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 seven areas listed above. 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 identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies
8. design a system, component, or process in at least two civil engineering contexts
9. explain basic concepts in project management, business, public policy, and leadership; analyze issues in professional ethics, and explain the importance of professional licensure

Civil Engineering Bachelor of Science

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.

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.

Freshman Year

First Semester	Credits	Second Semester	Credits
FR ENG 1100[2]	1	MECH ENG 1720	3
CHEM 1310 & CHEM 1319	5	MATH 1215	4
MATH 1214 or 1211	4	PHYSICS 1135	4
ENGLISH 1120	3	Gen Ed Elective[1]	3
HISTORY 1200, or 1300, or 1310, or POL SCI 1200[1]	3	Gen Ed Elective[1]	3
	16		**17**

Sophomore Year

First Semester	Credits	Second Semester	Credits
CIV ENG 2401[2]	3	MECH ENG 2350	2
CIV ENG 2003[2]	3	STAT 3113	3
CIV ENG 2200[2]	3	GEO ENG 1150	3
MATH 2222	4	CIV ENG 2210[2]	3
PHYSICS 2135	4	CIV ENG 2211[2]	1
		MATH 3304	3
	17		**15**

Junior Year

First Semester	Credits	Second Semester	Credits
ENG MGT 1210[2]	2	CIV ENG 3116[2]	3
CIV ENG 3201[2]	3	CIV ENG 3842[2]	3
CIV ENG 3715[2]	3	CIV ENG 3500[2]	3
CIV ENG 3330[2]	3	CIV ENG 3334[2]	4
CIV ENG 2601[2]	3	CIV ENG 4448[2]	3
ENGLISH 1160, or 3560, or SPM S 1185[1]	3		
	17		**16**

Senior Year

First Semester	Credits	Second Semester	Credits
CIV ENG 4010[2]	1	CIV ENG 4097[2]	3
(2) CIV ENG Depth Electives[3,4]	6	CIV ENG Tech Elective[3,5]	3
CIV ENG 3210[2]	3	CIV ENG Depth Elective[3,4]	3
General Education Humanities and Fine Arts Elective[1]	3	Gen Ed Elective[1]	3
CIV ENG 3220[2]	3	CIV ENG Tech Elective[3,5]	3
	16		**15**

Total Credits: 129

1. Gen Ed electives must fulfill the Missouri S&T general education requirements as applicable to the students catalog year.
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.
5. Choose technical electives using Guidelines for Depth and Technical Electives.

Note: All Civil Engineering students must take the Fundamentals of Engineering examination prior to graduation. A passing grade on

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

Guidelines for Depth and Technical Electives

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

Course Listings by Area

Construction Engineering

CIV ENG 5441	Professional Aspects Of Engineering Practice	3
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
CIV ENG 5451	Information Technology Applications in the Construction Industry	3
CIV ENG 5452	Pre-Project Planning and Feasibility Studies	3
CIV ENG 5453	Logistics for Construction Industry	3
CIV ENG 5454	Construction Technology for High-Rise Buildings	3
CIV ENG 5455	Construction Industry Best Practices	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 5118	Smart Materials and Sensors	3
CIV ENG 5156	Pavement Design	3

Environmental Engineering

CIV ENG 3615	Water And Wastewater Engineering	3
CIV ENG 5605	Environmental Systems Modeling	3
CIV ENG 5619	Environmental Engineering Design	3
CIV ENG 5630	Remediation of Contaminated Groundwater and Soil	3
CIV ENG 5635	Phytoremediation and Natural Treatment Systems: Science and Design	3
CIV ENG 5640	Environmental Law And Regulations	3
CIV ENG 5642	Sustainability, Population, Energy, Water, and Materials	3
CIV ENG 5650	Public Health Engineering	3
CIV ENG 5660	Introduction To Air Pollution	3
CIV ENG 5662	Air Pollution Control Methods	3
CIV ENG 5665	Indoor Air Pollution	3
CIV ENG 5670	Solid Waste Management	3

Geotechnical Engineering

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

Water Resources Engineering

CIV ENG 5330	Unsteady Flow Hydraulics	3
CIV ENG 5331	Hydraulics Of Open Channels	3
CIV ENG 5332	Transport Processes in Environmental Flows	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
CIV ENG 5360	Water Resources And Wastewater Engineering	3

