## CIVIL ENGINEERING (CE)

**CE 1. Civil Engineering Seminar.**
- **General Education Area/Graduation Requirement:** Understanding Personal Development (E)
- **Term Typically Offered:** Fall, Spring

Introduces students to civil engineering as a profession. Topics include the technical disciplines (environmental, geotechnical, structural, transportation, and water resources), the role of civil engineers in planning, constructing and operating infrastructure, and professional responsibilities such as licensure and ethics. Case studies are used to explore both technical and nontechnical aspects of civil engineering projects such as design and environmental constraints, constructability, and social and political issues.

**CE 4. Engineering Graphics and CAD.**
- **General Education Area/Graduation Requirement:** Understanding Personal Development (E)
- **Term Typically Offered:** Fall, Spring

In-depth graphic analysis and solution of typical three dimensional space problems by applying the principles of orthogonal projection. Fundamentals of interactive computer aided design and drafting. Lecture one hour; laboratory three hours.

**CE 9. Plane and Topographic Surveying.**
- **Prerequisite(s):** MATH 30 and CE 9L. CE 9L may be taken concurrently. MATH 30 may be taken concurrently. Not currently enrolled in CE 9.
- **Term Typically Offered:** Fall, Spring

Methods for the measurement of distance, direction, angles and elevations. Computational methods for locating points, closing traverses and determining areas and earthwork volumes. Horizontal and vertical curves. Introduction to legal aspects of surveying, geodetic surveys, maps, boundary surveys and new technologies used in surveying. Lecture two hours.

**CE 9L. Plane and Topographic Surveying Laboratory.**
- **Prerequisite(s):** MATH 30 and CE 9. CE 9 may be taken concurrently. MATH 30 may be taken concurrently. Not currently enrolled in CE 9L.
- **Term Typically Offered:** Fall, Spring, Summer

Laboratory course that supports CE 9. Use of surveying instruments and measurement techniques in field setting. Laboratory three hours.

**CE 100. Engineering Geology.**
- **Prerequisite(s):** ENGR 112; may be taken concurrently.
- **Term Typically Offered:** Fall, Spring

Soil and rock mechanics and their relations to geological features influencing design, construction and maintenance of engineering projects. Lectures and field problems.

**CE 101. Computer Applications in Civil Engineering.**
- **Prerequisite(s):** ENGR 30 and CE 4; CE 4 may be taken concurrently.
- **Term Typically Offered:** Fall, Spring

Development of programming- and algorithm-based problem-solving skills in civil engineering using modern programming and scripting languages and scientific computing programs. Application to numerical methods, data science, and visualization.

**CE 130. Water Resources Engineering.**
- **Prerequisite(s):** CE 1, CE 101, ENGR 115, ENGR 132, CE 130L. CE 130L may be taken concurrently. Not currently enrolled in CE 130.
- **Term Typically Offered:** Fall, Spring

Hydrologic and hydraulic fundamentals which are common to water resources projects; introduction to reservoirs, dams, pipelines, channels, hydraulic machinery, ground water, water rights, statistical analysis, engineering economy applications, and water resources planning.

**CE 130L. Hydraulics Laboratory.**
- **Prerequisite(s):** CE 101 and CE 130. CE 130 may be taken concurrently. WPJ Score of 70+ or equivalent. Not currently enrolled in CE 130L.
- **Term Typically Offered:** Fall, Spring

Laboratory experiments relating the principles of fluid mechanics to real fluid flow. Laboratory three hours.

**CE 131. Hydrology.**
- **Prerequisite(s):** CE 130 and CE 130L. Not currently enrolled in CE 131.
- **Term Typically Offered:** Fall only

Introduction to surface water hydrology for engineering. Evapotranspiration and infiltration prediction. Precipitation analysis, hydrograph and flood routing applications for civil engineering. Statistical applications in hydrology.

**CE 132. Groundwater Engineering.**
- **Prerequisite(s):** CE 130 and CE 130L. Not currently enrolled in CE 132.
- **Term Typically Offered:** Spring only


**CE 133. Design of Urban Water and Sewer Systems.**
- **Prerequisite(s):** CE 130 and CE 130L. Not currently enrolled in CE 133.
- **Term Typically Offered:** Fall only

Hydraulic design of water distribution and sewerage systems. Computer-assisted pipe network analysis. Analysis of pump systems. Pump station design. Other selected topics.

