CE - CIVIL ENGINEERING

CE 2000 How Cities Work: An Introduction to Civil and Environmental Infrastructure Cr. 3
Satisfies General Education Requirement: Social Inquiry
Cities are built on the backbone of infrastructure, particularly civil and environmental infrastructure. These infrastructures provide essential services to residents. This course will make students aware of the tensions that arise out of the social, economic, and environmental demands on sustaining engineered infrastructure in the diverse, pluralistic social forums that are our cities. Students will learn how our engineered urban centers operate so they are better prepared for careers in governance and management, to perform social work with citizens who are disconnected from vital services, work as an engineer toward sustainable urban futures; serve as an informed public health or medical professional, among other endeavors that can benefit from an understanding of how cities strive to serve and provide services to residents. Offered Yearly.

CE 2410 Statics Cr. 3
Basic concepts and principles of statics with applications to Newton's Laws of Motion to engineering problems. Forces, moments, equilibrium, couples, free body diagrams, trusses, frames, fluid statics, friction, area and mass moment of inertia. Offered Every Term.
Prerequisites: MAT 2020 with a minimum grade of C- and PHY 2170 with a minimum grade of C-
Equivalent: ME 2410

CE 2420 Elementary Mechanics of Materials Cr. 3
Elastic relationships between external forces acting on deformable bodies and the associated stresses and deformations; structural members subjected to axial load, torsion, and bending; column buckling; combined stresses; repeated loads; unsymmetrical bending. Offered Every Term.
Prerequisites: ME 2410 with a minimum grade of C- or CE 2410 with a minimum grade of C-
Equivalent: ME 2420

CE 3010 Introduction to CAD: For Civil Engineers Cr. 3
Hands-on introduction to CAD for civil engineers using AutoCAD and Civil 3D. Students learn drafting fundamentals, layers, blocks, viewports, annotation, plotting, and Civil 3D workflows including points, surfaces, parcels, alignments, profiles, corridors, and pipe networks. A term project produces a coordinated civil drawing set aligned to professional conventions. Offered Every Other Year.
Prerequisite: MAT 2020 with a minimum grade of C- and BE 1200 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CE 3070 Surveying Cr. 3
Principles of plane surveying; measurement of horizontal and vertical distance, directions and angles, traverses, areas. Offered Intermittently.
Prerequisite: PHY 2185 with a minimum grade of C- or PHY 2180 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $20

CE 3250 Applied Fluid Mechanics Cr. 4
Application of theoretical fluid mechanics to problems of special interest to civil engineers including pipe flow, open channel flow, forces on submerged bodies, and flow measurement. Laboratory component of course provides experimental verification of theories and computer visualization. Offered Fall.
Prerequisite: MAT 2030 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $15

CE 3450 Civil Engineering Materials Cr. 4
Structure, composition and engineering properties of aggregates, cement concrete, asphalt, asphalt concrete, and other civil engineering materials. Mix design, testing, and quality control. Material Fee as indicated in the Schedule of Classes. Offered Winter.
Prerequisites: BE 2100 with a minimum grade of C- and CE 2420 with a minimum grade of C- (may be taken concurrently)
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $35

CE 4020 Introduction to Construction Engineering and Management Cr. 3
An introduction to the organization and management of construction projects. This course will cover the life cycle of a construction project including planning, design, procurement, construction, commissioning, and close-out phases. Also, the students will learn about fundamentals of cost estimating, scheduling, quality, safety and risk management, sustainability, and various applicable technology for construction projects. Offered Winter.
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering.

CE 4210 Introduction to Environmental Engineering Cr. 3
Introduction to environmental laws; reaction kinetics; principles of mass balances; plug-flow and completely stirred tank reactors; Stoke's Law; Streeter-Phelps oxygen sag curves; water chemistry; hydrologic cycle; population growth models; elements of soil waste management and air pollution. Offered Winter.
Prerequisite: CE 3250 with a minimum grade of C-
Corequisite: CE 4230
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $10

CE 4230 Environmental Engineering Laboratory Cr. 1
This laboratory course includes multiple experiments that demonstrate fundamental environmental engineering concepts and principles. The course involves laboratory and field work techniques commonly used in the field of environmental engineering. Through this course, students will 1) develop safe and effective laboratory and field work techniques, 2) understand how to apply hypothesis development and testing, along with experimental and engineering design, data analysis and interpretation, and 3) build a foundation of good engineering understanding that they can apply in their future academic and industrial career. Offered Winter.
Prerequisites: CE 4210 with a minimum grade of C- (may be taken concurrently)
Fees: $75

