in teaching you may enter the Teacher Education Program. The purpose of the program is to satisfy the continuing need for well-qualified teachers in Missouri public schools.

You may earn a B.A. or B.S. Degree in your chosen field from UMR and a certificate to teach in the schools of Missouri. The program may be completed in four academic years, although you may wish to carry lighter course loads during the regular academic semesters. Student teaching is arranged with area public schools.

Secondary certification (grades 9-12) may be earned in the following majors: chemistry, physics or biological sciences in the science area; history, economics, or psychology in the social studies area; English in the language arts area; and mathematics in the mathematics area.

If you are enrolled in Geological Sciences and Engineering; Materials Science and Engineering; Mining and Nuclear Engineering; Electrical & Computer Engineering; Civil, Architectural & Environmental Engineering; Chemical & Biological Engineering; Engineering Management and Systems Engineering; Interdisciplinary

Engineering; Mechanical and Aerospace Engineering, you also have the opportunity to earn certification in mathematics or science through the Teacher Education Program. You should consult the coordinator of the Teacher Education Program early in your academic career in order to plan curricula that will satisfy all requirements.

For updated information contact the coordinator of UMR Teacher Education Program and look on the homepage: http://www.umr.edu/~tchreduc

Secondary Teacher Education Program

University of Missouri-Rolla is approved by the Missouri State Board of Education to offer professional education programs for purposes of professional certification. **Admission to the University does not automatically qualify a student to participate in the professional component of the teacher education program**. That participation is granted upon demonstration of a high level of academic and professional competence.

1) Requirements for Professional Standing in the Teacher Education Program. Students who plan to complete teacher certification requirements must be admitted to the Teacher Education Program. The criteria used to determine admission to the Teacher Education Program are outlined below. In addition to having completed at least 60 semester hours of university course work, the student must:

- **A)** have a combined (UMR and/or Transfer) GPA of 2.50 or above.
- **B)** have a valid ACT score of 22 or above on file in the education office or a comparable score on the SAT.
- **C)** have passed all sections of the Missouri State Board of Education Entry Examination with a minimum CBASE score of 265 on each section.
- **D)** have attained a minimum grade of “C” or higher in Speech 85, English 20 and 60, and in a math course in college algebra or in a higher level math course.
- **E)** have completed Educ 40 and 174 with a grade of “C” or higher.
- **F)** have obtained a satisfactory background check from the Missouri Highway Patrol and the Division of Family Services.
- **G)** have successfully completed a professional interview.

When all of the requirements listed above have been completed, a student’s application to the Teacher Education Program will be considered.

2) Requirements for Assignment to Student Teaching. Successful completion of student teaching is a requirement for teacher certification. The criteria used to determine eligibility for student teaching are outlined below. The student must:

- **A)** have been admitted to the Teacher Education Program.
- **B)** have obtained a satisfactory background check from the Missouri Highway Patrol and the Division of Family Services.
- **C)** have a combined GPA of 2.50 or above for all college level course work completed.
- **D)** have a combined GPA of 2.50 or above and have a “C” in all professional courses.
- **E)** have a combined GPA of 2.50 or above in major and no grade lower than a "C"
- **F)** have completed at least 15 hours at UMR with a GPA of 2.50 before making an application to do Student Teaching
- **G)** have been recommended by the Coordinator of the Teacher Education Program
- **H)** have passed the PRAXIS exam(s) according to the Missouri Board of Education requirements in the area(s) in which he/she is going to student teach - *A student must complete at least eight weeks of student teaching in his/her content area
- **I)** have evidence of a working portfolio that is aligned with MO-Step indicators approved by DESE and approved by the education faculty

3) Requirements for Certification Recommendation. To be recommended for an initial Missouri teaching certification the student must have:

- **A)** Successfully completed Student Teaching.
- **B)** have a completed application for Missouri State Certification
- **C)** have met all Missouri teacher certification requirements which are in effect at the time of certification
- **D)** have a cumulative combined (both UMR and transfer) GPA of 2.50 or higher
- **E)** have completed all professional education courses for secondary education with a GPA of 2.50 or higher (UMR and transfer combined) and no grade lower than a "C." These professional education courses include the following:

Edu 40 Perspectives in Education
Edu 174 School Organization and Administration for Elementary and Secondary Education
Edu 216 Teaching Reading in the Content Area
Edu 251 Historical Foundations in American Education
Edu 280 Teaching Methods and Skills In the Content Areas
Edu 104 Teacher Field Experience
Edu 164 Aiding Elementary, Middle and Secondary Schools
Edu 298 Student Teacher Seminar
Edu 299 Student Teaching
Psych 155(Edu 102) Educational Psychology
Psych 208 Psychological and Educational Development Of The Adolescent
Psych 354(Edu 354) Psychology Of The Exceptional Child

- **F)** have a grade point average of 2.5 or higher (UMR and transfer) combined in the certificate subject area of endorsement and no grade lower than a "C"

G) have a completed pre-service portfolio with all current MO STEP indicators met. The portfolio must be approved by the education faculty and the discipline area advisor
H) have completed a FBI fingerprinting for certification during student teaching

General Education Requirements

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

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

Symbolic Thought and Communications

1) **Linguistic Studies** (9 semester hours) You are required to take two courses in written communication and one course in oral communication. (You must have a grade of "C" or better in each course.)
2) **Mathematical Studies** (3 semester hours) The course must be college algebra or above.

Systems of Intellectual Inquiry

1) **Humanities** At least one course each from two of the following areas required: art, music, philosophy, literature and theater.
2) **Natural Science** One course in biological sciences and one in physical science is required. One of these two courses must include a laboratory.
3) **Social and Behavioral Science** One course in each of the following areas is required: (1) American History, (2) American Government, and (3) General Psychology.

Secondary Education Certification

In addition to the prescribed general educational courses, if you are preparing to become a secondary school teacher you must complete the following secondary professional education courses and the required courses of at least one teaching major.

You may major in English with English Certification 9-12); Economics, History or Psychology with Social Sciences Certification (9-12); Mathematics with Mathematics Certification (9-12); Biological Sciences, Chemistry or Physics with Certification (9-12).

You must meet UMR degree requirements and, in addition, course requirements for certification. (Those having a degree prior to certification must check with the education office for clarification of requirement procedures.)

The necessary course requirements and arrangements will be coordinated through the education office. Please pick up a sheet from the education office for your discipline area or print from umr.edu/~tchreduc

Elementary Education Endorsement

A student may have a second area of certification which is called an endorsement. The student must take the Praxis II in Elementary Education for certification. Elementary classes are offered each semester, and it is suggested, but not required, that anyone interested in teaching at the elementary level take them. If there are further questions, contact: Dr. Evalee Lasater, lasater@umr.edu, 573-341-4692.

Middle School Endorsement

A student may have a second area of certification which is called an endorsement. Any student planning to obtain a middle school endorsement while completing a secondary certification should consider takeing these courses: Education 305, 335, 215 and 221 and English 311. The student must take the Praxis II Middle School Education or PLT exam for certification. If there are further questions, contact: Dr. Evalee Lasater, lasater@umr.edu, 573-341-4692.

Missouri State Board of Education Approved Programs

The following professional education programs have been approved by the Missouri State Board of Education for the purpose of teacher preparation and certification. The approval date for the University of Missouri-Rolla is December 1998 through 2010. In the following areas:

- Elementary Education 1-6
- Secondary Education:
  English 9-12
  Mathematics 9-12
  Social Science 9-12
  Biology, Chemistry, Physics 9-12

Note: If changes occur at the State level, then the state's education requirements will supercede those in the catalog and DO NOT fall under the grandfather clause.

Title II Report 2004-2005

The federal government this year required we report our Title II results for the 2004-2005 year. The report was submitted in April 2006. The University of Missouri-Rolla has a 100% passing rate on the PRAXIS for our completers. The state percent was 96%. A completer is one who has fulfilled all an institutions guidelines to be recommended to the state for his/her teaching certificate. We have 100% of the completers teaching with 92% teaching in Missouri.

Education Courses

40 Perspectives In Education (LEC 2.0) This course is an introduction course which will assist students planning to enter the teacher-education program in assessing their personal and profes-

sional characteristics required for the teaching profession. It is an overview of the teacher education profession for elementary, middle and secondary.

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.

102 Educational Psychology (LEC 3.0) Principles of psychology relevant to the field of education. Concepts of human growth and development; the learning process, with special emphasis on abilities and teaching-learning processes; measurement and evaluation of school learning; mental health in the classroom. Observation of children will be included. Prerequisite: Psych 50. (Co-listed with Psych 155)

104 Teacher Field Experience (LAB 2.0) Observation and analysis of instructional techniques and duties in the classroom and school environment by discipline. Student will spend at least 30 contact hours per credit hours in classroom. In addition, library and field experience reports will be made. In addition, Action Research and Seminars will be required. Prerequisite: Educ 40.

164 Aiding Elementary, Middle And Secondary Schools (LAB 2.0) Instructionally-related clinical/administrative and monitorial duties in the classroom during semesters and summer. Student works 30 hours for each credit, with instructor supervising. Also, Action Research and Seminars are required. Prerequisites: Educ 40 and 104.

174 School Organization & Adm For Elementary & Secondary Teachers (LEC 2.0) Required for certification of elementary and secondary teachers. Course content relates to methods of organization and management in the elementary and secondary schools. Prerequisites: Educ 40 and 104.

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.

202 Problems Of Teaching Social Studies (LEC 2.0) A study of current methodologies for teaching in area of specialization.

203 Problems Of Teaching Mathematics (LEC 2.0) A study of current methodologies for teaching in area of specialization.

205 Problems Of Teaching Science/Chemistry (LEC 2.0) A study of current methodologies for teaching in area of specialization.

206 Problems Of Teaching Science/Physics (LEC 2.0) A study of current methodologies for teaching in area of specialization.

207 Problems Of Teaching English (LEC 2.0) A study of current methodologies for teaching in area of specialization.

208 Psychological & Educational Development Of The Adolescent (LEC 3.0) A theoretical and empirical examination of the psychological and educational development of the adolescent.

211 Child Psychology (LEC 3.0) The psychological, intellectual, social, and physical development of children with emphasis on the cognitive and affective processes. The theory, research and application will be studied. Prerequisite: Educ 40 or Psych 50.

212 Children'S Literature (LEC 3.0) Introduction to the study and teaching of children's literature. Emphasis on historical developments, multi-cultural issues and works. Computer intensive. Prerequisites: English 20 and one semester of college literature. (Co-listed with English 212)

215 Teaching Of Reading In Elementary And Middle School (LEC 3.0) Current materials, methods and teaching techniques in teaching reading in elementary and middle school grades. Emphasis on assessing elementary and middle students needs, individualizing programs based on needs, reading in the content areas, study skills and recreational reading as a lifetime habit. Prerequisite: Educ 40.

216 Teaching Reading In Content Area (LEC 3.0) For elementary, middle and secondary school teachers. Specific ways teachers can help students improve reading skills in content areas and ways reading can be taught in reading classes.

217 Analysis And Correction Of Reading Difficulties (LEC 3.0) Procedures for diagnosing and correcting reading problems within the classroom. Acquaint preservice teachers preparing for elementary with commercial prepared informal diagnostic instruments, attitude and interest inventories, prescriptive measures, anecdotal records and strategies for corrective reading instruction within the regular classroom for elementary children. Prerequisite: Educ 215.

218 Language Arts For Elementary Teachers (LEC 3.0) Procedures used in teaching integrated language arts in elementary grades. The strategies would be the development of written and oral communication for use in elementary grades. Prerequisite: Educ 40.

219 Art For Elementary Teachers (LEC 3.0) Considers the vital role of art activities and creative experiences in the growth and development of children at their level. Prerequisite: Educ 40. (Co-listed with Art 219)

221 Teaching Math In Elementary And Middle Schools (LEC 3.0) The course presents an overview of how children learn mathematics, various techniques in teaching mathematics, and examples of applying these techniques to specific mathematical concepts (such as geometry, measurement, basic operations, statistics and probability, etc.). Prerequisite: Educ 40 or Math 2 or 4. (Co-listed with Math 221)

222 Geometric Concepts For Elementary Teachers (LEC 3.0) The course covers methods of teaching the study of points, lines, polygons, sim-

ilarity, congruence, constructions, and proof in Euclidean Plane Geometry. Transformational geometry and trigonometry are introduced to elementary teachers. Prerequisite: Educ 40 or Math 2 or 4. (Co-listed with Math 222)

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 Phy Ed 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 Phy Ed 231)

251 Historical Foundation Of American Education (LEC 3.0) Development of American educational institutions and ideas, and of social forces that have influenced them. Prerequisites: Educ 40 and Hist 175 or 176.

280 Teaching Methods And Skills In The Content Areas (LEC 6.0) Series of weekly experiences, demonstrations, observations, micro teaching, small group discussions to develop concepts of and skills in a variety of basic teaching tasks. Also, demonstration and lecture exercises in the preparation and use of audio visual materials for teaching. Prerequisites: Educ 40 and 104.

298 Student Teaching Seminar (LEC 1.0) Weekly seminars will be required for all students enrolled in student teaching. Contemporary educational topics, trends, reflective decision making and other pertinent topics will be covered. Reflection of topics and experiences will be exhibited in papers, portfolios and journal writings. Prerequisites: Meet all requirements for student teaching and concurrently be enrolled in student teaching.

299 Student Teaching (LEC 12.0) Student teaching will be supervised participation, on the level of certification in an assigned Public School. Student teaching is based on 16 weeks (8 weeks in two schools and requires the student teacher to demonstrate his/her ability to be effective decision making teacher and an inquiry learner. Prerequisites: Professional standing and arrangements made previous semester.

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 Philosophy And Administration Of The Middle School (LEC 3.0) This course will acquaint students with aspects of education that are unique to the middle school. Attention will be given to the philosophy underlying the middle school. Finally, leadership theories most appropriate to the middle school will be studied.

315 Advanced Adolescent Development (LEC 3.0) This course is an advanced examination of the intellectual and social development of the adolescent. Theories of adolescent development and their implications for the educative process are covered and debated.

320 Professional Development (LEC 1.0) This online course focuses on the responsibilities of the professional development committee, state requirements, and components of effective programs that positively impact student performance. Students will examine the relationships among the district's Comprehensive School Improvement Plan, MSIP and the PD Plan. Prerequisite: Graduate standing.

325 Novell Netware 4.1 / 4.11 (LEC 3.0) A practial, hands-on course for Novell network administration including NDS planning, mapping and documentation; system power up/down; security, resource service management; user management from creation to user and workstation maintenance; application software installation and management, and Novell Server installation.

335 Curriculum And Instruction Of The Middle School (LEC 3.0) This course advances teachers' understanding of middle school curriculum and instruction. It utilizes knowledge about the nature and needs of young adolescents in developing interdisciplinary learning units, and fosters applications appropriate to experienced teachers' professional assignments. Prerequisite: Graduate standing.

339 Current Issues In Educ: Performance Based Assessment, Beginning (LEC 1.0 and LAB 2.0) This course is intended to provide an understanding of the principles of sound classroom assessment, the five different types of learning outcomes that need to be assessed and the choice of an assessment that best evaluates the achievement targets. Prerequisite: Practicing educator.

340 Current Issues In Educ:Performance Based Assessment, Intermediate (LEC 3.0) This course will provide participants with an understanding of performance-based assessments, how to construct performance tasks and how to construct scoring guides.

341 Current Issues In Educ: Performance Based Assessment, Advanced (LEC 1.0 and LAB 2.0) This course is intended to provide an understanding of balanced classroom assessment. Students will learn to create multiple types of assessment measures for the purpose of evaluating a wide variety of achievement targets. Prerequisite: Practicing educator.

