CIVIL ENGINEERING (CE)

CE 97: Special Topics
1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in depth, a comparatively narrow subject which may be topical or of special interest.

CE 100S: Topics and Contemporary Issues in Civil and Environmental Engineering: First-Year Seminar
1 Credits

First-Year Seminar exploring a specific topic or contemporary issue in civil and environmental engineering. CE 100S Topics and Contemporary Issues in Civil and Environmental Engineering: First-Year Seminar (1) (FYS)The first-year seminar in civil engineering will provide an opportunity for students to explore a specific topic or contemporary issue, which may fall within one of the Department of Civil and Environmental Engineering's technical emphasis areas, or include many of the facets of civil engineering. Civil engineers plan, design, construct, operate, and maintain the physical works and facilities essential to modern life: highways, streets, bridges, dams and levees, water distribution and wastewater collection, and treatment systems. Civil engineers work with architects and other engineers in the design and construction of buildings and industrial structures and facilities. They also have a major responsibility for identifying and remediating environmental hazards. The specific course topic, chosen by the course instructor, will vary by section and semester and will be indicated by the section subtitle. Examples of the topics that may form the core of a seminar section include droughts and floods, lessons from structural failures, engineers as environmental change agents, beneficial reuse of treated wastewater, highway accident reconstruction and engineering, and landmark civil engineering projects. Within the context of the specific seminar topic, each section will provide students with an introduction to the civil engineering field, exposure to some of the professional skills and competencies associated with academic study and the practice of engineering, and access to relevant student and professional societies. Each seminar section will include an active learning element that may include laboratory experiments, group projects, class discussions, and possible trips, providing close interaction with the faculty member teaching the course. This seminar course will help incoming students become acclimated to University life and become aware of available resources and support services.

First-Year Seminar

CE 197: Special Topics
1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in depth, a comparatively narrow subject which may be topical or of special interest.

CE 199: Foreign Studies
1-12 Credits/Maximum of 12

Courses offered in foreign countries by individual or group instruction.

International Cultures (IL)

CE 209: Fundamentals of Surveying
2 Credits

Fundamental surveying measurements, traverse computations, coordinate geometry, mapping, CAD applications. Intended for architectural engineering students. (The lecture will be taught concurrently with CE 211.)

Enforced Prerequisite at Enrollment: MATH 141

CE 254: Personal & Occupational Safety
3 Credits

Students will learn about principles of safety in work and personal settings. CE 254 Personal & Occupational Safety (3) (GHA; US) This is a 3 credit course designed for students who want an understanding of safety, practices related to the individual's wellness and developing knowledge, attitudes, habits and skills needed for a safe healthful lifestyle. General safety topics that are relevant to students as they adjust to the transition into and through college are introduced through a values and decision making approach to learning. The students will understand direct and indirect cost related to an accident; identifying the major occupational and general injuries and deaths and the role of workers compensation, and safe procedures. OSHA will be discussed including its structure & organization, citations & fines, inspections, various standard areas, and developing an effective safety program. The course content will also be related to principles of personal and general safety including, preventive and protective systems, highway/road safety, general child safety, emergency response, and how safety is integrated with their lifestyle and our society. The course is designed to give students a broader understanding of both short-term and long-term wellness and how it is affected by safety behavior.

United States Cultures (US)

General Education: Health and Wellness (GHW)

CE 271: Water and Wastewater Transport Systems
3 Credits

Water, wastewater quantities; water storage; design of water distribution and sewerage systems; pumping stations; introduction to water-wastewater treatment processes.

CE 296: Independent Studies
1-18 Credits/Maximum of 18

Creative projects, including research and design, which are supervised on an individual basis and which fall outside the scope of formal courses.

CE 297: Special Topics
1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in depth, a comparatively narrow subject which may be topical or of special interest.

CE 299: Foreign Studies
1-12 Credits/Maximum of 12

Courses offered in foreign countries by individual or group instruction.
International Cultures (IL)

CE 310: Surveying

3 Credits

Fundamental surveying measurements, traverse computations, coordinate geometry, mapping, GPS and GIS, circular and parabolic curves, earthwork, boundary surveys, CAD applications. C E 310 Surveying (3) This is an introductory course in the fundamentals of surveying designed for Civil Engineering students. It includes basic measurement techniques of distance and angles, both horizontal and vertical. Traverse measurements analysis and mapping are discussed. Boundary surveys and legal descriptions are studied. Instruction includes the analysis of circular and parabolic curves, earthwork, and the use of coordinate geometry. Global positioning and graphic information systems are studied.

