Civil Engineering

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https://engineering.missouri.edu/civil/

Civil engineers are responsible for planning, design, construction, and operation of public and private facilities essential to modern life; including infrastructure for transportation of people and goods, water supply and water treatment, waste disposal, communications, and energy. Civil engineers are problem solvers, meeting societal challenges pertaining to infrastructure, the environment, drinking water supply, energy, resilience, national security, traffic congestion, smart cities, urban redevelopment, and sustainable community planning.

Faculty

Professor W. G. Buttlar** P. E., Z. Chen**, B. Deng**, P. K. Edara** P. E., Z. Hu** P.E., H. A. Salim** P.E., C. C. Sun** P.E., Esq. G. Washer** P.E.,
Associate Professor Y. Adu-Gyamfi**, M. M. Fidalgo**, T. C. Matisziw**, S. L. Orton** P.E., B. L. Rosenblad**, M. Salehi**, B. Wang**, P.E., F. Xiao** P.E., H. Yazdani** P.E.
Assistant Professor O. Giraldo-Londoño*, B. Sansom*
Assistant Teaching Professor P. Earney
Adjunct Faculty H. Brown* P.E., A. Elsisi*, A. Saucier*
Courtesy Faculty N. Aloysius*, R. Rogers*, R. Rotman
Professor Emeritus S. Banerji, J. J. Bowders Jr, T. E. Clevenger, V. S. Gopalaratnam* P.E., S. A. Kiger P.E., C. J. Nemmers P.E, K. M. Trauth** P.E., M. R. Virkler P.E.

* Graduate Faculty Member - membership is required to teach graduate-level courses, chair master's thesis committees, and serve on doctoral examination and dissertation committees.
** Doctoral Faculty Member - membership is required to chair doctoral examination or dissertation committees. Graduate faculty membership is a prerequisite for Doctoral faculty membership.

Undergraduate

- BSCiE in Civil Engineering (https://catalog.missouri.edu/collegeofengineering/civilengineering/bscie-civil-engineering/)

Advising and Scholarship Contact

Engineering Advising Office
Phone: (573) 884-6961
Email: muengradvising@missouri.edu

Website: https://engineering.missouri.edu/student-services/advising/

The Department of Civil and Environmental Engineering offers a Bachelor of Science in Civil Engineering (BSCIE). The undergraduate program at the University of Missouri provides students with the requisite fundamentals and prepares them for beginning practice in the traditional and emerging fields of Civil Engineering. The degree program has a flexible credit structure that provides the fundamentals of engineering, in addition to a thorough coverage of the major specialties within Civil Engineering. In addition, technical electives allow concentration in selected areas (environmental, water resources, structural, geotechnical, and transportation). Most graduates take the Fundamentals of Engineering Exam and are encouraged to become registered professional engineers and to continue their education throughout their careers.

Bachelor of Science in Civil Engineering (BS CiE) requires students to earn a C- or better in the Civil Engineering core classes (CV_ENG 3010, CV_ENG 3100, CV_ENG 3200, CV_ENG 3300, CV_ENG 3312/CV_ENG 3313 (C- only required in class that serves as core requirement), CV_ENG 3400, CV_ENG 3600, CV_ENG 3700, CV_ENG 3702, CV_ENG 4980).

Departmental Honors

The CEE Honors Program follows the general rules and philosophy of the College of Engineering Honors Program. Students may enter the program from the beginning of the junior year and must have a GPA of 3.0/4.0 at the start. Eligible students participate in the program by enrolling in CV_ENG 4995 Undergraduate Honors Research in Civil Engineering for one to three credit hours, which replaces an equivalent number of hours of CEE technical electives.

The heart of the program is a research or advanced design project culminating in an undergraduate honors thesis. The project is conducted under the supervision of the honors advisor, who is an CEE faculty member selected by mutual agreement between the student and the professor. Satisfactory completion of the project requires approval (signatures) of the honors thesis by both the honors advisor and an additional faculty member, who serves as second reader of the thesis. Students who complete the program and graduate with a GPA of a least 3.0 receive the designation “Honors Scholar in Engineering” at graduation and on their diploma.

Another valuable feature of the Honors Program is that participants may reduce the number of credit hours required for degree completion to the University minimum of 120 by substituting up to six hours of credit from graduate courses through dual (undergraduate/graduate) enrollment during the last four semesters of the undergraduate program and after completion of the honors project.

Educational Mission

The educational objectives of the Bachelor of Science in Civil Engineering describe the expected accomplishments of graduates after graduation. It is expected that nearly all students completing the requirements of the Bachelor of Science in Civil Engineering will engage in the life-long learning necessary to advance professionally in the field of civil engineering and contribute to society and the profession through involvement in professional or other service activities.

It is expected that most graduates will

1. Enter the profession of civil engineering with proficiency in environmental engineering, geotechnical engineering, structural engineering, transportation engineering and water resources engineering. In doing so, these students will
   a. Take and pass the Fundamentals of Engineering exam
   b. Gain employment as an engineer-in-training
   c. Take and pass the Professional Engineers Exam, and
   d. Be licensed to practice engineering in one or more states

It is expected that some graduates will

1. Begin careers in civil engineering-related industries, especially construction and other careers not requiring professional licensure

2. Begin and complete graduate study in civil engineering at MU or other Carnegie doctoral extensive universities, and
3. Begin and complete graduate/professional study in other associated fields

The following list of outcomes describes what graduates are expected to know and to be able to do when they complete the program. At graduation, graduates will have:

- Ability to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry and at least one additional area of basic science
- Ability to conduct laboratory experiments and to critically analyze and interpret experimental data
- Ability to perform civil engineering design by means of design experiences integrated throughout the professional component of the curriculum
- Ability to function on teams that must integrate contributions from different areas of civil engineering toward the solution of multidisciplinary projects
- Ability to identify, formulate and solve civil engineering problems
- Understanding of professional practice issues in civil engineering including professional and ethical responsibility
- Ability to communicate effectively
- The broad education necessary to understand the impact of civil engineering solutions in a global economic, environmental, and societal context
- Recognition of the need for, and an ability to engage in, life-long learning
- Knowledge of contemporary issues as they relate to civil engineering problems and solutions
- Ability to use the techniques, skills and modern engineering tools necessary for civil engineering practice, particularly in areas of environmental/water resources, geotechnical, structural and transportation engineering

Graduate

- MS in Civil Engineering (https://catalog.missouri.edu/collegeofengineering/civilengineering/ms-civil-engineering/)
- PhD in Civil Engineering (https://catalog.missouri.edu/collegeofengineering/civilengineering/phd-civil-engineering/)

https://engineering.missouri.edu/civil/

Director of Graduate Studies: Maria Fidalgo

About the Program

Civil engineering education at MU began in 1856. Graduate programs offered by the department prepare students for leadership positions in academia, research and advanced practice engineering careers. Major program areas include: structural mechanics, structural engineering and materials, transportation engineering, geotechnical and geoenvironmental engineering, environmental engineering, hydrology and water resources engineering.

Areas of Study

Structural Mechanics, Structural Engineering and Materials. Study areas: fracture and failure of composites, model-based simulation, inelastic response of materials and structures, bridge engineering, linear and nonlinear structural dynamics, explosion resistant structural design, timber engineering, microstructure of porous materials, concrete and aggregate durability, advanced fiber reinforced composites for construction and nondestructive structural health evaluation

Environmental Engineering. Study areas: water and air pollution control, water purification, wastewater treatment, environmental remediation, hazardous and solid waste treatment and management, membrane processes, implication and application of environmental nanotechnology and renewable energy issues. Other areas of research include the application of physical, chemical and biological principles to design of water supply systems, pollution control facilities and fate and transport of contaminants in soils and groundwater.

Geotechnical and Geoenvironmental. Study areas: strength, deformation and flow properties of earthen materials and application of this understanding to foundation engineering, slope stability analyses, earth structures design, pavement design and performance, and geoenvironmental challenges. Research areas include: unsaturated soil mechanics, soil improvement techniques, geosynthetics, landfills and waste containment, stabilization and maintenance of earth slopes, in situ soil cleanup technologies, geotechnical earthquake engineering, nondestructive geophysical technologies for subsurface applications, satellite – and ground-based remote sensing risk analysis and reliability-based design.

Transportation Engineering. Study areas: traffic engineering, intelligent transportation systems, highway safety, network modeling and simulation, geographic information systems, security and evacuations, transportation planning, traffic flow theory, highway design, intersection operations, bicycle and pedestrian facilities, infrastructure management, driver behavior, airport engineering, transportation legal issues, artificial intelligence and advanced computing applications in transportation.

Water Resources Engineering. Study areas: hydrologic, hydraulic, regulatory/public policy and geographic information system applications for transportation, surface water quality and storm water management and decision making.

Facilities and Resources

The department has laboratories for experimental research in structural engineering, materials, geotechnical and geoenvironmental engineering, environmental engineering, and transportation engineering.

Structural Testing. Several computer-controlled electrohydraulic testing machines and associated instrumentation are available in the high-bay structural engineering and materials engineering laboratories. The laboratories are serviced by a 5-ton overhead crane. An additional structural testing facility located south of the campus houses a 100-foot by 20-foot structural floor with anchor points on a 4-foot-square grid. This high-bay facility is serviced by a 10-ton overhead crane. There is also a materials laboratory for concrete mix design and evaluation.

Geotechnical Testing. The laboratories house state-of-the-art permeability, consolidation, triaxial, geosynthetics, soil dynamics and unsaturated soil mechanics testing equipment and is home to the Missouri Soil Characterization Laboratory. Additional laboratories include facilities and equipment for large-scale model testing of slopes, piles and other geotechnical systems, including a 10-acre geotechnical experiment site.

Environmental Laboratories. The laboratories are supplied with analytical equipment for the complete physical, chemical and

microbiological analysis of environmental samples. Additional capacities include membrane fabrication and characterization facilities, and chemical reactors and bioreactors for contaminant removal and/or degradation.

