CIVIL ENGINEERING

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

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

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

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

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

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

Mission Statement

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

Civil Engineering Program

Educational Objectives

1. Graduates of the civil engineering program are able to apply their scientific and technical knowledge base as they progress along their career in civil engineering as evidenced by:
   A. having the preparedness and eligibility to pass the PE examination
   B. having led a small design team
   C. being able to independently assess others’ work
   D. being able to integrate their own work with the work of others
   E. keeping up with technological advances

2. Graduates of the civil engineering program are able to identify, formulate, develop, and execute practical, innovative, high quality, and cost efficient solutions for civil engineering problems as evidenced by:
   A. having led or managed a key project task from start to finish
   B. having developed a cost-effective creative design or construction ideas that was ultimately adopted
   C. having completed the design and/or the construction of a significant project that was well put-together

3. Graduates of the civil engineering program are ethical professionals who are able to function as part of a professional enterprise while protecting human health and welfare and the environment in a global society as evidenced by:
   A. an understanding of and the ability to apply design codes
   B. a recognition and an understanding of the political and regulatory environments
   C. having maintained active membership in professional societies
   D. an awareness of current trends and future opportunities in local, regional, and global issues
   E. an active involvement in organizations that promote global societal well-being

4. Graduates of the civil engineering program are professionals whose growth through continuing education, professional development, and professional licensure has positioned them to have a positive impact on regional, national, and global professional communities as evidenced by:
   A. a pursuit of advanced education
   B. keeping up with continuing education requirements
   C. having held positions of increasing responsibility in professional societies or their committees, etc.
   D. having exhibited increasing responsibility in community involvement through participation in civic/social activities and organizations
   E. positive experiences involving networking with clients
5. Graduates of the civil engineering program are professionals who develop individual and team skills to maximize the benefits of their engineering education by applying it in actual situations as evidenced by:
   A. an ability to communicate clearly across disciplines as well as across company divisions
   B. assignment to a leadership or management role
   C. an ability to resolve conflicts in a group or team setting
   D. an ability to apply their knowledge in practical situations
   E. involvement with company marketing and sales operations

Program Outcomes
Consistent with the program educational objectives listed above, the Missouri S&T civil engineering program graduate will have:
1. an ability to apply knowledge of mathematics, science, and engineering
2. an ability to design and conduct experiments, as well as to analyze and interpret data
3. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. an ability to function on multi-disciplinary teams
5. an ability to identify, formulate, and solve engineering problems
6. an understanding of professional and ethical responsibility
7. an ability to communicate effectively
8. an understanding of the impact of engineering solutions in a global, economic, environmental, and social context
9. a recognition of the need for, and an ability to engage in life-long learning
10. a knowledge of contemporary issues
11. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
12. be able to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of science
13. be able to design a system, component, or process in more than one civil engineering context
14. be able to explain basic concepts in management, business, public policy, and leadership

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

For the Bachelor of Science degree in Civil Engineering a minimum of 129 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. An average of at least two grade points per credit hour must be attained. An average of at least two grade points per credit hour must also be attained in all courses taken in Civil Engineering.

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

1. All students are required to take one American history course, one economics course, one humanities course, and ENGLISH 1120. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100 or ECON 1200. The humanities course must be selected from the approved lists for art, English, foreign languages, music, philosophy, speech and media studies, or theater.
2. Depth requirement. Three credit hours must be taken in humanities or social sciences at the 2000-level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 1180 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 4000-level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.
3. The remaining two courses are to be chosen from the list of approved humanities/social sciences courses and may include one communications course in addition to ENGLISH 1120.
4. Any specific departmental requirements in the general studies area must be satisfied.
5. Special topics and special problems and honors seminars are allowed only by petition to and approval by the student’s department chair.

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

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electives in the B.S. Civil Engineering curriculum. A maximum total of 6 credit hours of independent study is allowed. Please consult the Department’s Advising Center or your academic advisor for guidelines regarding the selection of depth and technical electives. A maximum total of 6 credit hours of independent study (CIV ENG 5000 or CIV ENG 4099) can be used as depth or technical electives in the B.S. Civil Engineering curriculum.