**CE 134. Open Channel Hydraulics.**
- **Prerequisite(s):** CE 130 and CE 130L. Not currently enrolled in CE 134.
- **Term Typically Offered:** Spring only

Civil engineering design problems in steady, uniform, gradually and rapidly varied open channel flow. Hydraulic analysis in structures, transitions, culverts, weirs and spillways. Channel design including roughness for subcritical and supercritical flow. Prediction of water surface profiles via simulation software.

**CE 140. Transportation Engineering.**
- **Prerequisite(s):** Complete CE 1, CE 9, CE 9L, CE 101, ENGR 115, and CE 140L. CE 140L may be taken concurrently. Not currently enrolled in CE 140.
- **Term Typically Offered:** Fall, Spring

Introduction to the fundamental topics in Transportation Engineering. Focus on roadway geometric design, layout considerations, pavement materials and design, traffic operations and analysis.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
<th>Prerequisite(s)</th>
<th>Corequisite(s)</th>
<th>Term Typically Offered</th>
<th>GPA Requirement</th>
<th>General Education Area/Graduation Requirement</th>
<th>Further Studies in Area</th>
<th>Corequisite(s)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 140L</td>
<td>Transportation Engineering Laboratory.</td>
<td>1</td>
<td>CE 1A and ENGR 30; GWAR; CE 1A may be taken concurrently.</td>
<td></td>
<td>Fall, Spring</td>
<td>B (B5)</td>
<td>Further Studies in Area B (B5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 141</td>
<td>Traffic Analysis and Design.</td>
<td>3</td>
<td>CE 140 and CE 140L. Not currently enrolled in CE 141.</td>
<td></td>
<td>Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 142</td>
<td>Transportation Systems.</td>
<td>3</td>
<td>CE 140. Not currently enrolled in CE 142.</td>
<td></td>
<td>Fall only</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 146</td>
<td>Civil Engineering Professional Practice.</td>
<td>3</td>
<td>CE 1A and ENGR 30; GWAR; CE 1A may be taken concurrently.</td>
<td></td>
<td>Fall, Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 150</td>
<td>Principles of Environmental Engineering.</td>
<td>2</td>
<td>CHEM 1E or CHEM 1A, ENGR 115, CE 1, CE 101, and CE 150L.</td>
<td></td>
<td>Fall, Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 150B</td>
<td>Environmental Engineering Practice.</td>
<td>2</td>
<td>CE 150. Not currently enrolled in CE 150B.</td>
<td></td>
<td>Fall, Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 151</td>
<td>Introduction to GIS in Civil Engineering.</td>
<td>3</td>
<td>ENGR 115, CE 9, and either CE 137, CE 147, CE 170A, or CE 171A.</td>
<td></td>
<td>Fall, Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 153</td>
<td>Design of Water Quality Control Processes.</td>
<td>3</td>
<td>CE 150B and ENGR 132. Not currently enrolled in CE 153.</td>
<td></td>
<td>Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 156</td>
<td>Geoenvironmental Engineering.</td>
<td>3</td>
<td>CE 150B and CE 170; CE 150B may be taken concurrently.</td>
<td></td>
<td>Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 160</td>
<td>Introduction to Structural Analysis.</td>
<td>3</td>
<td>CE 1, CE 101, ENGR 112, and (MATH 35 or MATH 100).</td>
<td></td>
<td>Fall, Spring</td>
<td></td>
<td>Further Studies in Area B (B5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 160L</td>
<td>Structural Laboratory.</td>
<td>1</td>
<td>CE 101 and ENGR 112. WPJ score of 70+ or equivalent.</td>
<td></td>
<td>Fall, Spring</td>
<td></td>
<td>Further Studies in Area B (B5)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CE 163. Structural Steel Design. 3 Units
Prerequisite(s): CE 160. Not currently enrolled in CE 163.
Term Typically Offered: Fall, Spring

Theory and practice in design of structural steel members and connections using current design specifications. Design of tension and compression members, laterally supported and unsupported beams, beam-columns, and bolted and welded connections.