Transportation Laboratory. The laboratories include capabilities in advanced surveillance and video image processing, transportation modeling and simulation, Geographical Information Systems, traffic management and control, driver behavior, and safety, and ZouSim (bicycle, wheelchair, and driving simulator).

Missouri Asphalt Pavement and Innovation Laboratory (MAPIL). Advanced asphalt binder and mixture tests, including bending beam rheometer, dynamic shear rheometers (2), extraction and recovery apparatus, mixture creep, fatigue, rutting and fracture tests, compaction and fabrication equipment, advanced numerical modeling workstations and software, and an innovation center focusing on sustainable and resilient infrastructure development and intelligent infrastructure sensing and data analytics.

Funding

In addition to assistantships sponsored by the National Science Foundation (NSF), the US Environmental Protection Agency, Federal Highway Administration and other governmental agencies, several graduate assistantships are available each year. The assistantships are primarily research appointments; however, the Department does make a limited number of teaching assistantship appointments. Most assistantships offer tuition waivers and health insurance.

CV_ENG 1000: Introduction to Civil Engineering
This course introduces the Civil Engineering field, including contemporary issues, career opportunities, systematic design, problem solving, communication, and ethical/social issues. There will be lectures and design problems given by MU Civil Engineering faculty in each area as well as failure case studies and career advisement given by Civil industry representatives.

Credit Hour: 1
Prerequisites: Restricted to freshman/sophomore students who are BS Civil Engineering. Undeclared Engineering or Pre-Engineering may enroll in the class without permission

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CV_ENG 1001: Experimental Course
For freshman-level students. Content and number of credit hours to be listed in Schedule of Courses.

Credit Hour: 1-99

CV_ENG 2001: Experimental Course
For sophomore-level students. Content and number of credit hours to be listed in Schedule of Courses.

Credit Hour: 1-99

CV_ENG 2080: Dynamics
(same as MAE 2600, ENGINR 2260). Introductory study of the motion of particles and rigid bodies under the influence of forces and moments. Topics include kinematics and kinetics of particles, systems of particles, and rigid bodies; Newton's laws of motion; work-energy principles; impulse and momentum; and the application of these principles to engineering problems. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: C- or better in ENGINR 1200. Restricted to Engineering Students only or departmental consent required

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CV_ENG 2510: Introduction to Surveying
This course examines surveying's practical applications and how they relate to the design, and the translation of such design on paper to the site. The first part of the course focuses on mathematical ideas, horizontal and vertical control, and angle measurement in surveying. The second part of the course uses topography, property surveys, area calculations, traverses, and construction layout for highway and building applications to apply surveying data to site layout. The course includes field labs where students learn the fundamentals of surveying and construction layout, including the use of surveying instruments, field computations, and data recording.

Credit Hours: 3
Prerequisites: MATH 1100 or MATH 1140

CV_ENG 2520: Civil Engineering Drawings and Plans
An introductory course on fundamental visual principles for built facilities. A basic construction drawings course in which students learn to produce and understand the message construction drawings contain. Students learn about drafting and design of construction drawings, standards of construction drawings, layout of construction drawings (civil drawings, architectural drawings, structural drawings, industrial drawings, MPE, and miscellaneous drawings), and interpreting specifications. The course will incorporate basic CAD techniques, 3D scanning, and reverse engineering by converting files from a 3D scanned image to a CAD file (as-builts).

Credit Hours: 3

CV_ENG 2800: Introduction to Engineering Sustainability
Methods for considering the technical and technological aspects of engineering sustainability. Graded on A-F basis only.

Credit Hours: 3

CV_ENG 3010: Decision Methods for Civil Engineering Design
Essential features of civil engineering including the design process, design teams, experimental and computational tools, engineering economy, communication skills, and ethical considerations.

Credit Hours: 3

Prerequisites or Corequisites: ENGINR 1200
Prerequisites: grade of C- or better in ENGLSH 1000

CV_ENG 3010W: Decision Methods for Civil Engineering Design - Writing Intensive
Essential features of civil engineering including the design process, design teams, experimental and computational tools, engineering economy, communication skills, and ethical considerations. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: MATH 1700 and Grade C- or better in ENGLSH 1000

CV_ENG 3050: Introduction to Geographic Information Systems GIS
(same as GEOG 3040) Introduces theory, concepts and techniques related to the creation, manipulation, processing, and basic analysis of spatial data using GIS. Data management, current data models, GIS applications and course topics are reinforced through hands-on computer laboratory exercises.

Credit Hours: 3
Prerequisites: sophomore standing

CV_ENG 3100: Fundamentals of Transportation Engineering
Covers fundamentals of transportation engineering including geometric design, traffic engineering, pavements, and planning.

Credit Hours: 4
Prerequisites or Corequisites: CV_ENG 3010
Prerequisites: grade of C- or better in ENGINR 1100

CV_ENG 3200: Fundamentals of Environmental Engineering
Fundamentals of water quality engineering and water resources, water and wastewater treatment, solid and hazardous and radioactive waste management, air pollution, environmental regulation, and environmental ethics.

Credit Hours: 4
Prerequisites or Corequisites: CV_ENG 3010
Prerequisites: grade of C- or better in CHEM 1320 or equivalent

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CV_ENG 3250: Pollutant Fate and Transport
(same as ENV_SC 3250). Introduction to concepts governing pollutant fate and transport in the environment, including pollutant interactions within and migration through environmental systems, as will as analytical techniques and tools necessary to quantify conditions and movement.

Credit Hours: 3
Prerequisites: ENV_SC 1100 or SOIL 2100 or CV_ENG 3200; and CHEM 1320; or instructor's permission

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CV_ENG 3300: Structural Analysis I
Analysis of statically determinate beams, frames; shear and moment diagrams; influence line diagrams; beam deflections. Analysis of statically indeterminate structures; moment distribution; energy methods. Introduction to matrix analysis.

Credit Hours: 4
Prerequisites: grade of C- or better in ENGINR 1200 and ENGINR 2200

CV_ENG 3300H: Structural Analysis I - Honors
Analysis of statically determinate beams, frames; shear and moment diagrams; influence line diagrams; beam deflections. Analysis of statically indeterminate structures; moment distribution; energy methods. Introduction to matrix analysis.

Credit Hours: 4
Prerequisites: grade of C- or better in ENGINR 1200 and ENGINR 2200. Honors Eligibility required

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CV_ENG 3312: Reinforced Concrete Design
Basic principles of reinforced concrete design. Design of beams for flexture and shear; design of short and slender columns.

Credit Hours: 3
Prerequisites or Corequisites: CV_ENG 3600
Prerequisites: grade of C- or better in CV_ENG 3300

CV_ENG 3313: Structural Steel Design
Basic principles of structural steel design. Design of beams, axially loaded members, columns, and bolted and welded connections.

Credit Hours: 3
Corequisites: CV_ENG 3300 and CV_ENG 3600

CV_ENG 3400: Fundamentals of Geotechnical Engineering
Detailed study of physical and mechanical properties of soil governing its behavior as an engineering material.

Credit Hours: 4
Prerequisites: grade of C- or better in ENGINR 2200; Restricted to Civil Engineering major students only

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CV_ENG 3600: Civil Engineering Materials
Introduces composition, structure, properties, behavior, and selection of civil engineering materials.

Credit Hours: 4
Prerequisites or Corequisites: CV_ENG 3010

Prerequisites: grade of C- or better in ENGINR 2200 or instructor's consent

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CV_ENG 3700: Fluid Mechanics
Statics and dynamics of fluids, principles of continuity, momentum and energy, pipe flow.

Credit Hours: 3
Prerequisites: grade of C- or better PHYSCS 2750

CV_ENG 3702: Fundamentals of Water Resources Engineering
Fundamental concepts of hydrology and hydraulics: rainfall-runoff processes; river and reservoir routing; spillway and culvert design, concepts of pump curves and pressure systems; evolving nature of stormwater management requirements; and basics of topographic maps and surveying. Semester-long group design project. Graded on A-F basis only.

Credit Hours: 4
Prerequisites: Grade of C- or better CV_ENG 3700

CV_ENG 4001: Topics in Civil Engineering
Study of current and new technical developments in civil engineering.

Credit Hour: 1-3
Prerequisites: Requisites will vary depending on Topic

CV_ENG 4006: Computational Methods in Civil Engineering
(cross-leveled with CV_ENG 7006). Use of numerical methods for solution of engineering problems involving roots of equations, simultaneous equations, curve fitting, integration, optimization, differentiation, and differential equations. The numerical methods are demonstrated through computer implementation and application to engineering design problems.

Credit Hours: 3
Prerequisites: MATH 2300
Corequisites: MATH 4100

CV_ENG 4008: Risk and Reliability for Civil Engineers
(cross-leveled with CV_ENG 7008). This course focuses on how to use probability and statistics to quantify uncertainties and consider risks when making civil engineering decisions and designing civil engineering systems.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3010 or other introductory probability/statistics course

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CV_ENG 4085: Problems in Civil and Environmental Engineering
Directed investigation of civil engineering.

Credit Hour: 2-4
Prerequisites: instructor's consent

CV_ENG 4100: Traffic Engineering
(cross-leveled with CV_ENG 7100). Characteristics and studies associated with highway traffic. Capacity analysis and evaluation of freeways, rural highways, and urban streets. Traffic signal control and coordination.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3100

CV_ENG 4104: Pavement Materials and Design
(cross-leveled with CV_ENG 7104). Properties of materials used in roads, airports and other pavement construction. Design methods for rigid and flexible pavements.