Course Listings by Area

### Construction Engineering
- CIV ENG 5442 Construction Planning and Scheduling Strategies 3
- CIV ENG 5445 Construction Methods 3
- CIV ENG 5446 Management Of Construction Costs 3
- CIV ENG 5448 Green Engineering: Analysis of Constructed Facilities 3
- CIV ENG 5449 Engineering and Construction Contract Specifications 3

### Materials Engineering
- CIV ENG 5112 Bituminous Materials 3
- CIV ENG 5113 Composition And Properties Of Concrete 3
- CIV ENG 5117 Asphalt Pavement Design 3
- CIV ENG 5156 Concrete Pavement Design 3

### Environmental Engineering
- CIV ENG 3615 Water And Wastewater Engineering 3
- CIV ENG 5505 Environmental Systems Modeling 3
- CIV ENG 5619 Environmental Engineering Design 3
- CIV ENG 5630 Remediation Of Contaminated Groundwater and Soil 3
- CIV ENG 5540 Environmental Law And Regulations 3
- CIV ENG 5542 Sustainability, Population, Energy, Water, and Materials 3
- CIV ENG 5550 Public Health Engineering 3
- CIV ENG 5660 Introduction To Air Pollution 3
- CIV ENG 5662 Air Pollution Control Methods 3
- CIV ENG 5665 Indoor Air Pollution 3
- CIV ENG 5670 Solid Waste Management 3

### Geotechnical Engineering
- CIV ENG 4729 Foundation Engineering 3
- CIV ENG 5715 Intermediate Soil Mechanics 3
- CIV ENG 5716 Geotechnical Earthquake Engineering 3
- CIV ENG 5729 Foundation Engineering II 3
- CIV ENG 5744 Geosynthetics in Engineering 3
- CIV ENG 5750 Transportation Applications of Geophysics 3

### Water Resources Engineering
- CIV ENG 5330 Unsteady Flow Hydraulics 3
- CIV ENG 5331 Hydraulics Of Open Channels 3
- CIV ENG 5333 Intermediate Hydraulic Engineering 3
- CIV ENG 5335 Water Infrastructure Engineering 3
- CIV ENG 5337 River Mechanics And Sediment Transport 3
- CIV ENG 5338 Hydrologic Engineering 3

### Structural Engineering
- CIV ENG 5001 Special Topics (Structural Masonry Design) 0-6
- CIV ENG 5118 Smart Materials And Sensors 3
- CIV ENG 5203 Applied Mechanics In Structural Engineering 3
- CIV ENG 5208 Structural Dynamics 3
- CIV ENG 5260 Analysis And Design Of Wood Structures 3
- CIV ENG 5265 Structural Analysis II 3
- CIV ENG 5266 Low-rise Building Analysis and Design 3
- CIV ENG 5207 Computer Methods of Structural Analysis 3
- CIV ENG 5210 Advanced Steel Structures Design 3
- CIV ENG 5220 Advanced Concrete Structures Design 3
- CIV ENG 5222 Prestressed Concrete Design 3
- CIV ENG 5231 Infrastructure Strengthening with Composites 3

### Transportation Engineering
- CIV ENG 5250 Air Transportation 3
- CIV ENG 5510 Geometric Design Of Highways 3
- CIV ENG 5513 Traffic Engineering 3

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Daniel R Abbott, Lecturer
MS University of Missouri-Rolla

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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 ENGLISH 1160, ENGLISH 3560, or SP&M S 1185.

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 Missouri S&T undergraduate catalog for this prerequisite information.

4. Choose depth electives using Guidelines for Depth and Technical Electives.


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

Guidelines for Depth and Technical Electives

Please consult the Department’s Advising Center or your academic advisor for guidelines regarding the selection of depth and technical electives. A maximum total of 6 credit hours of independent study (CIV ENG 5000 or CIV ENG 4099) can be used as depth or technical electives in the B.S. Civil Engineering curriculum.
Stuart W Baur, Associate Professor
PHD University of Missouri-Rolla

Jerry R Bayless, Professor Emeritus
MS Missouri School of Mines

Joel G Burken, Curators Distinguished Professor
PHD University of Iowa

Genda Chen, Professor
PHD State University of New York-Buffalo

Wen Deng, Assistant Professor
PHD Iowa State University

Mohamed Abdelmonem ElGawady, Associate Professor
DE Swiss Federal Institute of Technology

Dimitri Feys, Assistant Professor
PHD Ghent University, Belgium

Mark W Fitch, Associate Professor
PHD University of Texas-Austin

William Gillis, Assistant Teaching Professor
PHD Missouri University of Science and Technology

Kamal Khayat, Professor
DE University of California-Berkeley

Roger Allen LaBoube, Professor Emeritus
PHD University of Missouri-Rolla

Nicholas Ali Libre, Assistant Teaching Professor
PHD University of Tehran

Hongyan Ma, Assistant Professor
PHD Hong Kong University of Science and Technology

