## CIVIL ENGINEERING (CE)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Offered</th>
<th>Description</th>
<th>Prerequisites</th>
<th>Lecture + Lab + Other</th>
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<tbody>
<tr>
<td>CE F112</td>
<td>Elementary Surveying</td>
<td>3</td>
<td>Spring</td>
<td>Basic plane surveying; use of transit, level, theodolite and total station.</td>
<td>Traverses, public land system, circular curves, cross-sectioning and earthwork.</td>
<td>2 + 3 + 0</td>
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<tr>
<td>CE F302</td>
<td>Fundamentals of Transportation Engineering</td>
<td>3</td>
<td>Spring</td>
<td>Introduces multi-modal transportation systems including highways, airports</td>
<td>Introduces multi-modal transportation systems including highways, airports, railroads and water transportation. Factors that influence planning, design and operation of these systems is discussed. Highway systems are emphasized in the course.</td>
<td>3 + 0 + 0</td>
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<tr>
<td>CE F326</td>
<td>Introduction to Geotechnical Engineering</td>
<td>4</td>
<td>Spring</td>
<td>Fundamentals of geotechnical engineering including identification and</td>
<td>Provides and introduction to matrix methods.</td>
<td>3 + 3 + 0</td>
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<td>classification of soil, physical and mechanical properties of soil,</td>
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<td>subsurface exploration, laboratory testing techniques, seepage, compaction,</td>
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<td>stresses in soil, soil consolidation, and drained and undrained shear strength of soil.</td>
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<td>CE F331</td>
<td>Structural Analysis</td>
<td>3</td>
<td>Spring</td>
<td>Introduces techniques for the analysis of statically determinate and</td>
<td>Provides and introduction to matrix methods.</td>
<td>2 + 3 + 0</td>
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<tr>
<td>CE F334</td>
<td>Properties of Materials</td>
<td>3</td>
<td>Fall</td>
<td>Properties of engineering materials. Bonding, crystal and amorphous</td>
<td>Provides and introduction to matrix methods.</td>
<td>2 + 3 + 0</td>
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<td>structures. Relationships between microstructure and engineering</td>
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<td>properties. Modification of properties and environmental serviceability.</td>
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<td>Concrete and asphalt mixes.</td>
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<td>CE F341</td>
<td>Environmental Engineering</td>
<td>4</td>
<td>Fall</td>
<td>Introduces fundamentals of environmental engineering including theory</td>
<td>Provides and introduction to matrix methods.</td>
<td>2 + 3 + 0</td>
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<td>and application of water and wastewater, solid waste and air quality</td>
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<td>CE F344</td>
<td>Water Resources Engineering</td>
<td>3</td>
<td>Fall</td>
<td>Fundamentals of engineering hydrology and hydraulic engineering. Water</td>
<td>Provides and introduction to matrix methods.</td>
<td>3 + 0 + 0</td>
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<td>cycle and water balance, precipitation, evaporation, runoff, statistical</td>
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<td>CE F405</td>
<td>Design of Highways and Streets</td>
<td>3</td>
<td>Fall</td>
<td>Design and analysis of streets and highways with an emphasis on safety</td>
<td>Provides and introduction to matrix methods.</td>
<td>3 + 0 + 0</td>
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<tr>
<td>CE F422</td>
<td>Foundation Engineering</td>
<td>3</td>
<td>Winter</td>
<td>Reviews slope stability analysis. Introduces bearing capacity of soils and</td>
<td>Provides and introduction to matrix methods.</td>
<td>3 + 0 + 0</td>
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<tr>
<td>CE F424</td>
<td>Introduction to Permafrost Engineering (a)</td>
<td>3</td>
<td>Winter</td>
<td>Introduction to permafrost and frozen ground engineering, types of</td>
<td>Provides and introduction to matrix methods.</td>
<td>3 + 0 + 0</td>
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<td>permafrost and ways of its formations, factors important for permafrost</td>
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<td>existence, hazards related to permafrost, index, thermal, and mechanical</td>
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<td>properties of frozen and thawing soils, methods of thermal analysis of</td>
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<td>soil freezing and thawing, foundations design alternatives, pipelines,</td>
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<td>roads and airfields in the permafrost region.</td>
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CE F433  Reinforced Concrete Design  
3 Credits  
Offered Spring  
Introduces structural design philosophies and current practices related to reinforced concrete design. Utilizes the ACI 318 Specification to discuss the behavior of reinforced concrete members and their design including flexural members, such as rectangular, T-beams, and one-way slabs, and axial members. Crack control, anchorage, development lengths and deflections are also covered.  
Prerequisites: CE F331; ES F331.  
Lecture + Lab + Other: 3 + 0 + 0