Enforced Prerequisite at Enrollment: EDSGN 100 and MATH 141

CE 321: Highway Engineering

3 Credits

Highway engineering principles, vehicle and driver characteristics; geometric and pavement design; highway drainage; traffic engineering, capacity analysis, and signal timing. C E 321 Highway Engineering (3) This course provides an introduction to highway engineering and is designed for civil engineering students. It includes topics such as vehicle motion, highway cross-sections, horizontal and vertical alignment, and sight distance. Other topics are pavement design, drainage analysis, traffic engineering and highway capacity. The students will also have a CAD lab where they design a highway using computer software. The semester project provides hands-on highway design experience. This course serves as a prerequisite for advanced highway engineering study.

Enforced Prerequisite at Enrollment: CE 310

CE 332: Professionalism, Economics & Construction Project Delivery

3 Credits

Introduction to engineering management process; economic analysis; pricing; contract documents; estimating; ethics; professional practice and engineering economy. C E 332 C E 332 Project Development (3) The first five weeks of the course introduces concepts relating to engineering ethics, professionalism including the importance of licensure, and engineering economy. The remainder of the semester concentrates on project development and the design and construction of the delivery process. Topics include: scope of design services; conceptual cost estimates; the bidding process, estimating, and risk management.

Enforced Prerequisite at Enrollment: EMCH 213 Enforced Concurrent at Enrollment: GEOSC 1

CE 336: Materials Science for Civil Engineers

3 Credits

Introduction to civil engineering materials; their structure and behavior; relationship between structure and behavior. C E 336 C E 336 Materials Science for Civil Engineers (3) This course introduces engineering students to the structure, properties and behavior of construction materials, providing the bridge between engineering mechanics and engineering design. The course is an engineering science course focused at providing the students with a working knowledge of the nature and engineering properties of construction materials to understand prediction models and statistical variations for quality control. The course provides an introduction to aggregates, concrete, asphalt, timber, steel, structural alloys, and polymers used in the civil infrastructure and in building construction.

Enforced Prerequisite at Enrollment: EMCH 213 Enforced Concurrent at Enrollment: STAT 401

CE 337: Civil Engineering Materials Laboratory

1 Credits

Laboratory investigating the physical and mechanical properties of civil engineering materials; soils, aggregates, concrete, steel, wood; and polymers. C E 337 C E 337 Civil Engineering Materials Laboratory (1) The understanding of the structure, physical and mechanical properties and behavior of engineering materials is at the very core of engineering design. A command of this knowledge is essential for all civil engineers. This 1-credit laboratory provides a hands-on experience with the testing and evaluation of civil engineering materials, including soils, aggregates, concrete, steel, wood and polymers. In addition, this lab builds on the topics of professional communication and engineering in groups that are present throughout the Civil Engineering curriculum. This course is required for all Civil Engineering majors and is a required laboratory component for ABET review. The course also may serve selected Architectural Engineering students that currently enroll in Material Science for Engineers. The laboratory will be taught every semester with
Design of steel tension members, beams, columns, beam-columns, and composite beams, and connections. Discussion of design requirements focuses on failure mechanisms and behavior, evaluation of existing components, and the process to develop economical steel member designs. All discussions are based on the current American Institute of Steel Construction steel design specifications with an overview of historical requirements as appropriate. Students complete a design project of a multi-story, steel, commercial building that is intended to synthesize the course material and create a realistic context for the course. Weekly assignments are typically derived from the course project. Computer applications are an important component of these assignments.

**Enforced Prerequisite at Enrollment:** CE 336 and CE 340

**CE 360: Fluid Mechanics**
3 Credits
Mechanics of fluids; flow in conduits and around bodies, friction and energy loss, fluid measurements. C E 360 Fluid Mechanics (3) The course objective is to provide students with the fundamental physical and analytical principles of fluid mechanics through the understanding of the: conservation of mass, conservation of energy, and the conservation of momentum equations. The student will demonstrate the understanding of these fundamentals by solving problems dealing with: fluid properties, fluid statics, pressure on plane and curved surfaces, buoyancy and flotation, kinematics, systems, control volumes, conservation principles, ideal incompressible flow, impulse-momentum, and flow of a real fluid. Fluid mechanics is a prerequisite to all courses in hydrosystems and environmental engineering. It is typically offered fall and spring semesters and during summer session. A series of homework problems are assigned after each lecture and there are typically 3 examinations given during the semester and final examination during the final examination period.