Cesar Mendoza, Associate Professor
PHD Colorado State University

Glenn Morrison, Professor
PHD University of California-Berkeley

John J Myers, Professor
PHD University of Texas-Austin

Daniel B Oerther, Professor
PHD University of Illinois-Urbana

David N Richardson, Associate Professor
PHD University of Missouri-Rolla

William P Schonberg, Professor
PHD Northwestern University

Richard Wesley Stephenson, Professor Emeritus
PHD Oklahoma State University

Jeffery S Thomas, Associate Teaching Professor
PHD Missouri Science & Technology

Jianmin Wang, Associate Professor
PHD University of Delaware

Chenglin Wu, Assistant Professor
PHD, PHD University of Texas-Austin, Missouri University of Science and Technology

Guirong Yan, Assistant Professor
PHD Harbin Institute of Technology, China

Xiong Zhang, Associate Professor
PHD Texas A&M University

CIV ENG 2001 Special Topics (LEC 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

CIV ENG 2002 Cooperative Engineering Training (IND 1.0-3.0)
On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisors evaluation.

CIV ENG 2003 Engineering Communications and Computations (LAB 1.0 and LEC 2.0)
Programming and software tools (including computer aided design and drafting, computer-based mathematics, word processing, spreadsheet, and presentation software) with application to and emphasis on written, graphical, and oral communication in professional civil and architectural engineering practice. (Co-listed with Arch Eng 2003).

CIV ENG 2200 Statics (LEC 3.0)
Application of the principles of mechanics to engineering problems of equilibrium. Topics include resultants, equilibrium, friction, trusses, center of gravity and moment of inertia. Prerequisites: Physics 1135 or Physics 1111 with a grade of "C" or better; Math 1215 or Math 1221 with a grade of "C" or better; preceded or accompanied by Math 2222.

CIV ENG 2210 Mechanics Of Materials (LEC 3.0)
Application of the principles of mechanics to engineering problems of strength and stiffness. Topics include stress, strain, thin cylinders, torsion, beams, and combined stresses at a point. Prerequisite: Civ Eng 2200 with grade of "C" or better.

CIV ENG 2211 Materials Testing (LAB 1.0)
Designed to assist in the teaching of mechanics of materials. Topics include strain measurement, testing machines and properties of materials. Prerequisite: Preceded or accompanied by Civ Eng 2210.

CIV ENG 2401 Fundamentals Of Surveying (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 1214 (or 1208).
CIV ENG 2601 Fundamentals Of Environmental Engineering And Science (LEC 2.0 and LAB 1.0)
Course discusses fundamental chemical, physical, and biological principles in environmental engineering and science. Topics include environmental phenomena, aquatic pollution and control, solid waste management, air pollution and control, water and wastewater treatment systems, sustainability and life cycle analyses. Prerequisites: Chem 1310, Chem 1301, or Chem 1351; Math 1214, Math 1212, or Math 1208. (Co-listed with Env Eng 2601).

CIV ENG 2602 Biological Fundamentals Of Environmental Engineering (LEC 3.0)
Introduction to the function of organisms related to environmental engineering. The course focuses on both the application of organisms to removing contaminants and the effects of contaminants on organisms. Prerequisites: Bio Sci 1113 and preceded or accompanied by Civ/Env Eng 2601. (Co-listed with Env Eng 2602).

CIV ENG 3000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

CIV ENG 3001 Special Topics (IND 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

CIV ENG 3116 Construction Materials, Properties And Testing (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: Civ Eng 2211 or Min Eng 3812; Civ Eng 3715 or both Geo Eng 1150 and Min Eng 3412.

CIV ENG 3201 Structural Analysis I (LAB 1.0 and LEC 2.0)
Loads on Structures. Analysis of statically determinate and indeterminate beams, frames and trusses. Influence lines and moving loads. Computation of deflections. Development and use of theorems of displacement methods including slope-deflection and moment distribution to analyze statically indeterminate structures. Computer solutions. Prerequisites: Civ Eng 2200, 2210 each with a grade of "C" or better. (Co-listed with Arch Eng 3201).

CIV ENG 3210 Structural Design in Metals (LEC 2.0 and LAB 1.0)
The analysis and design of structural elements and connections for buildings, bridges and specialized structures utilizing structural metals. Both elastic and plastic designs are considered. Prerequisite: Civ Eng 3201 with a grade of "C" or better. (Co-listed with Arch Eng 3210).