CE 4240 Environmental Engineering Design Cr. 3
Design of engineered environmental systems, including drinking water distribution systems, sanitary and storm water sewer systems, and municipal waste disposal sites. Offered Fall.
Prerequisite: CE 3250 with a minimum grade of C- and CE 4210 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CE 4400 Structural Analysis Cr. 4
Basic concepts of structural analysis; reactions, forces, and stresses in trusses and beams; influence lines; elastic deflections; introduction to indeterminate structures; computer applications. Offered Fall.
Prerequisites: CE 2410 with a minimum grade of C- and CE 2420 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CE 4410 Steel Design Cr. 3
First course in design of steel structures. Introduction to the concepts, requirements, and fundamental skills for steel building structural design. Offered Winter.
Prerequisites: CE 4400 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CE 4420 Reinforced Concrete Design Cr. 3
First course in design of concrete structures. Design and analysis of reinforced concrete beams, columns, and other structural members; ACI code requirements, cost concerns, safety, industry practices; introduction to prestressed concrete. Offered Fall.
Prerequisite: CE 4400 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CE 4510 Introduction to Geotechnical Engineering Cr. 4
Composition, engineering properties and behavior of soils. Principles of soil mechanics. Experimental determination of engineering classification, strength and deformation characteristics of natural and artificially placed soils. Offered Fall.
Prerequisites: CE 3250 with a minimum grade of C- (may be taken concurrently) and CE 3450 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $30

CE 4600 Transportation Engineering Cr. 3
Transportation functions; transportation systems including highways, railways and airways. Techniques of transportation systems analysis including optimization, network flows and queueing theory. Offered Winter.
Prerequisite: BE 3220 with a minimum grade of C- or BE 2100 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CE 4610 Highway Design Cr. 3
This course covers the standards recommended by: American Association of State Highway and Transportation Officials (AASHTO); FHWA; and MDOT for designing and evaluation of highways. Its objective is to introduce the students to the concepts, requirements, and fundamental skills for highway design and evaluation. The primary goal of geometric design is to provide for the safety and comfort of road users with due regard to social, economic and environmental constraints. Although there are suggested design standards and controls that must be followed to meet design goals, their application is determined on a case-by-case basis. The objective of this course is to illustrate the practical application of scientific knowledge to the planning and designing of roadway elements. The course uses up-to-date software design tools in accomplishing these goals. Upon completion of the course, the student is expected to be able to design and evaluate highways per AASHTO, MDOT and FHWA standards. Offered Fall.
Prerequisite: CE 4600 with a minimum grade of C-

CE 4640 Transportation Systems Design and Operation Cr. 3
Provides an overview of various system components of transportation, including the driver, vehicle and roadway. The subject matter will be covered at an intermediate level, appropriate for CEE students already familiar with the basic concepts of transportation engineering who wish to expand their knowledge. There will be a particular emphasis on transportation safety and multimodal roadway operations, as are typical priorities in an urban or suburban setting. Topics include: traffic flow design elements including volume, density and speed; intersection design elements including delay, capacity and crash countermeasures and terminal design elements including inflow, outflow and circulation. Offered Fall.
Prerequisite: CE 4600 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CE 4850 Engineering Economy Cr. 3
Economic analysis of engineering projects. Selection of appropriate financial parameters (e.g., interest rates) and methods of analysis for depreciation, tax considerations, and use of accounting data for comparison among investment options. Offered Fall.
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Computer Science, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Equivalent: IE 4850

CE 4985 Fundamentals of Civil Engineering Cr. 1
Prepares students to take the first step toward licensure and pass the Fundaments of Engineering (FE) examination administered by the National Council of Examiners for Engineering and Surveying (NCEES). Students will review material covered on the exam and be presented with strategies to maximize the likelihood of successfully passing the FE exam. Offered Winter.
Prerequisites: CE 3250 with a minimum grade of C-, CE 4020 with a minimum grade of C-, CE 4400 with a minimum grade of C-, and CE 4600 with a minimum grade of C-
Restriction(s): Enrollment limited to students with a class of Junior or Senior.

CE 4990 Directed Study Cr. 1-4
Supervised study and instruction in civil engineering. Written report required. Offered Every Term.
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Repeatable for 6 Credits

CE 4995 Senior Design Project Cr. 3
Capstone design experience through civil engineering projects. Offered Winter.
Prerequisites: CE 3250 with a minimum grade of C-, CE 4020 with a minimum grade of C-, CE 4400 with a minimum grade of C-, and CE 4600 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CE 5020 Introduction to Construction Safety Cr. 3
This course provides an understanding of safe work practices, mandatory training, record-keeping, and compliance with OSHA worker safety and environmental safety laws. Topics include the role of construction personnel, ethics, worker's compensation, OSHA compliance, hazard analysis, accident investigation, and emergency response plan. The course aims to improve students' knowledge of construction safety, enhance their communication skills, and foster a sense of civic duty and responsibility grounded in high moral and ethical standards. Offered Every Other Year.
Restriction(s): Enrollment is limited to Undergraduate level students.