**Enforced Prerequisite at Enrollment:** EMCH 212

**CE 370: Introduction to Environmental Engineering**
3 Credits
Nature and scope of environmental issues; air, water, land impacts; fundamentals and processes of pollution control. CE 370 Introduction to Environmental Engineering (3) The objectives of this course are to introduce science and engineering principles for dealing with natural and engineered environmental systems; to provide quantitative tools to solve environmental engineering problems dealing with water and wastewater treatment, air pollution control, and management of solid and hazardous wastes; and to identify alternative ways to deal with pollution and to minimize pollution.

**Enforced Prerequisite at Enrollment:** CHEM 110 and (MATH 111 or MATH 141)

**CE 371: Water and Wastewater Treatment**
3 Credits
Water treatment; water storage; design of water distribution and wastewater systems; pumping stations. CE 371 Water and Wastewater Treatment (3) This course includes engineering design of water and wastewater treatment facilities, and it emphasizes quantitative problem solving. Numerous examples pertain to contemporary water and wastewater treatment facility designs. This course will nurture the ability to use the techniques, skills and state-of-the-art engineering tools so
as to prepare students for water and wastewater treatment engineering practice. Water treatment-related topics include: water quality criteria for potable water, reactor characteristics, reaction rates in water and wastewater treatment, mixing and flocculation sedimentation, rapid sand filtration, chlorination and alternative disinfection. Wastewater pretreatment, biological principles for treatment of wastewater, suspended growth bio-systems, attached film bio-systems, nutrient removal processes, and de-watering and treatment processes for sludges is also included.

**Enforced Prerequisite at Enrollment:** CE 360 and CE 370

CE 396: Independent Studies

1-18 Credits/Maximum of 18

Creative projects, including research and design, which are supervised on an individual basis and which fall outside the scope of formal courses.

CE 397: Special Topics

1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in depth, a comparatively narrow subject that may be topical or of special interest.

CE 399: Foreign Studies

1-12 Credits/Maximum of 12

Courses offered in foreign countries by individual or group instruction.

International Cultures (IL)

CE 402: Computing Methods for Civil and Environmental Engineering

3 Credits

This course will cover essential computing methods, implementations, and applications in civil and environmental engineering. Computing is essential for the civil and environmental engineering profession. It is used in many aspects of civil and environmental engineering, for example analyzing data and making impressive visualizations, computing backwater curve in a river, solving species concentration in chemical reactors, finding deflection of a beam, or calculating seepage and consolidation of soils. In engineering practice, computers are used to solve real world, complex problems beyond the capability of hand calculations. Major topics covered in this course include basic programming with Python, scientific and technical visualization, root finding, interpolation and curve fitting, direct and iterative solution of linear equation systems, numerical integration, numerical differentiation, and numerical solution of ordinary differential equations. Application examples of these computing techniques will be introduced and explained to help students understand the context. For example, root finding can be used to solve the nonlinear Manning’s equation to design drainage channels, curve fitting and regression can be used to analyze measurement data, the solution of linear equation systems is at the core of many modern engineering software solving governing differential equations, numerical integration can be used to calculate wind load on buildings, numerical differentiation is essential for solving governing differential equations, the solution of ordinary differential equations can be used to model the dynamics of a structure or a reaction system.

The objectives are for the students to have a fundamental understanding of algorithms and solution techniques for common computing problems in civil and environmental engineering, the ability to correctly implement computing algorithms with a programming language, and the ability to utilize existing numerical libraries and understand their strength and limitations. The course is structured to have two lectures and one computer lab session per week. Students will work on simple problems with manual calculations and more complex problems with computer codes which implement the covered computing methods. Homework and exams will draw on many application examples students may encounter in their coursework for the civil and environmental engineering major and in their future professional career.

**Prerequisite:** CMPSC 200; or CMPSC 201 or CMPSC 121; or CMPSC 131

Concurrent: MATH 251

CE 410: Sustainable Residential Land Development

3 Credits

CE 410 provides students with a working knowledge of the residential land development design process including conservation and green design approaches; site assessment; grading and earthwork; utility design and layout; and stormwater management. The course covers the subdivision and land development regulatory process, zoning issues, and the elements of civil infrastructure design required in the residential land development process. Conservation design and sustainable development techniques are emphasized throughout the course. The course focuses on practice-oriented design problems and a real piece of land (either University owned or privately held) will be used throughout the semester for demonstration of design approaches for homework assignments and in-class examples. The course is an elective for students in the Civil Engineering major and an elective in the Residential Construction Minor.

**Enforced Prerequisite at Enrollment:** CE 332 and seventh semester standing in AE_BAE or CE_BS. Enforced Corequisite at Enrollment: AE 372

CE 411: Residential Construction Design Project

1 Credits

Interdisciplinary teams will develop a complete design and investment package for a real life new residential or real estate development.