345 Introducing Educators To Computers (LEC 1.0) A basic introduction to computers for K-12 educators. Includes identification and use of hardware components, as well as the fundamentals of using the operating system and basic computer software. Actual software taught will reflect current usage. Prerequisite: Post Bac/practicing teacher.

350 Social Studies In The Elementary School (LEC 3.0) Problems in preparation, teaching of social studies units with suitable materials, techniques for elementary teachers. Prerequisite: Instructor's approval.

354 Psychology Of The Exceptional Child (LEC 3.0) An understanding of the abilities and disabilities of children classified as exceptional, the instructional organization utilized to meet the needs of the exceptional child in the classroom, the import of educational and psychological handicaps upon these children. Guest lectures and field trips. Prerequisite: Psych 50. (Co-listed with Psych 354)

360 Teaching For Responsible Behavior (LEC 3.0) A valuing approach to drug abuse and other high risk behaviors. A study of specific methods, strategies, and techniques to help students from kindergarten to twelfth grade to develop value-sharing attitudes and decision-making skills, based on sound information, which will inhibit their involvement in such high risk behaviors as drug abuse. Prerequisite: Senior standing.

Electrical Engineering

Bachelor of Science
Master of Science
Doctor of Philosophy
Doctor of Engineering

Emphasis areas at all levels in circuits, communications-signal processing, computer engineering, control, electromagnetics, electronics, and power.

Electrical engineers are involved in channeling natural resources into uses for man such as heating, lighting, home appliances, transportation, and communications. They are primarily concerned with the processes of generation, transmission, transformation, control, and utilization of energy or information.

In electrical engineering education at UMR, you can choose to emphasize an area which especially interests you or you can study a broader spectrum of course work.

In circuits, you will study the application of basic electrical elements - energy sources, resistors, inductors, capacitors, diodes, and transistors - as they are found interconnected in operational electrical networks.

The communications-signal processing area includes such studies as the makeup of information-bearing signals, modulation systems, and detection techniques.

If you want to stress computer engineering, you will study the design and/or applications of microprocessor systems, digital logic, digital-logic devices, digital design and automation, large computer systems, robot vision systems, artificial intelligence, and distributed processing.

The control emphasis area provides course work in the design and application of circuits and systems used to automatically monitor and regulate devices, machines, and systems for optimal performance in a variety of operations including flexible manufacturing.

In electromagnetics, you will study high-frequency waves, antennas, and microwave systems of various types for propagation and transmission of electrical signals through space or conductors.

In optics and device physics, you may study light propagation, optical processing, fiber optics, optoelectronics, and solid-state devices which have application to telecommunications, computing, microscopy, lasers, sensing, and smart structures.

In power, you will deal with the design and application of motors, generators, transformers, distribution systems, high-voltage design methods, and the economic transmission of energy.

No matter which emphasis area you choose, your first two years of study will be devoted to courses in the fundamentals of engineering, basic sciences, mathematics, and humanities and social sciences. Electrical engineering courses become concentrated during the last two years. Required electrical engineering courses in the junior and senior years cover all the specialty topics of electrical engineering.

Elective courses provide for study in greater depth of areas of particular interest to individual students.

Your classrooms and laboratories will be in the Emerson Electric Co. Hall. Additional electrical and electronics research activities are being conducted in the various research centers and in the Engineering Research Laboratory.

Mission Statement

The mission of the Electrical Engineering Program, consistent with the UMR Campus mission statement, is the education of students to fully prepare them to provide leadership in the recognition and solution of society's problems in the area of Electrical Engineering. Fundamental to the mission of the Department of Electrical and Computer Engineering is the operation of the B.S., M.S., and Ph.D degree programs in electrical engineering. The educational objectives for the undergraduate program are: First, you will obtain a broad education that crosses departmental boundaries while still attaining technical depth in areas impacted by electrical engineering. Your skills will allow individual or team solutions to difficult, novel, multidisciplinary problems; effective balancing of multiple design issues; and lifelong adaptation to new technological developments. Secondly, you will obtain a solid understanding of professional and ethical responsibility and a recognition of the need for, and ability to engage in, a program of life long learning. Finally, you will experience an academic environment in which small classes are taught by full-time faculty and which fosters lifelong learning, leadership, scholarship, and an appreciation of the value of diversity.

Faculty

Professors:

Max Anderson[1] (Emeritus), Ph.D., Arizona State University
Jack Boone (Emeritus), Ph.D., University of Denver
Jack Bourquin (Emeritus), Ph.D., University of Illinois
Gordon Carlson[1], (Emeritus), Ph.D., University of Illinois
Badrul Chowdhury, Ph.D., Virginia Tech

Mariesa Crow[1], (Fred Finley, Professor), Ph.D., University of Illinois at Urbana-Champaign
David Cunningham[1], (Emeritus), Ph.D., Oklahoma State University
James Drewniak, (Curator's Professor, Director, MRC) Ph.D., University of Illinois at Urbana-Champaign
Richard E. DuBroff[1], Ph.D., University of Illinois
Kelvin T. Erickson[1], (Chair), Ph.D., Iowa State University
David Ronald Fannin (Emeritus), Ph.D., Texas Tech
Walter J. Gajda, Jr. , (Emeritus), Ph.D.,Massachusetts Institute of Technology
Burns Hegler[1], (Emeritus), Ph.D., Kansas State University
Frank Kern[1] (Emeritus), Ph.D., University of Oklahoma
George McPherson (Emeritus), M.S., Ohio State University
Ann K. Miller (Cynthia Tang Missouri Distinguished Professor), Ph.D., St. Louis University
Randy Moss[1], Ph.D., University of Illinois
S. Vittal Rao (William A. Rutledge-Emerson Electric Co., Distinguished Professor) Ph.D., I.I.T., New Delhi
Earl Richards[1] (Emeritus), Ph.D., UMR
Jagannathan Sarangapani, Ph.D., University of Texas-Arlington
E. Keith Stanek[1] , (Emeritus), Ph.D., Illinois Institute of Technology
Paul Stigall[1] (Emeritus), Ph.D., University of Wyoming
John Alan Stuller (Emeritus), Ph.D., University of Connecticut
William Tranter (Emeritus), Ph.D., University of Alabama
Thomas Van Doren[1] (Emeritus), Ph.D., UMR
Steve E. Watkins, Ph.D., University of Texas at Austin
Cheng-Hsiao Wu, Ph.D., University of Rochester
Donald C. Wunsch II[1] (Mary K. Finley Missouri Distinguished Professor), Ph.D., University of Washington
Reza Zoughi (Schlumberger Distinguished Professor), Ph.D., University of Kansas

Associate Professors:

Levant Acar, Ph.D., Ohio State University
Daryl Beetner[1], D.Sc., Washington University
Norman Cox[1], Ph.D., University of Texas at Arlington
Steven Grant, Ph.D., Rutgers University
James H. Hahn[1] (Emeritus), Ph.D., UMR
Thomas Herrick (Emeritus), M.S., UMR
Kurt Kosbar, Ph.D., University of Southern California
Jack Morris (Emeritus), M.S., UMR
David Pommerenke, Dr.-Ing, Technical University of Berlin
Hardy J. Pottinger (Emeritus), Ph.D., UMR
Ronald Joe Stanley, Ph.D., University of Missouri-Columbia
Ganesh Kumar Venayagamoorthy, Ph.D., University of Natal
Hai Xiao, Ph.D., Virginia Tech

Assistant Professors:

Waleed Al-Assadi, Ph.D., Colorado State University
Minsu Choi, Ph.D., Oklahoma State University
Mehdi Ferdowsi, Ph.D., Illinois Institute of Technology
Chang - Soo Kim, Ph.D., Kyungpook National University
Sahra Sedigh Sarvestani, Ph.D., Purdue University
Yahong Rosa Zheng, Ph.D., Carleton University, Ottawa, Canada

[1] Registered Professional Engineer

Bachelor of Science Electrical Engineering[1]

Entering freshmen desiring to study Electrical Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Electrical 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 Electrical Engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in Electrical Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1) All students are required to take one American history course, one economics course, one humanities course, and English 20. The history course is to be selected from History 112, History 175, History 176, or Political Science 90. The economics course may be either Economics 121 or 122. The humanities course must be selected from the approved lists for Art, English, Foreign Languages, Music, Philosophy, Speech and Media Studies, or Theater.

2) Depth requirement. Three credit hours must be taken in humanities or social sciences at the 100 level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 70 or 80 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 300 level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.

3) The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to English 20.

4) Any specific departmental requirements in the general studies area must be satisfied.

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

The Electrical Engineering program at UMR is characterized by its focus on the scientific basics of engineering and its innovative application; indeed, the underlying theme of this educational program is the application of the scientific basics to engineering practice through attention to problems and needs of the public. The necessary interrelations among the various topics, the engineering disciplines, and the other professions as

they naturally come together in the solution of real world problems are emphasized as research, analysis, synthesis, and design are presented and discussed through classroom and laboratory instruction.

FREE ELECTIVES FOOTNOTE:

Free electives. Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.

FRESHMAN YEAR

First Semester	Credit
FE 10-Study & Careers in Eng[2]	1
Chem 1-General Chemistry	4
Chem 2-General Chemistry Lab	1
Math 14-Calculus I for Engineers [3]	4
Hist 112, 175, 176, or Pol Sc 90	3
English 20-Exposition & Argumentation	3
	16

Second Semester	
IDE 20 - Eng. Design with Comp. Appl.	3
Math 15-Calculus II for Engineers[3]	4
Physics 23-Engineering Physics I [3, 4]	4
Econ 121 or 122	3
Elective-Hum[5]	3
	17

SOPHOMORE YEAR

First Semester	Credit
El Eng 151-Circuits I [3, 6, 7]	3
El Eng 152-Circuit Analysis Lab I [3, 6]	1
Math 22-Calculus w/Analytic Geometry III [3]	4
Cp Eng 111-Introduction to Computer Engr [3, 6, 8]	3
Cp Eng 112-Computer Engineering Lab [3, 6]	1
Physics 24-Engineering Physics II [3, 4]	4
	16

Second Semester	
El Eng 121-Introduction to Electronic Devices [3, 6, 7, 10]	3
El Eng 122-Electronic Devices Lab [3, 6, 7]	1
El Eng 153-Circuits II [3, 4, 8]	3
Math 204-Elementary Differential Equations [3]	3
Engineering Science Elective [11]	3
Cp Sc 53-Introduction to Programming	3
Cp Sc 54-Introduction to Programming Lab	1
	17

JUNIOR YEAR

First Semester	Credit
El Eng 253-Electronics I [3, 6, 9, 10]	3
El Eng 255-Electronics I Lab [3, 6, 9, 10]	1
El Eng 261-Linear Systems I [3, 6, 9]	3
El Eng 262-Linear Systems I Lab [3, 6, 9]	1
Sp&M 85-Principles of Speech	3
Math 208-Linear Algebra	3
	14

Second Semester	
El Eng 271-Electromagnetics [3, 6, 9]	3
El Eng 272-Electromagnetics Lab [3, 6, 9]	1
El Eng 263-Continuous Linear Systems [3, 6]	3
El Eng 264-Continuous Linear Systems Lab [3, 6]	1
El Eng Elective A [10, 14]	3
Stat 217-Prob & Stat for Eng and Scientists [12]	3
English 160-Technical Writing [13]	3
	17

SENIOR YEAR

First Semester	Credit
El Eng Power Elective [3, 6, 9, 15]	3
El Eng Power Elective Lab [3, 6, 9, 15]	1
El Eng Elective B [10, 14]	3
El Eng Elective D [10, 16]	3
El Eng 391-El Eng Senior Project I	1
Free Elective [18]	3
Elective-Hum or Soc Sci (any level) [5]	2
	16

Second Semester	Credit
El Eng Elective C [10, 14]	3
El Eng Elective E [17]	3
El Eng 392-El Eng Senior Project II	3
Elective-Hum or Soc Sci (upper level) [5]	3
Assessment [19]	0
Free Elective [18]	3
	15

NOTE: Student must satisfy the common engineering freshman year requirements and be admitted into the department.

1) The minimum number of hours required for a degree in Electrical Engineering is 128.
2) Students that transfer after their freshman year are not required to enroll in Freshman Engineering Seminars.
3) A minimum grade of "C" must be attained in Math 14, 15, 22, and 204, Physics 23 and 24 (or their equivalents), El Eng 151, 152, 153, 121, 122, 215, 216, 217, 218, 253, 255, 271 and 272, the El Eng power elective (205 and 208 or 207 and 209), and Cp Eng 111 and 112. Also, students may not enroll in other courses that use these courses as prerequisites until the minimum grade of "C" is attained.
4) Students may take Physics 21 and 22 or Physics 21 and 27 in place of Physics 23. Students may take Physics 25 and 26 or Physics 25 and 28 in place of Physics 24.
5) All electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog.
6) Students who drop a lecture prior to the last week to drop a class must also drop the corequisite lab.
7) Students must earn a passing grade on the El Eng Advancement Exam I (associated with El Eng 151) before they enroll in El Eng 153 or 121 and 122.
8) Students must earn a passing grade on the Cp Eng Advancement Exam (associated with Cp Eng 111) before they enroll in any course with Cp Eng 111 and 112 as prerequisites.
9) Students must earn a passing grade on the El Eng Advancement Exam II (associated with El Eng 153) before they enroll in El Eng 205 and 208, 207 and 209, 253 and 255, 215 and 216, or 271 and 272.
10) Students must earn a passing grade on the El Eng Advancement Exam III (associated with El Eng 121)

before they enroll in El Eng 253 and 255 or other courses with El Eng 121 as a prerequisite.

[11] Students must take IDE 140, Mc Eng 219, Mc Eng 227, Physics 207, Physics 208, Chem 221, Biology 211, or Biology 231. The following pairs of course are substitutions: IDE 50 and IDE 150, Physics 107 and Physics 311, Physics 107 and Cr Eng 284, Physics 107 and Nu Eng 205, or Eng Mt 211 and Eng Mt 282.

[12] Students may replace Stat 217 with Stat 215 or Stat 343.

[13] Students may replace English 160 with English 60.

[14] El Eng Electives A, B, and C must be chosen from the El Eng 205 and 208, 207 and 209, 231 or 235, 243, 254, Cp Eng 213, El Eng 225.

[15] The El Eng Power Elective may be satisfied with El Eng 205 and 208 or El Eng 207 and 209.

[16] El Eng Elective D must be a 300-level El Eng or Cp Eng course with at least a 3-hour lecture component. This normally includes all El Eng and Cp Eng 3xx courses except El Eng 300, 390, 391, and 392.

[17] El Eng Elective E may be any 200 or 300-level El Eng or Cp Eng course except El Eng 281, 282, and 283 and El Eng or Cp Eng 391 and 392.

[18] Students are required to take five hours of free elective in consultation with their academic advisors. Credits that do not count toward this requirement are deficiency courses (such as algebra and trigonometry) and extra credits from courses meeting other requirements. Any courses outside of engineering and science must be at least three credit hours.

[19] All Electrical 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 UMR assessment process as described in Assessment Requirements found elsewhere. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.

Emphasis Areas for Electrical Engineering

Note: The following emphasis 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 electrical engineering.

