CIVIL ENGINEERING, BACHELOR OF SCIENCE

The Department of Civil Engineering offers a complete undergraduate program to University of Nebraska students on City Campus in Lincoln and Scott Campus in Omaha. Curriculum requirements are nearly identical on both campuses. The goal is to prepare students for entry into the civil engineering profession immediately after graduation or to pursue graduate-level studies.

Website (https://engineering.unl.edu/civil/)

The general educational objectives of the University of Nebraska–Lincoln (UNL) civil engineering undergraduate program are to prepare our graduates so that, with a UNL BSCE degree, a few years beyond graduation:

1. Graduates are employed in civil and environmental engineering or a closely related field; or, graduates are pursuing an advanced degree in civil and environmental engineering or a closely related field.
2. Graduates contribute to society and address societal and environmental needs through engagement in professional, community, or service organizations.
3. Graduates agree that the Civil and Environmental Engineering program prepared them for success in their careers in terms of knowledge and skillsets as embodied in the program and the Complete Engineer(TM) Initiative.

As a professional discipline, civil engineering is closely related to the total human environment. In all professional endeavors, the civil engineer must consider ecological effects as well as the social, economic, and political needs of people. The civil engineer designs systems to control and manage our water resources to provide electric power, agricultural irrigation, flood control, recreation, water supplies and wastewater treatment systems for our urban and industrial needs.

The civil engineer plans, designs, and constructs our transportation systems including highways, railroads, waterways, and airports to connect rural, urban, and industrial areas. The civil engineer also designs and constructs housing and facilities for recreational, industrial, and commercial complexes, which comprise the urban environment. It is the responsibility of civil engineering to minimize air, water, and land pollution and protect the environment.

Instructional emphasis is placed on fundamental engineering principles derived from mathematics, chemistry, physics, and engineering science. These subjects provide a sound background for the subsequent introductory courses in environmental, geotechnical, structural, transportation, and water resources engineering. Students are introduced to design concepts in the freshman year. Design is incorporated throughout the curriculum that culminates in two senior-level courses, CIVE 385 Professional Practice and Management in Civil Engineering and CIVE 489 Senior Design Project.

Instructional laboratories in environmental engineering, hydraulics, geotechnical engineering, structures, and surveying provide each student with an opportunity to learn, through individual participation, the operation of the testing equipment used to establish engineering design criteria and to monitor and model engineering facilities such as water and wastewater treatment plants, highway systems, river control systems, and structural systems.

Some students may desire to obtain a degree in construction management in addition to the degree in civil engineering. Because some civil engineering courses require prerequisites beyond those required for similar construction management courses, students should obtain the civil engineering degree first. Advising will be done by a civil engineering faculty member familiar with the construction management curriculum. After completing the civil engineering degree, the student will move to the construction management department to complete requirements for the second undergraduate degree in construction management.

The Departments of Civil Engineering and Architecture have a joint program awarding licensing degrees in both fields of study. A bachelors degree in civil engineering and masters degree in architecture are awarded, after approximately seven years of study. The departments work with individual students in tailoring a joint degree program. More information can be obtained from either department office.

Learning Outcomes

Graduates of the civil engineering program will have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Professional Admission to Civil Engineering

Criteria for Professional Admission to the Civil Engineering Degree Program

Pre-professionally admitted College of Engineering students majoring in civil engineering must have their academic records reviewed for professional admission to the Civil Engineering Degree Program during the fall, spring or summer immediately following the term in which:

• At least 12 credits (one semester) have been completed after admission to the College of Engineering;
• At least 43 credits applicable to the degree have been earned; and
• PHYS 2110 General Physics I, MENG 2230 Engineering Statics, MENG 3730 Mechanics of Elastic Bodies and MENG 3250 Engineering Dynamics have been completed.

Additionally, the student can have no more than two declined professional admission requests to other engineering majors. It is likely a student may need to complete four full semesters of credits applying to the Program before these requirements are able to be completed.