CE F434  Timber Design  
3 Credits  
Offered Fall  
Prerequisites: CE F331; ES F331.  
Lecture + Lab + Other: 3 + 0 + 0

CE F435  Design and Construction of Bridges  
3 Credits  
Offered Spring  
Design-build technology for bridge structures is introduced. A bridge system is developed for a given crossing with predetermined specifications. Alternate designs are developed. These alternatives are based on design calculations, prepared drawings and suitability. Design ideas are developed and tested to verify if the idea meets the design assumptions. Techniques in design, fabrication, fund raising, project management, fiscal responsibility, safety, public speaking and teamwork are learned and used during the semester. The final structure will be load tested and graded based on meeting the goals of the specification.  
Prerequisites: Permission of instructor.  
Recommended: CE F432.  
Lecture + Lab + Other: 1 + 6 + 0

CE F437  Design of Engineered Systems I  
3 Credits  
Offered Fall  
Critical skills for a successful engineer with emphasis on: project planning; preliminary investigations; permitting; reading, interpreting, and creating plans and specification; use and technical applications of AutoCAD; proposal writing and project management; continuing education and professional registration. Civil engineering major with senior standing; COJO F131X or COJO F141X; WRTG F111X or WRTG F211X or WRTG F212X or WRTG F213X or WRTG F214X.  
Lecture + Lab + Other: 3 + 0 + 0

CE F438  Design of Engineered Systems II  
3 Credits  
Offered Spring  
System design principles using service learning projects with civil and environmental engineering focus. Practical applications of concepts covered in CE F437: ethics, liability and legal principles to professional practice. Emphasis on teamwork and leadership.  
Prerequisites: COJO F131X or COJO F141X; WRTG F111X; WRTG F211X, WRTG F212X, WRTG F213X or WRTG F214X; CE F405 or CE F422 or CE F432 or CE F433 or CE F434 or CE F442 or CE F445; CE F437.  
Lecture + Lab + Other: 3 + 0 + 0

CE F442  Environmental Engineering Design  
3 Credits  
Offered Fall  
Presents design methods for pollution control and remediation systems. Applies theories and principles for the design of engineering systems for environmental protection, management and control, water and wastewater treatment and solid waste management.  
Prerequisites: CE F341.  
Lecture + Lab + Other: 3 + 0 + 0

CE F443  Air Pollution Management  
3 Credits  
Offered Spring  
Air pollution topics including the quantity and quality of atmospheric emissions and their effects on the human environment. Identification and location of sources, measurement of quantity and conformance with standards. Legal considerations of Clean Air Act and Amendments and local regulations. Evaluation of stationary and moving sources. Meteorology and modeling requirements. Control mechanisms for gases and particulates.  
Prerequisites: CHEM 106X; graduate standing.  
Recommended: MATH F252X.  
Stacked with ENVE F643.  
Lecture + Lab + Other: 3 + 0 + 0

CE F445  Hydrologic Analysis and Design  
3 Credits  
Offered Spring  
Design and analysis; extended coverage of hydrologic concepts from CE F344. Precipitation, snow cover and evaporation analysis; groundwater hydraulics; runoff analysis and prediction; statistical hydrology; application of simulation models. Design of structures such as culverts, reservoirs, wells, pumps and pipe networks.  
Prerequisites: CE F344.  
Lecture + Lab + Other: 2 + 3 + 0