Circuits

Highly Recommended

- El Eng 225-Electronic & Photonic Devices
- El Eng 254-Electronics II
- El Eng 256-Electronics Laboratory II
- El Eng 351-Advanced Electronic Circuits
- El Eng 363-Introduction to Circuit Synthesis

Suggested

- El Eng 353-Power Electronics
- El Eng 355-High Frequency Amplifiers
- El Eng 361-Computer Aided Network Design
- El Eng 371-Grounding & Shielding

Communications-Signal Processing

Highly Recommended

- El Eng 243-Communication Systems
- El Eng 341-Digital Signal Processing
- El Eng 343-Communications Systems II

Suggested

- Cp Eng 213-Digital Systems Design
- El Eng 231-Control Systems
- El Eng 331-Digital Control
- El Eng 345-Digital Image Processing
- El Eng 347-Machine Vision

Computer Engineering

Highly Recommended

- Cp Eng 213-Digital Systems Design
- Cp Eng 311-Introduction to VLSI Design
- Cp Eng 312-Digital Systems Design Laboratory
- Cp Eng 313-Microprocessor Systems Design

Suggested

- El Eng 235-Controllers for Factory Automation
- El Eng 254-Electronics II
- El Eng 256-Electronics Laboratory II
- Cp Eng 315-Digital Computer Design
- Cp Eng 316-Advanced Microcomputer System Design
- Cp Eng 317-Fault-Tolerant Digital Systems
- El Eng 331-Digital Control
- El Eng 341-Digital Signal Processing
- El Eng 345-Digital Image Processing
- El Eng 371-Grounding and Shielding

Controls

Highly Recommended

- El Eng 231-Control Systems
- El Eng 235-Controllers for Factory Automation
- El Eng 331-Digital Control

Suggested

- Cp Eng 213-Digital Systems Design
- El Eng 332-Plantwide Process Control
- El Eng 333-System Simulation & Identification
- El Eng 335-Advanced PLC
- El Eng 337-Neural Networks for Control

Electromagnetics

Highly Recommended

- Physics 107-Introduction to Modern Physics
- El Eng 225-Electronic & Photonic Devices
- El Eng 371-Grounding & Shielding

Suggested

- El Eng 373-Antennas & Propagation
- El Eng 379-Microwave Principles for Mixed-Signal Design
- El Eng/Physics 324-Fourier Optics
- Math 325-Partial Differential Equations

Electronics

Highly Recommended

- Physics 107-Introduction to Modern Physics
- El Eng 225-Electronic & Photonic Devices

Suggested
- El Eng/Physics 323-Classical Optics
- El Eng/Physics 324-Fourier Optics
- El Eng 325-Optical Computing
- El Eng/Physics 326-Fiber & Integrated Optics
- Physics 371-Laser Physics

Power

Highly Recommended
- El Eng 205-Electromechanics
- El Eng 208-Electromechanics Lab
- El Eng 207-Power System Analysis & Design
- El Eng 209-Power System Analysis & Design Lab

Suggested
- El Eng 303-Elec Dist System Design & Protection
- El Eng 304-Electric Drive Systems
- El Eng 307-Power Systems Engineering
- El Eng 331-Digital Control
- El Eng 353-Power Electronics
- Cmp Sc 228-Intro to Numerical Methods
- Eng Mg 208-Engineering Economy
- Nu Eng 205-Principles of Nuclear Engineering

Electrical Engineering 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.

110 Transfer Student Seminar (LEC 0.5) Discussion of current topics. Prerequisite: First semester transfer student.

121 Introduction to Electronic Devices (LEC 3.0) Materials and device structures for applications in analog and digital electronics. Topics include characteristics and basic circuits for diodes, field-effect transistors, bipolar junction transistors, and operational amplifiers. Prerequisites: Elec Eng 151, Elec Eng 152, and Physics 24 with grade of "C" or better; passing the Elec Eng Advancement Exam I. Students should enroll in Elec Eng 121 and Elec Eng 122 simultaneously.

122 Electronic Devices Laboratory (LAB 1.0) Laboratory tools and measurement techniques for basic electronic circuits using diodes, field-effect transistors, bipolar junction transistors, and operational amplifiers. Topics include DC biasing and applications in analog and digital electronics. Prerequisites: Elec Eng 151, Elec Eng 152, and Physics 24 with grade of "C" or better; passing the Elec Eng Advancement Exam I. Preceded or accompanied by Elec Eng 121.

151 Circuits I (LEC 3.0) Circuit elements, signals, Kirchhoff's laws, network theorems, mesh and nodal analysis, transient and complete response of RL, RC, and RLC circuits. Prerequisites: Math 15 (or 21) with a grade of "C" or better. Students should enroll in El Eng 151 and El Eng 152 simultaneously.

152 Circuit Analysis Laboratory I (LAB 1.0) Safety, basic measurements and meters, oscilloscopes, resistor networks, measurement of capacitors and inductors, RLC circuit response. Prerequisite: Preceded or accompanied by El Eng 151. A student who drops El Eng 151 must also drop El Eng 152.

153 Circuits II (LEC 3.0) Analysis of steady state AC circuits, phasor notation, polyphase circuits, complex frequency and frequency response, magnetically coupled circuits. Prerequisites: Elec Eng 151 and Math 22 each with grade of "C" or better; passing the Elec Eng Advancement Exam I.

154 Circuit Analysis Laboratory II (LAB 1.0) Continuation of EL Eng 152. Advanced oscilloscope measurement techniques, direct current power supply circuits, resonance. Prerequisites: Preceded or accompanied by El Eng 153, passing grade on EE Advancement Exam I. A student who drops El Eng 153 must also drop El Eng 154.

155 Circuit Analysis Laboratory I And II (LAB 2.0) A combination of El Eng 152 and 154. Prerequisites: Preceded or accompanied by El Eng 153, passing grade on EE Advancement Exam I. A student who drops El Eng 153 must also drop El Eng 155.

200 Special Problems (IND 1.0-6.0) 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.

202 Cooperative Engineering Training (IND 0.0-6.0) On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation.

205 Electromechanics (LEC 3.0) Magnetics and magnetically coupled circuits, electromechanical energy conversion, rotating magnetic fields, stepper motors, DC machines, induction machines, synchronous machines, and brushless DC machines. Prerequisites: El Eng 153 with a grade of "C" or better, passing grade on the El Eng Advancement Exam II. El Eng 208 is a corequisite.

207 Power System Design And Analysis (LEC 3.0) Power system components and transmission lines, three phase balanced power system theory, analysis and design including economic and reliability considerations, and fault analysis. A power system design project using a graphical power flow program is included. Prerequisites: El Eng 153 with a grade of "C" or better and passing grade on the El Eng Advancement Exam II. Co-req El Eng 209.

208 Electromechanics Laboratory (LAB 1.0) Experiments with power measurement, transformers, magnetically coupled circuits, rotating magnetic fields, stepper motors, DC machines, induction machines, synchronous machines, and brushless DC machines. Prerequisites: El Eng 153 with a grade of "C" or better, passing grade on the El Eng Advancement Exam II. El Eng 205 is a corequisite.

209 Power System Design And Analysis Laboratory (LAB 1.0) Computer-aided analysis of voltage regulation, power flow, compensation, and economic analysis. Individual projects are required.

Prerequisites: El Eng 153 with a grade of "C" or better, passing grade on the El Eng Advancement Exam II. El Eng 207 is a corequisite.

210 Senior Seminar (RSD 0.5) Discussion of current topics. Prerequisite: Next to last semester senior.

215 Discrete Linear Systems (LEC 3.0) Analysis methods for discrete-time signals and systems in the time and frequency-domains including signal models and Fourier techniques. Continuous-time concepts are included as introductory material. Prerequisites: Elec Eng 153 with grade of "C" or better; passing the Elec Eng Advancement Exam II. Students should enroll in Elec Eng 215 and corequisite of Elec Eng 216.

216 Discrete Linear Systems Laboratory (LAB 1.0) Software tools for signal and system representation and for time and frequency-domain systems analysis. Prerequisites: Elec Eng 153 with grade of "C" or better; passing the Elec Eng Advancement Exam II. Preceded or accompanied by Elec Eng 215 and corequisite of 216.

217 Continuous Linear Systems (LEC 3.0) Analysis methods for continuous-time signals and systems in the time and frequency domains including signal models, Fourier transforms, and Lalace transforms. Examples of control and communication systems are included. Prerequisites: Elec Eng 215, Elec Eng 216, and Math 204 each with grade of "C" or better. Students should enroll in Elec Eng 217 and corequisite of Elec Eng 218 .

218 Continuous Linear Systems Laboratory (LAB 1.0) Laboratory and software tools for the analysis of linear and non-linear systems. Topics include spectral analysis, transforms, and applications. Prerequisites: Elec Eng 215, Elec Eng 216, and Math 204 each with grade of "C" or better. Corequisite of Elec Eng 217.

225 Electronic And Photonic Devices (LEC 3.0) Application of semiconductor materials for electronic and photonic applications. Topics include crystal physics, electron and photon behavoir, pn junctions, heterojunctions, junction diodes, optoelectronic devices, and ohmic and rectifying contacts. Prerequisites: Physics 24, Math 22, and preceded or accompanied by El Eng 271.

231 Control Systems (LEC 3.0) Formulation of the control problem, system equations and models, frequency, time, and state space analysis and design of linear control systems. Prerequisite: Elec Eng 217 with a grade of "C" or better.

235 Controllers For Factory Automation (LEC 2.0 and LAB 1.0) Introduction to programmable automation, programmable logic controller (PLC) hardware, programming languages and techniques, closed-loop strategies using PLC's, sensors, transducers. Case studies. Laboratory experiments. Prerequisites: Elec Eng 153 and Comp Eng 111 each with a grade of "C" or better.

243 Communication Systems (LEC 3.0) Signals and their spectra; signal filtering; amplitude, angle and pulse modulation; multiplexing; noise in communications systems. Prerequisite: Elec Eng 217 with a grade of "C" or better.

253 Electronics I (LEC 3.0) Diode and transistor circuits, small signal analysis, amplifier design, differential and operational amplifiers, flipflop circuits and waveshaping. Prerequisites: Elec Eng 153, Elec Eng 121, Elec Eng 122, and Comp Eng 111 each with a grade of "C" or better. Passing grade on Elec Eng Advancement Exam II and III. Elec Eng 255 is a corequisite.

254 Electronics II (LEC 3.0) Continuation of Elec Eng 253. Diode and transistor circuits, small signal analysis, amplifier design, differential and operational amplifiers, flipflop circuits and waveshaping. Prerequisites: Elec Eng 253 and Elec Eng 255 each with a grade of "C" or better. Elec Eng 256 is a corequisite.

255 Electronics I Laboratory (LAB 1.0) Experiments in design with diodes, transistors, differential and operational amplifiers, and logic components. Prerequisites: Elec Eng 153, Elec Eng 121, Elec Eng 122, and Comp Eng 111 each with a grade of "C" or better. Passing grade on Elec Eng Advancement Exam II and III. Elec Eng 253 is a corequisite.

256 Electronics II Laboratory (LAB 1.0) Experiments in design with diodes, power transistors, integrated circuits, advanced bipolar and FET logic gates, flipflops and registers. Prerequisites: Elec Eng 253 and Elec Eng 255 each with a grade of "C" or better. Elec Eng 254 is a corequisite.

265 Linear Systems I (LEC 3.0) Analysis methods for continuous-time systems in the time frequency domains including signal models. Fourier transforms, and Laplace transforms. Examples of control and communication systems are included. Prerequisites: El Eng 153 and Math 204 with a grade of "C" or better, El Eng 154; passing grade on the El Eng Advancement Exam II. El Eng 266 is a corequisite.

266 Linear Systems I Laboratory (LAB 1.0) This laboratory explores the use of software tools for signal and system representation and analysis. Prerequisites: El Eng 153 and Math 204 with a grade of "C" or better, El Eng 154, a passing grade on El Eng Advancement Exam II. El Eng 265 is a corequisite.

267 Linear Systems II (LEC 3.0) Design and analysis methods for continuous and discrete-time systems including analog filter design, analog to digital conversion, z-transforms, and Discrete Fourier Transforms. Prerequisites: El Eng 265 and El Eng 266. El Eng 268 is a corequisite.

268 Linear Systems IILaboratory (LAB 1.0) This laboratory introduces the spectrum analyzer and other tools for that analysis of specific systems. Prerequisites: El Eng 265 and El Eng 266. El Eng 267 is a corequisite.

271 Electromagnetics (LEC 3.0) Static electric and magnetic fields using vector analysis and time-varying electromagnetic fields using Maxwell's equations. Topics include Coulomb's law, Gauss's law, Ampere's law, dielectric and magnetic materi-

als, plane waves, and transmission lines. Prerequisites: Elec Eng 153, Elec Eng 152, Physics 24, and Math 204 each with a grade of "C" or better. Passing grade on Elec Eng Advancement Exam II. Elec Eng 272 is a corequisite.

272 Electromagnetics Laboratory (LAB 1.0) Safety using electrical and high-frequency devices, measurement of circuit parameters, and application of Maxwell's equations. Topics include electromagnetic coupling, circuit models, transmission lines, and laser propagation. Prerequisites: Elec Eng 153, Elec Eng 152, Physics 24, and Math 204 each with a grade of "C" or better. Passing grade on Elec Eng Advancement Exam II. Elec Eng 271 is a corequisite.

281 Electrical Circuits (LEC 3.0) Alternating and direct current circuits taught primarily as an a-c course with d-c as special case. Current, voltage and power relations; complex algebra, network theorems; voltage and power relations in polyphase circuits. Not for electrical majors. Prerequisites: Math 204 or 229; Physics 24.

282 Electronic Circuits & Machines (LEC 3.0) Direct and alternating current circuit theory. Network theorems, complex algebra, power in single phase and polyphase circuits. Introduction to electronic circuits. DC and AC generation and machines. Machine types and characteristics, protection and control devices. Electric power systems. Electrical safety. (Not for Electrical Engineering majors.) Prerequisites: Physics 24, Math 204 or 229.

283 Electronics For Instrumentation (LEC 3.0) Electronic device characteristics; electronic circuits for signal processing including amplifying and filtering; wave-shaping, modulating, analog computing and digital circuits; instruments; electronic power conversion and control. Not for electrical majors. Prerequisite: El Eng 281.

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 Electrical Distribution System Design And Protection (LEC 3.0) Analysis of unbalanced faults in distribution systems. Computer methods are used for modeling and calculations, protection devices and their applications, new technologies such as load management and distribution automation are developed and demonstrated. Prerequisite: El Eng 207.

304 Electric Power Quality (LEC 3.0) Definitions and standards of power quality, kinds of power quality problems; sources of sags and transient overvoltages; distribution principles of controlling harmonics, devices for filtering harmonics, time and frequency domain methods of analysis; power quality monitoring; power quality improvement methods. Prerequisite: El Eng 153 - Circuits II.

305 Electric Drive Systems (LEC 3.0) Course content is roughly 1/3 power electronics, 1/3 applied control and 1/3 electric machinery and focuses on analysis, simulation, and control design of electric drive based speed, torque, and position control systems. Prerequisites: El Eng 205 and El Eng 231.

307 Power Systems Engineering (LEC 3.0) Network analysis applied to power systems; the load flow concept; economic operation of power systems; synchronous machine reactances and transient stability; symmetrical components and asymmetrical faults; protective relaying. Prerequisite: El Eng 207.