CE 5030 Introduction to Construction Planning and Scheduling Cr. 3
This course introduces students to the principles and practices of construction project scheduling and control within the context of outcome-based education and accreditation standards. Emphasizing the core requirements outlined by accrediting bodies such as ACCE and ABET, the course focuses on developing students' ability to plan, schedule, and manage construction projects effectively using industry-standard tools including Primavera P6 and Microsoft Project. Students will learn to interpret and prepare Critical Path Method (CPM) schedules, develop accompanying narratives, and apply scheduling techniques across multiple levels of detail. Through a combination of lectures, applied exercises, and assignments, the course trains students to analyze, communicate, and resolve scheduling challenges in alignment with professional standards in Construction Management and Construction Engineering programs. Offered Every Other Year.
Restriction(s): Enrollment is limited to Undergraduate level students.

CE 5080 Causal Inference Research Methods for Engineers and Planners Cr. 3
This course focuses on causal inference methods in engineering and planning research. Students will learn how to design studies, estimate causal effects, and address heterogeneity in real-world infrastructure and policy applications. Topics include regression models, instrumental variables, simultaneous equation models, discrete choice modeling, duration analysis, and quasi-experimental approaches (e.g., difference-in-differences, propensity score matching). While examples from transportation and urban planning will be emphasized, the methods covered are broadly applicable to engineering, public policy, and infrastructure decision-making. Offered Fall.
Prerequisite: BE 2100 with a minimum grade of D-

CE 5220 Environmental Chemistry Cr. 3
Fundamentals of aqueous chemistry for environmental engineers and scientists. Basic chemistry, equilibria, kinetics and thermodynamics; includes acid/base reactions, precipitation/dissolution, oxidation/reduction reactions and partitioning. Offered Every Other Year.
Fees: $5

CE 5230 Water Supply and Wastewater Engineering Cr. 3
Analysis and design of water supply and wastewater treatment systems; water distribution systems; treatment of municipal water supplies, including sedimentation, softening, filtration and disinfection; design of sanitary and storm sewers; primary, secondary and tertiary treatment plant design; sludge handling. Offered Yearly.
Prerequisite: CE 4210 with a minimum grade of C-
Fees: $5

CE 5240 Air Pollution Engineering Cr. 3
Designed to introduce students to the fields of air pollution and air quality, this course will provide an overview of the U.S. regulation of air pollution and explain the fundamental principles of the physical and chemical processes of air pollutants associated with natural and anthropogenic emission sources. In particular, we will focus on air pollutants that contribute to the formation of acid rain, smog and haze, as well as the gas- and particle-phase tropospheric chemistry. Engineering methods to control and mitigate air pollution will be also covered. Offered Yearly.

CE 5350 Introduction to Structural Dynamics Cr. 4
Dynamic properties of structures,. Modeling of dynamic loads. Structural response to dynamic loading. Structural design requirements for dynamic loads. Fundamental techniques of dynamic system analysis. Offered Winter.
Prerequisite: ME 3400 with a minimum grade of C- and CE 4400 with a minimum grade of C-

CE 5370 Finite Element Analysis Fundamentals Cr. 3
Matrix structural analysis, discretization of continuous structural systems, stress analysis. Commercial finite element software preprocessing for developing finite element models; post-processing for evaluating analysis results. Offered Fall.
Prerequisites: CE 4400 with a minimum grade of C-

CE 5390 Design of Prestressed Concrete Structures Cr. 3
Focuses on the design of prestressed structures. The principle and methods of prestressing are discussed including approaches for computing prestress losses. The course deals with the estimation of capacity of various structural members such as beams and columns and their response to various structural actions such as flexure, vertical shear, horizontal shear, and combined axial and flexure loads. Performance at service is discussed in terms of stresses, deflections and crack control. Offered Yearly.
Prerequisite: CE 4420 with a minimum grade of C-

CE 5410 Energy, Emissions, Environment (E3) Design Cr. 3
Provides students the tools to uncover the relation between energy consumption and energy generation and optimize processes to take most advantage of low emitting energy options. Exposes students to design tools and methodologies from a diverse group of sources including US EPA, DOE, EIA, and the latest in emerging research. Offered Fall.
Equivalent: AET 5410, STE 5410

CE 5510 Geotechnical Engineering I Cr. 4
Site investigation, site improvement, bearing capacity and settlement of shallow foundations, axial capacity and lateral deflection of deep foundations, design of conventional earth retaining walls, and basics of slope stability analyses. Offered Fall.
Prerequisites: CE 4510 with a minimum grade of C-

CE 5520 Geotechnical Engineering II Cr. 3
Lateral earth pressure theories, design of conventional earth-retaining walls and of reinforced earth walls, anchored sheet-pile walls and cofferdams, fundamentals of soft-ground tunneling, two- and three-dimensional slope stability analyses, and static design of earth dams. Offered Every Other Year.
Prerequisites: CE 4510 with a minimum grade of C-