Professional admission approval to the Civil Engineering Degree Program also requires that all of the following Departmental-specific criteria must be met:

• Earn a C letter grade or better in PHYS 2110, MENG 2230, MENG 3730, and MENG 3250
• Earn a cumulative grade point average of 2.4 or greater; and
• Earn a C letter grade or better in ALL math, science and engineering courses required for the bachelor of science in civil engineering degree if the cumulative grade point average is less than 2.700.

Students approved for professional admission to the Program are then allowed to take 400-level civil engineering courses to complete their degree.
# Requirements
(City Campus in Lincoln and Scott Campus in Omaha)

Students must have completed the equivalent of the fourth semester before admission to the civil engineering program. Transfer students must have all transfer hours accepted before being considered for the degree program.

## Degree Requirements - 130 hours

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIVE 112</td>
<td>INTRODUCTION TO CIVIL ENGINEERING</td>
<td>1</td>
</tr>
<tr>
<td>CIST 1400</td>
<td>INTRODUCTION TO COMPUTER SCIENCE I</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 100</td>
<td>FRESHMAN ENGINEERING SEMINAR</td>
<td>0</td>
</tr>
<tr>
<td>CHEM 1180</td>
<td>GENERAL CHEMISTRY I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 1184</td>
<td>GENERAL CHEMISTRY I LABORATORY</td>
<td>1</td>
</tr>
<tr>
<td>MATH 1950</td>
<td>CALCULUS I</td>
<td>5</td>
</tr>
<tr>
<td>ACE Elective</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td><strong>Credits</strong></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td><strong>Second Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIVE 130</td>
<td>COMPUTER-AIDED DESIGN</td>
<td>2</td>
</tr>
<tr>
<td>CIVE 221</td>
<td>GEOMETRIC CONTROL SYSTEMS</td>
<td>3</td>
</tr>
<tr>
<td>MATH 1960</td>
<td>CALCULUS II</td>
<td>5</td>
</tr>
<tr>
<td>PHYS 2110</td>
<td>GENERAL PHYSICS I - CALCULUS LEVEL</td>
<td>4</td>
</tr>
<tr>
<td>ACE Elective</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td><strong>Credits</strong></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td><strong>Third Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGR 200</td>
<td>SOPHOMORE ENGINEERING SEMINAR</td>
<td>0</td>
</tr>
<tr>
<td>ENGL 3980</td>
<td>TECHNICAL WRITING ACROSS THE DISCIPLINES</td>
<td>3</td>
</tr>
<tr>
<td>MATH 1970</td>
<td>CALCULUS III</td>
<td>4</td>
</tr>
<tr>
<td>MENG 2230</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PHYS 2120</td>
<td>GENERAL PHYSICS-CALCULUS LEVEL</td>
<td>4</td>
</tr>
<tr>
<td>or CHEM 1190</td>
<td>or GENERAL CHEMISTRY II</td>
<td></td>
</tr>
<tr>
<td>ACE Elective</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td><strong>Credits</strong></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td><strong>Fourth Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIVE 361</td>
<td>HIGHWAY ENGINEERING</td>
<td>3</td>
</tr>
<tr>
<td>CMST 3130</td>
<td>SPEECH COMMUNICATION IN BUSINESS AND THE PROFESSIONS</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2350</td>
<td>DIFFERENTIAL EQUATIONS</td>
<td>3</td>
</tr>
<tr>
<td>MENG 3250</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>MENG 3730</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td><strong>Credits</strong></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td><strong>Fifth Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIVE 310/ MENG 3100</td>
<td>FLUID MECHANICS</td>
<td>3</td>
</tr>
<tr>
<td>CIVE 319</td>
<td>HYDRAULICS LAB</td>
<td>1</td>
</tr>
<tr>
<td>CIVE 326</td>
<td>INTRODUCTION TO ENVIRONMENTAL ENGINEERING</td>
<td>3</td>
</tr>
<tr>
<td>CIVE 327</td>
<td>ENVIRONMENTAL ENGINEERING LABORATORY</td>
<td>1</td>
</tr>
<tr>
<td>CIVE 341</td>
<td>INTRODUCTION TO STRUCTURAL ENGINEERING</td>
<td>4</td>
</tr>
<tr>
<td>STAT 3800</td>
<td>APPLIED ENGINEERING PROBABILITY AND STATISTICS</td>
<td>3</td>
</tr>
<tr>
<td>or MENG 3210</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Credits</strong></td>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>