Credit Hours: 3
Prerequisites: grade of C- or better in ENGINR 2200

CV_ENG 4105: Asphalt Materials and Mixture Design
(cross-leveled with CV_ENG 7105). This course consists of a combination of interactive classroom lectures and discussions, group activities, hands-on laboratory exercises, laboratory demonstrations, and field trips (live and/or recorded) to observe asphalt binder and mixture design, production, and control. Upon completion of the course, the student will be able to: (1) select, specify, and design an asphalt paving mixture for specific climatic and traffic conditions using the SUPERPAVE mixture design system; (2) understand the sources, types, and manufacturing aspects of asphalt binders and aggregates; (3) understand the key elements of asphalt mixture construction, process control, and acceptance; (4) perform key SUPERPAVE laboratory tests for asphalt binders, aggregates, and mixtures and master the analysis and interpretation of data collected; (5) understand contemporary concepts and approaches in sustainable asphalt mixture design and construction; (6) understand and mathematically describe fundamental properties of asphalt binders and mixtures, which is a critical step in mastering mixture/pavement design, evaluation, and rehabilitation, and; (7) understand and describe the key types and uses of special asphalt binder and mixture products, including emulsions, cutbacks, polymer-modified binders, warm-mix asphalt, other additives, and mixtures containing recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS). Graded on A-F only.

Credit Hours: 3
Prerequisites or Corequisites: CV_ENG 3600

CV_ENG 4106: Intelligent Transportation Systems
(cross-leveled with CV_ENG 7106). This is an introductory course in Intelligent Transportation Systems (ITS). Topics include the

theory of transportation networks and systems optimization, current implementations of ITS, and practical issues and implications of ITS.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3100

CV_ENG 4110: Transportation Simulation
(cross-leveled with CV_ENG 7110). Theory and application of simulation in transportation engineering.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3100

CV_ENG 4120: Airport Engineering
(cross-leveled with CV_ENG 7120). Airport systems planning, design, and management.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3100

CV_ENG 4125: Transportation Legal Issues
(cross-leveled with CV_ENG 7125). This course discusses some of the legal issues that transportation engineers encounter throughout the course of their careers.

Credit Hours: 3
Prerequisites: CV_ENG 3100

CV_ENG 4130: Transportation Safety
(cross-leveled with CV_ENG 7130). This course is an introduction to transportation safety. The focus will be on surface transportation. The student is expected to analyze safety data and to devise engineering solutions to safety problems.

Credit Hours: 3
Prerequisites: CV_ENG 3100

CV_ENG 4145: Civil and Environmental Engineering Legal Issues
(cross-leveled with CV_ENG 7145). Discussion of legal issues facing civil engineers including right of way, risk and liability, environment, financing public works, contracting and ethics.

Credit Hours: 3
Prerequisites: CV_ENG 3100

CV_ENG 4155: Transportation Geography
(same as GEOG 4850; cross-leveled with CV_ENG 7155, GEOG 7850). Introduction to fundamental concepts and modes of analysis in transportation geography. Focus on descriptive, explanatory, as well as normative approaches. Topics reviewed include spatial organization, transportation economics, spatial interaction, network analysis, location/allocation, and urban transportation planning.

Credit Hours: 3

CV_ENG 4160: Urban Transportation Data Science
(cross-leveled with CV_ENG 7160). This is a hands-on course that trains students to use advance data analytic techniques to analyze transportation data, develop indicators, and create visualizations using the Python programming language, open source tools, and public data. The course will first introduce the fundamentals of programming in Python before moving on to a survey of data analysis/visualization tools and technologies. Students will be introduced to cloud computing concepts and tasked to build applications using cloud-based services. Classroom sessions will include lectures and workshops. A series of exercises will reinforce the skills and topics being presented, and a final project/paper will provide an opportunity for students to develop a more complete project from harvesting data from Open Data portals to synthesizing and analyzing those data to explore a question or problem, to communicating their results through term projects and presentations. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: INFOTC 1040 or equivalent
Recommended: Introduction to Python or Fundamentals of Transportation Engineering

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CV_ENG 4175: The Geospatial Science in National Security
(Same as GEOG 4130; cross-leveled with CV_ENG 7175, GEOG 7130). This course explores the critical contribution of the geospatial sciences in the collection processing, visualization and analysis of geospatial information related to national security. May be repeated for credit.

Credit Hours: 3
Prerequisites: instructor's consent
Recommended: junior standing

CV_ENG 4185: Location Analysis/Site Selection
(same as GEOG 4740; cross-leveled with CV_ENG 7185, GEOG 7740). An overview of location analysis in regional planning and spatial decision support, this course focuses on the use of Geographic Information Science (GIS) and location analysis methods in addressing regional service needs. Maybe be repeated for credit.

Credit Hours: 3

CV_ENG 4190: Infrastructure Project Development
(cross-leveled with CV_ENG 7190). Students will learn how the key elements of major civil engineering infrastructure projects fit together. The course will focus on the horizontal integration of: financing - planning - environment - right of way - design - construction - operations -

maintenance. Engineering is important but so are a lot of other things. Graded on A-F basis only. Prerequisites: junior standing

Credit Hours: 3

CV_ENG 4211: Design of Air Pollution Control Systems
(cross-leveled with CV_ENG 7211). Enrolling in the Design of Air Pollution Control Systems course offers an exciting opportunity to explore the sources of air pollution, its impacts on human health and the environment, the principles of industrial ventilation system design, and the design of air pollution control devices. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CHEM 1400 or CV_ENG 3200 and MATH 1700 or Instructor consent required

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CV_ENG 4220: Hazardous Waste Management
(same as CH_ENG 4220; cross-leveled with CV_ENG 7220, CH_ENG 7220). Engineering principles involved in handling, collection, transportation, processing and disposal of hazardous wastes, waste minimization, legislation on hazardous wastes and groundwater contamination.

Credit Hours: 3

CV_ENG 4230: Introduction to Water Quality
(cross-leveled with CV_ENG 7230). Methods for determining and characterizing water quality, effects of pollution on streams and lakes, and an introduction to engineered systems for the distribution, collection and treatment of water and wastewater.

Credit Hours: 3
Prerequisites: junior standing

CV_ENG 4232: Physicochemical Processes in Water and Wastewater Treatment
(cross-leveled with CV_ENG 7232). Physical and chemical processes for treating drinking water supplies and wastewater from domestic and industrial sources.

Credit Hours: 3
Prerequisites: CV_ENG 4230 or CV_ENG 7230 or instructor's consent required

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CV_ENG 4240: Integrated Environmental and Hydrology Laboratory
(cross-leveled with CV_ENG 7240). This course provides a practical and theoretical foundation in environmental and hydrology laboratory work. Students will engage in hands-on experiments to understand hydraulic phenomena and contaminant transport in aquifers, applying key concepts like Darcy's Law and exploring aquifer remediation techniques. They will learn to collect and analyze data using statistical methods and advanced techniques such as mass spectrometry, develop detailed laboratory reports, and present their findings. The curriculum is designed to prepare students for advanced studies or careers in environmental engineering by equipping them with skills to conduct in-depth environmental experiments, critically interpret data, and address real-world environmental challenges. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in CV_ENG 4230 or Instructor's consent required

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CV_ENG 4245: Environmental Chemistry for Engineers
(cross-leveled with CV_ENG 7245). This course will cover the fundamentals of environmental chemistry. Physical, equilibrium, organic and colloid chemistry topics will be presented from an environmental perspective with a focus on their relevant engineering applications.

Credit Hours: 3
Prerequisites: CHEM 1320 or CV_ENG 3200

CV_ENG 4250: Environmental Regulatory Compliance
(cross-leveled with CV_ENG 7250). Systems of water law; provisions of major federal environmental laws and regulations; development of regulations at the federal, state, and local levels; regulatory frameworks; permits; and enforcement.

Credit Hours: 3

CV_ENG 4270: Environmental Engineering Microbiology
(cross-leveled with CV_ENG 7270). Theory and application of fundamental principles of microbiology, ecology, and aquatic biology of the microorganisms of importance to sanitary engineers.

Credit Hours: 3
Prerequisites: senior standing or instructor's consent

CV_ENG 4286: Environmental Sustainability
(cross-leveled with CV_ENG 7286). This course will present an introduction to sustainability in engineering, tools for assessing sustainability and principles of sustainable design practices. Topics include climate change, energy and renewable resources, limits to growth, risk assessment, life cycle assessments, water and energy footprints, green buildings, and the water-food-energy-nexus. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CV_ENG 3200

CV_ENG 4290: Water and Wastewater Treatment Engineering
(cross-leveled with CV_ENG 7290). Principles and design techniques related to water and wastewater collection, quality and treatment

including physical, chemical, and biological unit processes. Selection and design of water and wastewater treatment processes, sustainable treatment for water and wastewater reuse.

Credit Hours: 3
Prerequisites: Grade of C- or better in CV_ENG 3200

CV_ENG 4300: Advanced Structural Steel Design
(cross-leveled with CV_ENG 7300). Design of steel structures and bridges. Topics include composite beams, plate girder design, and moment resistant connections.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3313

CV_ENG 4302: Prestressed/Advanced Reinforced Concrete
(cross-leveled with CV_ENG 7302). Principles of prestressing. Constituent materials, loading and allowable stresses. Working and ultimate stress analysis and design. Shear and torsion. Deflections. Prestress losses. Continuous beams. Composite beams. Compression members. Footings.

Credit Hours: 3
Prerequisites or Corequisites: CV_ENG 3312

CV_ENG 4320: Energy Methods in Mechanics
(cross-leveled with CV_ENG 7320). Variational mechanics including practical examples. Topics include calculus of variation of boundary value problems, energy methods such as Ritz and Galerkin methods, approximate solutions methods such as the finite element and finite difference, and eigenvalue problems.

Credit Hours: 3
Prerequisites: senior or graduate standing required

CV_ENG 4330: Structural System Design
(cross-leveled with CV_ENG 7330). Design of buildings in steel and reinforced concrete, including estimation of loads and design of gravity and lateral force resisting systems.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3312 and CV_ENG 3313

CV_ENG 4350: Matrix Methods of Structural Analysis
(cross-leveled with CV_ENG 7350). An introduction to the fundamentals of stiffness and flexibility methods for analysis of truss and frame structures. Application of the STRUDL and NASTRAN programs to three dimensional structures.