CE 164. Reinforced Concrete Design. 3 Units
Prerequisite(s): CE 160 and CE 160L. CE 160L may be taken concurrently. Not currently enrolled in CE 164.
Term Typically Offered: Fall, Spring

Introduction to reinforced concrete design according to American Concrete Institute (ACI) 318 Building Code, including: design and safety concepts; loads and load path; structural systems; material properties; flexural analysis and design of reinforced concrete beams and one-way slabs; development of reinforcement; serviceability; shear; columns; and other topics.

CE 165. Masonry Design. 3 Units
Prerequisite(s): CE 160. Not currently enrolled in CE 165
Term Typically Offered: Spring only

History of masonry. Masonry materials. Masonry as a structural material. Design of masonry beams, concentrically and eccentrically loaded columns, walls for vertical and lateral loading including effects of wind and seismic forces. Design of a small building for wind and seismic loading including torsional effects.

CE 166. Seismic Behavior of Structures. 3 Units
Prerequisite(s): CE 101, CE 160, and ENGR 110. Not currently enrolled in CE 166
Term Typically Offered: Fall, Spring

Analyzes simple structures’ response to dynamic loads with emphasis on response to earthquake ground motion. Introduction to multi-story buildings dynamics. Modal and approximate analyses of earthquake response. Dynamic analysis and building code procedures.

CE 168. Prestressed Concrete Design. 3 Units
Prerequisite(s): CE 160 and CE 164. CE 164 may be taken concurrently. Not currently enrolled in CE 168.
Term Typically Offered: Fall only – even years

Introduction to prestressed concrete design, focusing on bridges and buildings. Topics include: basic concepts; technology for fabrication and construction; material properties; flexural analysis and design for non-composite and composite beams; development of strands; prestress losses; camber and deflections; shear; and other topics. Design conforming to American Concrete Institute (ACI) 318 Building Code or AASHTO LRFD Bridge Design Specifications is emphasized, as appropriate.

CE 169. Timber Design. 3 Units
Prerequisite(s): CE 160. Not currently enrolled in CE 169.
Term Typically Offered: Fall only

Wood as a structural material. Design of sawn and glulam beams, concentrically and eccentrically loaded columns, shear walls, flexible diaphragms and connections for vertical and lateral loading including effects of wind and seismic forces.
CE 190A. Civil Engineering Project Skills. 3 Units
Prerequisite(s): CE 130 or CE 140 or CE 150 or CE 160 or CE 170. WPJ Score of 70+ or equivalent. Not currently enrolled in CE 190A.
General Education Area/Graduation Requirement: GE AREA D
Term Typically Offered: Fall, Spring

Introduction to professional engineering practice through case studies of existing projects, including estimating, scheduling, and specifications. Evaluation of design alternatives for engineering projects using principles of engineering economy and cost benefit analysis. Engineering ethics and professional responsibilities.

Note: This course is intended to be taken in the final year of study before taking CE 191.

CE 191. Senior Project. 3 Units
Prerequisite(s): CE 190
Term Typically Offered: Fall, Spring

Culminating degree requirement. Completion of a conceptual design and evaluation of alternatives under realistic constraints for proposed infrastructure projects. Students work in teams with practicing professionals providing mentoring. Draws upon full educational experience to date. Lecture two hours. Laboratory three hours.

Note: This course must be taken in the final semester.

CE 194. Career Development in Civil Engineering. 1 Unit
Prerequisite(s): Instructor permission.
Term Typically Offered: Fall, Spring

Designed for Civil Engineering students making career decisions. Instruction will include effective career planning strategies and techniques including skill assessments, employment search strategy, goal setting, time management, interview techniques and resume writing. Lecture one hour.

Note: Units earned cannot be used to satisfy major requirements. Cross Listed: ENGR 194, EEE194

Credit/No Credit

CE 195. Fieldwork in Civil Engineering. 1 - 3 Units
Prerequisite(s): Petition approval by supervising faculty member and Department chair.
Term Typically Offered: Fall, Spring

Supervised work experience in civil engineering with public agencies or firms in the industry.

Note: May be repeated for credit.

Credit/No Credit

CE 195A. Professional Practice. 1 - 12 Units
Prerequisite(s): Instructor permission.
Term Typically Offered: Fall, Spring

Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science.

Note: Requires satisfactory completion of the work assignment and a written report.