### Sixth Semester

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 334</td>
<td>INTRODUCTION TO GEOTECHNICAL ENGINEERING</td>
<td></td>
</tr>
<tr>
<td>CIVE 352</td>
<td>INTRODUCTION TO WATER RESOURCES ENGINEERING</td>
<td>3</td>
</tr>
<tr>
<td>CIVE 378</td>
<td>MATERIALS OF WATER RESOURCES ENGINEERING</td>
<td>3</td>
</tr>
<tr>
<td>CIVE 385</td>
<td>PROFESSIONAL PRACTICE AND MANAGEMENT IN CIVIL ENGINEERING</td>
<td>3</td>
</tr>
<tr>
<td><strong>Credits</strong></td>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>

### Seventh Semester

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE Design electives</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>ACE Elective</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Science Elective</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td><strong>Credits</strong></td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

### Eighth Semester

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 489</td>
<td>SENIOR DESIGN PROJECT</td>
<td></td>
</tr>
<tr>
<td>CIVE Design Elective</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Technical Elective</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Professional Development Electives</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td><strong>Credits</strong></td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

**Total Credits**: 130

1. ACE elective: Choose one course from each ACE Student Learning Outcome (SLO) 5,6,7,8 and 9 elective courses.
2. Computer Aided Design: AE 2250 or equivalent.
3. PHYS 2120: CHEM 1190 & CHEM 1194 is an acceptable substitute.
4. CIVE 221: CONE 2210 is acceptable substitute.
5. ENGL 3980: ENGR 3000 is an acceptable substitute.
6. Professional Development Elective: The Department has a list of acceptable courses.
7. Technical elective: The department has a list of acceptable courses.

### CIVE Design Electives

CIVE Design Electives: Nine (9) credits must be taken from courses designated as Design Electives. CIVE Design electives must be taken from at least two sub-disciplines.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 419</td>
<td>FLOW SYSTEMS DESIGN</td>
<td></td>
</tr>
<tr>
<td>CIVE 425</td>
<td>PROCESS DESIGN IN WATER SUPPLY AND WASTEWATER TREATMENT</td>
<td></td>
</tr>
<tr>
<td>CIVE 426</td>
<td>DESIGN OF WATER TREATMENT FACILITIES</td>
<td></td>
</tr>
<tr>
<td>CIVE 427</td>
<td>DESIGN OF WASTEWATER TREATMENT AND DISPOSAL FACILITIES</td>
<td></td>
</tr>
<tr>
<td>CIVE 436</td>
<td>FOUNDATION ENGINEER</td>
<td></td>
</tr>
<tr>
<td>CIVE 440</td>
<td>REINFORCED CONCRETE DESIGN I</td>
<td></td>
</tr>
<tr>
<td>CIVE 441</td>
<td>STEEL DESIGN I</td>
<td></td>
</tr>
<tr>
<td>CIVE 452</td>
<td>WATER RESOURCES DEVELOPMENT</td>
<td></td>
</tr>
<tr>
<td>CIVE 462</td>
<td>HIGHWAY DESIGN</td>
<td></td>
</tr>
<tr>
<td>CIVE 463</td>
<td>TRAFFIC ENGINEERING</td>
<td></td>
</tr>
<tr>
<td><strong>Credits</strong></td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

### Civil Engineering Technical Electives

Technical Electives: Technical electives will be selected by the student in consultation with his/her adviser to formulate a coherent program in civil engineering. Two technical electives (up to six credits) can be taken from MENG 2000, ECEN 2110, CONE 2060 or any approved course in science,
Prerequisite(s)/Corequisite(s): CIVE 221 or MENG 3100

CIVE 211 INTRODUCTION TO CIVIL ENGINEERING (1 credit)
Introduction to civil engineering as a career by use of case studies; alternate approaches to engineering designs illustrated by use of engineering principles.