Credit Hours: 3
Prerequisites: senior standing; grade of C- or better in CV_ENG 3300

CV_ENG 4360: Bridge Engineering
(cross-leveled with CV_ENG 7360). Review of Highway Bridge Analysis and Design Fundamentals. Study of Influence Line Diagrams and Shear and Moment Envelopes. Design of Medium- and Short-Span Girder Bridges based on AASHTO LRFD specs.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3312 and CV_ENG 3313

CV_ENG 4365: Design of Structures for Blast and Fire
(cross-leveled with CV_ENG 7365). General overview of Blast Design; risk assessment and design criteria; simplifies Blast Effects Analysis; ground shock, material response; anti-terrorism design considerations; weapons effects and mitigation; internal explosions; progressive collapse analysis; and introduction to Fire Design. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CV_ENG 3300
Recommended: CV_ENG 3312 or CV_ENG 3313

CV_ENG 4404: Geotechnical Earthquake Engineering
(cross-leveled with CV_ENG 7404). This course provides an introduction to geotechnical aspects of earthquake engineering. Topics include: basic seismology, seismic hazard analysis, dynamic soil properties, site response analysis and soil liquefaction.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3400 or instructor's consent

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CV_ENG 4406: Geotechnics of Landfill Design
(cross-leveled with CV_ENG 7406). This course will focus on geotechnical and construction aspects in the analysis, design and construction of waste containment facilities (landfills) including expansions of existing facilities.

Credit Hours: 3
Prerequisites: instructor's consent

CV_ENG 4410: Foundation Engineering
(cross-leveled with CV_ENG 7410). Subsurface exploration. Design of basic foundation structures, shallow foundations, retaining walls, deep foundations.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3400

CV_ENG 4412: Applied Geotechnical Engineering
(cross-leveled with CV_ENG 7412). Study of concepts, theories, and design procedures for modern earthwork engineering including: compaction and densification of soils and soil improvement, seepage and drainage, slope stability and performance, and earth retaining structures.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3400

CV_ENG 4500: Introduction to Construction Management
(cross-leveled with CV_ENG 7500). Structure of the construction industry; construction drawings and specifications; estimating and bidding; construction contracts, bonds and insurance; planning and scheduling of construction operations; project management; computer techniques.

Credit Hours: 3
Prerequisites: Civil Engineering major
Recommended: Construction Management minor

CV_ENG 4520: Construction Contracting
(cross-leveled with CV_ENG 7520) This course covers various aspects of construction contracting including interpretation, formation, terms, bidding, breach, innovative methods, change orders, bonds, and federal contracting. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Junior or senior standing
Recommended: It is recommended for students to have had CV_ENG 4500/CV_ENG 7500 and CV_ENG 4145/CV_ENG 7145

CV_ENG 4530: Construction Safety
(cross-leveled with CV_ENG 7530). An overview of construction safety and health conditions on the job as they relate to workers, supervisors, inspectors, and the public combined with the instruction on the OSHA requirements. Graded on A-F basis only.

Credit Hours: 3
Recommended: CV_ENG 4500

CV_ENG 4540: Construction Planning and Scheduling
(cross-leveled with CV_ENG 7540). Network scheduling, a technique that was formalized in the 1950s through the development of the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT), has evolved to become a fundamental tool in the construction industry. Scheduling techniques have not only been widely accepted but are also often required by many construction project clients. Furthermore, the use of network scheduling extends beyond merely satisfying client demands. When properly implemented, these techniques can significantly enhance the efficiency of the entire construction process. In today's highly competitive construction market, such enhanced efficiency can often spell the difference between success and failure. Therefore, a comprehensive understanding of network scheduling has become an essential requirement for all professionals involved in the construction sector. Graded on A-F basis only.

Credit Hours: 3
Recommended: CV_ENG 4500

CV_ENG 4550: Construction Project Costing
(cross-leveled with CV_ENG 7550). The course connects job site level activities with cost accounting activities performed by the home office including development of financial statements, equipment depreciation, and taxes and audits. The course also covers advanced financial management aspects of earned value, activity-based costing, lean construction techniques, value engineering, supply chain material management, and time value of money. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Sophomore standing required

CV_ENG 4560: Construction Estimating
Extensive review and application of Civil Construction Estimating techniques and technology associated with Civil Estimating practices. This course covers, among other things, earthwork and excavation, highways and pavements, substructures, sewer systems, water distribution systems, labor and equipment costs, and the use of HCSS HeavyBid software to estimate project costs. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: MATH 1100 or MATH 1140

CV_ENG 4600: Advanced Mechanics of Materials
(same as MAE 4600; cross-leveled with CV_ENG 7600, MAE 7600). Advanced concepts, methodology and solution procedures in mechanics of materials, including the theories of stress and strain in three-dimensions, linear stress-strain-temperature relations, inelastic material behavior and energy methods, as well as selected topics such as torsion, nonsymmetrical bending and shear center for thin-wall beam cross sections.

Credit Hours: 3
Prerequisites: C- or better in ENGINR 2200 and Junior standing

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CV_ENG 4610: Sensors and Experimental Stress Analysis
(cross-leveled with CV_ENG 7610, MAE 7610). Sensors and instrumentation for stress analysis, mechanical measurement and health monitoring of civil structures. Application and design of data acquisition systems, basic digital signal processing. Electronics and instrumentation circuits.

Credit Hours: 3
Prerequisites: grade of C- or better in ENGINR 2200 and PHYSCS 2760

CV_ENG 4660: Vibration Analysis
(same as MAE 4660; cross-leveled with CV_ENG 7660, MAE 7660). Vibration theory and its application to mechanical systems. Topics include free and forced vibration analysis of single- and multi-degree of freedom systems.

Credit Hours: 3
Prerequisites: C- or better in MATH 4100 and MAE 2600

CV_ENG 4680: Introduction to the Finite Element Method
(same as MAE 4280; cross-leveled with CV_ENG 7680, MAE 7280). This course covers a variety of topics related to the finite element method when applied to the analysis of solid, structural, fluid, and heat transfer problems. Specifically, we will apply the finite element method to solve a variety of problems including trusses, beams, frames, thermal analysis, and fluid mechanics. Students are required to use FEA software for computer assignments. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: ENGINR 2200, and CV_ENG 3300 or MAE 3100
Recommended: CV_ENG 4006/CV_ENG 7006, CV_ENG 4350/CV_ENG 7350

CV_ENG 4692: Introduction to Structural Dynamics
(cross-leveled with CV_ENG 7692). Theory of structural response to dynamic loads. Computation of dynamic response of structures to dynamic loads like blast and earthquake. Modal analysis and single degree of freedom methods will be covered.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3300

CV_ENG 4700: Hydraulics of Open Channels
(cross-leveled with CV_ENG 7700). Gradually varied flow and theory of the hydraulic jump. Slowly varied flow involving storage; rating curves.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3700

CV_ENG 4704: Data Analysis Modeling in Environmental Engineering
(cross-leveled with CV_ENG 7704). This course focuses on the data analysis and modeling of environmental systems using open-source codes/programs/resources. Its objective is to facilitate hands-on computer labs, bridging the gap between programming languages and practices in Water Resources Engineering (WRE) and Environmental Engineering (EE). The course comprises lectures, laboratory modules, and discussions. Lectures cover specific numerical tools for WRE and EE problems, which are then applied in the laboratory modules. Each module is supplemented with discussion sessions aimed at honing communication skills. Each module is designed based on a specific topic in WRE or EE, allowing students to develop their own programs to learn, explore, and investigate WRE or EE problems. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in CV_ENG 3700
Recommended: CV_ENG 3702

CV_ENG 4710: Soil and Water Conservation Engineering
(same as BIOL_EN 4150; cross-leveled with CV_ENG 7710, BIOL_EN 7150). Urban and rural run-off and erosion analysis. Design and layout of erosion control structures.

Credit Hours: 3
Prerequisites: BIOL_EN 2180 or CV_ENG 3200

CV_ENG 4720: Watershed Modeling Using GIS
(same as BIOL_EN 4350; cross-leveled with BIOL_EN 7350, CV_ENG 7720). Watershed evaluation using AVSWAT for hydrology, sediment yield, water quality; includes USLE, MUSLE, WEPP, Procedures for model calibration/sensitivity data analysis.

Credit Hours: 3
Prerequisites: BIOL_EN 2180 or CV_ENG 3200

CV_ENG 4730: Hydraulic Design
(cross-leveled with CV_ENG 7730). Design of hydraulic infrastructure utilizing principles of both pressure conduits and open channels. Hand calculations and use of commercial design software for water distribution (quantity and quality), stormwater collection and sanitary sewer systems, and detention basins. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CV_ENG 3700 or equivalent

CV_ENG 4740: Irrigation and Drainage Engineering
(same as BIOL_EN 4250; cross-leveled with CV_ENG 7740, BIOL_EN 7250). Soil, water, plant relationships. Water supplies and design of surface, sprinkler and drip irrigation systems. Surface and tile drainage.