Structural Engineering

CIV ENG 5118	Smart Materials and Sensors	3
CIV ENG 5203	Applied Mechanics In Structural Engineering	3
CIV ENG 5205	Structural Analysis II	3
CIV ENG 5206	Low-Rise Building Analysis and Design	3
CIV ENG 5207	Computer Methods of Structural Analysis	3
CIV ENG 5208	Structural Dynamics	3
CIV ENG 5209	Wind Engineering	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
CIV ENG 5260	Analysis And Design Of Wood Structures	3
CIV ENG 5270	Structural Masonry Design	3

Transportation Engineering

CIV ENG 5250	Air Transportation	3
CIV ENG 5510	Geometric Design Of Highways	3
CIV ENG 5513	Traffic Engineering	3
CIV ENG 5515	Advanced Traffic Operations and Capacity Analysis	3

Minor in Construction Engineering & Management

The minor in Construction Engineering and Management will require 15 credits of coursework from the following lists. Some courses may also count toward the students' undergraduate degree. To maintain the value of the minor, we require students to complete a minimum of 9 credits in addition to any classes counting towards the students undergraduate and/or graduate degree(s).

3 Credit Hours from the following List:

CIV ENG 2451	Engineering Drawings and Tools	3
CIV ENG 4448	Fundamentals Of Construction Engineering & Management	3
ENG MGT 3320	Introduction to Project Management	3

6 Credit Hours from the following List:

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 5449	Engineering and Construction Contract Specifications	3
ENG MGT 5316	Safety Engineering Management	3
ENG MGT 5610	Advanced Facilities Planning & Design	3
BUS 3205		1.5

6 Credit Hours from the following List:

CIV ENG 5451	Information Technology Applications in the Construction Industry	3
CIV ENG 5452	Pre-Project Planning and Feasibility Studies	3
CIV ENG 5453	Logistics for Construction Industry	3
CIV ENG 5454	Construction Technology for High-Rise Buildings	3

CIV ENG 5455	Construction Industry Best Practices	3
ARCH ENG 2103	Architectural Materials And Methods Of Construction	3

Daniel R Abbott, Lecturer
MS University of Missouri-Rolla

Magdy Abdelrahman, Professor[1]
PHD University of Illinois at Urbana-Champaign

Stuart W Baur, Associate Professor[4]
PHD University of Missouri-Rolla

Joel G Burken, Curators Distinguished Professor[1,5]
PHD University of Iowa

Genda Chen, Professor[1]
PHD State University of New York at Buffalo

Islam El-adaway, Professor[1]
PHD Iowa State University

Mohamed Abdelmonem ElGawady, Professor
DE Swiss Federal Institute of Technology

Dimitri Feys, Associate Professor
PHD Ghent University, Belgium

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Guirong Yan, Professor
PHD Harbin Institute of Technology, China

Xiong Zhang, Professor[1]
PHD Texas A&M University

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

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

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

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

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

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

CIV ENG 2401 Fundamentals Of Surveying (LAB 1.0 and LEC 2.0)
Surveying fundamentals: leveling, directions, angles, distances, errors, traverse calculations and basic adjustments. Fundamentals of horizontal curves. Lab exercises include leveling, traversing, horizontal circular curve layout and building layout. Prerequisite: Math 1211 or preceded or accompanied by Math 1214 or 1208.

CIV ENG 2451 Engineering Drawings and Tools (LEC 3.0)
Introduction to the basics of reading and developing engineering drawings including mapping and coordinating the different trades through the use of Autodesk's AutoCAD and Revit software as well as ESRI's ArcGIS package.

CIV ENG 2601 Fundamentals of Environmental Engineering and Science (LAB 1.0 and LEC 2.0)
Course discusses fundamental chemical, physical, and biological principles in environmental engineering and science. Topics include environmental phenomena, aquatic pollution and control, solid waste management, air pollution and control, water and wastewater treatment systems, sustainability and life cycle analyses. Prerequisites: Chem 1301, Chem 1310, or Chem 1351; Math 1208, Math 1211, or Math 1214. (Co-listed with Env Eng 2601).