CIV ENG 3220 Reinforced Concrete Design (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: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 3220).

CIV ENG 3300 Engineering Fluid Mechanics (LEC 3.0)
Study of fluids at rest and in motion. Topics include fluid properties, statics of fluids, and the control volume approach to conservation of mass, momentum and energy. Applications include flow in pipes, pipe systems, external flow, and fluid flow measurements. Prerequisites: Mech Eng 2350 or Mech Eng 2340, and MATH 3304, each with a grade of "C" or better.

CIV ENG 3330 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: Civ Eng 3330 with grade of "C" or better.

CIV ENG 3334 Water Resources Engineering (LAB 1.0 and LEC 3.0)
An introduction to the engineering of water resources; flow in closed conduits, pumps, flow in open channels, surface water hydrology, rainfall analysis, hydrograph analysis, flow routing; and ground-water hydrology. Prerequisites: Civ Eng 3330 and Stat 3113 with grades of "C" or better.

CIV ENG 3335 Hydraulic Engineering (LAB 1.0 and LEC 2.0)
A study of applied hydraulics to design of systems used for collection or distribution of water. Emphasis on open channel flow, hydraulic machinery, design of supply systems, drainage systems, and hydraulic transients. Prerequisites: Civ Eng 3330 with grade of "C" or better.

CIV ENG 3500 Transportation Engineering (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 2401 and Civ Eng 2003.

CIV ENG 3615 Water And Wastewater Engineering (LEC 3.0)
A study of the engineering design principles dealing with the quantity, quality and treatment of water, and the quantity, characteristics, treatment and disposal of wastewater. Prerequisites: Civ Eng 2601 and at least junior standing. (Co-listed with Env Eng 3615).

CIV ENG 3715 Fundamentals of Geotechnical Engineering (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 1150 or Arch Eng 2103; Civ Eng 2210; and preceded or accompanied by Civ Eng 3330.

CIV ENG 3842 Fundamentals of Building Systems (LEC 3.0)
An examination of building life support systems and technology of interest to civil engineers in the planning, operation, and maintenance of buildings. Topics include human comfort, electrical, mechanical, water and waste, transportation, lighting, and other systems necessary for building utilization. Prerequisites: Physics 2135, Math 2222, and Junior Standing.
CIV ENG 4001 Special Topics (LEC 2.0 and LAB 1.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

CIV ENG 4010 Senior Seminar: Engineering In A Global Society (RSD 1.0)
Discussion of contemporary issues: public safety, health, and welfare; the principles of sustainable development; lifelong learning; impact of engineering solutions in a global and societal and political context; relationships with owners, contractors, and the public; public service; the Code of Ethics; and the Missouri licensing Statutes and Board Rules. Prerequisite: Senior standing. (Co-listed with Arch Eng and Env Eng 4010).

CIV ENG 4097 Senior Design Project (LEC 3.0)
Open-ended design projects involving one or more areas of engineering. Planning design projects, philosophy of design, and application of engineering principles to design problems. Prerequisite: Civ Eng 4448 or Arch Eng 4448. (Co-listed with Arch Eng 4097 and Env Eng 4097).

CIV ENG 4099 Undergraduate Research (IND 0.0-6.0)
Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

CIV ENG 4447 Ethical, Legal and Professional Engineering Practice (LEC 2.0)
Discussions of laws concerning contracts, torts, agencies, real property, partnerships, and corporations. The purposes and implications of the engineering registration law, the effect of legal, ethical and marketing considerations of the practice of Civil Engineering. Prerequisite: Junior standing. (Co-listed with Arch Eng 4447).

CIV ENG 4448 Fundamentals Of Contracts And Construction Engineering (LEC 3.0)
A study of the concepts and techniques used in large construction projects for the preparation of engineer service contracts, the development of a project manual, detailed and conceptual cost estimating, and construction scheduling analysis. Prerequisite: Senior Standing. (Co-listed with Arch Eng 4448).

CIV ENG 4729 Foundation Engineering (LEC 3.0)
The effect of subsoil conditions on the behavior and choice of foundations. Topics include geotechnical explorations and the design of foundations, which includes the selection of foundation types, the analysis of bearing capacity and settlement of shallow/deep foundations, and retaining walls. Prerequisite: Civ Eng 3715.

CIV ENG 5000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

CIV ENG 5001 Special Topics (LEC 0.0 and LAB 0.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

CIV ENG 5010 Seminar (LEC 1.0)
Discussion of current topics. Prerequisite: Senior standing.