CIVE 212 ECOLOGY, THE ENVIRONMENT AND THE ENGINEER (3 credits)
Investigation into the nature of ecology, man's relation with the environment and man's chance of survival in that environment, and the potential influence, for good or bad, of modern man's activities.

CIVE 310 FLUID MECHANICS (3 credits)
Fluid statics, equations of continuity, momentum, and energy; dimensional analysis and dynamic similarity. Applications to: flow meters; fluid pumps and turbines; viscous flow and lubrication; flow in closed conduits and open channels. Two-dimensional potential flow.

Prerequisite(s)/Corequisite(s): CIVE 326

CIVE 326 INTRODUCTION TO ENVIRONMENTAL ENGINEERING (3 credits)
Introduction to the principles of environmental engineering, including water quality, atmospheric quality, pollution prevention, and solid and hazardous wastes engineering. Design of water, air, and waste management systems.

Prerequisite(s)/Corequisite(s): CIVE 310 pre/coreq

CIVE 328 CONCRETE MATERIALS (2 credits)

Prerequisite(s)/Corequisite(s): MENG 2230 and CHEM 1180. Not open to nondegree graduate students.

CIVE 334 INTRODUCTION TO GEOTECHNICAL ENGINEERING (4 credits)
Soil composition, structure and phase relationships; soil classification. Principles of effective stress; loading induced subsurface stresses; load history; deformation and failure of soils. Elastic and limit analysis with applications to design for bearing capacity, settlement, retaining walls and slope stability. Steady state seepage.

Prerequisite(s)/Corequisite(s): EMEC 3250 or MENG 3250; Coreq: CIVE 310.

CIVE 341 INTRODUCTION TO STRUCTURAL ENGINEERING (4 credits)
Introduction to the analysis and design of structural systems. Introduction to the analysis and design of structural systems. Analyses of determinate and indeterminate trusses, beams, and frames, and design philosophies for structural engineering. Laboratory experiments deal with the analysis of determinate and indeterminate structures.

Prerequisite(s)/Corequisite(s): MENG 3250

CIVE 352 INTRODUCTION TO WATER RESOURCES ENGINEERING (3 credits)
Introduction to water resources engineering design and planning, surface hydrology, groundwater hydraulics, reservoirs and other control structures. Introduction to field measurement and computational methods in water resources.

Prerequisite(s)/Corequisite(s): CIVE 310 or MENG 3300

CIVE 361 HIGHWAY ENGINEERING (3 credits)
Introduction to the principles of highway engineering and traffic operations and control.