CE 5530 Foundation Engineering Cr. 3
This course applies the principles of soil mechanics to address the engineering challenges encountered in the design and construction of foundations. Students will be introduced to the principles and practice of foundation engineering, with a focus on the analysis and design of shallow and deep foundations for buildings, retaining walls, and other structures. Topics will include both analytical, calculation-based problems and practical considerations that influence design decisions in the field. The knowledge and skills developed in this course will enhance the technical competencies expected of early-career engineers and support their progression toward professional credentialing. Offered Yearly.
Prerequisites: CE 4510 with a minimum grade of C-

CE 5600 Graduate Introduction to Transportation Engineering Cr. 3
The goal of this course is to provide students—both within Civil Engineering and from other disciplines—with an introduction to transportation engineering, with specific emphasis on traffic signals, the fundamentals of traffic flow theory, level-of-service and capacity analysis, the transportation planning process, traffic safety, geometric design of highways, and pavement design. Students must complete BE 2100 with a C- or higher as a prerequisite. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students.

CE 5610 Advanced Highway Design Cr. 3
This course covers the standards recommended by: American Association of State Highway and Transportation Officials (AASHTO); FHWA; and MDOT for designing and evaluation of highways. Its objective is to introduce the students to the concepts, requirements, and fundamental skills for highway design and evaluation. The primary goal of geometric design is to provide for the safety and comfort of road users with due regard to social, economic and environmental constraints. Although there are suggested design standards and controls that must be followed to meet design goals, their application is determined on a case-by-case basis. The objective of this course is to illustrate the practical application of scientific knowledge to the planning and designing of roadway elements. The course uses up-to-date software design tools in accomplishing these goals. Upon completion of the course, the student is expected to be able to design and evaluate highways per AASHTO, MDOT and FHWA standards. Offered Fall.
Prerequisites: CE 4640 with a minimum grade of C-

CE 5620 Intelligent Transportation Systems Cr. 3
This course aims to provide graduate students with a comprehensive understanding of Intelligent Transportation Systems (ITS) and their role in enhancing transportation efficiency, safety, and sustainability. Students will explore the principles, technologies, and applications of ITS, including data-driven decision making, vehicle-to-everything (V2X) communication, autonomous and connected vehicles, real-time traffic management, and multimodal transportation integration. In addition, emerging AI technologies and their applications are also covered. Through a combination of theoretical foundations and practical case studies, students will develop skills in designing, analyzing, and implementing ITS solutions to address contemporary challenges in urban mobility, traffic congestion, environmental impacts, and infrastructure resilience. Offered Winter.

CE 5640 Advanced Transportation Systems Design and Operation Cr. 3
Provides an overview of various system components of transportation, including the driver, vehicle and roadway. The subject matter will be covered at an intermediate level, appropriate for CEE students already familiar with the basic concepts of transportation engineering who wish to expand their knowledge, and for non-CEE students specifically interested in applications of transportation engineering theory. There will be a particular emphasis on transportation safety and multimodal roadway operations, as are typical priorities in an urban or suburban setting. Traffic flow design elements including volume, density and speed; intersection design elements including delay, capacity and crash countermeasures and terminal design elements including inflow, outflow and circulation. Offered Fall.

CE 5830 Business of Engineering Cr. 3
Defining the engineering company, creating the organization, support services, business development, project management, scheduling, budgeting and profitability, operations, financial management and risk management. Offered Every Term.
Prerequisites: CE 4850 with a minimum grade of C-

CE 5995 Special Topics in Civil Engineering I Cr. 1-3
Topics to be announced in Schedule of Classes. Offered Intermittently.
Repeatable for 12 Credits

CE 6010 Advanced Construction Engineering and Management Cr. 3
This course will cover the life cycle of a construction project including planning, design, procurement, construction, commissioning, and close-out phases. Also, the students will learn about fundamentals of cost estimating, scheduling, quality, safety and risk management, sustainability, and various applicable technology for construction projects. Offered Winter.

CE 6050 Construction Cost Estimating Cr. 3
Estimating construction costs of engineering projects including materials, man-hours, equipment and overhead. Emphasis on construction equipment, including productivity and planning. Bidding and bid documents. Offered Every Other Year.
Prerequisites: CE 4850 with a minimum grade of C-

CE 6060 Construction Techniques and Methods Cr. 3
Construction techniques and methods for excavation, foundations, concrete, wood, steel, masonry, heavy construction, wastewater treatment plants, highways and roads, high rise structures, bridges, and tunneling projects. Offered Every Other Year.
Prerequisites: CE 3450 with a minimum grade of C-

CE 6130 Open Channel Hydraulics Cr. 3
Theoretical development of equations governing flow in open channels. Application to real-world engineering problems involving water surface profiles, flood studies, and river. Offered Winter.
Prerequisites: CE 3250 with a minimum grade of C-