CE F451  Construction Cost Estimating and Bid Preparation  
3 Credits  
Offered Fall  
Compilation and analysis of the many items that influence and contribute to the cost of projects to be constructed. Preparation of cost proposals and study of bidding procedures.  
Recommended: College math.  
Lecture + Lab + Other: 3 + 0 + 0

CE F463  Groundwater Dynamics  
3 Credits  
Offered Fall Odd-numbered Years  
Fundamentals of geohydrology, hydraulics of flow through porous media, well hydraulics, groundwater pollution and groundwater resources development.  
Corequisites: CE F344.  
Stacked with CE F663.  
Lecture + Lab + Other: 3 + 0 + 0
CE F470  Civil Engineering Internship
1 Credit
Offered Fall, Spring and Summer
Supervised engineering field and work experience. Assignments individually arranged with cooperating agencies and must include data collection and reporting. As part of the requirements for earning credit, the student must have a letter of release from the company, prepare a written report and make an oral presentation. Program must be approved in advance by the department. This course is graded Pass/Fail.
Prerequisites: Upper division standing; permission of department coordinator.
Lecture + Lab + Other: 0 + 3 + 0

CE F471  Field Practicum
1 Credit
Offered Fall
Introduction to field data collection techniques used in civil engineering sub-disciplines such as structural, traffic, water, environmental and materials; preliminary data analysis and descriptive statistics.
Prerequisites: Senior standing in CEE program.
Lecture + Lab + Other: 0 + 3 + 0

CE F601  Engineering Research Communication
3 Credits
Offered As Demand Warrants
Oral and written communication techniques to describe results on current issues in environmental science and engineering.
Prerequisites: Graduate Standing.
Lecture + Lab + Other: 3 + 0 + 0

CE F603  Arctic Engineering (a)
3 Credits
Offered Fall and Spring
Introduces students to a broad spectrum of engineering challenges unique to cold regions. Discusses physical principles and practical data collection methods, analyses, designs and construction methods. Students gain a working knowledge of cold regions engineering problems and modern solutions as a basis for more detailed study.
Lecture + Lab + Other: 3 + 0 + 0

CE F605  Pavement Design
3 Credits
Offered As Demand Warrants
Provides instruction on the current practices of analysis and design of highway and airport pavements. The instruction includes theoretical and practical approaches for the design of flexible and rigid pavements. Materials characterization, load considerations, empirical and mechanistic design methods as well as rehabilitation are covered.
Lecture + Lab + Other: 3 + 0 + 0

CE F607  GIS Applications in Civil Engineering
3 Credits
Offered As Demand Warrants
Theories and advanced methods of Geographic Information Systems for civil engineering practice. Students will apply and execute concepts related to data integration, analysis and management in the ArcGIS suite during labs.
Prerequisites: Graduate standing in CE.
Lecture + Lab + Other: 2 + 3 + 0

CE F620  Construction Project Management
3 Credits
Offered As Demand Warrants
Construction equipment, methods, planning and scheduling, construction contracts, management and accounting, construction estimates, costs, and project control.
Recommended: ESM F450 or equivalent.
Lecture + Lab + Other: 3 + 0 + 0

CE F622  Foundations and Retaining Structures
3 Credits
Offered As Demand Warrants
Advanced study of shallow and deep foundations; analyses and design of retaining walls, free-standing sheet-pile walls, braced excavations, slurry walls, tied-back retention systems, reinforced earth, frozen soil walls, anchored bulkheads, and cellular cofferdams.
Prerequisites: CE F422.
Lecture + Lab + Other: 3 + 0 + 0

CE F624  Frozen Ground Engineering (a)
3 Credits
Offered Spring
Introduction to permafrost and frozen ground engineering, types of permafrost and ways of its formations, factors important for permafrost existence, hazards related to permafrost, index, thermal, and mechanical properties of frozen and thawing soils, methods of thermal analysis of soil freezing and thawing, foundations design alternatives, pipelines, roads and airfields in the permafrost region.
Prerequisites: Training or experience in soil mechanics.
Stacked with CE F424.
Lecture + Lab + Other: 3 + 0 + 0