Credit/No Credit

CE 196H. Concrete Technology. 3 Units
Prerequisite(s): ENGR 112.
Term Typically Offered: Spring only

History of portland cement, production, hydration, aggregates, supplementary cementitious materials, chemical admixtures, fresh and hardened concrete properties, concrete mixture design, and concrete construction. Introduction to concrete durability, concrete repair, and advances in concrete technology.

CE 199. Special Problems. 1 - 3 Units
Term Typically Offered: Fall, Spring

Individual projects or directed reading.

Note: Open to students judged capable of carrying out independent work. Admission requires departmental approval and sponsorship of a supervising faculty member. Cannot be used as a technical elective in the major. Consult the CE Department for admission procedures and other requirements. May be repeated.

CE 199E. Independent Study Technical Elective. 3 Units
Prerequisite(s): GPA of 2.5 or greater in the upper division courses of the major; grade of ‘B’ or better in the required major course associated with the proposed area of study (CE 130 or CE 140 or CE 150 or CE 160 or CE 170).
Term Typically Offered: Fall, Spring

Individual project, research, or directed reading on an advanced topic.

Note: Open to only those students prepared and capable of carrying out independent work.

CE 231A. Computer Methods of Structural Analysis I. 3 Units
Prerequisite(s): CE 161.
Term Typically Offered: Fall only – even years

Flexibility and stiffness methods of structural analysis are applied to two- and three-dimensional framed structures. Use of computer software to perform analysis is discussed in detail. Techniques of computer modeling are discussed.

CE 231B. Computer Methods of Structural Analysis II. 3 Units
Prerequisite(s): CE 231A or instructor permission.
Term Typically Offered: Spring only – odd years

Continuation of CE 231A with extension of theory to allow for the analysis of a wider variety of structures. Structural analysis software is used for the analysis of three-dimensional structures. Fundamentals of the finite element method and computer modeling with applications to structural problems.

CE 232. Nonlinear Structural Analysis. 3 Units
Prerequisite(s): CE 231A or instructor permission.
Term Typically Offered: Spring only – odd years

Theory and applications of nonlinear structural analysis including geometric and material nonlinear effects. Stability issues and second-order analysis methods in the context of moment amplification effects, member buckling, and the behavior of structural elements and frames undergoing large deformations. Inelastic material behavior and stress resultant plasticity concepts within a line-type element framework. Computer implementation of geometric nonlinear behavior.
Introduction to sludge treatment.

Stoichiometry and kinetics of microbial growth. Aerobic and anaerobic

Theory and practice of biological processes for controlling water.

Term Typically Offered: Fall only – odd years

Response of structures modeled as single-degree systems to harmonic,
periodic, and arbitrary excitation and earthquake ground motion;
effects of damping and material nonlinearity; numerical methods using
spreadsheets; response spectra. Response of structures modeled as
multi-degree systems: modeling of structure mass, damping and elastic
stiffness; solution by modal superposition; time-history and response
spectrum analysis; implications for codes for earthquake-resistant
design. Microcomputer software is extensively used.

Advanced design methodology of steel structures using Load and
Resistance Factor Design (LRFD). System level behavior, especially
from a seismic loading perspective, is integrated into the design of
steel components and connections. Other topics include plate girder
design, plastic design of indeterminate systems, design of moment frame
systems, and design of braced-frame systems.

Investigation of resource planning using the 'systems approach'.
Objectives of resource development; basic economic and technologic
concepts, and economic factors affecting system design. Consideration
of evaluation, institutional constraints, and uncertainty in water resources
systems. Familiarization with modern computer techniques. Applications
of concepts to air and land resources.

Application of single and multi-objective planning to the design and
operation of water resources projects. Objectives and constraints for
water projects, criteria and procedures for evaluation, planning under
uncertainty. Application in water development and water quality planning,
with case studies.

Theory and practice of chemical processes affecting water quality.
Chemical equilibrium, stoichiometry and kinetics of aqueous chemistry.
Acid-base, precipitation-dissolution, oxidation-reduction, and coordination
chemistry. Adsorption.

Theory and practice of biological processes for controlling water.
Stoichiometry and kinetics of microbial growth. Aerobic and anaerobic
metabolism. Engineered suspended and attached growth systems.
Introduction to sludge treatment.
CE 265. Analysis and Control of Traffic Systems. 3 Units
Prerequisite(s): CE 147 or CE 148; CE 263 or instructor permission.
Term Typically Offered: Fall only – odd years

Traffic data collection and analysis, practical application of theoretical methods of analysis such as capacity, level of service, and queuing theory. Investigation of traffic control techniques such as actuated signals and signal systems, and study of management techniques for traffic congestion.