CIV ENG 5070 Teaching Engineering (LEC 3.0)
Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mgt 5070, Env Eng 5070, Comp Eng 5070, Elec Eng 5070).

CIV ENG 5112 Bituminous Materials (LEC 2.0 and LAB 1.0)
Properties, types, and grades of bituminous materials are presented. Emphasis is placed on usage, distress, surface treatment design, and asphalt concrete mix properties, behavior, design manufacture, and construction. Prerequisite: Preceded or accompanied by Civ Eng 3116.

CIV ENG 5113 Composition And Properties Of Concrete (LEC 3.0)
Properties of plastic and hardened concrete and the influence of cements, aggregates, water and admixtures upon these properties. The microstructure of cement gel and other factors are related to the behavior of hardened concrete under various types of loading and environments, drying shrinkage, creep and relaxation, fatigue, fracture, and durability. Introduction to statistical quality control of concrete production. Prerequisite: Civ Eng 3116 with a grade of "C" or better.

CIV ENG 5117 Asphalt Pavement Design (LEC 3.0)
Structural design of flexible pavements including loading characteristics, properties of pavement components, stress distribution, and the effects of climatic variables on design criteria. Prerequisite: Civ Eng 3116 with a grade of "C" or better.

CIV ENG 5118 Smart Materials And Sensors (LEC 2.0 and LAB 1.0)
Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multidisciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior Standing and Math 3304. (Co-listed with Aero Eng 5229, Mech Eng 5229 and Elec Eng 5270).

CIV ENG 5156 Concrete Pavement Design (LEC 3.0)
Design of rigid pavements including loading characteristics, properties of pavement components, stress distribution, and the effects of climatic variables on design criteria. Prerequisite: Civ Eng 3116 with a grade of "C" or better.

CIV ENG 5158 Composition And Properties Of Concrete (LEC 2.0 and LAB 1.0)
A study of the basic relationships involved in the mechanics of structures. Topics include basic elasticity, failure criteria, fundamental theories of bending and buckling of plates and cylindrical shells for practical application in analysis and design of bridge, building floors, and shell roofs. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 5203).
**CIV ENG 5205 Structural Analysis II** (LEC 3.0)  
Classical displacement and force methods applied to structures of advanced design. Analysis of indeterminate structures such as continuous beams, arches, cables, and two and three dimensional frames, and trusses. Analysis of indeterminate structures involving temperature and support settlements effects. Prerequisites: Civ Eng 3201 or Arch Eng 3201. (Co-listed with Arch Eng 5205).

**CIV ENG 5206 Low-Rise Building Analysis and Design** (LEC 3.0)  
Characterization of various design loads, load combinations, general methodology of structural designs against lateral loads, code-oriented design procedures, distribution of lateral loads in structural systems, application of the International Building Code in design of loadbearing wall systems, building frame system and moment-resisting frame systems. Prerequisite: Preceded and/or accompanied by Civ -Arch Eng 3210 or Civ-Arch Eng 3220. (Co-listed with Arch Eng 5206).

**CIV ENG 5207 Computer Methods of Structural Analysis** (LEC 3.0)  
Force and displacement matrix methods and computer methods applied to structural analysis. Analysis of indeterminate structures such as continuous beams, and two and three dimensional frames and trusses. Analysis of indeterminate structures involving temperature and support settlements effects using computer methods formulation. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 5207).

**CIV ENG 5208 Structural Dynamics** (LEC 3.0)  
This course deals with fundamental concepts and structural responses under dynamic loads. Hand calculations and computer methods are developed. Specific topics include resonance, beating phenomenon, equation of motion, dynamic properties, frequencies and mode shapes, and modal and Ritz analyses. Prerequisites: Mech Eng 2350 or equivalent; Civ/Arch Eng 3201 or equivalent. (Co-listed with Arch Eng 5208).

**CIV ENG 5210 Advanced Steel Structures Design** (LEC 3.0)  
The design of structural steel systems into a final integrated structure. Plate girders, composite systems, stability, connections, rigid frames, single and multistory buildings, and similar type problems of interest to the student. Use of the computer as a tool to aid in the design will be emphasized. Prerequisite: Civ Eng 3210 with a grade of "C" or better. (Co-listed with Arch Eng 5210).

**CIV ENG 5220 Advanced Concrete Structures Design** (LEC 3.0)  
The design of structural concrete systems into a final integrated structure. Two-way slabs, long columns, connections, and discontinuity regions, deflections and cracking of beams and slabs, ACI design criteria, and similar type problems of interest to the student. Use of the computer as a tool to aid in the design will be emphasized. Prerequisite: Civ Eng 3220 with a grade of "C" or better. (Co-listed with Arch Eng 5220).