**Enforced Prerequisite at Enrollment:** Fifth semester standing or higher

CE 421W: Transportation Design

3 Credits

Design of streets and highway facilities; emphasis on geometric elements, intersections and interchanges, roadway drainage, and pavement design. C E 421W C E 421W Transportation Design (3) This course provides advanced study in highway engineering and is designed for civil engineering students who are interested in Transportation Engineering careers. It includes topics such as functional classification, highway cross-sections, horizontal and vertical alignment and sight distance. Other topics are pavement design, drainage intersection and interchange design and highway signs. The students will also have a CAD lab where they design a complete highway system. The semester project provides hands-on highway design experience and includes the planning and operational aspects of a new highway design. This course serves as a capstone design course with writing projects. Students are expected to do in-class presentations of their projects.

**Enforced Prerequisite at Enrollment:** CE 321

Writing Across the Curriculum
CE 422: Transportation Planning
3 Credits
Transportation systems planning, programming, and management; modeling and simulation, data collection, analysis, and forecasting. This course introduces students to the basic practical aspects of construction and operations. It is a new approach to project delivery in which a digital representation of the project process is used to facilitate the exchange and interoperability of information. Implementation of PIM generates significant benefits, including improved design quality, reduction in design errors, improved field productivity, reduction in conflicts and changes, and finally reduction in construction cost and time. In this course, students will learn applications of PIM used in the industry by different disciplines (e.g., architectural, engineering and construction), design model-based development and coordination (e.g., 3D, 4D, 5D, and XD), value engineering concepts, system clash prevention, and understand the benefits of various parametric modeling applications that can be used. Upon completion of this course, students will have full understanding of PIM concepts throughout the lifecycle of a building or an infrastructure project, from planning, design, pre-construction, construction and operations.

Enforced Prerequisite at Enrollment: EDSGN 100 and (CE 332 or CE 333W)

CE 423: Traffic Operations
3 Credits
The highway capacity manual, concepts and analyses, freeway operations, signalized and unsignalized intersections, signal coordination, traffic impact studies.

Enforced Prerequisite at Enrollment: CE 321

CE 424: Project Info. Modeling
3 Credits/Maximum of 3
Project Information Modeling is the process of constructing a 3D digital model of a project with attached information. Project Information Modeling (PIM) is an integrated process built on coordinated, reliable information about a project from design through construction and into operations. It is a new approach to project delivery in which a digital representation of the project process is used to facilitate the exchange and interoperability of information. Implementation of PIM generates significant benefits, including improved design quality, reduction in design errors, improved field productivity, reduction in conflicts and changes, and finally reduction in construction cost and time. In this course, students will learn applications of PIM used in the industry by different disciplines (e.g., architectural, engineering and construction), design model-based development and coordination (e.g., 3D, 4D, 5D, and XD), value engineering concepts, system clash prevention, and understand the benefits of various parametric modeling applications that can be used. Upon completion of this course, students will have full understanding of PIM concepts throughout the lifecycle of a building or an infrastructure project, from planning, design, pre-construction, construction and operations.

Enforced Prerequisite at Enrollment: EDSGN 100 and (CE 332 or CE 333W)

CE 425: Transportation Planning (3)In this course, students acquire basic knowledge on the history and recent developments in transportation planning problems and quantitative methods. They will develop an understanding of transportation planning, transportation modeling, transportation system simulation, data collection techniques, and gain laboratory experience with each. Students will use mathematical/statistical models and GIS software to analyze, simulate, and forecast the demand for transport services. They will gain familiarity with the software used in transportation planning practice.

Enforced Prerequisite at Enrollment: 3 credits of STAT

CE 426: Traffic Operations
3 Credits
The highway capacity manual, concepts and analyses, freeway operations, signalized and unsignalized intersections, signal coordination, traffic impact studies.

Enforced Prerequisite at Enrollment: CE 321

CE 427: Project Info. Modeling
3 Credits/Maximum of 3
Project Information Modeling is the process of constructing a 3D digital model of a project with attached information. Project Information Modeling (PIM) is an integrated process built on coordinated, reliable information about a project from design through construction and into operations. It is a new approach to project delivery in which a digital representation of the project process is used to facilitate the exchange and interoperability of information. Implementation of PIM generates significant benefits, including improved design quality, reduction in design errors, improved field productivity, reduction in conflicts and changes, and finally reduction in construction cost and time. In this course, students will learn applications of PIM used in the industry by different disciplines (e.g., architectural, engineering and construction), design model-based development and coordination (e.g., 3D, 4D, 5D, and XD), value engineering concepts, system clash prevention, and understand the benefits of various parametric modeling applications that can be used. Upon completion of this course, students will have full understanding of PIM concepts throughout the lifecycle of a building or an infrastructure project, from planning, design, pre-construction, construction and operations.