CE 266. Advanced Design in Reinforced Concrete. 3 Units
Prerequisite(s): CE 161, CE 163, CE 164.
Term Typically Offered: Spring only – even years

Advanced topics in behavior and design in reinforced concrete. Detailing for seismic response.

CE 267. Structural Systems for Buildings. 3 Units
Prerequisite(s): CE 232 or instructor permission.
Term Typically Offered: Spring only – even years

Analyzes and design of various structural systems for buildings: frames, tubes, shear walls with or without openings and interaction between these types. Secondary effects such as P^s, material and geometrical nonlinearities.

CE 268. Pre-stressed Concrete Bridge Design. 3 Units
Prerequisite(s): CE 164 or instructor approval.
Term Typically Offered: Fall only – even years

Behavior and design of short and medium-span prestressed concrete bridges using American Association of State Highway and Transportation Officials (AASHTO) Load Resistance Factor Design (LRFD) specifications. Topics include: bridge types, aesthetics; design process; superstructure load types and live load analysis; limit states and load combinations; prestressed concrete materials; flexural analysis and design; shear analysis and design; and introduction to substructure analysis and design, including seismic design criteria. A team project is required.

CE 269. Pavement Design. 3 Units
Prerequisite(s): CE 147 and CE 171A.
Term Typically Offered: Spring only – even years

Fundamental principles of pavement analysis, design, and evaluation. Topics include pavement materials, mechanics, traffic and environmental loadings, pavement performance, design methods, construction and economic evaluation.

CE 271. Modern Hydrologic Techniques. 3 Units
Prerequisite(s): CE 137 or CE 138 and ENGR 203 or instructor permission.
Term Typically Offered: Spring only – even years

Analyses of hydrologic and meteorologic phenomena by mathematical, statistical, and system methods, linear and non linear, stochastic and parametric hydrology, computer applications in hydrology.

CE 272. Advanced Engineering Hydraulics. 3 Units
Prerequisite(s): CE 137 or equivalent.
Term Typically Offered: Spring only – even years

Steady uniform and non-uniform open channel flows including gradually, rapid and spatially varied flows; analysis of supercritical flow in transition; basic principles of unsteady flows; long wave theory; Saint-Venant Equations and their solutions including method of characteristics, explicit and implicit finite difference numerical methods.

CE 274. Hydrologic Modeling. 3 Units
Prerequisite(s): CE 272 or equivalent; instructor permission.
Term Typically Offered: Spring only – odd years

Theories and structure of hydraulic model components; application of HEC-RAS (River Analysis System) and HEC-HMS (Hydrologic Modeling System) computer programs; emphasis on flood routing methods; dam safety analysis methodology including dam break and dam overtopping cases; application of microcomputers in hydraulics computations.

CE 276. Groundwater Hydrology. 3 Units
Prerequisite(s): CE 137 or instructor permission.
Term Typically Offered: Fall only – even years

Occurrence and movement of groundwater; physical characteristics of aquifers; analysis of steady-state groundwater flow problems by mathematical, digital computer, electrical analog and graphical methods; analysis of unsteady-state problems in confined and unconfined, aquifers; multiple well systems.

CE 280A. Advanced Soil Mechanics and Foundation Engineering I. 3 Units
Prerequisite(s): CE 171A or equivalent.
Term Typically Offered: Fall only – even years

Advanced analyses in soil mechanics and their practical applications in foundation engineering; compressibility of soils, settlement analysis, and tolerable settlement; lateral earth pressures and design of earth retaining structures; bearing capacity of shallow foundations; in-situ soil testing for foundation design; design of deep foundations, including driven piles, drilled shaft foundations, and laterally loaded piles.

CE 280B. Advanced Soil Mechanics and Foundation Engineering II. 3 Units
Prerequisite(s): CE 171A or equivalent.
Term Typically Offered: Fall only – even years

Advanced analyses in shear strength of cohesionless and cohesive soils, including stress-strain characteristics of soils, total and effective stress analyses; slope stability analyses for natural slopes, fill slopes, earth dams, levees, and methods of slope stabilization; analysis and design of anchored bulkheads, cellular cofferdams, soil nail walls, tieback walls, mechanically stabilized earth walls, and segmental retaining walls.