CE 6150 Hydrologic Analysis and Design Cr. 3
Principles of surface water hydrology and their application for evaluation of floods and the design of surface runoff control system; watershed characteristics; design storms and SCS methods; unit hydrographs; hydrologic models; application of computer methods. Offered Every Other Year.
Prerequisites: CE 4210 with a minimum grade of C-

CE 6160 Principles of Atmospheric Chemistry and Applications Cr. 3
Provides the student with an overview of photochemical reactions that directly impact atmospheric composition and thus pertinent to the management of air quality. Focuses on atmospheric radicals, tropospheric ozone and mechanisms of particulate matter formation; the impact of these constituents associated with air pollutions on air quality and global climate change. Students will be introduced to modeling atmospheric chemistry using simple box models as well as state-of-the-science 3-dimensional global chemical transport models. Offered Yearly.

CE 6170 River Assessment and Restoration I Cr. 3
Students will learn field methods to assess stability, condition of rivers and contributing watersheds. Students will learn basic surveying techniques, apply these to the collection, analysis of cross-sectional data and longitudinal profiles. Other field methods include: Wolman pebble count, measurement of plan-form geometry, identification of key geomorphic features (e.g., bankful elevation, abandoned floodplains, mid-channel and transverse features). Field measurements will be made to calculate Bank Erosion Hazard Index (BEHI), Near-Bank Stress Index. Students will learn how to monitor a river for bank erosion (e.g., bank pins), riverbed aggradation/degradation (e.g., scour chains). Students will learn stream classification, sediment budgeting, methods to quantify sediment yield and transport, and how to analyze data, and identify trends in river hyrdology and sediment supply. Offered Every Other Spr/Sum.
Equivalent: ESG 6150

CE 6180 River Assessment and Restoration II - Field Methods in Fluvial Geomorphology Cr. 3
Students will learn advanced field methods to assess the stability & condition of a river. Rivers are composed of water & sediment, both flowing under the influence of gravity. The proportions of water & sediment that make up the stream will dictate the stable form or the extent to which it is unstable. One must be able to accurately quantify the water & sediment delivered to & transported through a stream. A considerable portion of this class will be spent in the field where students will learn techniques for measuring stream-flow & sediment transport. Students will learn several methods for calculating sediment transport & sediment yield rates. Students will learn field methods to quantitatively characterize the bed of a stream & the movement of that bed. The quantification of sediment sinks such as deposition on the floodplain & in ponds/reservoirs, will be performed. Students will learn how the hydrology & sediment supplies have changed & how rivers have evolved. Offered Every Other Spr/Sum.
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment is limited to Undergraduate level students.

CE 6190 Groundwater Cr. 3
Historical background, aquifers and aquitards, saturated and unsaturated flow, sources of ground water contamination, artificial recharge of ground water, development of ground water basins and efficient use of ground water resources. Offered Yearly.
Prerequisites: CE 3250 with a minimum grade of C-

CE 6220 Wastewater Treatment and Resource Recovery Cr. 3
A critical challenge of wastewater treatment is the intensive energy usage, accounting for 2-5% of total US energy consumption. The energy consumed primarily originates from nonrenewable fossil fuels and is not sustainable. Therefore, there is an increasing expectation that WWTPs should deliver not only high-quality effluents but also energy recovery and value-added by-products. State regulators, municipalities and other industrialized jurisdictions are transitioning Wastewater Treatment Plant (WWTPs) to Water Resource Recovery Facilities (WRRFs). This course is designed for graduate and upper level undergraduate students who are interested in advancing their knowledge in wastewater treatment and resource recovery. This course will provide you 1) fundamental engineering principles and knowledge of wastewater treatment, 2) advanced wastewater treatment technologies for improved wastewater treatment efficiency and resource recovery. Offered Every Other Year.
Prerequisites: CE 4210 with a minimum grade of C-

CE 6270 Sustainability Assessment and Management Cr. 3
Sustainability assessment and management for engineering design and development; theoretical, regulatory, and practical implications; Detroit and global applications. Offered Yearly.
Equivalent: STE 6270

CE 6340 Bridge Design and Evaluation Cr. 3
Concepts, procedures, methods of design and condition evaluation for modern highway bridges, according to current specifications. Entire system is covered, including superstructure, substructure, and their connections. Offered Every Other Year.
Prerequisites: CE 4420 with a minimum grade of C-

CE 6370 Advanced Reinforced Concrete Design Cr. 3
Theory and design of two-way slabs, footings, retaining walls, shear walls, and composite beams using ultimate strength design. Precast and prestressed concrete fundamentals. Offered Yearly.
Prerequisites: CE 4420 with a minimum grade of C-

CE 6410 Advanced Steel Design Cr. 3
Advanced topics of structural steel design: thin walled rolled and built-up members, beam columns, lateral torsional buckling, steel fatigue design, connection details. Steel design project. Offered Every Other Year.
Prerequisites: CE 4420 with a minimum grade of C-