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

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

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

CIV ENG 3116 Construction Materials, Properties And Testing (LAB 1.0 and LEC 2.0)
A study of the origin, production, uses and general properties of construction materials accompanied by selected laboratory tests and demonstrations. Prerequisites: Math 1215, Physics 1135, Civ Eng 2211 or Min Eng 3812; Civ Eng 2210 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 (LAB 1.0 and LEC 2.0)
The analysis and design of structural elements and connections for buildings, bridges and specialized structures utilizing structural metals. Both elastic and plastic designs are considered. Prerequisite: Civ Eng 3201 with a grade of "C" or better. (Co-listed with Arch Eng 3210).

CIV ENG 3220 Reinforced Concrete Design (LAB 1.0 and LEC 2.0)
The analysis and design of reinforced concrete beams, slabs, columns, retaining walls and footings by the elastic and ultimate strength methods, including an introduction to the design of prestressed concrete. Introduction to use of computers as a design aid tool. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 3220).

CIV ENG 3330 Engineering Fluid Mechanics (LEC 3.0)
Study of fluids at rest and in motion. Topics include fluid properties, statics of fluids, and the control volume approach to conservation of mass, momentum and energy. Applications include flow in pipes, pipe systems, external flow, and fluid flow measurements. Prerequisites: A grade of "C" or better in Math 3304 and in one of Mech Eng 2340, Mech Eng 2350 or Mech 2360.

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: A grade of "C" or better in Civ Eng 3330 and in one of Stat 3111, Stat 3113, Stat 3115, or Stat 3117.

CIV ENG 3500 Transportation Engineering (LAB 1.0 and LEC 2.0)
A study of operating characteristics of transportation modes including highways, railways, inland waterways, airways, and pipelines. Consideration of traffic control devices, safety, system capacity, design of routes, planning of urban transportation systems, and economic evaluation of transportation alternatives. Prerequisites: Civ Eng 2401 and Civ Eng 2003.

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

CIV ENG 3715 Fundamentals of Geotechnical Engineering (LAB 1.0 and LEC 2.0)
Analysis of geotechnical systems including soil classification, index properties, permeability, compressibility and shear strength. Basic geotechnical engineering design principles as they apply to civil constructed facilities, such as analysis of foundations and earth structures. Laboratory determination of the basic properties of soils. Prerequisite: Math 1215, Physics 1135, Geo Eng 1150 or Geology 1110; 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 (LAB 1.0 and LEC 2.0)
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; Senior standing.

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 4321 Drone Mapping and Photogrammetry (LAB 1.0 and LEC 2.0)
The course will start with an overview of the basic knowledge required for passing the FAA Part 107 Remote Pilots Knowledge Test for small UAS operators, including UAS mapping technology and its rules and regulations, airspace classification, and reading aeronautical charts. The principles of UAS data collection are explained along with hands-on practice in flight planning and execution, as well as processing collected imagery. Prerequisites: Basic computer knowledge. Either Civ Eng 2401 or Geo Eng 3148 or equivalent. (Co-listed with Geo Eng 4321, Geology 4321, Geophys 4321, Min Eng 4321).

CIV ENG 4448 Fundamentals Of Construction Engineering & Management (LEC 3.0)
A study of the concepts and techniques used in large construction projects for the preparation of engineer service contracts, detailed and conceptual cost estimating, and construction scheduling analysis. Prerequisite: Junior Standing, Math 1215, and Physics 1135. (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 (LAB 0.0 and LEC 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 (LAB 1.0 and LEC 2.0)
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 (LAB 1.0 and LEC 2.0)
Smart structures with fiber reinforced polymer (FRP) composites and advanced sensors. Multi-disciplinary topics include characterization, performance, and fabrication of composite structures; fiber optic, resistance, and piezoelectric systems for strain sensing; and applications of smart composite structures. Laboratory and team activities involve manufacturing, measurement systems, instrumented structures, and performance tests on a large-scale smart composite bridge. Prerequisites: Senior standing and Math 3304. (Co-listed with Aero Eng 5229, Mech Eng 5229 and Elec Eng 5270).

CIV ENG 5156 Pavement Design (LEC 3.0)
Principles of flexible and rigid pavement design including stress analysis, load and environmental effects and material characteristics; Introduction to AASHTO, PCA, AI, FAA, MEPDG, and other design methods; design of overlays and drainage system; pavement performance evaluation and rehabilitation techniques. Prerequisite: Civ Eng 3116 with a grade of "C" or better.

CIV ENG 5181 Building Materials Physics (LEC 3.0)
Examines the effects of heat, air and moisture on the building envelop through engineering methods with examples and exercises. Prerequisite: Civ Eng 3330 or Mech Eng 2527. (Co-listed with Arch Eng 5181).

