Civil Engineering

Web Site: http://www.odu.edu/cee

Sherif Ishak, Chair

The Department of Civil and Environmental Engineering offers an undergraduate four-year program leading to the Bachelor of Science in Civil Engineering. The program is accredited by the Engineering Accreditation Commission (EAC) of ABET, http://www.abet.org. The department also offers a varied program of graduate study and research leading to the Master of Science, Master of Engineering, Doctor of Engineering, and Doctor of Philosophy degrees with majors in civil or environmental engineering. Areas of specialization include coastal, environmental, geotechnical, hydraulics and water resources, transportation, and structural engineering. For further information, please visit the web site: http://www.odu.edu/cee (http://www.odu.edu/cee/).

Bachelor of Science in Civil Engineering

The undergraduate degree in civil engineering prepares graduates for entry into professional practice and continued intellectual and professional development throughout their career. The program prepares its graduates to serve as master planners, designers, constructors, and operators/managers of the built environment as well as stewards of natural resources and the environment. Civil engineering graduates are also prepared to serve as both innovators and integrators in the application of existing and developing technologies in the creation and maintenance of society's infrastructure. They also serve as evaluators and managers of risk and uncertainty and apply engineering knowledge and science to the protection of the built environment and public health.

The curriculum in civil engineering is designed to provide education in fundamental engineering sciences, certain nontechnical subjects, and all major areas of civil engineering, which will serve as a basis for entrance into civil engineering practice and/or graduate study. Technical elective courses are available that allow pursuit of several programs of study or specialization:

• geotechnical
• hydraulics and water resources
• environmental
• transportation
• structural

In addition, course work in General Education skills and ways of knowing is required to assure a well-rounded program of study.

Civil Engineering Program Objectives

The program educational objectives describe the expected accomplishments of graduates during the first few years after graduation. The educational objectives of the civil engineering program, established with participation of all constituencies, are consistent with the mission of Old Dominion University and the Department of Civil and Environmental Engineering.

The objectives of the civil engineering program are to produce graduates who will:

• Successfully practice and/or pursue advanced studies in civil engineering or other fields.
• Effectively communicate the technical and social implications of civil engineering solutions.
• Appreciate and apply state-of-the-art practice in their chosen fields.
• Advance in the professional community through ethical practice, collaboration, and service.

Civil Engineering Program Outcomes

The program outcomes are statements that describe what students are expected to know and be able to do by the time of graduation. The program outcomes have been established based on the program educational objectives, in consultation with the advisory council as documented in the minutes of the Civil and Environmental Engineering Visiting Council (CEEVC) meetings.

Students who qualify for graduation will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and global, cultural, social, environmental, economic, and other factors as appropriate to the discipline.
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
4. An ability to communicate effectively with a range of audiences.
5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
6. An ability to recognize the ongoing need for additional knowledge, to choose appropriate learning strategies, and to apply this knowledge.
7. An ability to function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment.

In addition, students will have had opportunities for work experience through internships, practicum, and cooperative education. They will also have had opportunities to participate in student organizations for exposure to community service and for developing leadership skills. The students will be able to apply knowledge in environmental, geotechnical, structural, transportation, and water resources engineering.

In addition to the curriculum detailed below, all students in the Civil Engineering program are required to take the Fundamentals of Engineering exam (http://ncees.org/exams/fe-exam/) prior to graduation. Any student passing the FE exam prior to graduation will receive a reimbursement for the exam fee paid by the CEEVC.

Accreditation

The Bachelor of Science in Civil Engineering is accredited by the Engineering Accreditation Commission of ABET www.abet.org. (http://www.abet.org)

Four-Year Plan - Civil Engineering - BS (http://catalog.odu.edu/undergraduate/frankbattencollegeofengineerandtechnology/civilenvironmentalengineering/civilengn-bsce-fouryearplan/)

This is a suggested curriculum plan to complete this degree program in four years. Please consult information in this Catalog, Degree Works, and your academic advisor for more specific information on course requirements for this degree.