Credit Hours: 3
Prerequisites: CV_ENG 3700 or MAE 3400 or BIOL_EN 2180

CV_ENG 4980: Civil Engineering Systems Design
Senior design experience. Students work in teams on real design projects in various disciplines of civil engineering or construction management. Includes emphasis on technical writing and presentations as well as interactions with engineering practitioners. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Senior standing in Civil Engineering at the University of Missouri-Columbia or written consent of Chairman. Grade of C- or

better in CV_ENG 3100, CV_ENG 3200, CV_ENG 3300, CV_ENG 3400, CV_ENG 3600, and CV_ENG 3702

CV_ENG 4980W: Civil Engineering Systems Design - Writing Intensive
Senior design experience. Students work in teams on real design projects in various disciplines of civil engineering or construction management. Includes emphasis on technical writing and presentations as well as interactions with engineering practitioners. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Senior standing in Civil Engineering at the University of Missouri-Columbia or written consent of Department of Civil and Environmental Engineering Chair. Grade of C- or better in CV_ENG 3100, CV_ENG 3200, CV_ENG 3300, CV_ENG 3400, CV_ENG 3600, and CV_ENG 3702

CV_ENG 4990: Undergraduate Research in Civil and Environmental Engineering
Independent investigation or project in Civil Engineering. May be repeated to 6 hours. Enrollment limited to seniors in Civil and Environmental Engineering.

Credit Hour: 1-4
Prerequisites: instructor's consent

CV_ENG 4995: Research in Civil and Environmental Engineering-Undergraduate Honors
Independent project, supervised by the honors advisor, to be presented as a formal written report.

Credit Hour: 1-3
Prerequisites: Civil Engineering students only
Recommended: participation in the Civil and Environmental Engineering Departmental Honors Program

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CV_ENG 7001: Topics in Civil Engineering
Study of current and new technical developments in civil engineering.

Credit Hour: 1-3

CV_ENG 7002: Analysis of Civil Engineering Decisions
Formulates and analyzes probabilistic models of civil engineering systems and their environment. Elementary theory of decision making under uncertainty. Application to selected civil engineering problems.

Credit Hours: 3

CV_ENG 7003: Optimization of Civil Engineering Systems
Automated design techniques such as linear, nonlinear, and dynamic programming; gradient and random searching. Civil engineering applications emphasized throughout.

Credit Hours: 3

CV_ENG 7004: Engineering Administration
Cash flow analysis, financial analysis, managerial accounting and cost control, budgeting, organizational structure and behavior.

Credit Hours: 3
Prerequisites: MATH 1300 or MATH 1500, or instructor's consent

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CV_ENG 7006: Computational Methods in Civil Engineering
(cross-leveled with CV_ENG 4006).Use of numerical methods for solution of engineering problems involving roots of equations, simultaneous equations, curve fitting, integration, optimization, differentiation, and differential equations. The numerical methods are demonstrated through computer implementation and application to engineering design problems.

Credit Hours: 3
Prerequisites: MATH 2300
Corequisites: MATH 4100

CV_ENG 7007: Quality Management in Civil Engineering
Quantitative and qualitative quality planning and analysis concepts, including statistical tools and total quality management techniques, control, measurement and assessment. Graded on A-F basis only.

Credit Hours: 3

CV_ENG 7008: Risk and Reliability for Civil Engineers
(cross-leveled with CV_ENG 4008). This course focuses on how to use probability and statistics to quantify uncertainties and consider risks when making civil engineering decisions and designing civil engineering systems.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3010 or other introductory probability/statistics course

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CV_ENG 7080: Advanced Surveying
(cross-leveled with CV_ENG 4080). Celestial observations for determination of position; state coordinate systems, precise surveys, introduction to geodetic surveys, principles of photogrammetry. Theory of optical surveying instruments.

Credit Hours: 3
Prerequisites: MATH 1500

CV_ENG 7082: Property Boundary Location
Principles of real property ownership, deeds, property boundary surveying, legal principles of original and retracement surveys Missouri statutes and regulations affecting surveying, GLO corner restoration and re-establishment.

Credit Hours: 3

CV_ENG 7100: Traffic Engineering
(cross-leveled with CV_ENG 4100). Characteristics and studies associated with highway traffic. Capacity analysis and evaluation of freeways, rural highways, and urban streets. Traffic signal control and coordination.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3100

CV_ENG 7104: Pavement Materials and Design
(cross-leveled with CV_ENG 4104). Properties of materials used in roads, airports and other pavement construction. Design methods for rigid and flexible pavements.

Credit Hours: 3
Prerequisites: grade of C- or better in ENGINR 2200

CV_ENG 7105: Asphalt Materials and Mixture Design
(cross-leveled with CV_ENG 4105). This course consists of a combination of interactive classroom lectures and discussions, group activities, hands-on laboratory exercises, laboratory demonstrations, and field trips (live and/or recorded) to observe asphalt binder and mixture design, production, and control. Upon completion of the course, the student will be able to: (1) select, specify, and design an asphalt paving mixture for specific climatic and traffic conditions using the SUPERPAVE mixture design system; (2) understand the sources, types, and manufacturing aspects of asphalt binders and aggregates; (3) understand the key elements of asphalt mixture construction, process control, and acceptance; (4) perform key SUPERPAVE laboratory tests for asphalt binders, aggregates, and mixtures and master the analysis and interpretation of data collected; (5) understand contemporary concepts and approaches in sustainable asphalt mixture design and construction; (6) understand and mathematically describe fundamental properties of asphalt binders and mixtures, which is a critical step in mastering mixture/pavement design, evaluation, and rehabilitation, and; (7) understand and describe the key types and uses of special asphalt binder and mixture products, including emulsions, cutbacks, polymer-modified binders, warm-mix asphalt, other additives, and mixtures containing recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS). Graded on A-F only.

Credit Hours: 3
Prerequisites or Corequisites: CV_ENG 3600

CV_ENG 7106: Intelligent Transportation Systems
(cross-leveled with CV_ENG 4106). This is an introductory course in Intelligent Transportation Systems (ITS). Topics include the theory of transportation networks and systems optimization, current implementations of ITS, and its practical issues and implications of ITS.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3100

CV_ENG 7109: Urban Development and Planning
Introduction to planning processes; procedures and forces that shape urbanization.

Credit Hours: 3

CV_ENG 7110: Transportation Simulation
(cross-leveled with CV_ENG 4110). Theory and application of simulation in transportation engineering.

Credit Hours: 3
Prerequisites: C- or better in CV_ENG 3100

CV_ENG 7120: Airport Engineering
(cross-leveled with CV_ENG 4120). Airport systems planning, design, and management.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3100

CV_ENG 7125: Transportation Legal Issues
(cross-leveled with CV_ENG 4125). This course discusses some of the legal issues that transportation engineers encounter throughout the course of their careers.

Credit Hours: 3
Prerequisites: CV_ENG 3100

CV_ENG 7130: Transportation Safety
(cross-leveled with CV_ENG 4130). This course is an introduction to transportation safety. The focus will be on surface transportation. The student is expected to analyze safety data and to devise engineering solutions to safety problems.

Credit Hours: 3
Prerequisites: CV_ENG 3100

CV_ENG 7145: Civil and Environmental Engineering Legal Issues
(cross-leveled with CV_ENG 4145). Discussion of legal issues facing civil engineers including right of way, risk and liability, environment, financing public works, contracting and ethics.

Credit Hours: 3
Prerequisites: CV_ENG 3100

CV_ENG 7155: Transportation Geography
(same as GEOG 7850; cross-leveled with CV_ENG 4155, GEOG 4850). Introduction to fundamental concepts and modes of analysis in transportation geography. Focus on descriptive, explanatory, as well as normative approaches. Topics reviewed include spatial organization, transportation economics, spatial interaction, network analysis, location/allocation, and urban transportation planning.

Credit Hours: 3

CV_ENG 7160: Urban Transportation Data Science
(cross-leveled with CV_ENG 4160). This is a hands-on course that trains students to use advance data analytic techniques to analyze transportation data, develop indicators, and create visualizations using the Python programming language, open source tools, and public data. The course will first introduce the fundamentals of programming in Python before moving on to a survey of data analysis/visualization tools and technologies. Students will be introduced to cloud computing concepts and tasked to build applications using cloud-based services. Classroom sessions will include lectures and workshops. A series of exercises will reinforce the skills and topics being presented, and a final project/paper will provide an opportunity for students to develop a more complete project from harvesting data from Open Data portals to synthesizing and analyzing those data to explore a question or problem, to communicating their results through term projects and presentations. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: INFOTC 1040 or equivalent
Recommended: Fundamentals of Transportation Engineering or Introduction to Python

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CV_ENG 7165: Geographic Information Systems I
Introduces concepts of computer analysis of geographic data and emphasizes the techniques for handling geographic data. Application of computer-based GIS systems in coursework.

Credit Hours: 3
Prerequisites: instructor's consent

CV_ENG 7175: The Geospatial Sciences in National Security
(same as GEOG 7130; cross-leveled with CV_ENG 4175, GEOG 4130). This course explores the critical contribution of the geospatial sciences in the collection, processing, visualization and analysis of geospatial information related to national security. May be repeated for credit.

Credit Hours: 3
Prerequisites: instructor's consent

CV_ENG 7185: Location Analysis/Site Selection
(same as GEOG 7740; cross-leveled with CV_ENG 4185, GEOG 4740). An overview of location analysis in regional planning and spatial decision support, this course focuses on the use of Geographic Information Science (GIS) and location analysis methods in addressing regional service needs. May be repeated for credit.

Credit Hours: 3

CV_ENG 7190: Infrastructure Project Development
(cross-leveled with CV_ENG 4190). Students will learn how the key elements of major civil engineering infrastructure projects fit together. The course will focus on the horizontal integration of: financing - planning - environment - right of way - design - construction - operations - maintenance. Engineering is important but so are a lot of other things. Graded on A-F basis only.

Credit Hours: 3

CV_ENG 7200: Remote Sensing of the Environment
(cross-leveled with CV_ENG 4200). Principles, characteristics and applications of remote sensing in engineering, geosciences, agriculture and environmental projects. Topics: basic concepts, photographic, thermal multispectral and microwave systems, satellite remote sensing and digital image processing.