**CIV ENG 5222 Prestressed Concrete Design** (LEC 3.0)  
Behavior of steel and concrete under sustained load. Analysis and design of pre-tensioned and post-tensioned reinforced concrete members and the combining of such members into an integral structure. Prerequisite: Civ Eng 3220 with a grade of "C" or better. (Co-listed with Arch Eng 5222).

**CIV ENG 5231 Infrastructure Strengthening with Composites** (LEC 3.0)  
The course presents composite materials and includes principles of reinforcing and strengthening for flexure, shear, and ductility enhancement in buildings and bridges. It covers the design of existing members strengthened with externally bonded laminates and near surface mounted composites. Case studies are discussed. Prerequisites: Civ Eng / Arch Eng 3201, Civ Eng / Arch Eng 3220. (Co-listed with Arch Eng 5231).

**CIV ENG 5250 Air Transportation** (LAB 1.0 and LEC 2.0)  
Runway configuration, airfield capacity, geometrics and terminal layout and design. Aircraft performance; navigation and air traffic control; airport planning and design; airline operations; aviation systems planning. Prerequisite: Civ Eng 3500 with a grade of "C" or better.

**CIV ENG 5260 Analysis And Design Of Wood Structures** (LEC 3.0)  
A critical review of theory and practice in design of modern wood structures. Effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design; development of design criteria and their application to plane and three dimensional structures. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 5260).

**CIV ENG 5270 Structural Masonry Design** (LEC 3.0)  
Review of the theory and practice of analyzing low-rise masonry structures, materials and assembly types, constructability considerations, structural masonry components, repair and strengthening, and model code requirements to ensure adequate load resisting buildings. Prerequisites: Arch Eng 3201 or Civ Eng 3201. (Co-listed with Arch Eng 5270).

**CIV ENG 5300 Unsteady Flow Hydraulics** (LEC 3.0)  
The study of unsteady flow and its effect on closed water systems and in open channels. Prerequisites: Civ Eng 3330 with a grade of "C" or better.

**CIV ENG 5331 Hydraulics Of Open Channels** (LEC 3.0)  
The phenomena accompanying the flow of water in open channels, such as uniform and varied flow, critical conditions, backwater curves, hydraulic jump, hydraulic drop and applications are studied in detail. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

**CIV ENG 5332 Transport Processes in Environmental Flows** (LEC 3.0)  
Dynamics, mixing and contaminant transport in surface water bodies, including rivers and lakes. Buoyancy modifications to the mixing and dynamics of pollutant discharges and surface water bodies. Transport of sediments. Exchange processes at the air/water and sediment/water interfaces. Prerequisite: At least a "C" in Civ Eng 3330.

**CIV ENG 5333 Intermediate Hydraulic Engineering** (LEC 3.0)  
Application of fluid mechanics principles to the design. Kinematics of fluid motion, conservation of mass, linear and angular momentum, and energy. Requirements for similarity of fluid flow. Introduction to dynamics of fluid flows and viscous incompressible flows. Prerequisite: Civ Eng 3330 with a grade of "C" or better.
CIV ENG 5335 Water Infrastructure Engineering (LAB 1.0 and LEC 2.0)
Fundamental principles underlying comprehensive water infrastructure development; sanitary sewers, sanitary treatment facilities, stormwater sewers, stormwater detention, water power development, and hydraulic structures. The student is responsible for the planning and design of a water infrastructure development project. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

CIV ENG 5337 River Mechanics And Sediment Transport (LEC 3.0)
Formation of rivers and the laws governing river regulation and improvements, including navigation and flood protection. Principles governing sediment transport. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

CIV ENG 5338 Hydrologic Engineering (LEC 3.0)
A study of current up-to-date hydrologic techniques involving design of hydrologic input for bridges, culverts, reservoirs. Techniques involve extreme value statistics, model hydrographs, routing, etc. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

CIV ENG 5339 Water Resources And Wastewater Engineering (LEC 3.0)
Application of engineering principles to the planning and design of multipurpose projects involving water resources development and wastewater collection/treatment/disposal/systems. Latest concepts in engineering analysis are applied to evaluation of alternative solutions. Prerequisites: Civ Eng 3333, 3335, 3615. (Co-listed with Env Eng 5360).