Civil Engineering Four-Year Plan*

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Hours</th>
<th>Second Semester</th>
<th>Hours</th>
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<tbody>
<tr>
<td><strong>First Semester</strong></td>
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<td><strong>Second Semester</strong></td>
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<tr>
<td>MATH 211</td>
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<td>MATH 212</td>
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<tr>
<td>CHEM 121N</td>
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<td>CHEM 123N</td>
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<td>CHEM 122N</td>
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<td>PHYS 231N</td>
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<tr>
<td>ENGL 110C (grade of C or better required)</td>
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<td>CEE 111</td>
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### ENGN 110

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Gen Ed - Human Creativity Way of Knowing</td>
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**Sophomore**

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<th>First Semester</th>
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<tbody>
<tr>
<td>CEE 204 (grade of C or better required)</td>
<td>3 CEE 220</td>
<td>3</td>
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<tr>
<td>PHYS 232N</td>
<td>4 CEE 205</td>
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<tr>
<td>MATH 312 (285)</td>
<td>4 ENGL 211C (grade of C or better required)</td>
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<tr>
<td>Science Elective</td>
<td>CEE 219</td>
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<tr>
<td>OEAS 111N or BIOL 110N (and BIOL 111N)</td>
<td>4 MATH 307 (280)</td>
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<tr>
<td>CEE 240</td>
<td>3 Gen Ed - Literature Way of Knowing</td>
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**Junior**

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<tr>
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<th>First Semester</th>
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<tbody>
<tr>
<td>CEE 320</td>
<td>3 CEE 310 (grade of C or better required)</td>
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<tr>
<td>CEE 305</td>
<td>4 CEE 323 (grade of C or better required)</td>
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<tr>
<td>CEE 330 (grade of C or better required)</td>
<td>3 CEE 340</td>
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<tr>
<td>CEE 350</td>
<td>3 CEE 370</td>
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<td>CEE 304</td>
<td>3 CEE 324</td>
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<td>CEE 341</td>
<td>1 Gen Ed - Interpreting the Past Way of Knowing</td>
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**Senior**

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<tr>
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<th>First Semester</th>
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<th>Second Semester</th>
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<tbody>
<tr>
<td>CEE 410</td>
<td>3 CEE 403W (grade of C or better required)</td>
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<td>CEE 430</td>
<td>3 CEE 4XX</td>
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<tr>
<td>CEE 402</td>
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<td>CEE 401</td>
<td>3 ENMA 480**</td>
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<td>Gen Ed - Human Behavior Way of Knowing</td>
<td>3 Gen Ed - Upper Level Requirement</td>
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<tr>
<td>Gen Ed - Upper Level Requirement</td>
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**Total Hours**

16   16

### Total credit hours: 130

* Does not include the University's General Education language and culture requirement. Additional hours may be required.

** Meets philosophy and ethics general education requirement.

The General Education requirements in information literacy and research, impact of technology, and philosophy and ethics are met through the major.

### Minor in Civil Engineering

An undergraduate minor in civil engineering may be obtained by students from outside of the major by successful completion of 12 or more semester credit hours in approved civil engineering course work at the 300 or 400 level. In addition, a student seeking a minor in civil engineering must satisfy all pre- or corequisite requirements for the courses selected.

The course requirements are:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>CEE 323</td>
<td>Soil Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>or CEE 340</td>
<td>Hydraulics and Water Resources</td>
<td></td>
</tr>
<tr>
<td>CEE 310</td>
<td>Structures I</td>
<td>3</td>
</tr>
<tr>
<td>CEE 370</td>
<td>Transportation Fundamentals</td>
<td>3</td>
</tr>
<tr>
<td>or CEE 4xx **</td>
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<td></td>
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<tr>
<td>CEE 4xx **</td>
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<td>3</td>
</tr>
</tbody>
</table>

** CEE 4xx can be any senior-level elective in coastal, geotechnical, structural or water resources engineering. The precise course of study must be approved by the chief departmental advisor.

For completion of a minor, a student must have a minimum overall cumulative grade point average of 2.00 in all courses specified as a requirement for the minor exclusive of lower-level courses, prerequisites and corequisites and complete a minimum of six hours of upper-level courses in the minor requirement through courses offered by Old Dominion University. Completion of a minor in civil engineering with a grade point average of 3.00 or greater partially satisfies the leveling requirements for graduate degrees in civil engineering.