Credit Hours: 3

CV_ENG 7211: Design of Air Pollution Control Systems
(cross-leveled with CV_ENG 4211). Enrolling in the Air Pollution Control Engineering course offers an exciting opportunity to explore the sources of air pollution, its impacts on human health and the environment, the principles of industrial ventilation system design, and the design of air pollution control devices. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CHEM 1400 or CV_ENG 3200 and MATH 1700 or Instructor consent required

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CV_ENG 7220: Hazardous Waste Management
(same as CH_ENG 7220; cross-leveled with CV_ENG 4220, CH_ENG 4220). Engineering principles involved in handling, collection, transportation, processing and disposal of hazardous wastes, waste minimization, legislation on hazardous wastes and groundwater contamination.

Credit Hours: 3

CV_ENG 7230: Physicochemical Processes in Water and Wastewater Treatment
(cross-leveled with CV_ENG 7232). Physical and chemical processes for treating drinking water supplies and wastewater from domestic and industrial sources.

Credit Hours: 3
Prerequisites: CV_ENG 4230 or CV_ENG 7230 or instructor's consent required

CV_ENG 7232: Physicochemical Processes in Water and Wastewater Treatment
(cross-leveled with CV_ENG 4232). Physical and chemical processes for treating drinking water supplies and wastewaters from domestic and industrial sources.

Credit Hours: 3
Prerequisites: CV_ENG 4230 or CV_ENG 7230 or instructor's consent required

CV_ENG 7240: Integrated Environmental and Hydrology Laboratory
(cross-leveled with CV_ENG 4240). This course provides a practical and theoretical foundation in environmental and hydrology laboratory work. Students will engage in hands-on experiments to understand hydraulic phenomena and contaminant transport in aquifers, applying key concepts like Darcy's Law and exploring aquifer remediation techniques. They will learn to collect and analyze data using statistical methods and advanced techniques such as mass spectrometry, develop detailed laboratory reports, and present their findings. The curriculum is designed to prepare students for advanced studies or careers in environmental engineering by equipping them with skills to conduct in-depth environmental experiments, critically interpret data, and address real-world environmental challenges. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: C- or better in CV_ENG 4230 or instructor's consent required

CV_ENG 7245: Environmental Chemistry for Engineers
(cross-leveled with CV_ENG 4245). This course will cover the fundamentals of environmental chemistry. Physical, equilibrium, organic and colloid chemistry topics will be presented from an environmental perspective with a focus on their relevant engineering applications. Graded on A-F basis only.

Credit Hours: 3

CV_ENG 7250: Environmental Regulatory Compliance
(cross-leveled with CV_ENG 4250). Systems of water law; provisions of major federal environmental laws and regulations; development or regulations at the federal, state, and local levels; regulatory frameworks; permits; and enforcement.

Credit Hours: 3

CV_ENG 7260: Environmental Public Policy
(cross-leveled with CV_ENG 4260). Engineering and economic aspects of environmental policy. Basic understanding of environmental statutes and case law. Graded on A-F basis.

Credit Hours: 3

CV_ENG 7270: Environmental Engineering Microbiology
(cross-leveled with CV_ENG 4270). Theory and application of fundamental principles of microbiology, ecology, and aquatic biology of the microorganisms of importance to sanitary engineers.

Credit Hours: 3

CV_ENG 7286: Environmental Sustainability
(cross-leveled with CV_ENG 4286). This course will present an introduction to sustainability in engineering, tools for assessing sustainability and principles of sustainable design practices. Topics include climate change, energy and renewable resources, limits to growth, risk assessment, life cycle assessments, water and energy footprints, green buildings, and the water-food-energy-nexus. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CV_ENG 3200

CV_ENG 7290: Water and Wastewater Treatment Engineering
(cross-leveled with CV_ENG 4290). Principles and design techniques related to water and wastewater collection, quality and treatment including physical, chemical, and biological unit processes. Selection and design of water and wastewater treatment processes, sustainable treatment for water and wastewater reuse. Graded on A-F basis only.

Credit Hours: 3

CV_ENG 7300: Advanced Structural Steel Design
(cross-leveled with CV_ENG 4300). Design of steel structures and bridges. Topics include composite beams, plate girder design, and moment resistant connections.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3313

CV_ENG 7302: Prestressed/Advanced Reinforced Concrete
(cross-leveled with CV_ENG 4302). Principles of prestressing. Constituent materials, loading and allowable stresses. Working and ultimate stress analysis and design. Shear and torsion. Deflections. Prestress losses. Continuous beams. Composite beams. Compression members. Footings.

Credit Hours: 3
Corequisites: CV_ENG 3312

CV_ENG 7310: Structural Design and Analysis
(cross-leveled with CV_ENG 4310). Design and analysis of building frames and bridges in steel and concrete using case studies. Economic selection of structural type and material. Basic methods of analysis for statically indeterminate structures.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 4300

CV_ENG 7320: Energy Methods in Mechanics
(cross-leveled with CV_ENG 4320). Variational mechanics including practical examples. Topics include calculus of variation of boundary value problems, energy methods such as Ritz and Galerkin methods, approximate solutions methods such as the finite element and finite difference, and eigenvalue problems.

Credit Hours: 3

CV_ENG 7330: Structural System Design
(cross-leveled with CV_ENG 4330). Design of buildings in steel and reinforced concrete, including estimation of loads and design of gravity and lateral force resisting systems.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3312 and CV_ENG 3313

CV_ENG 7350: Matrix Methods of Structural Analysis
(cross-leveled with CV_ENG 4350). An introduction to the fundamentals of stiffness and flexibility methods for analysis of truss and frame structures. Application of the STRUDL and NASTRAN programs to three dimensional structures.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3300

CV_ENG 7360: Bridge Engineering
(cross-leveled with CV_ENG 4360). Review of Highway Bridge Analysis and Design Fundamentals. Study of Influence Line Diagrams and sheer and Moment Envelopes. Design of medium-and Sort-Span Girder Bridges based on AASHTO LRFD Specs. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in CV_ENG 3312 and CV_ENG 3313

CV_ENG 7365: Design of Structures for Blast and Fire
(cross-leveled with CV_ENG 4365). General overview of Blast Design; risk assessment and design criteria; simplifies Blast Effects Analysis; ground shock, material response; anti-terrorism design considerations; weapons effects and mitigation; internal explosions; progressive collapse analysis; and introduction to Fire Design. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CV_ENG 3300
Recommended: CV_ENG 3312 or CV_ENG 3313

CV_ENG 7404: Geotechnical Earthquake Engineering
(cross-leveled with CV_ENG 4404). This course will provide an introduction to topics relating to geotechnical aspects of earthquake engineering. Topics to be covered include; basic seismology, seismic hazard analysis, dynamic soil properties, site response analysis and soil properties, site response analysis and soil liquefaction. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in CV_ENG 3400 or instructor's consent

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CV_ENG 7410: Foundation Engineering
(cross-leveled with CV_ENG 4410). Subsurface exploration. Design of basic foundation structures: shallow foundations, retaining walls, deep foundations.

Credit Hours: 3
Prerequisites: Grade of C- or better in CV_ENG 3400

CV_ENG 7412: Applied Geotechnical Engineering
(cross-leveled with CV_ENG 4412). Study of concepts, theories, and design procedures for modern earthwork engineering including: compaction and densification of soils and soil improvement, seepage and drainage, slope stability and performance, and earth retaining structures.

Credit Hours: 3
Prerequisites: grade or C- or better in CV_ENG 3400

CV_ENG 7500: Introduction to Construction Management
(cross-leveled with CV_ENG 4500). Structure of the construction industry; construction drawings and specifications; estimating and bidding; construction contracts, bonds and insurance; planning and scheduling of construction operations; project management; computer techniques.

Credit Hours: 3

CV_ENG 7510: Construction Methods and Equipment
Selection and use of construction equipment, planning construction operations, equipment economics and operations analyses.

Credit Hours: 3
Prerequisites: MATH 1300 or MATH 1500, or instructor's consent

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CV_ENG 7520: Construction Contracting
(cross-leveled with CV_ENG 4520). This course covers various aspects of construction contracting including interpretation, formation, terms, bidding, breach, innovative methods, change orders, bonds, and federal contracting. Graded on A-F basis only.

Credit Hours: 3
Recommended: It is recommended for students to have had CV_ENG 4500/CV_ENG 7500 and CV_ENG 4145/CV_ENG 7145

CV_ENG 7530: Construction Safety
(cross-leveled with CV_ENG 4530). An overview of construction safety and health conditions on the job as they relate to workers, supervisors, inspectors, and the public combined with the instruction on the OSHA requirements. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CV_ENG 7500

CV_ENG 7540: Construction Planning and Scheduling
(cross-leveled with CV_ENG 4540). Network scheduling, a technique that was formalized in the 1950s through the development of the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT), has evolved to become a fundamental tool in the construction industry. Scheduling techniques have not only been widely accepted but are also often required by many construction project clients. Furthermore, the use of network scheduling extends beyond merely satisfying client demands. When properly implemented, these techniques can significantly enhance the efficiency of the entire construction process. In today's highly competitive construction market, such enhanced efficiency can often spell the difference between success and failure. Therefore, a comprehensive understanding of network scheduling has become an essential requirement for all professionals involved in the construction sector. Graded on A-F basis only.

Credit Hours: 3
Recommended: CV_ENG 7500

CV_ENG 7550: Construction Project Costing
(cross-leveled with CV_ENG 4550). The course connects job site level activities with cost accounting activities performed by the home office including development of financial statements, equipment depreciation, and taxes and audits. The course also covers advanced financial management aspects of earned value, activity-based costing, lean construction techniques, value engineering, supply chain material management, and time value of money. Graded on A-F basis only.

Credit Hours: 3
Recommended: CV_ENG 4560 and CV_ENG 4540

CV_ENG 7600: Advanced Mechanics of Materials
(same as MAE 7600; cross-leveled with MAE 4600, CV_ENG 4600). Advanced concepts, methodology and solution procedures in mechanics of materials, including the theories of stress and strain in three-dimensions, linear stress-strain-temperature relations, inelastic material behavior and energy methods, as well as selected topics such as torsion, nonsymmetrical bending and shear center for thin-wall beam cross sections.