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 Physics 323)

324 Fourier Optics (LEC 3.0) Applications of Fourier analysis and linear systems theory to optics. Topics include scalar diffraction theory, Fourier transforming properties of lenses, optical information processing, and imaging systems. Prerequisites: El Eng 265 & 271 or Physics 208 & 321. (Co-listed with Physics 324)

325 Optical Computing (LEC 3.0) Introduction to the principles, subsystems, and architectures of optical computing. Topics include characteristics of optical devices; optical implementations of memory, logic elements, and processors; and computational structures. Prerequisite: Comp Eng 111 or equivalent. (Co-listed with Comp Eng 325)

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 271 or Physics 321. (Co-listed with Physics 326)

329 Smart Materials And Sensors (LEC 2.0 and LAB 1.0) Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multidisciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior standing and Math 204. (Co-listed with Ae Eng, E Mech, Mc Eng 329 and Cv Eng 318)

331 Digital Control (LEC 3.0) Analysis and design of digital control systems. Review of ztransforms; root locus and frequency response methods; state space analysis and design techniques; controllability, observability and estimation. Examination of digital control algorithms. Prerequisites: Elec Eng 231.

332 Plantwide Process Control (LEC 3.0) Synthesis of control schemes for continuous and batch

chemical plants from concept to implementation. Mulitloop control, RGA, SVD, constraint control, multivariable model predictive control, control sequence descriptions. Design project involving a moderately complicated multivariable control problem. Prerequisites: Chem Eng 251, Elec Eng 231, Elec Eng 235 or graduate standing. (Co-listed with Ch Eng 359)

333 System Simulation And Identification (LEC 3.0) Computationally efficient methods of digital simulation of linear systems. Non-parametric identification. Parametric identification with least squares and recursive least squares algorithms. Algorithms programmed using MATLAB. Prerequisite: Elec Eng 231.

335 Advanced Plc (LEC 2.0 and LAB 1.0) Advanced programmable logic controller (PLC) programming, function block, structured text, function chart, sequencer. Factory communications, system simulation, human-machine interface (HMI) programming. Advanced PID control. Network security and reliability. Class-wide project. Prerequisite: El Eng 235.

337 Neural Networks For Control (LEC 3.0) Introduction to artificial neural networks and various supervised and unsupervised learning techniques. Detailed analysis of some of the neural networks that are used in control and identification of dynamical systems. Applications of neural networks in the area of Control. Case studies and a term project. Prerequisite: Elec Eng 265.

338 Fuzzy Logic Control (LEC 3.0) A mathematical introduction to the analysis, synthesis, and design of control systems using fuzzy sets and fuzzy logic. A study of the fundamentals of fuzzy sets, operations on these sets, and their geometrical interpretations. Methodologies to design fuzzy models and feedback controllers for dynamical systems. Various applications and case studies. Prerequisite: Elec Eng 265.

341 Digital Signal Processing (LEC 3.0) Spectral representations, sampling, quantization, z-transforms, digital filters and discrete transforms including the Fast Fourier transform. Prerequisite: El Eng 267.

343 Communications Systems II (LEC 3.0) Random signals and their characterization; noise performance of amplitude, angle and pulse modulation systems; digital data transmission; use of coding for error control. Prerequisite: El Eng 243.

344 Stochastic Signal Analysis I (LEC 3.0) Introduction to the application of probabilistic models to typical electrical engineering problems. Topics include: methods for describing random voltages, random digital signals, correlation, linear mean-square estimation, linear transformation of random digital signals, and bit-error rate calculation for communication systems. Prerequisites: Math 204 and El Eng 153.

345 Digital Image Processing (LEC 3.0) Fundamentals of human perception, sampling and quantization, image transforms, enhancement, restoration, channel and source coding. Prerequisite: El Eng 267. (Co-listed with Cp Eng 345)

347 Machine Vision (LEC 3.0) Image information, image filtering, template matching, histogram transformations, edge detection, boundary detection, region growing and pattern recognition. Complementary laboratory exercises are required. Prerequisites: Comp Eng 111 and preceded or accompanied by Elec Eng 267. (Co-listed with Comp Eng 347)

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 Sys Eng 348)

351 Advanced Electronic Circuits (LEC 3.0) Application of feedback theory, oscillators and frequency standards, precision analog techniques, low-power circuit design, interfacing sensors, designing for high reliability, electronics for harsh environments. Prerequisite: Elec Eng 254.

352 Photovoltaic Systems Engineering (LEC 3.0) Physics and characteristics of photovoltaic (solar) cell technologies, electronic control of alternative energy sources, site selection, array design, energy storage methods, electrical code compliance, stand-alone systems, grid-intertie systems, legal and economic considerations. Prerequisite: Senior or graduate standing in Science or Engineering.

353 Power Electronics (LEC 3.0) Power semiconductor devices in switching mode converter and control circuits, phase-controlled rectifiers, synchronous inverters, AC regulators, cyclo-convertors; self commutated inverters; and frequency changers; thermal analysis and protection. Applications to industry and HVDC. Prerequisite: El Eng 253.

354 Power Electronics Laboratory (LAB 2.0) An introduction to power electronic circuits is presented. Students will construct several dc/dc, dc/ac and ac/dc converters. Various switching algorithms, including pulse width modulation, delta modulation, and hysteresis control will be developed to regulate and control the respective circuits. Prerequisite: Co-requisite Elec Eng 353.

355 High-Frequency Amplifiers (LEC 3.0) Analysis and design of high frequency amplifiers. Topics include parameter conversions, activity and passivity, stability criteria, device operating conditions, Smith chart usage, matching networks, microstrip, scattering parameters, and practical applications. Prerequisites: El Eng 254, 271.

357 Communication Circuits (LEC 3.0) Analysis and design of circuits used in communication systems. Topics include RF semiconductor devices, low-noise amplifiers, mixers, modulators, crystal oscillators, AGC circuits, highpower RF amplifiers,

phase-locked loops, impedence matching, and frequency-selective networks and transformers. Prerequisites: El Eng 254, preceded or accompanied by El Eng 243.

361 Computer-Aided Network Design (LEC 3.0) Analysis and design of active and passive electric networks. Theory and computer application, including methods for automatic formulation of network state equations, network tolerance, network optimization, and device modeling. Prerequisites: El Eng 253, 267.

363 Introduction To Circuit Synthesis (LEC 3.0) Fundamentals of linear circuit theory. Matrix formulation, and topological methods as applied to circuit analysis. Properties of network functions and introductory network synthesis. Prerequisite: El Eng 267.

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 Comp Eng 358 and Sys Eng 367)

368 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 229 or Math 204 or equivalent. (Co-listed with Sys Eng 378, Cmp Sc 378)

371 Grounding And Shielding (LEC 3.0) Fundamental principles involved in typical grounding and shielding problems, objectives and techniques for grounding and shielding to reduce misconceptions and a more systematic approach to replace "trial and error" methods, interference mechanisms and shielding techniques. Prerequisites: El Eng 265 and 271.

372 Signal Integrity In High-Speed Digital & Mixed Signal Design (LEC 3.0) Signal integrity ensures signals transmitted over a propagation path maintain sufficient fidelity for proper receiver operation. Compromised signal integrity is often associated with parasitics (e.g. unintentional inductance, capacitance). Theory and CAD tools used for signal integrity analysis of functioning designs. Prerequisites: El Eng 271 or Cp Eng 213, and Senior standing. (Co-listed with Cp Eng 372)

373 Antennas And Propagation (LEC 3.0) Propagated fields of elemental dipole, directivity and gain, radiation resistance, the half-wave dipole, wire antennas, arrays, broadband antennas, aperture antennas, horn antennas, and antenna temperature. Prerequisite: El Eng 271.

377 Microwave And Millimeter Wave Engineering And Design (LEC 3.0) Introduce senior and graduate students to the concept of microwave an millimeter wave engineering and component design such as waveguide, couplers, detectors, mixers, etc., including network theory and scattering matrix. Finally, their application in various microwave circuits will be discussed. Prerequisites: El Eng 253, 271.

379 Microwave Principles For Mixed-Signal Design (LEC 3.0) Transmission lines; coupled transmission lines; microwave network analysis; impedance matching and tuning; design of microwave amplifiers and oscillators. Prerequisite: El Eng 271.

382 Teaching Engineering (LEC 3.0) Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mg 370, Env En 382, Cp Eng 382, Cv Eng 382)

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.

391 Electrical Engineering Senior Project I (RSD 0.5 and LAB 0.5) A complete design cycle. Working in small teams, students will design, document, analyze, implement and test a product. Topics include: Iteration in design, prototyping, group dynamics, design reviews, making effective presentations, concurrent design, designing for test, ethics and standards, testing and evaluation. Prerequisites: Stat 217, Cp Eng 111, Econom 121 or 122, Sp&M 85, English 160, at least 3 of the following: El Eng 205, El Eng 207, El Eng 265, El Eng 267, El Eng 271, El Eng 254.

392 Electrical Engineering Senior Project II (LAB 3.0) A continuation of El Eng 391. Prerequisite: El Eng 391.

Engineering

Engineering 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 Experiential Design (LEC 0.5) Members of the class will learn modern design methods and will have the opportunity to gain hands-on experience through team projects.

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.

Engineering Graphics

Engineering Graphics Courses

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

212 Computer Aided Drafting (LEC 2.0 and LAB 1.0) Expanded use of the UMR computer workstation environments and the use and evaluation of several CAD/CAM software packages. Prerequisite: Eng Gr 10.

Engineering Management

Bachelor of Science
Master of Science
Doctor of Philosophy

The Engineering Management Department prepares students for leadership roles in today's complex environment as engineers, managers and educators. Graduates are capable of designing, implementing, operating and optimizing sophisticated high technology enterprises in manufacturing, government or service sectors of our global economy.

In today's economy there is a need to see the business unit as a complete, technology driven enterprise and to integrate system components thus ensuring that the company thrives in global competition. In such an environment engineers need both excellent technical and managerial skills to cope effectively with the continuous change that will take place during their careers.

The Engineering Management discipline prepares individuals to successfully integrate engineering and management knowledge while optimizing the use of people, equipment, money and information. The discipline also seeks to develop students into individuals with leadership potential who achieve results in an ethical and sustainable manner.

UM-Rolla's Engineering Management program has served the needs of students at the B.S., M.S., and Ph.D. level, enabling graduates to pursue career opportunities in the private sector, government, and academia. Furthermore, many alumni now occupy top executive positions in a variety of enterprises. A recent survey indicates that approximately one-third of department alumni have achieved to top level executive positions.

Mission and Educational Objectives

Mission

The Engineering Management Department equips individuals with engineering and management expertise to prepare them to be leaders in the identification and solution of technical and organizational problems that are complex and evolving.

Engineering Management Educational Objectives:

A) Develop in students the capabilities to successfully apply engineering expertise to the problems of the 21st century in manufacturing and service enterprises.

B) Develop in students the knowledge and skills that are the foundation for successful management of people, systems, and projects.

C) Develop in students the ability and desire to grow intellectually and personally in light of an increasingly global and multicultural work environment.

D) Provide students with the knowledge of a specific engineering management emphasis area.

E) The Engineering Management Department at the University of Missouri-Rolla will provide an educational environment to support and encourage students to succeed.

Bachelor's Degree Components

The bachelor's program includes the basic chemistry, physics, mathematics and engineering science courses required by all engineering disciplines at UM-Rolla. These courses are followed by required core Engineering Management courses and students then specialize in focused emphasis areas with 24 hours of course work.

Engineering Management Core

- Managing Engineering & Technology
- Management Accounting Systems
- Marketing Management
- Financial Management
- Engineering Management Practices
- Operations and Production Management
- General Management Design & Integration

As a senior you will take General Management Design & Integration as a senior design course that integrates both the technical and managerial skills that you have previously acquired. Students complete their Bachelor of Science degree requirements by taking the Fundamentals of Engineering Examination and a Department Assessment exam prior to graduation.

Emphasis Areas in Engineering Management

Management of Technology focuses on the management aspects of scheduling, budgeting, information system design and development, legal aspects of technology management, managing people, and decision making for positions in project engineering/scheduling, operations management, cost control/estimating, technical marketing/procurement, sales engineering, engineering administration, information systems, and finance economic analysis.

Industrial Engineering focuses on productivity analysis and system optimization for manufacturing and service organizations. Industrial engineering includes a variety of quantitative and qualitative techniques to identify potential improvements in productivity, quality, safety, and other areas.

Manufacturing Engineering focuses on the design and improvement of manufacturing and packaging systems, including flexible manufacturing systems, computer integrated manufacturing systems, sustainable product design and process development, and packaging engineering systems.

Quality Engineering addresses the continous improvement needs of diverse industrial organizations including piece part manufacturing, health care, and government. This emphasis area includes courses in total quality management, statistical process control, engineering design optimization, reliability, experimentation and quality engineering.

General Emphasis Area allows students to customize their degree program and create a unique emphasis area, with the approval of their advisor that focuses on a traditional engineering field or even a unique combination of engineering courses.

Minor in Engineering Management

A student who receives a bachelor of science degree in an accredited engineering program from UMR may receive a minor in Engineering Management by completing 15 hours of the courses listed below.

- Eng Mgt 211 - Managing Engr. and Technology*
- Eng Mgt 282 - Operations and Productions Mgt.
- Eng Mgt 352 - Activity Based Accounting and Financial Decision Making
- Eng Mgt 200 or 300 level course work (6 hours) chosen in consultation with minor advisor

*Engineering Management 209 may be used in place of Engineering Management 211 if Engineering Management 209 is a required course in the student's B.S. degree field.

Faculty

Professors:

Venkat Allada, Ph.D, Cincinnati University
Cihan Dagli, Ph.D., University of Birmingham, England
William Daughton, (Professor and Chair), Ph.D., University of Missouri-Columbia
Donald Myers[1], J.D., Saint Louis University
Kenneth Ragsdell[1], Ph.D., The University of Texas
Henry Wiebe Ph.D.,(Dean, School of Extended Learning) University of Arkansas

Associate Professors:

Scott E. Grasman, Ph.D., University of Michigan
Susan L. Murray[1], Ph.D., Texas A & M University
Stephen Raper, Ph.D., University of Missouri-Rolla
Chung-Li Tseng, Ph.D., UC Berkeley

Assistant Professors:

Elizabeth Cudney, Ph.D., University of Missouri-Rolla
Zen Liu, Ph.D., Northwestern University
Ray Luechtefeld, Ph.D., Boston College

Lecturers:

Karl Burgher, Ph.D., University of Missouri-Rolla
Benjamin (Duke) Dow Jr., Ph.D., Purdue University
Donald Higginbotham, B.S., Washington University
Robert Laney, M.B.A., University of Missouri-Columbia
Christa Weisbrook, Ph.D., University of Missouri-Columbia

Emeritus:

John Amos Professor, Ph.D., Ohio State University
Daniel Babcock[1] Professor, Ph.D., University of California-Los Angeles
Madison Daily Professor, Ph.D., University of Missouri-Rolla
Yildirim Omurtag[1] Professor, Ph.D., Iowa State University
Henry Sineath[1] Professor, Ph.D., Georgia Institute of Technology
Henry Metzner, Associate Professor, Ph.D., Utah University
David Shaller, Assistant Professor, J.D., Cleveland State University

[1] Registered Professional Engineer

Bachelor of Science Engineering Management

Entering freshmen desiring to study Engineering Management will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Engineering Management 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 Engineering Management a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in Engineering Management.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1) All students are required to take one American history course, one economics course, one humanities course, and English 20. The history course is to be selected from History 112, History 175, History 176, or Political Science 90. The economics course may be either Economics 121 or 122. The humanities course must be selected from the approved lists for Art, English, Foreign Languages, Music, Philosophy, Speech and Media Studies, or Theater.

2) Depth requirement. Three credit hours must be taken in humanities or social sciences at the 100 level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 70 or 80 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 300 lev-

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

3) The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to English 20.

4) Any specific departmental requirements in the general studies area must be satisfied.

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

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

FREE ELECTIVES FOOTNOTE:

Free electives. Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.