### Minor in Environmental Engineering

An undergraduate minor in environmental engineering may be obtained by successful completion of 12 or more semester credit hours in approved environmental engineering course work at the 300 or 400 level. In addition, a student seeking a minor in environmental engineering must satisfy all pre- or corequisite requirements for the courses selected.

Two tracks are available: aqueous environmental systems and environmental protection. The course requirements are as follows:

#### Aqueous Environmental Systems

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE 350</td>
<td>Environmental Pollution and Control</td>
<td>3</td>
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</tbody>
</table>

Select three of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hours</th>
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<tbody>
<tr>
<td>CEE 440</td>
<td>Hydraulic Engineering</td>
<td>9</td>
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<tr>
<td>CEE 446</td>
<td>Urban Stormwater Hydrology</td>
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<tr>
<td>CEE 447</td>
<td>Groundwater Hydraulics</td>
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<tr>
<td>CEE 450</td>
<td>Water Distribution and Wastewater Collection System Design</td>
<td></td>
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<tr>
<td>CEE 451</td>
<td>Water and Wastewater Treatment</td>
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</tr>
<tr>
<td>CEE 482</td>
<td>Introduction to Coastal Engineering</td>
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</table>

** Total Hours **

12

### Environmental Protection

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<thead>
<tr>
<th>Course Code</th>
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<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE 350</td>
<td>Environmental Pollution and Control</td>
<td>3</td>
</tr>
</tbody>
</table>

Select three of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE 451</td>
<td>Water and Wastewater Treatment</td>
<td>9</td>
</tr>
<tr>
<td>CEE 452</td>
<td>Air Quality</td>
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</tbody>
</table>
For completion of a minor a student must have a minimum overall cumulative grade point average of 2.00 in courses specified as a requirement for the minor exclusive of lower-level courses, prerequisites and corequisites and complete a minimum of six hours of upper-level courses in the minor requirement through courses offered by Old Dominion University. Completion of a minor in environmental engineering with a grade point average of 3.00 or greater partially satisfies the leveling requirements for graduate degrees in environmental engineering.

CIVIL AND ENVIRONMENTAL ENGINEERING Courses

**CEE 111. Information Literacy and Research. 2 Credits.**
This course will introduce students to the needs, access, evaluation, use, impact and ethical/legal aspects of information, as well as to the application of information literacy and research in the fields of civil and environmental engineering. Prerequisite: ENGN 110.

**CEE 195. Topics in Civil and Environmental Engineering. 1-3 Credits.**
Special topics in civil and/or environmental engineering at the introductory level. Prerequisite: Permission of the department chair.

**CEE 204. Statics. 3 Credits.**
Introduction to engineering problems and their solutions through a study of the statics of particles and rigid bodies. Pre- or corequisite: PHYS 231N. Prerequisite: MATH 211 with a C or higher.

**CEE 205. Engineering Dynamics. 3 Credits.**
This course is designed to assist engineering students in acquiring a more thorough knowledge and proficiency in engineering mechanics. The course follows CEE 204 in the mechanics sequence. In this course, kinematics of particles and rigid bodies, mass moments of inertia, acceleration, work, energy, power, and special applications in the civil engineering field, such as inertia problems in vehicle collisions, rudiments of wave dynamics, etc. are included. Prerequisite: CEE 204 with a grade of C or better.

**CEE 219. Surveying for Engineers. 1 Credit.**
This course will provide an introduction to Land Surveying theory and practices as they relate to Civil Engineering. Upon successful completion of this course, prospective engineers will have a working knowledge of: survey computations; survey field methods; survey benchmarks and data; survey elements of land development; and survey legal issues.

**CEE 220. Mechanics of Deformable Bodies. 3 Credits.**
This course provides fundamental theories to understand the strength of materials focused on civil engineering applications. It will cover stress-strain relationship, equilibrium of deformable bodies and behavior of axially loaded members. It will also analyze for stresses, strains, and deformation of members subjected to torsions in both elastic and inelastic ranges. Other topics, such as buckling and stability of columns, Mohr circle, and energy methods will also be discussed. Prerequisites: CEE 204 with a grade of C or better.