Prerequisite(s)/Corequisite(s): MENG 2230; and CIVE 221 or CONE 2210.
CIVE 378 MATERIALS OF CONSTRUCTION (3 credits)
Introduction to the behavior, testing and design of soil, portland cement concrete, steel, wood and composites. Experiments covering the concepts of stress and strain under axial, torsional, shear and flexural loading conditions. Common ASTM laboratory test procedures and specifications, field quality control tests and statistical applications.
Prerequisite(s)/Corequisite(s): MENG 3250
CIVE 385 PROFESSIONAL PRACTICE AND MANAGEMENT IN CIVIL ENGINEERING (3 credits)
Basic elements of civil engineering practice. Roles of all participants in the process-owners, designers, architects, contractors, and suppliers. Basic concepts in business management, public policy, leadership, and professional licensure. Professional relations, civic responsibilities, and ethical obligations for engineering practice. Project management, contracts, allocation of resources, project estimating, planning, and controls.
Prerequisite(s)/Corequisite(s): Junior standing and CIVE major. Not open to non-degree graduate students.
CIVE 419 FLOW SYSTEMS DESIGN (3 credits)
Application of hydraulic principles to the design of water distribution systems, wastewater and stormwater collection systems, channelized flow systems and treatment facilities. (Cross-listed with CIVE 819)
Prerequisite(s)/Corequisite(s): CIVE 326 or CIVE 327; CIVE 352 coreq.
CIVE 421 HAZARDOUS WASTE MANAGEMENT AND TREATMENT (3 credits)
Survey of the hazardous waste management system in the USA. State and federal hazardous waste regulations. Chemical characteristics of hazardous waste and unit operations and processes used for treatment of soil, water, and air. (Cross-listed with CIVE 821).
Prerequisite(s)/Corequisite(s): CIVE 326.
CIVE 422 POLLUTION PREVENTION: PRINCIPLES AND PRACTICES (3 credits)
Introduction to pollution prevention (P2) and waste minimization methods. Practical applications to small businesses and industries. Legislative and historical development of P2 systems analysis, waste estimation, P2 methods, P2 economics, and sources of P2 information. (Cross-listed with CIVE 822).
Prerequisite(s)/Corequisite(s): Permission
CIVE 424 SOLID WASTE MANAGEMENT ENGINEERING (3 credits)
Planning and design of solid waste collection processing, treatment, and disposal systems including materials, resources and energy recovery systems. (Cross-listed with CIVE 824).
Prerequisite(s)/Corequisite(s): CIVE 326 and CIVE 334
CIVE 425 PROCESS DESIGN IN WATER SUPPLY AND WASTEWATER TREATMENT (3 credits)
Design of unit operations and processes associated with drinking water and wastewater treatment facilities.
Prerequisite(s)/Corequisite(s): CIVE 326 and CIVE 310
CIVE 426 DESIGN OF WATER TREATMENT FACILITIES (3 credits)
Analyses of water supplies and design of water treatment and distribution systems. (Cross-listed with CIVE 826).
Prerequisite(s)/Corequisite(s): CIVE 425
CIVE 427 DESIGN OF WASTEWATER TREATMENT AND DISPOSAL FACILITIES (3 credits)
Analysis of systems for wastewater treatment and disposal. (Cross-listed with CIVE 827).
Prerequisite(s)/Corequisite(s): CIVE 425
CIVE 430 FUNDAMENTALS OF WATER QUALITY MODELING (3 credits)
Comprehensive study of water quality and the effects of various water pollutants on the aquatic environment; modeling of water quality variables. (Cross-listed with CIVE 830).
Prerequisite(s)/Corequisite(s): CIVE 326
CIVE 431 SMALL TREATMENT SYSTEMS (3 credits)
Design of small and decentralized waste water management systems. (Cross-listed with CIVE 831.)
Prerequisite(s)/Corequisite(s): CIVE 326 or permission. Not open to non-degree graduate students.
CIVE 432 BIOREMEDIATION OF HAZARDOUS WASTES (3 credits)
Principles, applications, and limitations of bioremediation of hazardous wastes and design of some bioremediation systems.
Prerequisite(s)/Corequisite(s): CIVE 326 and (CIVE 310 or MENG 3100)
CIVE 434 SOIL MECHANICS II (3 credits)
Application of the effective stress principle to shear strength of cohesive soils; analysis of stability of slopes. Development of continuum relationships for soils; solutions for stresses and displacements for an elastic continuum. Solution of the consolidation equation for various initial and boundary conditions.
Prerequisite(s)/Corequisite(s): CIVE 334
CIVE 436 FOUNDATION ENGINEER (3 credits)
Subsoil exploration and interpretation; selection of foundation systems; determination of allowable bearing capacity and settlement; design of deep foundations; pile driving analysis; control of groundwater.
Prerequisite(s)/Corequisite(s): CIVE 334
CIVE 440 REINFORCED CONCRETE DESIGN I (3 credits)
Introduction to the design concepts of reinforced concrete building components. The design of flexural and compression members, simple walls, foundations, and floor systems using the latest American Concrete Institute (ACI) design requirements.
Prerequisite(s)/Corequisite(s): CIVE 341
CIVE 441 STEEL DESIGN I (3 credits)
Introduction to the design concepts for structural steel building components. Design of tension members, bolted and welded connections, column members, and beam members. Limit states design concepts used throughout, and emphasis on behavior of members and code design procedures.
Prerequisite(s)/Corequisite(s): CIVE 341
CIVE 443 ADVANCED STRUCTURAL ANALYSIS (3 credits)
Matrix analysis methods and computer solutions for indeterminate structures. Additional topics: static condensation, shear deformations, and non-prismatic members in matrix-based analyses, moment distribution method, load cases and load combinations for buildings and bridges, and influence lines and analysis for moving loads. (Cross-listed with CIVE 843)
Prerequisite(s)/Corequisite(s): CIVE 341. Not open to non-degree graduate students.
CIVE 444 STRUCTURAL DESIGN AND PLANNING (3 credits)
Principles of design of steel and reinforced concrete structural building systems, planning of building vertical and horizontal load resisting systems, and bridge systems. Several design projects in determining analysis and design concepts for both steel and reinforced concrete. (Cross-listed with CIVE 844).
Prerequisite(s)/Corequisite(s): CIVE 440 and CIVE 441
CIVE 446 STEEL DESIGN II (3 credits)
A continuation of the topics covered in CIVE 441. The principles and procedures used in design of steel buildings, design of plate girders, design and analysis of building systems, design and analysis of composite steel-concrete building systems, innovative building systems, and introduction to seismic design of steel buildings. Plate buckling, beam, column, and beam-column design, and frame stability. Introduction to connection design.
Prerequisite(s)/Corequisite(s): CIVE 441
CIVE 447 REINFORCED CONCRETE II (3 credits)
Shear friction theory, strut-and-tie modeling, anchorage, deflection, slender and bi-axially loaded members, torsion, two-way action and punching shear, and footing design. Excel spreadsheets are developed and used for various design tasks. (Continuation of topics covered in CIVE 440/CIVE 840.) (Cross-listed with CIVE 847).
Prerequisite(s)/Corequisite(s): CIVE 440 or CIVE 840
CIVE 452 WATER RESOURCES DEVELOPMENT (3 credits)
Theory and application of systems engineering with emphasis on optimization and simulation techniques for evaluating alternatives in water resources developments related to water supply, flood control, hydropower, irrigation, and water measurement. (Cross-listed with CIVE 852).
Prerequisite(s)/Corequisite(s): CIVE 352