FRESHMAN YEAR

First Semester	Credit
FE 10 Study and Careers in Engineering	1
Chem 1 General Chemistry	4
Chem 2 General Chemistry Lab	1
Chem 4 Intro to Lab Safety	1
Math 14 Calc I for Eng[1]	4
English 20 Expo & Argument	3
Hist 112, 175, 176, or Pol Sc 90	3
	17
Second Semester	
IDE 20 Eng Design w/Comp Appl	3
Math 15 Calc II for Eng[1]	4
Phys 23 Eng Physics I[1]	4
Econ 121 or122-Princ of Micro or Macro	3
Humanities Elective[2]	3
	17

SOPHOMORE YEAR

First Semester	Credit
Math 22-Calc w/Analytic Geometry III[1]	4
Physics 24-Eng Physics II[1]	4
IDE 50 or IDE 51-Eng of Mech-Statics[1]	3
Cmp Sc 74-Intro to Prog Meth[1]	2
Cmp Sc 78-Prog Meth Lab	1
Eng Mg 265 - Eng Mgt Practices[1]	2
	16
Second Semester	
Math 229-Diff Equat & Matrix Algebra[1]	3
Stat 211-Stat Tools For Decision Making or Stat 213-Stat Meth in Eng or Stat 215-Eng Stat[1]	3
IDE 110-Mechanics of Materials	3
IDE 120-Materials Testing	1
Eng Mg 211-Mgt Eng & Tech[1]	3
Psych 50-Gen Psych	3
	16

JUNIOR YEAR

First Semester	Credit
Eng Mg 230-Mgt Accounting Sys[1]	3
Eng Mg 251-Marketing Mg[1]	3
IDE 150-Eng Mech-Dyn	2
Mc Eng 227-Thermal Analysis	3
Hum/Soc Science Upper Level Elective	3
Sp&MS 85 or 181	3
	17
Second Semester	
Eng Mg 252-Financial Mgt[1]	3
Eng Mg 282-Operations & Prod Mgt [1]	3
El Eng 281-Electrical Circuits	3
English 160-Technical Writing	3
Free Elective[3]	3
	15

SENIOR YEAR

First Semester	Credit
Technical Electives[4]	12
Free Elective[3]	3
	15
Second Semester	
Eng Mg 260-Gen Mgt Design & Integ[1]	3
Technical Electives[4]	12
	15

Example Emphasis Area Programs for Engineering Management Students

One unique aspect of the Engineering Management degree is the student's ability to select an established emphasis area or create a specialize emphasis. Three examples of established emphasis areas are shown below.

Industrial Engineering

(6) Required Courses:

	Credit
Eng Mg 257-Mat. Hand & Plant Layout	3
Eng Mg 311-Human Factors	3
Eng Mg 372-Prod Plan & Schd	3
Eng Mg 380-Work Design	3
Eng Mg 382-Methods of Ind Eng	3
Eng Mg 385-Stat Process Control	3

(2) Elective Courses .....6 hours
(In consultation with your advisor, from approved elective clusters)

Management of Technology

Choose 6 of 7 courses

	Credit
Eng Mg 208-Engineering Economy	3
Eng Mg 313-Managerial Decision Making	3
Eng Mg 320-Tech Entrepreneurship	3
Eng Mg 327-Legal Environment	3
Eng Mg 333-Mgt Info Systems	3

Eng Mg 361-Project Management 3
Eng mg 366-Bus Logistics Systems Analysis 3
(2) Elective Courses . . . . . .6 hours
(In consultation with your advisor, from approved elective clusters)

Manufacturing Engineering

(6) Required Courses

Credit

Eng Mg 334-Cmp Integrated Mfg Sys 3
Eng Mg 344-Interdisp Prob in Mfg Auto 3
Eng Mg 354-Integ Prod and Process Design 3
Eng Mg 364-Value Analysis 3
Eng Mg 372-Prod Planning & Schd 3
Eng Mg 383-Packaging Mgt 3
(2) Elective Courses . . . . . .6 hours
(In consultation with your advisor, from approved elective clusters)

Quality Engineering

Choose 6 of 7 Courses

Credit

Eng Mg 361-Project Mgt 3
Eng Mg 374-Eng Design Opt 3
Eng Mg 375-Total Quality Mgt 3
Eng Mg 376-Intro to Quality Engineering 3
Eng Mg 381-Mgt & Methods in Reliability 3
Eng Mg 385-Stat Process Control 3
Eng Mgt 387-Exp In Eng Mgt (or equivalent) 3
(2) Elective Courses . . . . . .6 hours
(In consultation with your advisor, from approved elective clusters)

Specialized Emphasis Areas:
Students must choose courses in consultation with the Engineering Management General Emphasis Area advisor. A minimum of 24 hours must be specified. The courses specified must contribute to meeting Department outcomes and objectives and also must contain appropriate design content.

NOTE: All electives must be chosen in conference with the student's advisor. Students must satisfy the common engineering freshman year course requirements in addition to the sophomore, junior, and senior year requirements listed above with a minimum of 128 hours.

1) Must have a grade of "C" or better in these courses for graduation. Math 8 and 21 may be substituted for Math 14 and 15, respectively.
2) Humanities and Social Science electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study.These requirements are specified in the current catalogue.
3) Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.
4) Students are required to select an emphasis area and maintain a minimum 2.0 GPA for these courses.
5) All Engineering Management 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 UMR 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.

Engineering Management 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.

131 Accounting II (LEC 3.0) Accounting for the partnership and the corporation, consideration of cost and departmental accounting. Prerequisite: Eng Mg 130.

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.

202 Cooperative Engineering Training (IND 0.0-6.0) On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation.

207 Economic Analysis of Engineering Projects (LEC 2.0) This course covers engineering project analysis from an engineering economics perspective. Topics will include: interest, equivalent worth, comparing alternatives, rate of return methods, depreciation and taxes, inflation and price changes, and benefit-cost analysis.

208 Engineering Economy (LEC 3.0) Techniques for capital investment decision making; time-value of money and the concept of equivalence, multiple alternatives, replacement criteria, and cost of capital depreciation.

209 Engineering Economy And Management (LEC 3.0) Engineering economy topics include equivalence; present worth, annual and rate of return analysis; depreciation and taxes. Engineering management topics include planning, organizing, motivation, controlling and their applications in design and manufacturing.

211 Managing Engineering And Technology (LEC 3.0) Introduces the management functions of planning, organizing, motivating, and controlling. Analyzes the application of these functions in research, design, production, technical marketing, and project management. Studies evolution of the engineering career and the transition to engineering management. A grade of "C" or better is required in this course to meet Engineering Management degree requirements.

230 Management Accounting Systems (LEC 3.0) The course is designed to introduce the theory and practice of accounting, and to study the flows of accounting information through the business firm.

Topics are the fundamentals of accounting, technology of accounting information systems, and accounting system applications. A grade of "C" or better is required in this course to meet Engineering Management degree requirements.

251 Marketing Management (LEC 3.0) Study of basic functions of marketing in the technological enterprise, including product selection and development, market research, market development, selection of distribution channels and advertising, marketing strategy. Prerequisite: Eng Mg 211. A grade of "C" or better is required in this course to meet Engineering Management degree requirements.

252 Financial Management (LEC 3.0) Organization of financial function in the technically based enterprise; analysis and projection of financial statements, cost elements in pricing, cost control and design of accounting systems. Prerequisites: Eng Mg 211 and 230. A grade of "C" or better is required in this course to meet Engineering Management degree requirements.

256 Personnel Management (LEC 3.0) Selection, placement, training, motivation, and adjustment of the worker in an industrial organization. Forms and methods in practical use.

257 Materials Handling And Plant Layout (LEC 2.0 and LAB 1.0) The design and objectives of materials handling equipment including diversity of application in industry from the viewpoint of efficient movement of materials and products from the receiving areas to the shipping areas. The layout of a plant to include materials handling equipment is considered throughout. Cost comparison of various systems will be made. (Co-listed with Mech Eng 256)

260 General Management-Design And Integration (LEC 3.0) Integrating and executing marketing, production, finance, and engineering policies and strategies for the benefit of an enterprise. Analysis, forcasting, and design methods using case studies and management simulation. Prerequisites: Eng Mg 251, 252, and 282; senior standing. A grade of "C" or better is required in this course to meet Engineering Management degree requirements.

261 Introduction to Project Management (LEC 3.0) This course covers the fundamentals of project management including project definition, project selection, project planning, estimating, scheduling, resource allocation and project control.

265 Engineering Management Practices (LEC 2.0) This course will specifically address issues that are relevant to successful engineering management education and engineering management practice. Topics will include but are not limited to fundamentals of project management, fundamentals of teamwork, working in groups, and basic communication methods. Additional content will address ethics, global and societal issues, and life long learning. A grade of "C" or better is required in this course to meet Engineering Management degree requirements.

282 Operations And Production Management (LEC 3.0) Concepts of operations and production management are presented at an introductory level. Qualitative and quantitative tools and techniques used for the optimization of the operations component of the total enterprise are explored in the context of improved productivity and strategic competitiveness. Prerequisites: Eng Mg 211 and Stat 213 or 215. A grade of "C" or better is required in this course to meet degree requirements.

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.

308 Economic Decision Analysis (LEC 3.0) Comprehensive treatment of engineering economy including effects of taxation and inflation; sensitivity analysis; decisions with risk and uncertainty; decision trees and expected value, normally includes solutions on personal computer and student problem report. Prerequisite: Graduate students without previous course in engineering economy because of partial overlap.

309 Introduction to the Six Sigma Way (LEC 3.0) This course is an examination of the theory and practice of the breakthrough management strategy known as six sigma. The role of green and black belts, master black belts and champions will be examined. Prerequisites: Eng Mgt 375 or equivalent.

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 technology, particularly in manufacturing environments. Prerequisite: Psych 50. (Co-listed with Psych 311)

313 Managerial Decision Making (LEC 3.0) Individual and group decision making processes and principles for engineers and technical managers with emphasis on the limitations of human rationality and the roles of social influence and organizational contexts; principles and skills of negotiation. Prerequisite: Senior or graduate standing.

314 Management for Engineers and Scientists (LEC 3.0) The transition of the engineer or scientist to manager; study of management roles and theory, organizational systems and behavior, managing and motivating technical personnel, leadership, communication, processes, and customer focus. Prerequisite: Graduate standing.

320 Technical Entrepreneurship (LEC 3.0) Student teams develop a complete business plan for a company to develop, manufacture and distribute real technical/product service. Lectures & business fundamentals, patents, market/ technical forecasting, legal and tax aspects, venture capital,

etc., by instructor and successful technical entrepreneurs. Prerequisite: Senior or graduate standing.

322 Accounting For Engineering Management (LEC 3.0) Study of accounting principles, procedures, and the application of accounting principles to management planning, control and decision making. Includes financial statement analysis and cost and budgetary procedures.

324 Fundamentals Of Manufacturing (LEC 2.0 and LAB 1.0) This course provides a comprehensive treatment of topics of concern to the Manufacturing Engineer. The effect of manufacturing processes on product design and cost is discussed, and an introduction to inspection and quality control is presented. Prerequisite: Eng Mg 282.

327 Legal Environment (LEC 3.0) Study of the effect of the legal environment on the decisions which the engineering manager must make. The course investigates the social forces that produced this environment and the responsibilities incumbent upon the engineer.

333 Management Information Systems (LEC 3.0) Study of the operational and managerial information needs of an organization. Emphasis is on the information needed throughout an organization and on information systems to meet those needs. Prerequisite: Senior or graduate standing.

334 Computer Integrated Manufacturing Systems (LEC 2.0 and LAB 1.0) Study of the design and use of computer-based integrated manufacturing management systems in the allocation and control of plant, equipment, manpower, and materials. Prerequisite: Eng Mg 282.

344 Interdisciplinary Problems In Manufacturing Automation (LEC 1.0 and LAB 2.0) Introduction to basic techniques and skills for concurrent engineering, manufacturing strategies, product design, process planning, manufacturing data management and communication are the topics covered. Students experiment the design process through team projects and structured manufacturing laboratory work. (Co-listed with Mc Eng 344, Ch Eng 384)

351 Industrial Marketing Systems Analysis (LEC 3.0) An analysis of the factors of engineered products, customers, communication, promotion, personal selling, persuasion and management within a dynamic industrial sales environment.

352 Financial Decision Analysis (LEC 3.0) Understanding the principles and use of accounting standards and systems, financial statements, the time value of money, asset pricing models, sources of funds, financial ratios, dividend and growth policies, and capital structure for financial decision making.

354 Integrated Product And Process Design (LEC 3.0) Emphasize design policies of concurrent engineering and teamwork, and documenting of design process knowledge. Integration of various product realization activities covering important aspects of a product life cycle such as "customer" needs analysis, concept generation, concept selection, product modeling, process development, DFX strategies, and end-ofproduct life options. Prerequisite: Eng Mg 282 or Mc Eng 253. (Co-listed with Mc Eng 357)

356 Industrial System Simulation (LEC 3.0) Simulation modeling of manufacturing and service operations through the use of computer software for operational analysis and decision making. Prerequisite: Stat 213 or 215.

357 Advanced Facilities Planning & Design (LEC 1.0 and LAB 2.0) Development of an integrated approach to the planning and design of facilities; examination of advanced techniques and tools for facility location, space allocation, facility layout materials handling system design, work place design; e.g. mathematical programming, simulation modeling, CAD systems, ergonomics. Prerequisite: Eng Mg 257 or instructor's permission.

358 Integrated Product Development (LEC 1.0 and LAB 2.0) Students in design teams will simulate the industrial concurrent engineering development process. Areas covered will be design, manufacturing, assembly, process quality, cost, supply chain management, and product support. Students will produce a final engineering product at the end of the project. Prerequisite: Eng Mgt 354 or Mech Eng 357 or Mech Eng 253 or Mech Eng 308. (Co-listed with Mech Eng 358)

361 Project Management (LEC 3.0) Organization structure and staffing; motivation, authority and influence; conflict management; project planning; network systems; pricing, estimating, and cost control; proposal preparation; project information systems; international project management. Prerequisite: Graduate Standing.

364 Value Analysis (LEC 3.0) An organized effort at analyzing the function of goods or services for the purpose of achieving the basic functions at the lowest overall cost, consistent with achieving the essential characteristics. Covers the basic philosophy, function analysis, FAST diagramming, creativity techniques, evaluation of alternatives, criteria analysis, and value stream mapping. Prerequisite: Senior or graduate standing.

365 Operations Management Science (LEC 3.0) Application of management science with an emphasis on supporting managerial decision-making. Design and operations of systems are modeled and analyzed using quantitative and qualitative techniques implemented using modern technology. Specific approaches include mathematical modeling and optimization, probabilistic/statistical analysis, and simulation. Prerequisite: Eng Mgt 282 with at least a "C" or graduate standing.

366 Business Logistics Systems Analysis (LEC 3.0) An analysis of logistics function as a total system including inventory, transportation, order processing, warehousing, material handling, location of facilities, customer service, and packaging with trade-off and interaction. Prerequisite: Stat 213 or 215.

369 Patent Law (LEC 3.0) A presentation of the relationship between patent law and technology for students involved with developing and protecting new technology or pursuing a career in patent law. Course includes an intense study of patentability and preparation and prosecution of patent applications. Prerequisite: Senior or graduate standing. (Co-listed with Civ Eng 385, Chem Eng 385)

370 Teaching Engineering (LEC 3.0) Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Env En 382, Cp Eng 382, El Eng 382, Cv Eng 382)

372 Production Planning And Scheduling (LEC 3.0) Introduction to basic techniques of scheduling, manufacturing planning and control, just-in-time systems, capacity management, master production scheduling, single machine processing, constructive Algorithms for flow-shops, scheduling heuristics, intelligent scheduling systems are the topics covered. Prerequisite: Eng Mg 282.