**CEE 240. Geographic Information Systems in Civil and Environmental Engineering. 3 Credits.**
Geographic Information Systems as they apply to civil and environmental engineering. Spatial data acquisition, generation and analysis methods from terrestrial, aerial and satellite sources, Modeling of terrain, land, and hydrographic information using CADD. Use of GIS software in the creation and application of GIS spatial data bases to engineering problems. Prerequisite: MATH 212, sophomore standing or higher.

**CEE 295. Topics in Civil and Environmental Engineering. 1-3 Credits.**
Topics in civil and/or environmental engineering at the basic engineering level. Prerequisite: Permission of the department chair.

**CEE 304. Probability Statistics and Risk in Civil and Environmental Engineering. 3 Credits.**
CEE infrastructure systems definitions and methodology. CEE economics basics and use. Probability theory and applications. Statistics parameters, functions, variance, regression, and correlation analysis. Professional practice issues of ethics, licensure, procurement of work, and professional interaction. Prerequisite: junior standing in CEE.

**CEE 305. Civil and Environmental Computations. 4 Credits.**
Introduction to selected numerical methods and their specific application to solving problems in many of the areas of civil and environmental engineering. Further development of computer programming proficiency. Prerequisites: junior standing and MATH 307.

**CEE 310. Structures I. 3 Credits.**
Analysis of statically determinate structures. Influence lines and structural design. Displacement calculations. Introduction to analysis of indeterminate structures. Prerequisites: CEE 220 with a grade of C or better.

**CEE 320. Civil Engineering Materials. 3 Credits.**
Properties of steel, portland cement concrete, bituminous concrete, aggregates, and timber. Prerequisites: CEE 220.

**CEE 323. Soil Mechanics. 3 Credits.**
Fundamental engineering properties of soil and their application to earth structures and foundations. Topics include seepage, compaction, strength, and deformation characteristics of soils. Corequisite: CEE 324. Prerequisite: CEE 220.

**CEE 324. Soil Mechanics Laboratory. 1 Credit.**
Performance of various soil mechanics tests, including gradation, index testing, compaction, density, permeability, consolidation, shear tests for soils are conducted for students to gain hand-on experiences. The relevant principles are covered in CEE 323. Corequisite: CEE 323. Prerequisites: Junior standing.

**CEE 330. Hydromechanics. 3 Credits.**
Fluid properties, fluid statics and fundamentals of fluid kinematics. Steady, incompressible conservation laws for mass, momentum and energy including real fluid energy losses. Turbulent, incompressible fluid flows in closed conduits and with a free surface. Introduction to thermodynamics. Prerequisites: MATH 212 and CEE 205 or MATH 205.

**CEE 340. Hydraulics and Water Resources. 3 Credits.**
Analysis of closed-conduit flow and open-channel flow. Principles of surface water hydrology and groundwater hydrogeology. Economics and probability concepts in water resources planning. Corequisite: CEE 341. Prerequisites: CEE 304; CEE 330 with a grade of C or better.

**CEE 341. CE Hydraulics and Water Resources Laboratory. 1 Credit.**
Performing various labs and experiments for hydraulics, hydrology, and water resources for students to gain hand-on experiences. The relevant principles are covered in CEE 340. Corequisite: CEE 340. Prerequisites: Junior standing.

**CEE 350. Environmental Pollution and Control. 3 Credits.**
Introduction to the fundamental principles of environmental engineering. Topics in water quality, water and wastewater treatment, air quality, and solid waste and landfills are discussed. Prerequisites: CHEM 121N-CHEM 122N, MATH 211, PHYS 231N.

**CEE 367. Cooperative Education. 1-3 Credits.**
May be repeated for credit. Available for pass/fail grading only. Student participation for credit based on the academic relevance of the work experience, criteria, and evaluative procedures as formally determined by the department and Career Development Services prior to the semester in which the work experience is to take place. Prerequisites: approval by the department and Career Development Services in accordance with the policy for granting credit for cooperative education programs.

**CEE 368. Internship. 1-3 Credits.**
May be repeated for credit. Available for pass/fail grading only. Academic requirements will be established by the department and will vary with the amount of credit desired. Allows students to gain short duration career-related experience. Prerequisites: approval by department and Career Development Services.
CEE 369. Practicum. 1-3 Credits.
May be repeated for credit. Available for pass/fail grading only. Academic requirements will be established by the department and will vary with the amount of credit desired. Allows students to gain short-duration career-related experience. Prerequisites: approval by department and Career Development Services.