Credit Hours: 3
Prerequisites: C- or better in ENGINR 2200

CV_ENG 7610: Sensors and Experimental Stress Analysis
(same as MAE 7610; cross-leveled with CV_ENG 4610). Sensors and instrumentation for stress analysis, mechanical measurement and health monitoring of civil structures. Application and design of data acquisition systems, digital signals and basic digital signal processing. Electronics and instrumentation circuits.

Credit Hours: 3
Prerequisites: Grade of C- or better in ENGINR 2200 and PHYSCS 2760

CV_ENG 7660: Vibration Analysis
(same as MAE 7660; cross-leveled with CV_ENG 4660, MAE 4660). Vibration theory with application to mechanical systems.

Credit Hours: 3
Prerequisites: C- or better in MATH 4100 and MAE 2600

CV_ENG 7680: Introduction to the Finite Element Method
(same as MAE 7280; cross-leveled with CV_ENG 4680, MAE 4280). This course covers a variety of topics related to the finite element method when applied to the analysis of solid, structural, fluid, and heat transfer problems. Specifically, we will apply the finite element method to solve a variety of problems including trusses, beams, frames, thermal analysis, and fluid mechanics. Students are required to use FEA software for computer assignments. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: ENGINR 2200, and CV_ENG 3300 or MAE 3100
Recommended: CV_ENG 4006/CV_ENG 7006, CV_ENG 4350/CV_ENG 7350

CV_ENG 7692: Introduction to Structural Dynamics
(cross-leveled with CV_ENG 4692). Theory of structural response to dynamics loads. Computation of dynamic response of structures to dynamic loads like blast and earthquake. Modal analysis and single degree of freedom methods will be covered. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in CV_ENG 3300

CV_ENG 7700: Hydraulics of Open Channels
(cross-leveled with CV_ENG 4700). Gradually varied flow and theory of the hydraulic jump. Slowly varied flow involving storage; rating curves.

Credit Hours: 3
Prerequisites: graduate standing and Grade of C- or better in CV_ENG 3700

CV_ENG 7702: Pipeline Engineering
Theoretical and practical aspects of pipeline engineering including pipeline transport of natural gas and various solids such as coal, sand and solid wastes.

Credit Hours: 3
Prerequisites: CV_ENG 3700 and MAE 3400

CV_ENG 7703: Applied Hydrology
(cross-leveled with CV_ENG 4703). Modern methods of applied hydrologic analysis and synthesis of hydrologic records.

Credit Hours: 3
Prerequisites: grade of C- or better in CV_ENG 3700 and CV_ENG 3702, or instructor's consent

CV_ENG 7704: Data Analysis Modeling in Environmental Engineering
(cross-leveled with CV_ENG 4704). This course focuses on the data analysis and modeling of environmental systems using open-source codes/programs/resources. Its objective is to facilitate hands-on computer labs, bridging the gap between programming languages and practices in Water Resources Engineering (WRE) and Environmental Engineering (EE). The course comprises lectures, laboratory modules, and discussions. Lectures cover specific numerical tools for WRE and EE problems, which are then applied in the laboratory modules. Each module is supplemented with discussion sessions aimed at honing communication skills. Each module is designed based on a specific topic in WRE or EE, allowing students to develop their own programs to learn, explore, and investigate WRE or EE problems. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C- or better in CV_ENG 3700
Recommended: CV_ENG 3702

CV_ENG 7710: Soil and Water Conservation Engineering
(same as BIOL_EN 7150; cross-leveled with CV_ENG 4710, BIOL_EN 4150). Urban and rural run-off and erosion analysis. Design and layout of erosion control structures.

Credit Hours: 3
Prerequisites: BIOL_EN 2180 or CV_ENG 3200 or instructor's consent

CV_ENG 7720: Watershed Modeling Using GIS
(same as BIOL_EN 7350; cross-leveled with BIOL_EN 4350, CV_ENG 4720). Watershed evaluation using AVSWAT for hydrology, sediment yield, water quality; includes USLE, MUSLE, WEPP. Procedures for model calibration/sensitivity data analysis.

Credit Hours: 3
Prerequisites: BIOL_EN 2180 or CV_ENG 3200 or instructor's consent

CV_ENG 7730: Hydraulic Design
(cross-leveled with CV_ENG 4730). Design of hydraulic infrastructure utilizing principles of both pressure conduits and open channels. Hand calculations and use of commercial design software for water distribution (quantity and quality), stormwater collection and sanitary sewer systems, and detention basins. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CV_ENG 3700 or equivalent

CV_ENG 7740: Irrigation and Drainage Engineering
(same as BIOL_EN 7250; cross-leveled with CV_ENG 4740, BIOL_EN 4250). Soil, water, plant relationships. Water supplies and design of surface, sprinkler and drip irrigation systems. Surface and tile drainage.

Credit Hours: 3
Prerequisites: CV_ENG 3700 or MAE 3400 or BIOL_EN 2180

CV_ENG 7792: Analysis of Water-Resource Systems
(cross-leveled with CV_ENG 4792). Applies hydrology, hydraulic and sanitary engineering, and economics to water-resource design problems considering man and his environment. Uses methods of systems analysis.

Credit Hours: 3
Prerequisites: instructor's consent

CV_ENG 8001: Advanced Topics in Civil Engineering
New and current technical developments in civil engineering.

Credit Hour: 1-3

Prerequisites: CV_ENG 4006 or equivalent

CV_ENG 8002: Directed Reading In Civil Engineering
Faculty supervised readings course.

Credit Hour: 1-3

CV_ENG 8085: Problems in Civil Engineering
Supervised investigation in civil engineering to be presented in the form of a report.

Credit Hour: 1-6

CV_ENG 8100: Transportation Planning and Models
Regional and metropolitan transportation studies; land use, traffic generation, distribution and assignment models.

Credit Hours: 3
Prerequisites: CV_ENG 7002 or CV_ENG 7003

CV_ENG 8105: Advanced Asphalt Materials
Advanced topics in the formulation, analysis, and design of asphalt materials, flexible, and composite pavement systems. Fundamental topics including theories and techniques for accurate viscosity measurement, the phenomenological theory of linear viscoelasticity, non-linear and stress-dependent time- and temperature-dependent response, fracture mechanics of quasi-brittle materials, visco-eleasto-plasticity, micromechanics, and finite/discrete element modeling principles and applications. Application of fundamental topics in modern asphalt material and pavement design including AASHTOWare Pavement M-E. Pavement sustainability. A comprehensive term project is required, which can be centered around a literature review, laboratory study, and/or modeling study to be mutually agreed upon by the student and instructor. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CV_ENG 7105 or consent of instructor

CV_ENG 8106: Advanced Intelligent Transportation Systems
This course is intended to be an introductory course in Intelligent Transportation Systems (ITS). This course includes the background of ITS, current implementations, sample deployments, and practical issues and implications.

Credit Hours: 3

CV_ENG 8107: Transportation Safety Modeling
This course covers the transportation safety modeling process and focuses on the modeling of crash frequencies. Class topics include background, the Highway Safety Manual, exploratory data analysis, curve-fitting, safety-performance functions, model optimization, goodness-of-fit measures, variable introduction, and model equation. Graded on A-F basis only.

Credit Hours: 3

CV_ENG 8110: Theory of Traffic Flow
Scientific approach to study of traffic phenomena with emphasis on applications. Deterministic and stochastic models of traffic flow; optimization of intersection controls; computer simulation of traffic problems.

Credit Hours: 3
Prerequisites: CV_ENG 7002 or instructor's consent

CV_ENG 8140: Highway Transportation
Economics of transportation on highways. Comparison of vehicle operation costs. Project studies of highway problems in general.

Credit Hours: 3
Prerequisites: CV_ENG 4103 or equivalent

CV_ENG 8150: Transportation Networks
This course presents techniques used in equilibrium analysis of transportation networks. The details of traffic assignment algorithms will be discussed along with theory and practical algorithms.

Credit Hours: 3

CV_ENG 8160: Advanced Research Methods in Transportation Engineering
This course will cover advanced research methods used in transportation. A special focus will be on the state-of-art approaches in traffic engineering. Mathematical and analytical models will be reviewed in detail. This is a reading intensive course where students are expected to review research articles on various topics. The methods used in the articles and a critical review of the article findings will be discussed in an interactive manner in the class. Graded on A-F basis only.

Credit Hours: 3

CV_ENG 8187: Seminar in Transportation Engineering
Review of research in progress in the area of transportation engineering.

Credit Hour: 1

CV_ENG 8200: Water Quality Modeling
Derivation and application of models for describing oxygen budget, nutrient exchange, and biological productivity in streams, lakes and estuaries.

Credit Hours: 3
Prerequisites: CV_ENG 7230

CV_ENG 8215: Environmental Transport Phenomena
Fundamental processes that control the transport of constituents substances in fluids, and the implications of these processes for a variety of important applications in natural and engineered systems.

Credit Hours: 3

CV_ENG 8220: Advanced Hazardous Waste Treatment Processes
Course includes some introductory materials about hazardous waste regulations followed by advanced treatment methods such as air stripping, soil-vapor extraction, chemical oxidation, membrane processes, in-situ and ex-situ biotreatment methods, solidification and thermal processes.

Credit Hours: 3
Prerequisites: CV_ENG 4220

CV_ENG 8225: Aquatic Chemistry
Principles of chemical thermodynamics and equilibrium applied to processes in natural water and water and wastewater treatment systems. Emphasis on quantitative analyses of acid/base, complexation/dissociation, precipitation/dissolution, and reduction/oxidation reactions. Graded on A-F basis only.

Credit Hours: 3

CV_ENG 8230: Unit Process Laboratory
Studies chemical and physical relationships as applied to unit processes of water and wastewater.