CE 280C. Geotechnical Modeling. 3 Units
Prerequisite(s): CE 171A
Term Typically Offered: Fall only – even years

Advanced analysis principles and procedures for calculating monotonic and cyclic soil element response effective stress and pore water pressure distributions, dynamic site response, and soil deformations; application to analysis of complex geotechnical engineering systems such as levees, dams, and wharfs. Laboratory time devoted to numerical analysis software and physical element and small scale tests. Lecture two hours. Laboratory three hours.
CE 283. Ground Modification Engineering. 3 Units
Prerequisite(s): CE 171A or equivalent.
Term Typically Offered: Fall, Spring

Principles of soil stabilization and earth reinforcement; mechanical compaction and treatment of difficult soils, including expansive soils, collapsible soils, oversize materials, and compressible fill; prefabricated vertical drains and preloading; dynamic deep compaction; vibro compaction; vibro-replacement; rammed aggregate pier; compaction grouting; jet grouting; slurry grouting; chemical grouting; deep soil mixing; slurry trench walls.

CE 284. Soil Dynamics and Earthquake Engineering. 3 Units
Prerequisite(s): CE 171A or equivalent.
Term Typically Offered: Spring only – odd years

Introduction to vibration theory; wave propagation in soils and dynamic behavior of soils and foundations; dynamic tests; analysis of dynamically loaded foundations; causes of earthquakes; earthquake magnitude and zones; ground motions induced by earthquakes; earthquake-resistant design of foundations and earth dams.

CE 285. Geosynthetics I. 3 Units
Prerequisite(s): CE 171A or instructor permission.
Term Typically Offered: Fall only – even years

Overview of geotextiles, geogrids and geonets; geosynthetic properties and test methods; geosynthetic functions and mechanisms as in separation, roadway and soil reinforcement, filtration, and drainage; applications and design methods; construction, fabrication and installation.

CE 286. Geosynthetics II. 3 Units
Prerequisite(s): CE 171A or instructor permission.
Term Typically Offered: Fall, Spring

Overview of geomembranes, geosynthetic clay liners, and geocomposites. Topics include: geosynthetic properties and test methods; geosynthetic functions and mechanisms as in landfill liners, liquid barriers and carriers, erosion control, drainage, and design and construction methods.

CE 289. Project Management for Civil Engineers. 3 Units
Prerequisite(s): Graduate standing or instructor permission.
Term Typically Offered: Spring only

Theory and practice of project management in civil engineering. Interrelationship of planning, design, and construction. New technologies and techniques used in both US and international architectural/engineering/construction (A/E/C) markets. Topics: Project initiation, early estimates, project budgeting, work plans, design proposals, scheduling, tracking, design coordination, construction, project close-out, team and personal management skills, and quality control.

CE 296H. GIS Applications in Civil Engineering. 3 Units
Prerequisite(s): ENGR 115, CE 9 and CE 137 or CE 147 or CE 171A.
Term Typically Offered: Fall, Spring

Introduction to fundamental concepts of geographic information systems (GIS), methods, and applications in civil engineering. Design and develop GIS-based analytical methods and solutions for civil engineering problems. Lab exercises are used to design and practice GIS applications in civil engineering. This course may be paired with CE 196H.

CE 299. Special Problems. 1 - 3 Units
Term Typically Offered: Fall, Spring

Special problems in graduate research.
Note: Approval of a petition must be obtained from the faculty supervising the work and the Department Graduate Program Coordinator. Letter grade or Credit/No Credit.

CE 500. Culminating Experience. 3 - 6 Units
Prerequisite(s): Advanced to candidacy and permission of the faculty advisor and Department Chair.
Term Typically Offered: Fall, Spring

Successful completion of either A. Thesis (3-6 units), or B. Project (3-6 units) or C. Directed Study and Examination (3 units). Plan A requires a thesis and is primarily research-oriented. Plan B requires a project report that is primarily application oriented. Plan C requires a detailed literature review or experimental data analysis resulting in a written report plus an examination by three faculty. A public presentation is required for all three plans.