CEE 370. Transportation Fundamentals. 3 Credits.
This course surveys the current practice of transportation engineering in the United States. It focuses on various ground transportation modes and covers policy, institutional planning and operational issues. Students are introduced to planning models, capacity analysis, and traffic impact analysis. Prerequisite: Junior standing.

CEE 395. Topics. 1-3 Credits.
Topics in civil and/or environmental engineering. Prerequisite: permission of the instructor.

CEE 401. Civil Engineering Design Project and Professional Practice I. 3 Credits.
The course is an introduction to the design process used for the development of contract documents for the construction of infrastructure. It involves applying the theory of multiple disciplines of civil engineering to the design of a sustainable project. It introduces the skills necessary to plan, manage and prepare construction drawings, technical specifications, cost estimates and bid schedules necessary to prepare design and construction documents needed for bidding projects. Prerequisites: Senior standing.

CEE 402. Professional Practice of Engineering. 1 Credit.
The course will cover the practice and business aspects of engineering including concepts in management, business, public policy, and leadership. It will also cover public and private procurement of work, project management and execution, responsibility to clients, contracting, project finances, professional liability, and public safety. Prerequisite: Senior standing.

CEE 403W. Civil Engineering Design Project and Professional Practice II. 3 Credits.
For graduating seniors only. Group design project of civil engineering systems requiring synthesis, data gathering, preliminary investigation, master planning, conceptual designs, layouts, support studies, cost estimates and report writing. Emphasis will be on alternatives, constraints, economics, ethics and professional practice, business and project management, public policy and leadership. This is a writing intensive course. Prerequisites: grade of C or better in CEE 401, ENGL 211C or ENGL 221C or ENGL 231C.

CEE 410. Concrete Design. 3 Credits.
Fundamental concepts of reinforced concrete analysis and design by ultimate strength and working stress methods. Prerequisites: CEE 310 with a grade of C or better.

CEE 412/512. Computational Methods in Structures. 3 Credits.
Analysis of 2-D and 3-D determinate and indeterminate truss/beam/frame structures by the unified direct stiffness matrix method, for both hand-calculation and computer implementation. Popular commercialized (NASTRAN) software will also be discussed. Prerequisites: CEE 310.

CEE 414/514. Masonry Structures Design. 3 Credits.
Masonry materials, reinforced beams and lintels, walls, columns and pilasters, shear walls, and buildings. Prerequisite: CEE 310.

CEE 415/515. Steel Structures Design. 3 Credits.
Load and resistance factor design methods for steel structures. Prerequisite: CEE 310.

CEE 416/516. Wood Structures Design. 3 Credits.
Design of wood structures based on national design specification and load and resistance factor design. Prerequisite: CEE 310.

CEE 430/530. Foundation Engineering. 3 Credits.
Subsurface exploration, site preparation, design of shallow and deep foundations, and retaining structures. Prerequisites: CEE 323 with a grade of C or better.

CEE 431/531. Earth Structures Design with Geosynthetics. 3 Credits.
Seepage and stability analysis and design of manmade and natural slopes and retaining structures. Applications of geosynthetic material to seepage control, reinforcement of earth works, and containment of hazardous materials. Prerequisite: CEE 323.

CEE 432/532. Introduction to Earthquake Engineering. 3 Credits.
An overview of earthquake processes and details of the characteristics of destructive ground motion; the effects of such motion on civil engineering structures; reviews of current design practice in mitigating earthquake hazards for various civil engineering structures such as buildings, bridges, dams, lifelines, ports and harbors, etc. Prerequisites: senior standing and permission of the instructor.

CEE 433/533. Geomaterials Stabilization. 3 Credits.
This course studies soil and aggregate's physical, chemical and biological stabilization procedures. Students are introduced to chemical stabilization analysis and design using materials such as cement, lime, and fly ash. Physical ground modification, compaction methods and mechanical stabilization application and design are also studied. Prerequisite: CEE 323.