374 Engineering Design Optimization (LEC 3.0) This course is an introduction to the theory and practice of optimal design as an element of the engineering design process. The use of optimization as a tool in the various stages of product realization and management of engineering and manufacturing activities is stressed. The course stresses the application of nonlinear programming methods. Prerequisite: Math 204 or 229.

375 Total Quality Management (LEC 3.0) Examination of various quality assurance concepts and their integration into a comprehensive quality management system: statistical techniques, FMEA's, design reviews, reliability, vendor qualification, quality audits, customer relations, information systems, organizational relationships, motivation. Prerequisite: Senior or graduate standing.

376 Introduction To Quality Engineering (LEC 3.0) This course is an introduction to the theory and practice of quality engineering with particular emphasis on the work of Genichi Taguchi. The application of the quality loss function, signal to noise ratio and orthogonal arrays is considered in-depth for generic technology development; system, product and tolerance design; and manufacturing process design. The emphasis of the course is off-line quality control. Other contributions in the field are also considered. Prerequisite: Eng Mg 375.

377 Introduction To Intelligent Systems (LEC 3.0) Introduction to the design of intelligent systems. Topics include: definitions of intelligence, rule-based expert systems, uncertainty management, fuzzy logic, fuzzy expert systems, artificial neural networks, genetic algorithms and evolutionary computation, hybrid systems, and data mining. Prerequisite: Graduate or senior standing.

379 Packaging Machinery (LEC 3.0) Examination and evaluation of packaging machinery as a subset of the packaging system and its relation to the total production and marketing system. Determination of criteria for selection, design and implementation of packaging machinery and systems into the production facility. Prerequisite: Sr standing in engineering.

380 Work Design (LEC 3.0) Addresses the design of workstations and tasks. Topics include micromotion, operational analysis, manual material handling, workstations organization, macroergonomics, anthropometrics, biomechanics, cumulative trauma disorders, handtool design, controls/displays design, work sampling, stopwatch time studies, predetermined time standard systems, and time allowances. Prerequisite: Senior or graduate standing.

381 Management And Methods In Reliability (LEC 3.0) Study of basic concepts in reliability as they apply to the efficient operation of industrial systems. Prerequisite: Stat 213 or 215 or 343.

382 Introduction To Operations Research (LEC 3.0) Mathematical methods for modeling and analyzing industrial systems, topics including linear programming, transportation models, and network models. Prerequisite: Stat 213 or 215.

383 Packaging Management (LEC 3.0) Provides a comprehensive background in the field of packaging and its place in productive systems. Emphasizes the design or economics of the system. Analyzes the management of the packaging function and interrelationship with other functions of an enterprise.

385 Statistical Process Control (LEC 3.0) The theoretical basis of statistical process control procedures is studied. Quantitative aspects of SPC implementation are introduced in context along with a review of Deming's principles of quality improvement and a brief introduction to sampling inspection Prerequisite: Stat 213 or 215.

386 Safety Engineering Management (LEC 3.0) This course is an introduction to the principles of safety engineering applied to industrial situations. Job safety analysis, reduction of accident rates, protective equipment, safety rules and regulations, environmental hazards, health hazards, and ergonomic hazards are covered. Prerequisite: Senior or graduate standing.

387 Experimentation In Engineering Management (LEC 3.0) The techniques for planning and analyzing industrial experiments are introduced with emphasis on their application to the design, development, and production of quality goods and services. Prerequisite: Stat 213 or Stat 215.

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. Consent of instructor required.

Engineering Mechanics

Engineering Mechanics Courses

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.

202 Cooperative Engineering Training (IND 0.0-6.0) On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation.

211 Engineering Materials: Properties And Selection (LEC 3.0) A study treating the properties and uses of engineering materials. Treatment includes strengths, creep, fatigue, thermal and electrical characteristics, formability, and heat treating. Studies of joining processes, corrosion and dynamic loading are included. Practical applications requiring selection and justification of materials for specific applications are used. Prerequisites: E Mech 110, Mt Eng 121.

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 Industrial Applications Of Composite Materials Technology (LEC 1.0) Composite materials-industrial applications. Fibers and matrices. Fabrication and NDI. Lamination theory overview. Composite joints. Postbuckling. Fatigue and environmental effects. Testing and certification of composite structures. A majority of the presentations will be made by engineers in the industry. Prerequisite: IDE 110. (Co-listed with Mech Eng 383)

305 Applications Of Numerical Methods To Mechanics Problems (LEC 3.0) Numerical solutions of statics, vibrations and stability problems. Direct stiffness formulations are developed and user oriented computer codes are used to solve practical structures problems. Computer graphics techniques are utilized to prepare data and display results. Prerequisites: IDE 110, IDE 150 or Eng Mech 160. (Co-listed with Mech Eng 314)

307 Finite Element Approximation I - An Introduction (LEC 3.0) Variational statement of a problem, Galerkin approximation, finite element basis functions and calculations, element assemble, solution of equations, boundary conditions, interpretation of the approximate solution, development of a finite element program, two-dimensional problems. Prerequisite: Math 204. (Co-listed with Mc Eng 312, Ae Eng 352)

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

311 Introduction To Continuum Mechanics (LEC 3.0) Introductory cartesian tensor analysis to aid in the development of the theory of a continuum. Kinematics of deformation, stress tensor, equations of motion, equations of mass and energy balance. Examples from specific material theories in solid and fluid mechanics. Prerequisites: IDE 110, Math 204. (Co-listed with Mech Eng 311)

321 Intermediate Mechanics Of Materials (LEC 3.0) Continuation of first course in mechanics of materials. Topics to include: theories of failure, torsion of noncircular sections, shear flow, shear center, unsymmetrical bending, bending of curved members and pressurization of thick walled cylinders. Prerequisites: IDE 110, Math 204.

322 Introduction To Solid Mechanics (LEC 3.0) Review of basic concepts in continuum mechanics. Finite elasticity: some universal solutions for isotropic materials; application of special mechanical models. Linear elasticity: compatibility, stress functions, superposition, special examples such as extension, torsion, bending and plane problems. Elements of plasticity. Prerequisite: E Mech 311. (Co-listed with Ae Eng 322, Mc Eng 322)

324 Engineering Plasticity I (LEC 3.0) The stress-strain relations of materials loaded beyond the elastic range. Yield criteria. Applications to tension, bending, and torsion and their interaction, and to problems with spherical or cylindrical symmetry. Prerequisite: IDE 110.

329 Smart Materials And Sensors (LEC 2.0 and LAB 1.0) Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multi-disciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior standing and Math 204. (Co-listed with Mc Eng, Ae Eng, El Eng 329 and Cv Eng 318)

334 Stability Of Engineering Structures (LEC 3.0) Solution of stability problems with applications to columns, plates and shell structures. Torsional and lateral buckling of columns. Buckling under high temperatures. Effect of imperfections introduced by a technological process on stability. Design issues related to stability requirements. Prerequisites: IDE 110; Math 204; and IDE 150 or Mech Eng 160 or Aero Eng 160. (Co-listed with Mech Eng 334 and Aero Eng 334)

336 Fracture Mechanics (LEC 3.0) Linear elastic and plastic mathematical models for stresses around cracks; concepts of stress intensity; strain energy release rates; correlation of models with experiment; determination of plane stress and plane strain parameters; application to design. Prerequisite: IDE 110. (Co-listed with Aero Eng 336, Mech Eng 336)

337 Fatigue Analysis (LEC 3.0) The mechanism of fatigue, fatigue strength of metals, fracture mechanics, influence of stress conditions on fatigue strength, stress concentrations, surface treatment effects, corrosion fatigue and fretting corrosion, fatigue of joints, components and structures, design to prevent fatigue. Prerequisite: IDE 110. (Co-listed with Mech Eng 338, Aero Eng 344)

341 Experimental Stress Analysis I (LEC 2.0 and LAB 1.0) Acquaints the student with some techniques of experimental stress analysis. Principal stresses, strain to stress conversion, mechanical and optical strain gages, electrical resistance strain gages, transducers, and brittle coatings. Prerequisite: IDE 110. (Co-listed with Mech Eng 341, Aero Eng 341)

342 Experimental Stress Analysis II (LEC 2.0 and LAB 1.0) Acquaints the student with some techniques of experimental stress analysis. Topics include principal stresses, strain to stress conversion, transmission and reflection photo-elastic methods, Moire fringe methods and analogies. Prerequisites: IDE 110 and Eng Mech 321. (Co-listed with Mech Eng 342, Aero Eng 342)

354 Variational Formulations Of Mechanics Problems (LEC 3.0) Introduction and study of variational problems in classical dynamics and solid mechanics emphasizing the concepts of virtual work, minimum potential energy, and complementary energy. Variational inequalities. Prerequisites: IDE 110; Math 204; and IDE 150 or Mech Eng 160 or Aero Eng 160. (Co-listed with Mech Eng 354)

361 Vibrations I (LEC 3.0) Equations of motion, free and forced vibration or single degree of freedom systems and multidegree of freedom systems. Natural frequencies, resonance, modes of vibration and energy dissipation are studies. The vibration of continuous systems is introduced. Prerequisites: Mc Eng 211 and Mc Eng 213, or Ae Eng 213 and Math 204. (Co-listed with Mc Eng 307, Ae Eng 307)

362 Experimental Vibration Analysis (LEC 2.0 and LAB 1.0) Methods for measuring and analyzing motion and strain response of dynamically excited structures. Includes frequency-response testing of elementary beam, torsion bar, plate and shell structures. Experiments on the effectiveness of isolators and dynamic absorbers. Prerequisite: E Mech 361 or Ae Eng 307 or Mc Eng 307. (Co-listed with Mc Eng 362, Ae Eng 362)

373 Advanced Dynamics (LEC 3.0) Review of kinematics of particles and rigid bodies. Development of equations of motion using energy principles and Euler's equations. Stability of motions. Special topics. Prerequisites: IDE 150 or Eng Mech 160, Math 204.

375 Structural Modal Analysis: Theory And Application (LEC 2.0 and LAB 1.0) A modeling technique for the dynamic behavior of structures. Topics include structural dynamics theory, digital signal processing and instrumentation, modal parameter extraction, vibration simulation and design modification. Hands-on experience with an integrated analysis of the experimental modal testing and the analytical finite element method. Prerequisite: IDE 110 and 150 or Eng Mech 160, Math 203 and 204.

381 Introduction To Composite Materials & Structures (LEC 3.0) Introduction to fiber-reinforced composite materials and structures with emphasis on analysis and design. Composite micromechanics, lamination theory and failure criteria. Design procedures for structures made of composite materials. An overview of fabrication and experimental characterization. Prerequisite: IDE 110. (Co-listed with Mech Eng 382 and Aero Eng 311)

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. Consent of instructor required.

English

Bachelor of Arts in English
Master of Arts in English

Master of Arts available as a cooperative degree program with the English Department of the University of Missouri-St. Louis. A maximum of 12 graduate semester hours may be taken at UMR.

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

The English curriculum involves the study of language, literature, and culture. Topics include literary history, criticism, literary forms, and detailed examinations of individual authors. Additional genre and theme courses are available, including world literature, literature and film, and literature by women. Linguistics and writing courses include the history and structure of the English language, advanced composition, and desktop publishing.

If you plan to become a secondary school teacher of English-language arts, UMR offers a teacher certification program.

Five minors in English also are available. These minors consist of approved course work in American studies, literature, writing, technical communication, and literature and film. You can major in any other academic field and minor in these areas.

In addition to taking the courses in the English curriculum, English majors and minors, will have the opportunity to join the writing staffs of campus publications to contribute work to a creative magazine (Southwinds), to participate in Sigma Tau Delta and to attend lectures given by visiting scholars and writers.

Faculty

Associate Professors:

Anne Cotterill, Ph.D., Washington University
Gene Doty, M.A., Emporia State University
Kristine Swenson, Ph.D., University of Iowa

Assistant Professors:
Kate Drowne, Ph.D., University of North Carolina-Chapel Hill
Ed Malone, Ph.D., Southern Illinois University at Carbondale
Kathryn Northcut, Ph.D., Texas Tech University
Trent Watts, Ph.D., University of Chicago
David Wright, Ph.D., Oklahoma State University
Research Professor:
John Morgan, M.A., Kansas
Emeritus Faculty:
Elizabeth Cummins, (Emeritus) Ph.D., University of Illinois
Nicholas Knight, (Emeritus), Ph.D., University of Indiana
Michael Patrick (Emeritus), Ph.D., University of Missouri-Columbia
Marilyn Pogue (Emeritus), Ph.D., University of Missouri-Columbia
James Wise (Emeritus), Ph.D., University of Florida
Douglas Wixson (Emeritus), Ph.D., University of North Carolina

Bachelor of Arts English

The requirements for the English major are as follows:

1) Prerequisites for the English major are English 75, 80, 105, and 106. Six of these hours will satisfy the General Education Humanities requirements for the Bachelor of Arts degree.
2) Twenty-four hours of English course work at the 200 and 300 level, including English 202, "Critical Approaches to Literature," and English 350, "Texts and Contexts."

Of these twenty-four hours a minimum of fifteen hours must be at the 300 level. Only nine hours at the 200 level may count towards fulfilling the major requirements.

Students ar strongly recommended to work closely with their advisors in planning their major curriculum.

Bachelor of Arts (Preparation for Teacher Certification)

The student will fulfill the general requirements for the Bachelor of Arts degree, *except for foreign language; and a minor,* the requirements for the English major, *(teacher certification)*; and the requirements for Missouri certification in the teaching of English. See Education. Contact the UMR English Department for advising. Students preparing for Teacher Certification note the requirements for the English major are as follows:

1) English 75, 80, 105, 106.
2) Fifteen hours of course work at the 200 or 300 level in English and American literature, including two courses in English Literature; and two American Literature courses, including literature for adolescents.
3) Six hours of linguistics.
4) English 202, Critical Approaches to Literature.
5) Capstone course for major: English 350.
6) Twelve hours of writing, including a course in the teaching of writing. Six of these hours will also be satisfied by the General Education Composition requirement for the B.A. degree; three of these hours will also be satisfied by the capstone course.
7) A minimum of fifteen hours must be at the 300 level.

English Minor Curriculum

English offers five minors:

1) **Literature**. To complete this minor, students must take 12 hours of Literature courses offered by the English Department; at least 9 hours of these must be at the 200 or 300 level.
2) **Writing**. To complete this minor, students must take English 281, Theory of Written Communication, plus 9 hours selected from the following courses: English 60, 65, 70, 160, 260, 302, 305, or 306.
3) **Literature and Film**. The minor requires 12 hours, including the following required courses: Art 85: Study of Film (3) and the core course, English 177; Literature and Film (3). In addition, students will take 6 hours of electives in the field of literature and film studies. These electives can include but are not limited to Art 255: Script to Screen (3); English 278; Thematic Studies in Literature and Film (3); English 279: Genre Studies in Literature and Film; Art 250: Thematic Studies in Film and Literature (3); and Art 251: Genre Studies in Film and Literature (3).
4) **American Studies**. The minor requires 15 hours, including English 178, Introduction to American Studies and English 378, The American Experience. In addition, the student, in consultation with the minor advisor, will select three courses, one of which must be at the 300 level, from the areas of American art, history, literature, music, or philosophy.
5) **Technical Communication**. 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.