Enforced Prerequisite at Enrollment: EDSGN 100 and (CE 332 or CE 333W)

CE 428: Construction Engineering Materials
3 Credits
Fundamentals of project management, construction scheduling using the CPM technique, construction project preplanning, and control of quality, safety, and costs. C E 432 C E 432 Construction Project Management (3)This course introduces students to the basic practical aspects of the construction process and the quantitative methods used to manage projects within budget, deadline, and prescribed quality. Students will understand the construction market and the inter-relationships among the various players involved. Focus in this course is on integrating the various facets of construction cost estimating, planning, scheduling, control, and overall project management.

Enforced Prerequisite at Enrollment: CE 332

CE 432: Construction Engineering Materials
3 Credits
Design, production, application, specification, and quality control of construction materials unique to civil engineering. C E 436 Construction Engineering Materials (3) C E 436 provides students with a working knowledge of the safe design, production and application of quality construction materials unique to civil engineering. The course builds upon the understanding of civil engineering materials gained in the introductory course. C E 436 focuses on the materials design and quality control of aggregates, steel, portland cement concrete, and asphalt concrete.

Enforced Prerequisite at Enrollment: CE 336 and STAT 401

CE 433: Geotechnical Engineering Design
3 Credits
This is an advanced design course in geotechnical engineering, offered to undergraduate senior and graduate students in civil engineering. This course covers fundamental engineering geology, subsurface exploration including geophysical techniques, principles of shallow and deep foundation designs, slope stability, geosynthetics design, groundwater and drainage, and geotechnical earthquake engineering. The course is typically delivered in lecture format and concentrates on practice-oriented design problems in geotechnical engineering.

Enforced Prerequisite at Enrollment: CE 335

CE 434: Geotechnical Engineering Design
3 Credits
This is an advanced design course in geotechnical engineering, offered to undergraduate senior and graduate students in civil engineering. This course covers fundamental engineering geology, subsurface exploration including geophysical techniques, principles of shallow and deep foundation designs, slope stability, geosynthetics design, groundwater and drainage, and geotechnical earthquake engineering. The course is typically delivered in lecture format and concentrates on practice-oriented design problems in geotechnical engineering.

Enforced Prerequisite at Enrollment: CE 335

CE 435: Foundation Engineering
3 Credits
C E 435 provides students with a working knowledge of the state-of-practice of foundation engineering, covering bearing capacity, settlement, and structural design of shallow foundations; lateral earth pressure; design of retaining and sheet-pile walls; and an introduction to deep foundations. The course is an elective for students in the civil engineering major and serves as an essential prerequisite for continued study in the areas of construction and structural engineering. The course concentrates on practice-oriented design problems in foundation engineering.

Enforced Prerequisite at Enrollment: CE 335

CE 436: Construction Engineering Materials
3 Credits
Design, production, application, specification, and quality control of construction materials unique to civil engineering. C E 436 Construction Engineering Materials (3) C E 436 provides students with a working knowledge of the safe design, production and application of quality construction materials unique to civil engineering. The course builds upon the understanding of civil engineering materials gained in the introductory course. C E 436 focuses on the materials design and quality control of aggregates, steel, portland cement concrete, and asphalt concrete.

Enforced Prerequisite at Enrollment: CE 336 and STAT 401

CE 437: Engineering Materials for Sustainability
3 Credits
Environmental impact of materials; life-cycle assessment; material selection to optimize performance; design, evaluation, and production of green construction materials.

Enforced Prerequisite at Enrollment: CE 336
CE 438W: Construction Engineering Capstone Design
3 Credits
Construction project integrating geotechnical reports; materials specifications; quality control; equipment; estimation; scheduling; design details: excavations, foundations, retaining walls, formwork, pavements.

CE 439W: Geotechnical and Materials Engineering Design Capstone
3 Credits
Subsurface site evaluation; integrated design of retaining walls, foundations, pavements, and materials for airports, highways, dams, or other facilities.

Enforced Prerequisite at Enrollment: CE 432 and (CE 435 or CE 436) Writing Across the Curriculum
CE 441: Structural Design of Foundations
3 Credits
Design of concentrically and eccentrically loaded square, rectangular, and combined footings; analysis and design of mat foundations; retaining walls; piles caps; flexible retaining design, and caissons.