CIVE 454 HYDRAULIC ENGINEERING (3 credits)
 Fundamentals of hydraulics with applications of mechanics of solids, mechanics of fluids, and engineering economics to the design of hydraulic structures. Continuity, momentum, and energy principles are applied to special problems from various branches of hydraulic engineering. (Cross-listed with CIVE 854).
Prerequisite(s)/Corequisite(s): CIVE 352

CIVE 455 NONPOINT SOURCE POLLUTION CONTROL ENGINEERING (3 credits)
Identification, characterization, and assessment of nonpoint source pollutants; transport mechanisms and remediation technologies; design methodologies and case studies. (Cross-listed with CIVE 855).
Prerequisite(s)/Corequisite(s): CIVE 326 and CIVE 352

CIVE 456 SURFACE WATER HYDROLOGY (3 credits)
Stochastic analysis of hydrologic data and processes including rainfall, runoff, infiltration, temperature, solar radiation, wind, and non-point pollution. Space-time hydrologic modeling with emphasis on the application of techniques in the design of engineering projects. (Cross-listed with CIVE 856).
Prerequisite(s)/Corequisite(s): CIVE 352 or permission

CIVE 458 GROUNDWATER ENGINEERING (3 credits)
Application of engineering principles to the movement of groundwater. Analysis and design of wells, well fields, and artificial recharge. Analysis of pollutant movement. (Cross-listed with CIVE 858).
Prerequisite(s)/Corequisite(s): CIVE 352.

CIVE 459 RELIABILITY OF STRUCTURES (3 credits)
Fundamental concepts related to structural reliability, safety measures, load models, resistance models, system reliability, optimum safety levels, and optimization of design codes.
Prerequisite(s)/Corequisite(s): CIVE 341.