CE 6420 Masonry Design Cr. 3
Students will learn to use the Building Code Requirements for Masonry Structures (TMS 402/602-16) including masonry properties, anchors, lintels, bearing walls, and columns. The course will also utilize the 2021 Michigan Building Code for design loads. Offered Every Other Year.
Prerequisites: CE 4400 with a minimum grade of C-

CE 6430 Timber Design Cr. 3
Students will learn to use the ANSI/AF&PA NDS-2018 (2018 National Design Specification for Wood Construction) including beam, column, beam-column, tension, bearing, and connection design. Course discussion will also include glulam products and engineered wood products such as laminated veneer lumber and metal plate connected wood roof trusses. The student will also learn the application of the 2015 Michigan Building Code for use with timber design as well as properly designing load paths. Offered Every Other Year.
Prerequisites: CE 4400 with a minimum grade of C-

CE 6650 Pavement Design Cr. 3
The goal of this course is to provide graduate students with a comprehensive insight into the analysis and design of flexible and rigid pavements, with a keen emphasis on pavement materials, the mechanistic analysis of pavement structure under the impacts of traffic and weather, and the mechanistic-empirical pavement design method. Additionally, the course aims to enhance students' problem-solving skills in pavement research and prepare them for the Fundamentals of Engineering (FE) and Principles and Practice of Engineering (PE) exams. Offered Fall.
Prerequisite: CE 4600 with a minimum grade of C

CE 6660 Pavement Asset Management Cr. 3
Principles and practices of pavement management at the network and project level: serviceability, pavement design models, economic analysis, and priority programming. Offered Yearly.
Prerequisites: CE 4610 with a minimum grade of C- or CE 4640 with a minimum grade of C-

CE 6880 Building Information Modeling (BIM) Cr. 3
Lectures, hands-on demonstrations and lab exercises to familiarize students with concepts and tools in Revit Architecture 2010 software; how software integrates 3D and 2D modeling. Includes an overview of the Building Information Modeling (BIM) process; integration of designs from different disciplines (architectural, structural and MEP) in a BIM model; and use of BIM tools (including Revit and Navisworks) to create 2D, 3D, 4D (schedule) and 5D (cost) models for project control purposes, as well as clash detections. Offered Every Other Year.

CE 6910 Pharmaceutical Waste: Environmental Impact and Management Cr. 2-3
Course designed for advanced professional and graduate students with sufficient chemistry and/or biological sciences background who are interested in the environmental impact, management, and regulation of waste pharmaceuticals as emerging issues. Offered Winter.
Restriction(s): Enrollment is limited to Graduate or Professional level students.
Equivalent: PSC 6910

CE 6991 Internship in Industry Cr. 1-4
Written report describing internship experience. Offered Every Term.
Repeatable for 4 Credits

CE 7020 Construction Safety Cr. 3
Safety problems in the construction industry and their technical and managerial solutions, construction accident and failure analysis and control. Safety program design and implementation with TQM integration. Offered Yearly.
Prerequisite: CE 6010 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

CE 7070 Risk and Reliability in Civil Engineering Cr. 3
Uncertainty in civil engineering practice (e.g., loads, traffic, water demand, construction quality). Reliability theory based on probabilistic and statistical methods. Reliability-based engineering design and decision making. Offered Every Other Year.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7080 Civil Engineering Research Methods Cr. 3
Methods of data collecting and statistical analysis in context of civil engineering. Applications of advanced statistical analysis techniques, theory, discussion of methodological limitations. Offered Every Other Year.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

CE 7090 Statistical and Econometric Methods in Civil Engineering II Cr. 3
The purpose of this course is to provide students with advanced training in the application of various statistical/econometric analysis techniques for addressing civil engineering-related problems. The methods considered in this class are an extension of the techniques taught in CE 7080. The course will present a number of model-estimation methods that are used in the areas of planning, design, operations and management of transportation systems. The course will emphasize model estimation and application, but underlying theory and limitations will be discussed to ensure that the methods are properly applied and understood. After completing this course, students will have exposure to an assortment of statistical modeling tools and additional insight to transportation data sources, their limitations, and the analysis of such data. It is important to note that the methods presented go well beyond the techniques typically covered in statistics courses. Offered Intermittently.
Prerequisite: CE 7080 with a minimum grade of B-
Restriction(s): Enrollment is limited to Graduate level students.