Enforced Prerequisite at Enrollment: CE 435 and (CE 436 or CE 437) Writing Across the Curriculum
CE 448W: Advanced Structural Design
3 Credits
Wind, snow, seismic, bridge loads; building design using steel, concrete, and prestressed concrete; advanced steel connections; capstone project; computer applications.

Enforced Prerequisite at Enrollment: CE 340
CE 448W: Advanced Structural Design
3 Credits

draftsman, and concentration in civil engineering construction projects.

Enforced Prerequisite at Enrollment: CE 342 and CE 441 Enforced Concurrent at Enrollment: ENGL 202C Writing Across the Curriculum
CE 449: Advanced Structural Design
3 Credits
Special systems, frames and bracing in steel, wood and reinforced or precast concrete. Introduction to composite construction.

Enforced Prerequisite at Enrollment: CE 434 and CE 431 and CE 342
CE 454: Safety
3 Credits
This course will focus on safety issues as they relate to OSHA.
CE 456: Planning and Scheduling

3 Credits

Theory and practice used in planning and scheduling projects; defining task and resources, creating logic diagrams, and monitoring the projects. C E 456 C E 456 Planning & Scheduling (3) "Planning and Scheduling" encompasses construction tenets and fundamentals including organizing, staffing, directing, and controlling representing concepts and principles integral to career applications in project and design management. Students who successfully complete this course will be able to: 1) understand and use planning, scheduling, and control techniques for managing construction projects 2) understand scheduling techniques and computer applications in critical path methods, PERT, and resource scheduling 3) understand construction financing and schedule / cost relations 4) understand the principles of project tracking, progress measurements, trend analysis, and forecasting

Enforced Prerequisite at Enrollment: CE 332 or CE 333W

CE 458: Construction Management II

3 Credits

Procedures in construction organization including procurement, ethics, field supervision, legal and managerial problems, personnel, cost accounting, and construction business practices. C E 458 C E 458 Construction Management II (3) This course presents policies, procedures, and applications in construction management and organization including procurement, ethics, field supervision, legal and managerial problems, personnel, cost accounting, and construction business practices. The course encompasses construction tenets and fundamentals including planning, organizing, staffing, directing, and controlling. Students who successfully complete this course will be able to: 1) understand organizational issues concerning development of a project delivery system 2) comprehend the roles and responsibility of the Resident Project Representative and members of the construction team and the respective utility of the resident inspection office responsibilities 3) know the various documentation construction records/reports normally 4) recognize the salient features of specifications and drawings and the fundamentals for using them in contract administration 5) become familiar with the prevailing construction laws, policies, and procedures dealing with labor and safety 6) understand the utility of meetings during construction and the principles and techniques of negotiation 7) apply risk management through contractual allocation of rush and liability 8) become well versed in planning/orchestrating during reconstruction operations 9) apply management principles of directing and controlling construction operations and resources including CPM scheduling, inspections, tests, and contractor submittals 10) understand the concept of value engineering in construction operations 11) understand the critical control issues involved with measurement and payments, controlling construction materials and workmanship, and changes and extra work

Enforced Prerequisite at Enrollment: CE 333W and CE 456

CE 461: Water-resource Engineering

3 Credits

Qualitative and quantitative description of the hydrologic cycle, flood and drought frequency analysis, climate and land use change impacts, risk analysis and uncertainty, water resource management at regional, national and global scale.

Enforced Prerequisite at Enrollment: CE 360

CE 462: Open Channel Hydraulics

3 Credits

Free surface flow in rivers, canals, steep chutes, stilling basins, and transitions. C E 462 Open Channel Hydraulics (3) This is an advanced senior level course dealing with steady gradually varied flow. The laws of conservation of mass, energy and momentum are applied to gradually varied steady flow problems in rectangular and non-rectangular channels. Basic definitions and equations governing flow are developed for uniform and nonuniform flow conditions. The students will use their knowledge of fluid mechanics, calculus, numerical analysis and computer science to solve practical open channel flow problems.

Enforced Prerequisite at Enrollment: CE 360

CE 465W: Water Resources Capstone Course

3 Credits

Principles and design of unit operations for water; domestic and industrial wastewater treatment; equipment selection and application. C E 471 C E 472W Environmental Engineering Capstone Design (3) This course will integrate engineering science and design skills through application to an open-ended environmental problem dealing with one or more of the following: industrial sustainability and pollution prevention; water transmission and treatment; wastewater collection and treatment; solid waste collection, treatment, and disposal; remedial investigation and feasibility studies for a hazardous waste site.