CIV ENG 5346 Legal Aspects Of Boundary Surveying (LEC 3.0)
The U.S. Public Land Survey System (USPLSS): original GLO survey instructions and procedures. Resurveys on the USPLSS law, standards, procedures with emphasis on Missouri. Rights in real property; statute, case and administrative law applied to boundaries. Simultaneous and sequence conveyances. Unwritten rights in real property. Riparian boundaries. Writing and interpreting boundary descriptions. Land surveyor duties and responsibilities. Prerequisite: Civ Eng 2401 with grade of "C" or better.

CIV ENG 5347 Surveying Systems (LEC 3.0)
Celestial observations for azimuths. Introduction to State Plane Coordinate systems. Theory and calculations. Route surveying and geometrics, horizontal, spiral and vertical curves. Surveying aspects of residential and commercial subdivision design: lot layout, rights of way, easements, setbacks, platting, planning and zoning constraints, application of surveying software. Instrumentation: total stations, electronic levels, instrument calibrations. Prerequisite: Civ Eng 2401 with grade of "C" or better.

CIV ENG 5348 Geometric Design Of Highways (LEC 2.0 and LAB 1.0)
Development and applications of concepts of geometric design for rural and urban highways. Design controls and criteria; elements of design, including sight distance, horizontal and vertical alignment; cross-section elements; highway types; intersection design elements; types of interchanges and interchange design elements; grade separations and clearance; development of visual elements. Prerequisite: Civ Eng 3500 with grade of "C" or better.

CIV ENG 5349 Traffic Engineering (LEC 3.0)
Driver, vehicle, and roadway characteristics; traffic control devices; traffic studies; intersection capacity, intersection design, traffic safety, and evaluation of traffic improvements. Traffic laws and ordinances, traffic engineering, traffic circulation, parking design, and forecasting traffic impacts. Prerequisite: Civ Eng 3500 with a grade of "C" or better.

CIV ENG 5350 Advanced Traffic Operations and Capacity Analysis (LEC 3.0)
This course will introduce students to advanced traffic operation and capacity analysis as applied to an urban highway network. It will focus on the operations and management of freeway and arterials where a signalized intersection is one of the key elements affecting traffic flow operation and determining highway capacity. Prerequisite: Civ Eng 5513.
CIV ENG 5605 Environmental Systems Modeling (LEC 3.0)
Introductory course in modeling environmental systems. Course will focus on contaminant fate and transport in the environment. Models will be developed that will include physical, chemical and biological reactions and processes that impact this fate. Prerequisites: Env Eng/Civ Eng 2601, Env Eng/Civ Eng 2602 and Env Eng/Civ Eng 3603; or graduate standing. (Co-listed with Env Eng 5605).

CIV ENG 5619 Environmental Engineering Design (LEC 2.0 and LAB 1.0)
Functional design of water and wastewater facilities and other environmental cleanup systems. Prerequisite: Civ Eng 3615 or Env Eng 3615. (Co-listed with Env Eng 5619).

CIV ENG 5630 Remediation of Contaminated Groundwater and Soil (LEC 2.0 and LAB 1.0)
Course covers current in-situ and ex-situ remediation technologies. Current literature and case studies are utilized to provide the focus for class discussions and projects. Prerequisites: Civ Eng 3615 or Env Eng 5237 or Graduate Standing. (Co-listed with Env Eng 5630).

CIV ENG 5635 Phytoremediation and Natural Treatment Systems: Science and Design (LEC 3.0)
Students learn the scientific basics of chemical transport in soil and groundwater and learn fundamental plant physiology and processes. Students then learn how these processes are utilized in design of phytoremediation and natural treatment systems, including the most up to date literature and design guidance available. Prerequisites: Civ Eng 3615 or Env Eng 3615. (Co-listed with Env Eng 5635).

CIV ENG 5640 Environmental Law And Regulations (LEC 3.0)
This course provides comprehensive coverage of environmental laws and regulations dealing with air, water, wastewater, and other media. The primary focus is permitting, reporting, and compliance protocols. The course topics include U.S. and international legal systems and judicial processes, liability, enforcement, Clean Air Act, Clean Water Act (NPDES) permitting, Safe Drinking Water Act, OSGA, TSCA, RCRA, AND CERCLA. Case studies will be emphasized. (Co-listed with Env Eng 5640).