CE 7160 Advanced Principles of Atmospheric Chemistry and Applications Cr. 3
This course will provide students with an overview of photochemical reactions that directly impact atmospheric composition and thus pertinent to the management of air quality. In particular, we will focus on atmospheric radicals, tropospheric ozone and mechanisms of particulate matter formation; the impact of these constituents associated with air pollutions on air quality and global climate change. Students will be introduced to modelling atmospheric chemistry using simple box models as well as state-of-the-science 3-dimensional global chemical transport models. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7170 Advanced River Assessment and Restoration I Cr. 3
Students will learn field engineering methods to assess the stability and condition of rivers and contributing watersheds. Students will learn basic surveying techniques, apply them to the collection and analyze cross-sectional and longitudinal profile data. Other methods include: Wolman pebble count, measurement of plan-form geometry, identification of key geomorphic features. Field measurements will be made to calculate the Bank Erosion Hazard Index (BEHI) and Near-Bank Stress Index among other parameters. Students will learn how to monitor riverbank erosion and riverbed aggradation/degradation via scour chains. Students will learn stream classification, the importance of sediment budget, methods to quantify sediment yield and transport, and how to analyze data to assess trends in hyrdology and sediment supply. Offered Every Other Spr/Sum.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7180 Advanced River Assessment & Restoration II - Field Methods in Fluvial Geomorphology Cr. 3
Students will learn advanced field methods to assess the stability & condition of a river. Rivers are composed of water & sediment, both flowing under the influence of gravity. The proportions of water & sediment that make up the stream will dictate the stable form or the extent to which it is unstable. As such, one must be able to accurately quantify the water & sediment delivered to and transported through a stream. A considerable portion of this class will be spent in the field where students will learn techniques for measuring stream-flow & sediment transport. Students will learn several methods for calculating sediment transport & sediment yield rates. Students will learn field methods to quantitatively characterize the bed of a stream & the movement of that bed. Additionally, the quantification of sediment sinks such as deposition on the floodplain & in ponds/reservoirs, will be performed. Students will learn how the hydrology & sediment supplies to the Great Lakes have changed. Offered Every Other Spr/Sum.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7240 Advanced Air Pollution Engineering Cr. 3
Designed to introduce students to the fields of air pollution and air quality, this course will provide an overview of the U.S. regulation of air pollution and explain the fundamental principles of the physical and chemical processes of air pollutants associated with the natural and anthropogenic emission sources. In particular, we will focus on air pollutants that contribute to the formation of acid rain, smog and haze, as well as the gas- and particle-phase tropospheric chemistry. Engineering methods to control and mitigate air pollution will be also covered. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7270 Big Data Applications in Environmental Engineering Cr. 3
This graduate-level course will focus on numerical methods and computational techniques required to run state-of-the-art 3-dimensional (3D) chemical transport models and process big data in order to address problems in environmental engineering, with a focus on air pollution and air quality. Students will have hands-on experience running GEOS-Chem models over Grid High Performance Computing at Wayne State University and employing programming skills to analyze the often dense model output datasets, and then employing strategies to visualize and interpret these data. Offered Intermittently.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7280 Applied Environmental Microbiology Cr. 3
Provides knowledge of microbiology, roles and relations of microorganisms to the environment. Topics include practical applications of environmental microbiology to environmental issues including water treatment, biodegradation and bioremediation of environmental pollutants, production of alternative fuels, and emerging environmental concern. Special consideration will be given to water treatment and microbe-mediated cycling of organic materials (i.e. pollutants) in a variety of natural and engineered environment. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

CE 7311 Sustainability of Urban Environmental Systems Cr. 2
Students will be introduced to topics in urban sustainability from multiple disciplinary perspectives such as: ecology, anthropology, communication, engineering, economics and urban planning. Questions in fostering a more sustainable urbanism will be introduced and evaluated. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students.
Equivalent: BIO 7310