CIV ENG 5203 Applied Mechanics In Structural Engineering (LEC 3.0)
A study of the basic relationships involved in the mechanics of structures. Topics include basic elasticity, failure criteria, fundamental theories of bending and buckling of plates and cylindrical shells for practical application in analysis and design of bridge, building floors, and shell roofs. Prerequisite: Civ Eng 3201 with grade of "C" or better. (Co-listed with Arch Eng 5203).

CIV ENG 5205 Structural Analysis II (LEC 3.0)
Classical displacement and force methods applied to structures of advanced design. Analysis of indeterminate structures such as continuous beams, arches, cables, and two and three dimensional frames, and trusses. Analysis of indeterminate structures involving temperature and support settlements effects. Prerequisites: Civ Eng 3201 or Arch Eng 3201. (Co-listed with Arch Eng 5205).

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

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

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

CIV ENG 5209 Wind Engineering (LEC 3.0)
Introduction of wind engineering to advanced undergraduate and entry-level graduate students through structural engineering and atmospheric science fundamentals. Co-listed with Arch Eng 5001. Prerequisites: A grade of "C" or better in Civ Eng 3201.

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 perfomance; navigation and air traffic control; airport planning and design; airline operations; aviation systems planning. Prerequisite: Civ Eng 3500 with a grade of "C" or better.

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

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

CIV ENG 5330 Unsteady Flow Hydraulics (LEC 3.0)
The study of unsteady flow and its effect on closed water systems and in open channels. Prerequisites: Civ Eng 3330 with a grade of "C" or better.

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

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

CIV ENG 5333 Intermediate Hydraulic Engineering (LEC 3.0)
Application of fluid mechanics principles to the design. Kinematics of fluid motion, conservation of mass, linear and angular momentum, and energy. Requirements for similarity of fluid flow. Introduction to dynamics of fluid flows and viscous incompressible flows. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

CIV ENG 5335 Water Infrastructure Engineering (LAB 1.0 and LEC 2.0)
Fundamental principles underlying comprehensive water infrastructure development; sanitary sewers, sanitary treatment facilities, stormwater sewers, stormwater detention, water power development, and hydraulic structures. The student is responsible for the planning and design of a water infrastructure development project. Prerequisite: Civ Eng 3330 with a grade of "C" or better.

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

CIV ENG 5338 Hydrologic Engineering (LEC 3.0)
A study of current up-to-date hydrologic techniques involving design of hydrologic input for bridges, culverts, reservoirs. Techniques involve extreme value statistics, model hydrographs, routing, etc. Prerequisite: Civ Eng 3334 with a grade of "C" or better.

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

CIV ENG 5442 Construction Planning and Scheduling Strategies (LEC 3.0)
The goal of this course is to assist participants in gaining an understanding of schedule control techniques and the application of tools such as Primavera Software. Content areas to be addressed include: development of baseline schedules, progress monitoring and updating, recovery schedules, resource application and leveling. Prerequisite: Civ Eng or Arch Eng 4448. (Co-listed with Arch Eng 5442).

CIV ENG 5445 Construction Methods (LEC 3.0)
Introduction to construction planning, selection of equipment and familiarization with standard methods for horizontal and vertical construction. Application of network analysis and schedules to project control. Prerequisite: Civ Eng 4448 with a grade of "C" or better. (Co-listed with Arch Eng 5445).

CIV ENG 5446 Management Of Construction Costs (LEC 3.0)
Management of construction projects from inception to completion: estimates, role of network preplanning, project monitoring and control. Prerequisites: Civ Eng 4448 with a grade of "C" or better. (Co-listed with Arch Eng 5446).

CIV ENG 5448 Green Engineering: Analysis of Constructed Facilities (LEC 3.0)
Environmentally sound design and construction practices. Includes design issues, material selection and site issues that can reduce the impact on the environment caused by the construction process. LEED certification covered in depth. Prerequisites: Civ Eng 4448 or Arch Eng 4448; and Junior Standing. (Co-listed with Arch Eng 5448).

CIV ENG 5449 Engineering and Construction Contract Specifications (LEC 3.0)
Legal and business aspects of contracts and contracting procedure in the construction industry. Topics include formulation of contracts in common law, engineering services contracts, and construction project contract documents and contract administration issues. Prerequisite: Civ Eng 4448 with a grade of "C" or better. (Co-listed with Arch Eng 5449).