CEE 440/540. Hydraulic Engineering. 3 Credits.
Hydraulic transients; flow control structures; computer analysis of hydraulic systems; design of pipelines, open channels and culverts. Prerequisite: CEE 340.

CEE 446/546. Urban Stormwater Hydrology. 3 Credits.
Storm rainfall analysis, design rainfall hyetographs, runoff calculation procedures, detention basins, use of mathematical models to analyze and design urban storm drainage systems. Prerequisite: CEE 340.

CEE 447/547. Groundwater Hydraulics. 3 Credits.
Description of well hydraulics in single and multiple well systems. Determination of aquifer parameters from pumping tests. Use of computer models to determine drawdowns due to multiple well systems. Prerequisite: CEE 340.

CEE 450/550. Water Distribution and Wastewater Collection System Design. 3 Credits.

CEE 451. Water and Wastewater Treatment. 3 Credits.
Discussion of water quality constituents and introduction to the design and operation of water and wastewater treatment facilities. Prerequisites: CEE 330, CEE 350.

CEE 452/552. Air Quality. 3 Credits.
Study of air quality management standards and regulations and pollutant dynamics. Design and operation of emission control equipment for mobile and stationary sources of air pollution. Prerequisite: CEE 350.

CEE 454/554. Hazardous Waste Treatment. 3 Credits.
Study of sources, generation rates and characteristics of hazardous wastes and their regulation, handling, and design of treatment and disposal facilities. Prerequisite: CEE 350.

CEE 455/555. Pollution Prevention and Green Engineering. 3 Credits.

CEE 458/558. Sustainable Development. 3 Credits.
Overview of social, economical, technical environmental aspects of regional, national and international efforts to achieve sustainable development. Discussion of the integration of industrial activity and ecological concerns utilizing principles of zero emissions, pollution prevention and design for the environment. Prerequisite: junior standing or permission of instructor. (WEB Based, On-Line Course).
CEE 459/559. Biofuels Engineering, 3 Credits.
Course covers the overview of renewable energy sources; fundamentals of biofuels; biomass and types of biomass (e.g., woody biomass, forest residues, agricultural residues, energy crops); composition of lignocelluloses (cellulose, hemicellulose, and lignin); biomass conversion technologies; thermochemical, supercritical water, and biochemical conversion processes; types of biofuels from biomass; liquid fuels (bioethanol, bio-oil, biocrude, and hydrocarbons); gaseous fuels (synthesis gas, hydrogen, biodiesel); solid fuels (biochar, torrefied biomass); biodiesel from vegetable oils, algae to biofuels; value-added processing of biofuel residues; economic and environmental assessments; policies and future R&D. Prerequisite: permission of the instructor.

CEE 471/571. Transportation Operations I, 3 Credits.
This is the first course in transportation operations and traffic flow theory. Topics include traffic engineering studies, capacity analysis, intersection control, traffic flow models, shockwave analysis, signal warrant analysis, and safety analysis. Course includes applications of modeling and simulation to isolated intersections. Prerequisite: CEE 370.

CEE 474/574. Transportation Data Analytics, 3 Credits.
This course presents the basic techniques for transportation data analytics. It will discuss statistical modeling, prominent algorithms, and visualization approaches to analyze both small- and large-scale data sets generated from transportation systems. Practices of using different data for various real-world traffic/transportation applications and decision making will also be discussed. Prerequisites: Basic probability and statistics (e.g., STAT 330); any programming language such as C, Python or Java is beneficial but not required.

CEE 482/582. Introduction to Coastal Engineering, 3 Credits.
Classical small amplitude wave theory, wave transformations in shallow water, shoaling, refraction, diffraction, reflection, breaking. Wave induced near shore currents and sediment transport processes. Alternatives to mitigate coastal erosion processes. Introduction to coastal structures. Prerequisites: CEE 330 and permission of the instructor.

CEE 495/595. Topics in Civil and Environmental Engineering, 1-3 Credits.
Special topics of interest with emphasis placed on recent developments in civil and/or environmental engineering. Prerequisite: Permission of the department chair.

CEE 497. Independent Study in Civil and Environmental Engineering, 1-3 Credits.
Individual analytical, experimental and/or design study selected by the student and supervised by the advisor. Prerequisites: approval of the advisor.