CE 7385 Advanced Topics in Reinforced Concrete Design Cr. 3
Focuses on reinforced concrete plasticity, plastic mechanism analysis, and the application of these concepts to design for strength of reinforced concrete structures. Offered Every Other Year.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7395 Advanced Design of Prestressed Concrete Structures Cr. 3
Focuses on the design of prestressed structures. The principle and methods of prestressing are discussed including approaches for computing prestress losses. Deals with the estimation of capacity of various structural members such as beams and columns and their response to various structural actions such as flexure, vertical shear, horizontal shear, and combined axial and flexure loads. Performance at service is discussed in terms of stresses, deflections and crack control. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7460 Advanced Composite Materials for Civil Infrastructure Cr. 3
Infrastructure problems. Advanced fiber reinforced plastics, including applications in primary/secondary and marine structures, and in rehabilitation. High performance fiber reinforced concrete. Controlled composite properties via composite design. Review of composite analysis and failure criteria based on micromechanics and laminate theory. Offered Every Other Year.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7500 Constitutive Models in Geomechanics Cr. 3
This course introduces students to computational techniques and constitutive modeling in geomechanics. The first portion of the course develops essential numerical computing skills for numerical analysis and visualization. The remainder of the course focuses on fundamental models of soil and geomaterial behavior, including elastic, plastic, and elastoplastic formulations. Using the numerical computing skills, they develop early in the semester, students program and explore these constitutive models through a series of hands-on computational labs and structured homework assignments, gaining experience in analyzing stress-strain responses and interpreting material behavior under different loading conditions. Students should have completed Introductory Soil Mechanics (CE 4510) and engineering calculus sequence (MAT 2010, 2020, 2030) or their equivalents as prerequisites. Offered Every Other Year.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7580 Environmental Remediation Cr. 3
Site assessment; soil and groundwater investigation for remediation; application of remediation technologies; legislation related to remediation. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7600 Highway Safety and Risk Management Cr. 3
The focus of this course is on developing knowledge, skills, and abilities for planning, managing, and operating safe roadways for all users and modes of travel. It includes analysis of roadway design alternatives, statistical analysis of roadway safety issues, and crash countermeasure selection and evaluation. Students should have prior knowledge of the roadway geometric design process, traffic flow fundamentals (i.e., volume, density, speed, etc.), traffic control devices, and basic statistics (linear regression, t-tests, p-values, etc.). Offered Every Other Year.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7620 Traffic Engineering Control and Operation Cr. 3
Traffic flow theories, macroscopic and microscopic models of traffic control, statistical analysis; design and application of intelligent transportation systems on traffic flow characteristics; evaluation. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7625 Advanced Intelligent Transportation Systems Cr. 3
This course aims to provide graduate students with a comprehensive understanding of Intelligent Transportation Systems (ITS) and their role in enhancing transportation efficiency, safety, and sustainability. Students will explore the principles, technologies, and applications of ITS, including data-driven decision-making, vehicle-to-everything (V2X) communication, autonomous and connected vehicles, real-time traffic management, and multimodal transportation integration. In addition, emerging AI technologies and their applications are also covered. Through a combination of theoretical foundations and practical case studies, students will develop skills in designing, analyzing, and implementing ITS solutions to address contemporary challenges in urban mobility, traffic congestion, environmental impacts, and infrastructure resilience. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7630 Urban Transportation Planning Cr. 3
This course provides an in-depth view of transportation planning and the analytical and statistical tools needed to understand different planning principles and the relationship between transportation and land use, travel demand forecasting, demand versus supply characteristics, and the development and evaluation of alternative systems. Additional topics will include benefit-cost analysis, transportation equity analysis, and transit accessibility measurement. Offered Every Other Year.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7810 Advanced Legal Aspects of Engineering and Construction Cr. 3
Examines the legal structure of the architecture, engineering, and construction (AEC) industry from the perspective of the working professional. Topics covered include: fundamental principles of law; components of a contract; industry standard agreements; project delivery methods; liabilities of owner, architect, engineer, contractor, and subcontractors/suppliers; torts, negligence, and claims; delays and unforeseen conditions; insurance and indemnification; intellectual property; liens and bonds; dispute resolution basics; rights in land, boundaries, and foundations. Case studies will be used, where appropriate, to illustrate keys concepts. Offered Intermittently.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7830 Construction Planning and Scheduling Cr. 3
Planning and scheduling of construction projects, project networks and critical path methods, resource leveling, use of Primavera software. Offered Yearly.
Prerequisite: CE 6010 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

CE 7840 Facilities Management Cr. 3
Buildings and grounds operations and maintenance, planning design and construction, facilities economics and financing, real estate administration, environmental health and safety, health issues. Offered Winter.
Prerequisite: CE 6010 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

CE 7860 Construction Accounting and Financial Management Cr. 3
Construction financial management, construction accounting systems, analysis of financial statements, monitoring and controlling construction costs, managing overhead costs, markup, profit center analysis, cash flows for construction projects, financing, making financial decisions. Offered Every Other Year.
Prerequisite: CE 6010 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

CE 7890 Integrated Construction Project Management Cr. 3
Construction project management framework, construction project integration, project scope management, time management, cost management, quality management, procurement management, risk management, communication management. Offered Every Other Year.
Restriction(s): Enrollment is limited to Graduate level students.

CE 7990 Directed Study Cr. 1-4
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 6 Credits

CE 7995 Special Topics in Civil Engineering II Cr. 1-3
A consideration of special subject matter in civil engineering. Topics to be announced in Schedule of Classes. Offered Intermittently.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

CE 7996 Research Cr. 1-4
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 6 Credits

CE 8999 Master's Thesis Research and Direction Cr. 1-8
Offered Every Term.
Restriction(s): Enrollment limited to students with a class of Candidate Masters; enrollment is limited to Graduate level students.
Repeatable for 8 Credits

CE 9990 Pre-Doctoral Candidacy Research Cr. 1-8
Research in preparation for doctoral dissertation. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

CE 9991 Doctoral Candidate Status I: Dissertation Research and Direction Cr. 3-9
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 9 Credits

CE 9992 Doctoral Candidate Status II: Dissertation Research and Direction Cr. 1-18
Offered Every Term.
Prerequisite: CE 9991 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 18 Credits

CE 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction Cr. 0
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 0 Credits