Enforced Prerequisite at Enrollment: CE 370 and CE 371

Writing Across the Curriculum

CE 473: Ecological Design of Regenerative Aquatic Systems

3 Credits

This course begins with an introduction to natural wetlands, and then extends those fundamental ecological principles to the design of constructed wetlands for wastewater and mine water treatment. In the second half of the course, these ecological principles are applied to the design of a variety of aquaponics systems for fish and vegetable production. Throughout the semester, emphasis is given to how beneficial byproducts (food, energy, water) can be produced in ecological systems
to support sustainable communities in both developed and developing countries. The course culminates with a final team project on the design of an ecological system for a real community.

Enforced Prerequisite at Enrollment: CE 370

CE 475: Water Quality Chemistry

4 Credits

Chemistry applicable to the understanding and analysis of water quality, pollution, and treatment. C E 475 C E 475 Water Quality Chemistry (4) C E 475 Water Quality Chemistry is a senior/graduate-level course focused on both theoretical aspects of water chemistry and applied aspects of engineering practice. The course will cover a wide range of fundamental chemical principles that will be investigated further in the laboratory exercises and through an independent research project. The course covers reaction stoichiometry and reaction type with specific examples of processes typically encountered in water, wastewater and hazardous waste treatment situations. The course distinguishes between kinetic and equilibrium reactions and presents mathematical formulations for both types of reactions. The course reviews thermodynamics and electrochemistry and relates them to equilibrium constants and the spontaneity of reactions. The course covers redox reactions especially with respect to the corrosion of civil infrastructure, the generation of acid rock drainage, and biological wastewater treatment processes. The course covers acid/base reactions especially with respect to disinfection of drinking water and pH adjustments commonly used to enhance air stripping of pollutants. The course introduces the use of computer models for determining chemical speciation of acid/base constituents. The course covers alkalinity and the carbonate system especially with respect to the issues of acidification, acidification of the Earth’s oceans, and limestone buffering of surface waters in Pennsylvania. Computer models are used to calculate chemical speciation in carbonate-containing systems. The course covers pH-dependent solubility of common minerals - primarily carbonates, hydroxides, and aluminosilicates. The course covers engineering applications related to metal solubility including water softening, coagulation for turbidity removal in water treatment plants, heavy metal generation from acid rock drainage, and heavy metal removal in hazardous waste treatment. The course covers complexation reactions especially with respect to disinfection and metal toxicity. Computer models are used to calculate chemical speciation in multi-complexant systems. The course covers analytical chemistry especially with respect to the most common parameters measured in water and wastewater treatment systems, and with respect to the principles of measurement (i.e. gravimetric, spectrometric, volumetric, potentiometric analyses). The course covers instruction in microbiology; (2) microbial diversity and ecology; and (3) the application of these fundamental microbial principles to environmental systems. In the fundamentals section, the course covers microbial nomenclature, macromolecules, cell biology, energetics, growth, and genetic regulation. This is illustrated with calculations of thermodynamic constraints in microbially catalyzed reactions, the calculation of efficiencies based on energy conservation from common pathways, and the connection of these efficiencies to microbial growth in a chemostat. Building on these fundamental concepts of metabolic potential and conserving energy and acquiring reducing equivalents from redox reactions, the second section covers the reactions and energetics of the primary microbial functional diversity such as phototrophy, lithotrophy, autotrophy, anaerobic respirations, and fermentations. It also introduces modern molecular biology techniques for studying microbial systems, and pulls the concepts of functional diversity together by illustration with the major nutrient cycles, including discussions of environments in which each reaction might be encountered. Finally, the last section applies these ecological principles to several specific engineered environments of interest. Homework assignments throughout the semester involve questions about the methods, findings, or applications of recent articles that highlight the recently covered material, giving the students experience in the critical evaluation of primary literature and demonstrating the relevance of the material to environmental microbiology research and application. Complementing the progression of the lectures are eight instructional laboratories that provide hands-on application of diagnostic microbiological techniques to the characterization of environmental enrichment cultures and pure cultures. For example, a microscopy lab immediately follows the lecture material on cell biology; an enrichment experiment follows the material on nutrition, an enumeration experiment follows the section on microbial growth, etc. The final seven weeks of the laboratory period are devoted to group projects, in which students apply the techniques the have learned as appropriate to answer specific short-term research hypotheses. The final period is devoted to group presentations of their projects.