All students who minor in English must have a minor advisor in the English Department, must complete a minor form, and must file it with the English Department. (English 20 Exposition and Argumentation cannot be counted toward an English minor.)

English Courses

1 **IEP Basic ESL Skills** (LEC 0.0) Focuses on basic reading comprehension with basic vocabulary development, and on listening comprehension. The primary focus of this course is on the development of functional proficiency. For non-native speakers of English. Prerequisites: By placement examinations in ALI; accepted student to UMR. The IEP Program will assess fees for this course.

2 **IEP Grammar Through Writing** (LEC 0.0) Presents basic English grammar to promote a beginning-level understanding of the structure and workings of the English language. Introduces basic writing applications. For nonnative speakers of English. Prerequisites: By placement examinations in ALI; accepted student to UMR. The IEP Program will assess fees for this course.

3 IEP Core ESL Skills (LEC 0.0) Focuses on reading comprehension including vocabulary development, and on listening comprehension through basic academic applications. For non-native speakers of English. Prerequisites: By placement examinations in ALI; accepted student to UMR. The IEP Program will assess fees for this course.

4 IEP Writing & Grammar (LEC 0.0) Introduces more complex writing applications, focusing on basic academic requirements. Focuses on more complex aspects of English grammar. For non-native speakers of English. Prerequisites: By placement examinations in ALI; accepted student to UMR. The IEP Program will assess fees for this course.

5 IEP Academic ESL Skills (LEC 0.0) Focuses on reading comprehension using academic reading materials, on development of academic vocabulary, and on listening comprehension using academic-level lectures. For non-native speakers of English. Prerequisites: By placement examinations in ALI; accepted student to UMR. The IEP Program will assess fees for this course.

6 IEP ESL Writing Workshop (LEC 0.0) Focuses on developing academic writing applications. For nonnative speakers of English. Prerequisites: By placement examinations in ALI; accepted student to UMR. The IEP Program will assess fees for this course.

7 IEP American English Articulation (LEC 0.0) Students who need specific instruction and practice in pronunciation receive heavy drills and activities to improve their articulation of American English. For non-native speakers of English. Prerequisites: By approval; accepted student to UMR. The IEP Program will assess fees for this course.

8 IEP ESL Conversation, Discussion, Presentation (LEC 0.0) Students who need intense practice in verbal activities participate in numerous varied activities to further develop their verbal skills. For non-native speakers of English. Prerequisites: By approval; accepted student to UMR. The IEP Program will assess fees for this course.

10 English As A Second Language-I (IND 0.0-6.0) Elementary English for non-English speakers. Conversation and reading. A study of English recommended for international students during their first semester in the United States.

11 English As A Second Language-II (LEC 3.0) Elementary English II for non-English speakers. A course concurrent with or subsequent to ESL I, designed to provide more intensive instruction in conversation and reading for international students.

20 Exposition And Argumentation (LEC 3.0) Practice in college level essay writing.

60 Writing And Research (LEC 3.0) Practice in techniques of analytical writing and in methods of research. Prerequisite: English 20.

65 The Technical Writer In Business and Industry (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 TCH COM 65)

70 Creative Writing (LEC 3.0) Practice in forms and techniques of poetry and prose fiction, with special attention to narrative development. Prerequisite: English 20.

75 British Literature I: The Beginnings To 1800 (LEC 3.0) A survey of works and authors that explores the way these works represent the chronological period and express the individual concerns and techniques of those authors.

80 British Literature II 1800 To Present (LEC 3.0) A survey of works and authors that explores the way these works represent the chronological period and express the individual concerns and techniques of those authors.

100 Special Problems And Readings (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.

102 World Literature I: From The Beginnings To The Renaissance (LEC 3.0) A survey of representative works and authors from the world's cultures. (Excludes British and American works).

105 American Literature: 1600 To 1865 (LEC 3.0) A chronological survey that explores the ways the literature represents the concerns of individual authors as well as the history of literature.

106 American Literature: 1865 To Present (LEC 3.0) A chronological survey that explores the ways the literature represents the concerns of individual authors as well as the history of literature.

160 Technical Writing (LEC 3.0) The theory and practice of writing technical papers and reports in the professions. Prerequisites: English 20 and second-semester junior standing.

177 Literature And Film (LEC 3.0) This course will examine intertextual connections between literature and film, in terms of such things as adaptations, narrative technique and theory, genre, theme, and ideological movements. Prerequisite: English 20.

178 Introduction To American Studies (LEC 3.0) Introduces the core subjects as well as the methods and theories that constitute the field of American Studies.

200 Special Problems And Readings (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.

202 Critical Approaches To Literature (LEC 3.0) Study and application of the terminology and critical approaches used in understanding literary forms and genres.

210 Seminar (IND 0.0-6.0) Discussion of current topics. Prerequisites: English 20 and a semester of college literature.

212 Children's Literature (LEC 3.0) Introduction to the study and teaching of children's literature. Emphasis on historical developments, multi-cultural issues and works. Computer intensive. Prerequisites: English 20 and one semester of college literature. (Co-listed with Education 212)

213 Literature For Adolescents (LEC 3.0) Primarily intended for teacher certification students. Selection and organization of materials for teaching literature to adolescents. Emphasizes literature written for adolescents and includes a unit of literature of American ethnic groups. Prerequisites: English 20 and a semester of college literature.

215 Literature By Women (LEC 3.0) A study of writings by women, emphasizing major writers and the development of a female literary tradition. Prerequisites: English 20 and a semester of college literature.

225 Science Fiction And Fantasy Literature (LEC 3.0) A study of short stories, poems, or novels which represent the development and the techniques of the science fiction-fantasy genre. Prerequisites: English 20 and a semester of college literature.

227 Fantasy Literature (LEC 3.0) A study of the development of fantasy literature in the nineteenth and twentieth centuries. The primary focus will be on novels, especially the work of J.R.R. Tolkien. Prerequisites: English 20 and a semester of college literature.

230 African American Literature (LEC 3.0) The history and development of African American literature, with special emphasis upon contemporary achievements. Prerequisites: English 20 and a semester of college literature.

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

245 American Crime And Detective Fiction (LEC 3.0) An introduction survey of American crime literature emphasizing the works of Hammett, Chandler, and James M. Cain to the more recent "true crime" tradition beginning with Capote's In Cold Blood. Prerequisites: English 20 and a semester of college literature.

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 TCH COM 260)

278 Thematic Studies In Literature And Film (LEC 3.0) Topics examine different thematic relationships between literature and film (e.g. Poe and Hitchcock, Shakespeare on film, etc.) announced at time of registration. Prerequisites: English 20 and semester of college literature, or English 177.

281 Theory Of Written Communication (LEC 3.0) Major critical and conceptual approaches to written communication theory; includes semantics, history of print media, visible language, grammars, discourse theory, socio-linguistics reception theory, stylistics. Prerequisites: English 20 and a semester of college literature.

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 Advanced Composition (LEC 3.0) Instruction and practice in writing expository essays of substantial content and skill, with particular emphasis on the rhetorical applications of recent findings in language research. Papers required will include critical analyses of literary works, and library research. Prerequisite: English 60 or 160.

303 Internship (LEC 0.0-6.0) Internship will involve students applying critical thinking skills and discipline specific knowledge in a work setting based on a project designed by the advisor and employee. Activities will vary depending on the student's background and the setting. Prerequisite: Senior status; must have completed 24 hours in the major.

305 History And Structure Of The English Language (LEC 3.0) An introduction to the study of the English language and its history through Old English, Middle English, and Modern English. Prerequisite: English 20.

306 A Linguistic Study Of Modern English (LEC 3.0) A descriptive analysis of Modern English--its phonology, grammar, and vocabulary. Prerequisite: English 20.

310 Seminar (RSD 3.0) Discussion of current topics. Prerequisites: English 20 and a semester of college literature.

311 Teaching And Supervising Writing (LEC 3.0) Students will study contemporary and traditional approaches to writing instruction. The course will give students practice in applying composition theory and research to development of teaching methods, including course syllabi and assignments. Prerequisite: 6 hours of college level writing courses.

312 Survey Of Old And Middle English Literature (LEC 3.0) Survey of Old English poetry in translation and Middle English literature (excluding Chaucer) through Malory. Special emphasis on culture and language with some attention given to modern reinterpretation of medieval works. Prerequisites: English 20 and a semester of college literature.

315 Chaucer (LEC 3.0) A study of Chaucer as a narrative poet by an intensive examination of The Canterbury Tales and Troilus and Criseyde. Prerequisites: English 20 and a semester of college literature.

330 Sixteenth Century English Literature (LEC 3.0) A survey of the poetry and prose of England

from 1500 to 1600. Prerequisites: English 20 and a semester of college literature.

331 Seventeenth Century English Literature (LEC 3.0) A study of major authors (excluding Milton) of prose and poetry in England from 1600 to 1660. Special attention will be paid to John Donne and the metaphysical poets, to Ben Jonson and the Cavalier poets, and to major prose writers such as Francis Bacon, Sir Thomas Browne, and others. Prerequisites: English 20 and a semester of college literature.

337 The Plays Of William Shakespeare (LEC 3.0) Selected comedies, tragedies, histories, and romances from early middle, and late periods of William Shakespeare's life. Prerequisites: English 20 and a semester of college literature.

345 The Restoration & Eighteenth Century (LEC 3.0) The history, development, and cultural contexts of British literature from 1660 to 1798. Prerequisites: English 20 and a semester of college literature.

350 Texts And Contexts (LEC 3.0) Examines the relationships between selected texts written or published in a given year and the context of events of that time. Also explores current critical approaches to such texts and contexts. Writing intensive and Computer intensive. Prerequisites: English 20 and a semester of college literature; junior standing.

353 British Romantic Literature (LEC 3.0) A study of the prose and poetry of the British Romantic period, 1775 to 1832. Prerequisite: English 20 and a semester of college literature.

355 Victorian Literature (LEC 3.0) A study of British prose and poetry from 1832 to 1900. Prerequisites: English 20 and a semester of college literature.

361 The British Novel I (LEC 3.0) The history, development, and cultural contexts of the British novel from the late seventeenth to the early nineteenth century. Prerequisite: English 20 and a semester college literature.

362 The English Novel II (LEC 3.0) A study of the development of the novel with major attention given to the Victorian and 20th century novelists. Prerequisites: English 20 and a semester of college literature.

368 Early American Literature (LEC 3.0) This course will follow the development of American literature from its Colonial beginnings (1614) to the rise of Romanticism (1836). The course will pay particular attention to how American writers used literature in defining and even creating the New World. Prerequisites: English 20 and a semester of college literature.

370 American Poetry I (LEC 3.0) A study of significant selected poets of, primarily, the 19th century, with special attention to theme, diction, and form, and to poetry as a compressed image of the human condition. Prerequisites: English 20 and a semester of college literature.

371 The American Renaissance (LEC 3.0) A study of American literature from Poe to Whitman. Prerequisites: English 20 and a semester of college literature.

372 American Poetry II (LEC 3.0) A study of significant selected poets of the 20th century, with special attention to theme, diction, and form, and poetry as a compressed image of the human condition. Prerequisites: English 20 and a semester of college literature.

375 The American Novel I (LEC 3.0) A study of selected, representative novels in chronological sequence from the beginning to the major realists. Prerequisites: English 20 and a semester of college literature.

376 The American Novel II (LEC 3.0) A study of selected, representative novels in chronological sequence from the major realists to the present. Prerequisites: English 20 and a semester of college literature.

378 The American Experience (LEC 3.0) Examines one or more of the subjects of the American experience such as race, gender, class, ethnicity, region, technology, religion, as it is expressed in the culture. Prerequisite: English 178.

379 Mark Twain (LEC 3.0) A study of Mark Twain's works which may include such topics as Twain's contribution to American humor and American prose style. Prerequisites: English 20 and a semester of college literature.

380 Contemporary American Literature (LEC 3.0) Studies in American prose (fiction and non-fiction), drama, poetry, and screen plays published within the last fifteen years. Prerequisites: English 20 and a semester of college literature.

382 Contemporary British Literature (LEC 3.0) Studies in British prose (fiction and non-fiction), drama, poetry, and screen plays published within the last fifteen years. Prerequisites: English 20 and a semester of college literature.

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. Consent of instructor required.

392 Advanced Writing For Science & Engineering (LEC 3.0) Focus on writing applications specifically for students in scientific or engineering fields. Primary emphases will be on producing effective and readable professional writing. Prerequisites: English 160 and 260, or graduate standing.

393 Advanced Writing For Science And Engineering II (LEC 2.0) This course -- second in a series -- focuses on writing for publication, from the initial proposal and query to the final product. Students will work on the materials they have underway with their advisers and/or research colleagues. Prerequisites: English 160 and 260, or graduate standing.

Environmental Engineering

Bachelor of Science
Master of Science

Emphasis areas at all levels in Water and Wastewater Resources Engineering; Geo-Environmental Engineering; Air Pollution and Control; Environmental Chemistry and Processes, Environmental Microbiology and Processes

Environmental engineers uphold the dual goals of minimizing our impact on the local, regional, and global environment and concurrently improving our standard of living. In this role of preserving environmental and public well being, environmental engineers face unique issues and must have a strong background in the fundamental earth sciences in order to understand complex environmental problems and then pose and design appropriate engineering solutions. As problem solvers for something as diverse as "the environment," environmental engineers also need to understand the most current technologies used in practice and have a desire to maintain a high level of learning in this rapidly evolving and developing field.

The environmental engineering work place is diverse. Consulting firms represent a large portion of the work force and many specialize in areas of drinking water and wastewater treatment. Drinking water and wastewater treatment are cornerstones of the environmental engineering field, and students' education in these areas is thorough. Turning river, lake, or even sea water into drinking water is a unique expertise and takes great understanding as each water source offers distinctive challenges. Air pollution has become a great concern on scales ranging from the global atmosphere to the indoor environment. From a fundamental understanding of the chemistry and dynamics of air pollution, students learn how human activities degrade air quality and also be able to evaluate and design control technology to reduce emissions from industry and other sources. The geology of a location greatly impacts its water resources, and comprehension of hydrogeology is important as an environmental engineer. The amount and quality of water a geologic formation can produce can predicate development in an area, and subsurface hydrology is the most critical aspect in remediation of contaminated groundwater.

The US Environmental Protection Agency, state departments of natural resources, departments of health, and the US Departments of Energy and Defense all have positions that require a wide array of skills and expertise. These skills and expertise can include all those mentioned above and specific chemical and biological processes used to mitigate unique contamination problems, as well as public health, regulation enforcement, or project management. The courses and skills learned as an undergraduate student also provide preparation for graduate studies and advanced leadership roles. Many specialized positions require a graduate education.

Within the UMR Environmental Engineering Program elective courses can focus the curriculum in any of the emphasis areas: Water and Wastewater Resources Engineering; Geo-Environmental Engineering; Air Pollution and Control; Environmental Chemistry and Processes, Environmental Microbiology and Processes. Some courses are required in each of these areas to provide breadth, which allows graduates to interact with the wide range of professionals in this particularly interdisciplinary field. Project teams may include health care professionals, city planners, developers, and all types of engineers. Additionally, the ever-developing field of environmental engineering is saturated with legal issues, many of which are yet to have precedents or legal statutes established.

Many courses include laboratory exercises in the recently built Environmental Engineering Program Laboratories in the Civil Engineering Building. In addition to new teaching laboratories, the laboratory facilities include a pilot-scale unit-operations laboratory, temperature control facilities, a roof-top greenhouse, and state of the art analytical facilities. Undergraduate-level research is encouraged and promotes participation in environmental research carried out, largely in the Environmental Research Center. In summary, the diverse curricula, interdisciplinary faculty, and superb facilities affords students an excellent opportunity for an unparalleled education and prepare you for a bright future of solving tomorrow's problems in environmental engineering.