CIV ENG 5451 Information Technology Applications in the Construction Industry (LEC 3.0)
Study of IT in construction industry including building information modeling and mobile sensing. Topics will include: collaborative design, clash detection, level of development, BIM contracts, automated code checking, and finally, information systems specific functions such as estimating, scheduling and cost control, lean, and integrated project delivery. Prerequisites: Civ Eng 2451 or Civ Eng 4448.

CIV ENG 5452 Pre-Project Planning and Feasibility Studies (LEC 3.0)
Overview of the studies and tools needed to make go-ahead decisions for construction projects including assimilation of client needs, surveys of project area and infrastructure conditions, scope validation, team development, project planning and cost estimation, and financial feasibility. Prerequisites: Civ Eng 4448 or both Eng Mgt 3320 and Eng Mgt 1210.

CIV ENG 5453 Logistics for Construction Industry (LEC 3.0)
Overview of construction site layout, team organization, information flow, and complexities as related to: productivity improvement approaches, data gathering for analysis of construction operations, process innovation, and safety practices. Prerequisites: Civ Eng 4448 or Eng Mgt 3320.

CIV ENG 5454 Construction Technology for High-Rise Buildings (LEC 3.0)
Overview of latest construction practices and processes for high-rise buildings from foundation to roof including advanced methods, materials, equipment and systems used for the construction of high-rise buildings, as well as the associated principles of sustainable construction. Prerequisites: Civ Eng 4448 or Eng Mgt 3320.

CIV ENG 5455 Construction Industry Best Practices (LEC 3.0)
Overview of the best practices developed by the Construction Industry Institute (CII), and how they are implemented by the leading owners and contractors in the construction industry. Guest lecturers include CII staff and visiting industry subject matter experts. Prerequisites: Civ Eng 4448 or Eng Mgt 3320.

CIV ENG 5510 Geometric Design Of Highways (LAB 1.0 and LEC 2.0)
Development and applications of concepts of geometric design for rural and urban highways. Design controls and criteria; elements of design, including sight distance, horizontal and vertical alignment; cross-section elements; highway types; intersection design elements; types of interchanges and interchange design elements; grade separations and clearance; development of visual elements. Prerequisite: Civ Eng 3500 with grade of "C" or better.

CIV ENG 5513 Traffic Engineering (LEC 3.0)
Introduction to multimodal transportation systems and the factors that influence the planning, design, control, operation and safety of the systems will be made. This course will also include the discussion of Intelligence Transportation Systems and how emerging technologies are changing transportation systems. Prerequisite: Civ Eng 3500 with a grade of "C" or better.

CIV ENG 5515 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 3500 with a grade of "C" or better.

CIV ENG 5605 Environmental Systems Modeling (LEC 3.0)
Introductory course in modeling environmental systems. Course will focus on contaminant fate and transport in the environment. Models will be developed that will include physical, chemical and biological reactions and processes that impact this fate. Prerequisites: Env Eng/Civ Eng 2601, Env Eng/Civ Eng 2602 and Env Eng/ Civ Eng 3603; or Graduate standing. (Co-listed with Env Eng 5605).

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

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

CIV ENG 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-ofthe-art control techniques to gaseous and particulate emissions from fossil fuel combustion, industrial and transportation sources. Prerequisite: Civ Eng 3330; or graduate standing. (Co-listed with Env Eng 5662).

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

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

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

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

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

CIV ENG 5729 Foundation Engineering II (LEC 3.0)
Classical earth pressure theories. Analysis of shallow and deep foundations to include bearing capacity and settlement of footings, rafts, piles, and drilled piers. Analysis of stability and design of retaining walls and anchored bulkheads. Prerequisites: Civ Eng 4729 with a grade of "C" or better. (Co-listed with Arch Eng 5729).

CIV ENG 5744 Geosynthetics in Engineering (LEC 3.0)
Geotechnical principles are applied to design of geosynthetic systems for foundation support, earth retention, drainage, and disposal of hazardous conventional wastes. Geosynthetic testing and identification. Emphasis is on design of geosynthetic earth reinforcement, roadway stabilization, filters, and waste containment systems. Prerequisite: Civ Eng 3715 with grade of "C" or better.

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