Enforced Prerequisite at Enrollment: CHEM 111 and CE 370

CE 479: Environmental Microbiology for Engineers

3 Credits

Intro microbiology for engineers; microbe structure, function, and diversity; environmental ecosystems; diagnostic labs. C E 479 Environmental Microbiology for Engineers (3) C E 479 Environmental Microbiology for Engineers is a senior/graduate-level course comprised of three main sections: (1) the fundamentals of microbial structure, function, nutrition, and growth for students with no prior formal instruction in microbiology; (2) microbial diversity and ecology; and (3) the application of these fundamental microbial principles to environmental systems. In the fundamentals section, the course covers microbial nomenclature, macromolecules, cell biology, energetics, growth, and genetic regulation. This is illustrated with calculations of thermodynamic constraints in microbially catalyzed reactions, the calculation of efficiencies based on energy conservation from common pathways, and the connection of these efficiencies to microbial growth in a chemostat. Building on these fundamental concepts of metabolic potential and conserving energy and acquiring reducing equivalents from redox reactions, the second section covers the reactions and energetics of the primary microbial functional diversity such as phototrophy, lithotrophy, autotrophy, anaerobic respirations, and fermentations. It also introduces modern molecular biology techniques for studying microbial systems, and pulls the concepts of functional diversity together by illustration with the major nutrient cycles, including discussions of environments in which each reaction might be encountered. Finally, the last section applies these ecological principles to several specific engineered environments of interest. Homework assignments throughout the semester involve questions about the methods, findings, or applications of recent articles that highlight the recently covered material, giving the students experience in the critical evaluation of primary literature and demonstrating the relevance of the material to environmental microbiology research and application. Complementing the progression of the lectures are eight instructional laboratories that provide hands-on application of diagnostic microbiological techniques to the characterization of environmental enrichment cultures and pure cultures. For example, a microscopy lab immediately follows the lecture material on cell biology; an enrichment experiment follows the material on nutrition, an enumeration experiment follows the section on microbial growth, etc. The final seven weeks of the laboratory period are devoted to group projects, in which students apply the techniques the have learned as appropriate to answer specific short-term research hypotheses. The final period is devoted to group presentations of their projects.

Enforced Prerequisite at Enrollment: CHEM 111 and CE 370

CE 488C: Capstone Project - Construction

4 Credits/Maximum of 4

This course consists of a project either selected by the students with approval or assigned by the instructor. C E 488C Capstone Project - Construction (4) This course integrates the structural design and construction skills through an application to a project focusing in the construction management area. The course is serves as the capstone of the senior student’s education courses. The course C E 488C identifies
the student selection of a construction capstone project. The student works on a team during the course project process. The team will evaluated on different assignments during the project as well the final product. The team will submit a final written report as well make an oral presentation. The SDCET advisory board is invited to participate in the oral participations. The 4 credit hour course is separated into two parts which are taken in two consecutive semesters. The first course offering is for 1 credit to provide the students an overview of the course and an introduction to the project. The course is then repeated for 3 credits the following semester for the project. This is to allow the necessary time for students to complete the project.

**Enforced Prerequisite at Enrollment:** Eighth-semester Structural Design and Construction Engineering Technology (SDCET_BS) Enforced Concurrent at Enrollment: CET 430 and CET 431 and CET 432 and CET 435 and CE 456

CE 488D: Capstone Project - Structural Design

4 Credits/Maximum of 4

This course consists of a structural design project either selected by the students with approval or assigned by the instructor. C E 488D Capstone Project - Structural Design (4) This course integrates the structural design and construction skills through an application to a project focusing in the construction management area. The course is serves as the capstone of the senior student's education courses. The course C E 488D identifies the student selection of a structural design capstone project. The student works on a team during the course project process. The team will evaluated on different assignments during the project as well the final product. The team will submit a final written report as well make an oral presentation. The SDCET advisory board is invited to participate in the oral participations. The 4 credit hour course is separated into two parts which are taken in two consecutive semesters. The first course offering is for 1 credit to provide the students an overview of the course and an introduction to the project. The course is then repeated for 3 credits the following semester for the project. This is to allow the necessary time for students to complete the project.

**Enforced Prerequisite at Enrollment:** Eighth-semester Structural Design and Construction Engineering Technology (SDCET_BS) Enforced Concurrent at Enrollment: CET 430 and CET 431 and CET 432 and CET 435

CE 494: Senior Thesis

1-9 Credits/Maximum of 9

Students must have approval of a thesis adviser before scheduling this course.

CE 494H: Honors Senior Thesis

1-6 Credits

Investigation of an original project in the area of Civil Engineering. C E 494H C E 494H Honors Senior Thesis (1-6) Investigation of an original project in the area of Civil Engineering. The thesis topic must be approved by the honors advisor and thesis advisor and submitted as a thesis proposal to the Schreyer Honors College prior to scheduling the course. Students may register for a total of 6.0 credits over their last two semesters.

Honors