Credit Hours: 3

CV_ENG 8240: Physicochemical Treatment Processes
Fundamental principles, analysis and modeling of physical and chemical processes for water and wastewater treatment.

Credit Hours: 3

CV_ENG 8245: Particles in the Environment
This course is an introduction to interfacial and colloid science, with an emphasis on aqueous systems of natural colloids and engineered nanomaterials. Graded on A-F basis only.

Credit Hours: 3

CV_ENG 8250: Biochemical Treatment Processes
Biochemical principles, kinetic models and energy considerations in the design of biological wastewater treatment processes.

Credit Hours: 3

CV_ENG 8260: Environmental Biotechnology
Major biochemical reactions relevant to environmental engineering. Theory and application of fundamental principles of attached and suspended microbial growth and process engineering for sanitary engineering and biodegradation.

Credit Hours: 3
Prerequisites: CV_ENG 8250 or instructor's consent

CV_ENG 8270: Design of Water and Wastewater Treatment Facilities
Development of design criteria and their application to the design of water and wastewater treatment facilities.

Credit Hours: 3

CV_ENG 8287: Seminar in Environmental Engineering
Review of research in progress in the area of environmental engineering.

Credit Hour: 1

CV_ENG 8295: Environmental Regulatory Policy
Discussion of the various policy aspects of environmental regulation: economic and non-economic impacts of degradation; risk assessment and management; distribution of environmental risks; regulatory tools; federal vs. state; disclosure; enforcement. Relation to environmental laws. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CV_ENG 4250 or CV_ENG 7250 or equivalent

CV_ENG 8303: Behavior of Reinforced Concrete Members
The design philosophy, constitutive laws, creep rate sensitivity and aging, shrinkage. Nonlinear response of reinforced concrete members. Deflection computation and control. Bond and anchorage.

Credit Hours: 3

Prerequisites: CV_ENG 3312

CV_ENG 8311: Nondestructive Evaluation Engineering
This course will present the interaction of nondestructive evaluation (NDE) technologies and engineering decision-making. Theory and application NDE technologies will be presented in the context of the engineering analysis required to effectively utilize the technologies. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: PHYSCS 2760, ENGINR 1200, MATH 4100

CV_ENG 8312: Advanced Structural Analysis
Current trends in structural analysis. Elastic analysis of curved beams, arches and suspensions. Finite element and nonlinear methods of analysis.

Credit Hours: 3

CV_ENG 8313: Random Vibration
Analysis of random vibrations including topics in stationary, ergodic and nonstationary random processes, with application to single-degree of freedom, discrete and continuous mechanical systems.

Credit Hours: 3
Prerequisites: CV_ENG 4606

CV_ENG 8320: Continuum Mechanics
(same as MAE 8320). Introductory course in the mechanics of continuous media. Basic concepts of stress, strain, constitutive relationships; conservation laws are treated using Cartesian tensor notation. Examples from both solid and fluid mechanics investigated.

Credit Hours: 3
Prerequisites: CV_ENG 3700, MATH 7100, ENGINR 2200

CV_ENG 8330: Theory of Elasticity
(same as MAE 8330). Stress and strain at a point. General equations of elasticity. Plane stress, plain strain problems; torsion of prismatic bars. Energy methods.

Credit Hours: 3

CV_ENG 8340: Theory of Plates and Shells
(same as MAE 8340). Rectangular and circular plates. Variational methods in the analysis of plates and shells. Plates of unusual shape. Shear deformation effects. Large deformation analysis. Analysis of cylindrical shells.

Credit Hours: 3

CV_ENG 8342: Space Mechanics
Rigid body dynamics analysis of satellites, space vehicles. Trajectories, time of flight optimization.

Credit Hours: 3
Prerequisites: MAE 3600 or equivalent, and MATH 4100

CV_ENG 8350: Theory of Elastic Stability
(same as MAE 8350). Buckling of Columns, frames, arches and other structural systems. Kinematic approach to stability. Large deflections. Energy approach to buckling. Plate and shell buckling. Inelastic buckling of columns. Creep buckling.

Credit Hours: 3

CV_ENG 8360: Theory of Plasticity
(same as MAE 8360). Plastic yield conditions and stress-strain relations. Behavior of elastic-perfectly plastic members. Plain strain in plastic members.

Credit Hours: 3
Prerequisites: CV_ENG 8330 or instructor's consent

CV_ENG 8372: Reinforced Concrete Theory and Design
Advanced design of reinforced concrete structures; review of standard codes and specifications and their influence.

Credit Hours: 3
Prerequisites: CV_ENG 4350 or equivalent

CV_ENG 8380: Nonlinear Mechanical Analysis
Analysis of behavior of nonlinear mechanical systems. Nonlinear phenomena of importance in mechanical design.

Credit Hours: 3
Prerequisites: MAE 3600 or equivalent and MATH 4100

CV_ENG 8387: Seminar in Structural Engineering
Review of research in progress in the area of structural engineering.

Credit Hour: 1

CV_ENG 8390: Advanced Topics Structural Analysis
Computer implementation and application of finite element analysis. Material and geometric nonlinearities. Plastic analysis of structures. Code provisions for analysis of seismic and wind loadings.

Credit Hours: 3
Prerequisites: CV_ENG 4350

CV_ENG 8392: Dynamics of Structures
(same as MAE 8392). Study of the dynamic behavior of structures. Analysis of equivalent lumped parameter systems for the design of structures in a dynamic environment.

Credit Hours: 3
Prerequisites: MAE 2600 and MATH 4100 or MATH 7100

CV_ENG 8402: Advanced Shear Strength of Soils
Theoretical soil mechanics as applied to solution of specific engineering problems.

Credit Hours: 3

CV_ENG 8403: Consolidation and Settlement
Settlement of soil, Theory of Consolidation, consolidation testing, settlements of earth fills and embankments, stress distribution in soils, elastic settlement, bearing capacity of shallow foundations, shallow foundations design.

Credit Hours: 3
Prerequisites: CV_ENG 3400

CV_ENG 8404: Seepage in Soils
General principles that govern flow of water through soils and specific procedures for analysis and design of filtration and drainage media in geotechnical and geoenvironmental applications.

Credit Hours: 3
Prerequisites: CV_ENG 3400 or instructor's consent

CV_ENG 8407: Soil Behavior
Detailed study of composition, fabric, and geotechnical and hydrologic properties of soils that consist partly or wholly of clay. Emphasizes physico-chemical factors governing volume change and shear strength. Expansive clay behavior is examined in detail.

Credit Hours: 3
Prerequisites: CV_ENG 3400 or instructor's consent

CV_ENG 8408: Soil Dynamics
Cover topics relating to the response of soils to dynamic loading. Topics to be covered include: lab and field methods, cyclic soil models, foundation vibrations, and wave propagation through soil. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CV_ENG 3400 and instructor's consent

CV_ENG 8410: Advanced Foundation Engineering
Foundation design beyond simple spread footings, special footings and beams on an elastic foundations, mat foundations, pile foundations - static capacity, lateral loads, bucklin, dynamic analysis load tests, pile groups, drilled piers.

Credit Hours: 3
Prerequisites: CV_ENG 4410

CV_ENG 8412: Stability and Performance of Earth Slopes
Principles, mechanics and procedures for analyzing the stability of earth slopes and landfills under short-term, long-term, rapid drawdown, and earthquake conditions.

Credit Hours: 3
Prerequisites: CV_ENG 3400 or instructor's consent

CV_ENG 8413: Design and Analysis of Earth Retaining Structures
General principals and specific procedures for analysis and design of earth retention systems including consideration of soil-structure interaction.

Credit Hours: 3
Prerequisites: CV_ENG 3400 or instructor's consent

CV_ENG 8487: Seminar in Geotechnical Engineering
Review of research in progress in the area of geotechnical engineering.

Credit Hour: 1

CV_ENG 8610: Materials and Measurement
About 25% of the course is devoted to the physical measurement of strain, force, displacement and motion. Remainder of course is devoted to advanced study of the behavior of steel and concrete with emphasis on brittle fracture in steel.

Credit Hours: 3
Prerequisites: CV_ENG 3600 or equivalent

CV_ENG 8620: Advanced Dynamics
(same as MAE 8620). Fundamental principles of advanced rigid body dynamics with applications. Special mathematical techniques including Lagrangian and Hamiltonian methods.

Credit Hours: 3

Prerequisites: CV_ENG 2080 and MATH 4100

CV_ENG 8630: Vibrations of Distributed Parameter Systems
(same as MAE 8630). Vibration analysis of strings, cables, bars, rods, shafts, beams, membranes, plates, circular rings, frames; free and forced oscillation; miscellaneous loading; various boundary conditions; effect of damping; energy methods; method of difference equations.

Credit Hours: 3
Prerequisites: CV_ENG 4660

CV_ENG 8720: Hydrotechnical Practicum
Application of advanced analysis and design techniques to practical problems in hydrotechnical engineering. Collaborative group investigations that may include experimental and computer aided studies. No more than 6 practicum hours may be applied toward the MS degree. Graded on A-F basis only.

Credit Hour: 2-4
Prerequisites: graduate standing in Civil Engineering

CV_ENG 8770: Environmental Hydraulics
Fundamental and applied fluid dynamics in various environmental hydraulics systems. Topics include mechanics of gravity waves, layers in stratified fluids, turbulence and modeling, jet and plumes, mixing and transport in rivers, lakes, and estuaries. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: CV_ENG 3700

CV_ENG 8990: Research-Masters Thesis in Civil & Environmental Engineering
Independent investigation in the field of civil engineering to be presented in the form of a thesis. Graded on a S/U basis only.

Credit Hour: 1-99

CV_ENG 9990: Research-Doctoral Dissertation Civil & Environmental Engineering
Independent investigation in the field of civil engineering to be presented in the form of a thesis. Graded on a S/U basis only.

Credit Hour: 1-99