CIVE 461 URBAN TRANSPORTATION PLANNING (3 credits)
Development of urban transportation planning objectives and goals. Data collection procedures, land use and travel forecasting techniques, trip generation, trip distribution, modal choice analysis, and traffic assignment. Site development and traffic impact analysis. (Cross-listed with CIVE 861).
Prerequisite(s)/Corequisite(s): CIVE 361

CIVE 462 HIGHWAY DESIGN (3 credits)
Design of roadways, intersections, interchanges, parking facilities, and land development site access and circulation. Emphasis on design projects. (Cross-listed with CIVE 862)
Prerequisite(s)/Corequisite(s): CIVE 361

CIVE 463 TRAFFIC ENGINEERING (3 credits)
Design of signalized intersections, arterial street and network signal systems, and freeway control systems. Emphasis on design projects. (Cross-listed with CIVE 863)
Prerequisite(s)/Corequisite(s): CIVE 361

CIVE 468 AIRPORT PLANNING AND DESIGN (3 credits)
Planning and design of general aviation and air-carrier airports. Land-side components include vehicle ground access systems, vehicle circulation parking and terminal buildings. Air-side components include aircraft apron gate area, taxi-way system, runway system and air traffic control facilities and airspace. Emphasis on design projects. (Cross-listed with CIVE 868)
Prerequisite(s)/Corequisite(s): CIVE 361

CIVE 471 BITUMINOUS MATERIALS AND MIXTURES (3 credits)
Understanding of the physical, chemical, geometrical, and mechanical characteristics and practical applications of bituminous materials and mixtures. Fundamental mechanics for elastic and inelastic materials and basic theories associated with mechanical data analyses and designs. Recent advances and significant research outcomes for further discussions. Applications of theories to laboratory and field testing. (Cross-listed with CIVE 871)
Prerequisite(s)/Corequisite(s): CIVE 378. Not open to non-degree graduate students.

CIVE 472 PAVEMENT DESIGN AND EVALUATION (3 credits)
Thickness design of flexible and rigid pavement systems for highways and airports; design of paving materials; evaluation and strengthening of existing pavements. (Cross-listed with CIVE 872).
Prerequisite(s)/Corequisite(s): CIVE 334

CIVE 475 WATER QUALITY STRATEGY (3 credits)
Holistic approach to the selection and analysis of planning strategies for protecting water quality from nonpoint sources of contamination. Introduction to the use of methods of analyzing the impact of strategies on whole systems and subsystems for selecting strategies; and for evaluating present strategies.
Prerequisite(s)/Corequisite(s): Senior standing

CIVE 476 CONSTRUCTION COST CONTROLS (3 credits)
Development of cost accounting principles and financial controls appropriate for construction contractors. Includes purchasing policies and procedure, labor and equipment cost reporting techniques, accounting procedures for control of materials and supplies, billing methods, principles of financial reporting and analysis.
Prerequisite(s)/Corequisite(s): ACCT 2010 and ACCT 2020.

CIVE 481 COMPUTATIONAL PROBLEM SOLVING IN CIVIL ENGINEERING (3 credits)
Introduction to numerical methods to solve problems in civil engineering, including finding roots of equations, solving linear algebra equations, optimization, curve fitting, numerical differentiation and integration, and finite difference method. Computational methods in numerical integration, matrix operations and ordinary differential equations as they apply to civil engineering problems. (Cross-listed with CIVE 881)
Prerequisite(s)/Corequisite(s): Not open to non-degree graduate students.

CIVE 489 SENIOR DESIGN PROJECT (3 credits)
Requires the formulation and completion of a civil engineering design project. Course provides senior civil engineering students with the opportunity to apply engineering concepts and principles to a comprehensive design project of multiple sub-disciplinary nature. The principal objectives are for students to develop an understanding of the entire life-cycle of civil engineering projects with emphasis on the development of a unified and sustainable design that addresses the client’s needs; project team work; strong engineer-client relationships; and effective project communications.
Prerequisite(s)/Corequisite(s): Senior standing and CIVE 385

CIVE 498 SPECIAL TOPICS IN CIVIL ENGINEERING (1-6 credits)
Special problems, topics, or research in civil engineering. (Cross-listed with CIVE 898).
Prerequisite(s)/Corequisite(s): Permission.