Mission Statement

The Environmental Engineering Program will prepare students for a career in the global, interdisciplinary field of environmental engineering and for life-long development in the profession. The program's fundamental base in biological and earth sciences and development of specific engineering application skills prepares graduates to approach unique, atypical problems with a true problem-solving approach, develop solutions to benefit society and the environment, and promote these solutions.

Environmental Engineering Program Educational Objectives

Consistent with the mission of the Environmental Engineering Program, graduates of the UMR Environmental Engineering Program will have:

1) a strong and broad fundamental scientific and technical knowledge base which they will be able to apply to experimental design, to conducting experiments, and to the interpretation and analysis of experimental data;
2) the ability to apply engineering skills and work in multi-disciplinary teams to identify and formulate solutions for environmental engineering problems and to analyze and design environmental engineering projects;
3) an appreciation for the continuous acquisition of

knowledge;

4) competence in the use of the latest tools and techniques in environmental engineering practice and the ability to effectively communicate technical and professional information in written, oral, and graphical forms; and,
5) an awareness and understanding of the moral, ethical, legal, and professional obligations needed to function as part of a professional enterprise and to protect human health and welfare, and the environment in a global society.

Program Outcomes - An Overview

Consistent with the program educational objectives listed above, the UMR environmental engineering program graduates will have:

1) knowledge of contemporary issues, through broad education, which allows them to appreciate the impact of engineering solutions on humankind, and to be eager about and have the ability to engage in continued education throughout their lives;
2) knowledge of mathematics, science, and engineering, an ability to apply it with proficiency in at least four environmental engineering areas, and an understanding of the need for up to date engineering tools acquired through life-long learning;
3) ability to outline and conduct experiments in more than one environmental engineering area; to communicate effectively in multi-disciplinary environments and to analyze and interpret data and provide the results;
4) ability to carry out the design of an integrated system and its various components and processes for an environmental engineering project;
5) ability to provide leadership and effectively communicate among engineers and non-engineers when working in multi-disciplinary teams;
6) ability to define and state engineering and science problems in technical and non-technical language and to apply engineering principles to solve problems;
7) understanding of the responsibility of environmental engineers to practice in a professional and ethical manner at all times, including procurement of work, quality based selection processes, and interaction of design professionals and construction professionals;
8) ability to communicate effectively using oral, written, and graphic forms;
9) knowledge of the interactions of technology and society and their possible impacts on the practice of environmental engineering;
10) ability to utilize their background in science, humanities and engineering, and analytical and design skills when approaching ever changing engineering practice; and,
11) a sense of responsibility for the continued well-being of their alma mater and their profession.

Faculty

Professors:

Craig D. Adams[1] (John and Susan Mathes Professor), Ph.D., Kansas
Jeffrey Cawlfield[1], Ph.D., California-Berkeley
Douglas Ludlow, Ph.D., Arizona State University

Associate Professors:

Joel Burken (Undergraduate Program Coordinator), Ph.D., Iowa
Mark Fitch, Ph.D., Texas-Austin
Cesar Mendoza, Ph.D., Colorado State University
Melanie Mormile, PhD. Oklahoma
Glenn Morrison, Ph.D., California-Berkeley
David Wronkiewicz, Ph.D., New Mexico Institute of Mining and Technology

Assistant Professors:

Jianmin Wang[1], Ph.D., Delaware

[1] Registered Professional Engineer

Environmental Engineering Technical Areas And Course Listings

AREA I, WATER AND WASTEWATER RESOURCES ENGINEERING

Cv Eng 331 Hydraulics of Open Channels
Cv Eng 335 Water Infrastructure Engineering
Cv Eng 346 Management of Construction Costs
Cv Eng 380 Water Resources and Wastewater Engineering

AREA II, GEO-ENVIRONMENTAL ENGINEERING

Cv Eng 314 Geosynthetics in Engineering
Cv Eng 386 Groundwater Hydraulics
Ch Eng 351 Principles in Environmental Monitoring (Pre-req Chem, 221, 223)
Ge Eng 248 Fundamentals of GIS
Ge Eng 275 Geomorphology and Terrain Analysis
Ge Eng 333 Risk Assessment in Environmental Studies
Ge Eng 335 Environmental Geological Engineering
Ge Eng 339 Groundwater Remediation
Ge Eng 376 Mined Land Reclamation
Pet Eng 131 Drilling Practices
Geo 275 Introduction to Geochemistry
Geo 376 Aqueous Geochemistry
Geo 382 Environmental and Engineering Geophysics

AREA III, AIR POLLUTION AND CONTROL

Cv/Env Eng 368 Air Pollution Control Methods
Cv/Env Eng 390 Undergraduate Research
Chem 241 Physical Chemistry I (prereq for Chem 243)
Chem 373 Atmospheric Chemistry
Physics 337 Atmospheric Science

AREA IV, ENVIRONMENTAL CHEMISTRY AND PROCESSES

Ch Eng 245 Chemical Engineering Thermodynamics II
Ch Eng 231 Chemical Engineering Fluid Flow
Ch Eng 233 Chemical Engineering Heat Transfer
Ch Eng 371 Environmental Chemodynamics
Chem 014 Elementary Analytical Chemistry
Chem 051 Elementary Quantitative Chemical Analysis
Chem 221 Organic Chemistry I

Chem 241 Physical Chemistry
Geo 275 Introduction to Geochemistry
Geo 376 Aqueous Geochemistry

AREA V, ENVIRONMENTAL MICROBIOLOGY AND PROCESSES

Bio Sc 231 General Genetics
Bio Sc 251 Ecology
Bio Sc 321 Pathogenic Microbiology
Bio Sc 322 Pathogenic Microbiology Laboratory
Bio Sc 325 Microbiology in Bioengineering
Bio Sc 331 Molecular Genetics (prereq = Bio 231)
Bio Sc 332 Molecular Genetics Laboratory (accomp. Bio 331)
Bio Sc 370 Toxicology

Environmental Engineering Bachelor of Science

Entering freshmen desiring to study Environmental Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Environmental Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the 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 Environmental Engineering a minimum of 128 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. At least two grade points per credit hour must also be attained in all courses taken in Environmental Engineering.

Each student's program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1) All students are required to take one American history course, one economics course, one humanities course, and English 20. The history course is to be selected from History 112, History 175, History 176, or Political Science 90. The economics course may be either Economics 121 or 122. The humanities course must be selected from the approved lists for Art, English, Foreign Languages, Music, Philosophy, Speech and Media Studies, or Theater.

2) Depth requirement. Three credit hours must be taken in humanities or social sciences at the 100 level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 70 or 80 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 300 level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.

3) The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to English 20.

4) Any specific departmental requirements in the general studies area must be satisfied.

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

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

FREE ELECTIVES FOOTNOTE:

Free electives. Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.

FRESHMAN YEAR

First Semester	Credit
FE 10-Study & Careers in Eng[2]	1
Chem 1,2-Gen Chem	5
Math 14-Calculus for Engineers I	4
English 20-Expos & Argumentation	3
General Education Elective[1]	3
	16
Second Semester	
IDE 20-Eng Design w/Cmp Apps	3
Math 15-Calculus for Engineers II	4
Phy 23-Engineering Physics I	4
General Education Elective[1]	6
	17

SOPHMORE YEAR

First Semester	Credit
IDE 140-Statics & Dynamics	3
Math 22-Calculus w/Analytic Geo III	4
EnvE 261-Intro to Env Engr & Sci[3]	3
Chem 3 or Geo 275-Geochemistry	3
Bio Sc 110-General Biology	3
	16
Second Semester	**Credit**
ChE 120-Chem Eng Mat Bal	3
EnvE 262-Env Eng Bio Fund[5]	3
CE 230-Elem Fluid Mech[2]	3
Phys 24-Engineering Physics II	4
Math 204-Elem Diff Equations	3
	16

JUNIOR YEAR

First Semester	Credit
EnvE 265-Water & Wastewater Eng[3]	3
EnvE 263-Env Eng Chem Fund[5]	3
Stat 213-Applied Eng Stat	3
GE 50-Geology for Engineers	3
Communications Elective[9]	3
	15

Second Semester	Credit
Env E 367 or 368 Air Pollution	3
EnvE Depth Elective[4,6]	3
CE 234-Hydraulic Eng	4
ChE 141 or ME 227-Thermal Analysis	3
Hist 270-History of Technology or Hist 275-History of Science	3
	16

SENIOR YEAR

First Semester	Credit
CE 248-Contracts & Construc Eng	3
EnvE 210-Senior Seminar[3]	1
EnvE 369-Sanitary Design	3
EnvE Depth Elective[4,6]	3
EnvE Technical Elective[6,8]	3
Free Elective[9]	3
	16

Second Semester	Credit
EnvE 298-CE Design Project[3]	3
EnvE Depth Elective[4,6]	3
EnvE Depth Elective[4,6]	3
EnvE Technical Elective[6,8]	3
EnvE 269-Research in Env Eng	1
Free Elective[7]	3
	16

(1) All general education electives must be approved by the student's advisor. Students must comply with the general education requirements with respect to selection and depth of study. These requirements are specified in the current catalog.

(2) A grade of 'C' or better required to satisfy graduation requirements

(3) Existing CE Course that is cross-listed as Env E course.

(4) Choose 3 of the following: Env Eng 360, 361, 362, 363, 364, 367, 368 or GE 331. One class may not be used to fulfill both the air pollution requirement and a depth elective.

(5) New Courses to be developed as needed for students enrolled in program.

(6) A grade of 'C' or better may be required in CE technical and depth elective prerequisite courses. Refer to the UMR undergraduate catalog for this prerequisite information.

(7) Each student is required to take six hours of free electives in consultation with his/her academic advisor. Credits which do not count towards this requirement are deficiency courses (such as algebra and trigonometry), and extra credits in required courses. Any courses outside of Engineering and Science must be at least three credit hours.

(8) Select technical electives from approved list.

(9) Choose 1 of the following: CE 3, Engl 60, Engl 160, or SP&MS 85

Note: All Environmental Engineering students must take the Fundamentals of Engineering examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree, however, it is the first step toward becoming a registered professional engineer. This requirement is part of the UMR assessment process as described in Assessment Requirements found elsewhere in this catalog. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.

Environmental Engineering 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.

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 Senior Seminar: Engineering In A Global Society (RSD 1.0) Discussion of contemporary issues: public safety, health, and welfare; the principles of sustainable development; lifelong learning; impact of engineering solutions in a global and societal and political context; relationships with owners, contractors, and the public; public service; the Code of Ethics; and the Missouri licensing Statutes and Board Rules. Prerequisite: Senior standing. (Co-listed with Cv Eng and ArchE 210)

262 Biological Fundamentals Of Environmental Engineering (LEC 3.0) Introduction to the function of organisms related to environmental engineering. The course focuses on both the application of organisms to removing contaminants and the effects of contaminants on organisms. Prerequisites: Bio Sci 110 and preceded or accompanied by Civ/Env Eng 261. (Co-listed with Civ Eng 262)

263 Chemical Fundamentals Of Environmental Engineering (LEC 2.0 and LAB 1.0) Introduction to the key chemical and physical concepts integral to environmental systems and processes. This course provides a fundamental background in those chemical and environmental engineering principles that are common to all environmental engineering disciplines. Prerequisites: Chem 3, Physics 23, Math 22. (Co-listed with Cv Eng 263)

265 Water And Wastewater Engineering (LEC 3.0) A study of the engineering design principles dealing with the quantity, quality and treatment of water, and the quantity, characteristics, treatment and disposal of wastewater. Prerequisites: Civ Eng 230 with grade of "C" or better, Civ Eng 261. (Co-listed with Civ Eng 265)

269 Research in Environmental Engineering (LEC 1.0) Students will investigate cutting edge research in the environmental engineering field including experimental studies, current environmental policy changes, and international environmental issues. Investigation to include live re-

search seminars, reading current literature, and/or laboratory experimentation. Prerequisite: Env Eng or Civ Eng 265.

298 Senior Design Project (LEC 3.0) Open-ended design projects involving one or more areas of engineering. Planning design projects, philosophy of design, and application of engineering principles to design problems. Prerequisite: Civ Eng 248 or Arch Eng 248. (Co-listed with Arch Eng 298 and Civil Eng 298)

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

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.

360 Environmental Law And Regulations (LEC 3.0) This course provides comprehensive coverage of environmental laws and regulations dealing with air, water, wastewater, and other media. The primary focus is permitting, reporting, and compliance protocols. The course topics include U.S. and international legal systems and judicial processes, liability, enforcement, Clean Air Act, Clean Water Act (NPDES) permitting), Safe Drinking Water Act, OSGA, TSCA, RCRA, and CERCLA. Case studies will be emphasized. (Co-listed with Cv Eng 360)

361 Remediation Of Contaminated Groundwater And Soil (LEC 2.0 and LAB 1.0) Course covers current in-situ and ex-situ remediation technologies. Current literature and case studies are utilized to provide the focus for class discussions and projects. Prerequisites: Cv Eng 265, Ge Eng 337 or Graduate Standing. (Co-listed with Cv Eng 361)

362 Public Health Engineering (LEC 3.0) A comprehensive course dealing with the environmental aspects of public health. Prerequisites: Cv Eng 261 with grade of "C" or better. (Co-listed with Cv Eng 362)

363 Solid Waste Management (LEC 3.0) A systematic study of the sources, amounts and characteristics of solid wastes and methods used for their collection, reclamation, and ultimate disposal. Prerequisites: Cv Eng 261 with grade of "C" or better; or graduate standing. (Co-listed with Cv Eng 363)

364 Environmental Systems Modeling (LEC 3.0) Introductory course in modeling environmental systems. Course will focus on contaminant fate and transport in the environment. Models will be developed that will include physical, chemical and biological reactions and processes that impact this fate. Prerequisites: Env En/Cv Eng 261, Env En/Cv Eng 262 and Env En/ Cv Eng 263; or Graduate standing. (Co-listed with Cv Eng 364)

367 Introduction To Air Pollution (LEC 3.0) Introduction to the field of air pollution dealing with sources, effects, federal legislation, transport and dispersion and principles of engineering control. Prerequisite: Cv Eng 230 or equivalent; or graduate standing. (Co-listed with Cv Eng 367)

368 Air Pollution Control Methods (LEC 3.0) Study of the design principles and application of the state-ofthe-art control techniques to gaseous and particulate emissions from fossil fuel combustion, industrial and transportation sources. Prerequisite: Cv Eng 230 or equivalent; or graduate standing. (Co-listed with Cv Eng 368)

369 Sanitary Engineering Design (LEC 2.0 and LAB 1.0) Functional design of water and waste water treatment facilities. Prerequisites: Cv Eng 265 with grade of "C" or better. (Co-listed with Cv Eng 369)

380 Water Resources And Wastewater Engineering (LEC 3.0) Application of engineering principles to the planning and design of multipurpose projects involving water resources development and wastewater collection/treatment/disposal systems. Latest concepts in engineering analysis are applied to evaluation of alternative solutions. Prerequisites: Cv Eng 233, 235, 265. (Co-listed with Cv Eng 380)

382 Teaching Engineering (LEC 3.0) Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mg 370, Cp Eng 382, El Eng 382, Cv Eng 382)

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.

Etymology

Etymology Courses

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

306 Introduction To Etymology (LEC 3.0) Introduction to etymology in its broadest sense: origin of words, idioms, writing systems, etc. Prerequisite: Any foreign language course or English 20.