CIV ENG 5642 Sustainability, Population, Energy, Water, and Materials (LEC 3.0)
This course will examine the concepts regarding the continued advancement of humankind while maintaining our ecological niche on earth. Key topics include: population growth, poverty, and impacts of development; energy consumption, sources, storage, conservation and policy; water quality and quantity; materials and building; and policy implications. Prerequisite: Senior or graduate standing. (Co-listed with Env Eng 5642 and Arch Eng 5642).

CIV ENG 5650 Public Health Engineering (LEC 3.0)
A comprehensive course dealing with the environmental aspects of public health. Prerequisite: Civ Eng 2601 with a grade of "C" or better. (Co-listed with Env Eng 5650).

CIV ENG 5660 Introduction To Air Pollution (LEC 3.0)
Introduction to the field of air pollution dealing with sources, effects, federal legislation, transport and dispersion and principles of engineering control. Prerequisite: Civ Eng 3330; or graduate standing. (Co-listed with Env Eng 5660).

CIV ENG 5662 Air Pollution Control Methods (LEC 3.0)
Study of the design principles and application of the state-of-the-art control techniques to gaseous and particulate emissions from fossil fuel combustion, industrial and transportation sources. Prerequisite: Civ Eng 3330; or graduate standing. (Co-listed with Env Eng 5662).

CIV ENG 5665 Indoor Air Pollution (LEC 3.0)
By developing a practical understanding of indoor air pollution sources, physics, chemistry and consequences, students will learn how radon, cigarette smoke, VOCs from furnishings, and so forth affect indoor air quality and apply engineering analyses to specify ventilation rates, choose furnishings and minimize occupant exposure to pollutants. Prerequisite: Civ Eng 2601 or Mech Eng 5571 or Graduate Status. (Co-listed with Env Eng 5665 and Arch Eng 5665).

CIV ENG 5670 Solid Waste Management (LEC 3.0)
A systematic study of the sources, amounts and characteristics of solid wastes and methods used for their collection, reclamation, and ultimate disposal. Prerequisite: Civ Eng 2601 with grade of "C" or better; or graduate standing. (Co-listed with Env Eng 5670).

CIV ENG 5702 Geomatics (LEC 3.0)
Horizontal and vertical geodetic datums and networks. Theory, calculations and applications of State Plane Coordinate Systems. Introduction to Geographic and Land Information Systems: hardware and software issues; data quality and accuracy; resource, environmental, cadastral and governmental applications; databases; GIS/LIS trends. Introduction to Global Positioning Systems (GPS): Project planning, data collection, data processing and network adjustment applications, Kinematic and RealTime GPS applications, hardware and software options and costs. Prerequisite: Civ Eng 2401 with grade of "C" or better.

CIV ENG 5715 Intermediate Soil Mechanics (LEC 3.0)
General principles of soil mechanics and their applications, including mineralogy, soil structure, flow through porous media, shear strength, slope stability and consolidation. Prerequisites: Civ Eng 3715 with grade of "C" or better.

CIV ENG 5716 Geotechnical Earthquake Engineering (LEC 3.0)
Geotechnical earthquake hazards and mitigations, damage to structures, plate tectonics, seismicity, wave propagation, characterization of ground motions, theory of vibrations (1-DOF), effect of local soil conditions on ground response, development of design ground motions, liquefaction, dynamic lateral earth pressures and slope stability/deformation. Prerequisites: Civ Eng 3715 with a grade of "C" or better.

CIV ENG 5729 Foundation Engineering II (LEC 3.0)
Classical earth pressure theories. Analysis of shallow and deep foundations to include bearing capacity and settlement of footings, rafts, piles, and drilled piers. Analysis of stability and design of retaining walls and anchored bulkheads. Prerequisites: Civ Eng 4729 with a grade of "C" or better. (Co-listed with Arch Eng 5729).
**CIV ENG 5744 Geosynthetics in Engineering** (LEC 3.0)
Geotechnical principles are applied to design of geosynthetic systems for foundation support, earth retention, drainage, and disposal of hazardous conventional wastes. Geosynthetic testing and identification. Emphasis is on design of geosynthetic earth reinforcement, roadway stabilization, filters, and waste containment systems. Prerequisite: Civ Eng 3715 with grade of "C" or better.

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**CIV ENG 5750 Transportation Applications of Geophysics** (LEC 2.0 and LAB 1.0)
Overview of geophysical and non-destructive test methods that are commonly used to investigate transportation structures and their foundations. Emphasis is placed on bridge system substructure, bridge system superstructure, pavement, roadway subsidence, subsurface characterization and vibration measurements. Prerequisite: Junior level standing or higher. (Co-listed with Geo Eng 5761 and Geophys 5761).