CE F625  Soil Stabilization and Embankment Design
3 Credits
Offered As Demand Warrants
Soil and site improvement using deep and shallow compaction, additives, pre-loading, vertical and horizontal drains, electro-osmosis and soil reinforcement, dewatering and stabilization; embankment design, earth pressure theories and pressure in embankment, embankment stability, embankment construction, control and instrumentation.
Prerequisites: CE F422.
Lecture + Lab + Other: 3 + 0 + 0

CE F626  Thermal Geotechnics
3 Credits
Offered As Demand Warrants
Prerequisites: CE F326; CE F422. Cross-listed with GE F626.
Lecture + Lab + Other: 3 + 0 + 0

CE F627  Geotechnical Earthquake Engineering
3 Credits
Offered As Demand Warrants
Introduction to soil dynamics and geotechnical aspects of earthquakes; influences of soils on ground motion, determination of soil response under strong seismic motion, causes of soil failures, soil liquefaction, lateral spreading, the seismic response of earth structures, and seismic deformation procedures for slopes.
Prerequisites: CE F326.
Lecture + Lab + Other: 3 + 0 + 0
CE F628  Unsaturated Soils Mechanics  
3 Credits  
Offered As Demand Warrants  
Fundamentals of soil behavior under load; pore pressure during monotonic loading; Ladd's "Simple Clay" model; densification and drained cyclic loading of sand; undrained cycle loading of soil.  
Prerequisites: CE F326.  
Lecture + Lab + Other: 3 + 0 + 0  

CE F630  Advanced Structural Mechanics  
3 Credits  
Offered As Demand Warrants  
Shear and torsion, non-symmetrical bending, shear center, curved beams, introduction to composite material mechanics, application in bridge engineering.  
Prerequisites: Math F302; ES F331.  
Recommended: Graduate standing in engineering.  
Lecture + Lab + Other: 3 + 0 + 0  

CE F631  Advanced Structural Analysis  
3 Credits  
Offered As Demand Warrants  
Derivation of the basic equations governing linear structural systems. Application of stiffness and flexibility methods to trusses and frames. Solution techniques utilizing digital computers. Planar structures and space structures (trusses and frames) will be covered. Both exact and approximate solution techniques will be reviewed.  
Prerequisites: CE F331.  
Lecture + Lab + Other: 3 + 0 + 0  

CE F633  Theory of Elastic Stability  
3 Credits  
Offered As Demand Warrants  
The theory and implementation of the buckling of slender elements will be covered. Both lateral and local buckling concepts will be discussed. Emphasis will be placed on developing the ability to evaluate if a member is likely to buckle. The course will cover elastic and inelastic buckling of columns. Other topics include lateral torsional buckling of beams, potential buckling of beam-columns and rigid frame members and the buckling of non standard shapes.  
Prerequisites: CE F331; CE F432; MATH F302.  
Lecture + Lab + Other: 3 + 0 + 0  

CE F634  Structural Dynamics  
3 Credits  
Offered As Demand Warrants  
This course covers the theory of structural dynamics. Subjects include equations of motion for un-damped single and multiple degree of freedom systems. Free vibration and response to harmonic and periodic excitations will be studied. Response to arbitrary, step and pulse type excitations are studied in preparation for a study of earthquake type loading. The basic concepts related to the interaction of a structure to an earthquake event will be discussed.  
Prerequisites: ES F210; CE F331; MATH F302.  
Lecture + Lab + Other: 3 + 0 + 0  

CE F635  Numerical Methods for Geomechanics and Soil-Structure Interaction  
3 Credits  
Offered As Demand Warrants  
Applications of numerical methods for problems involving seepage, consolidation, foundation on expansive soils and pile installation. Finite difference and element methods, non-linear analysis techniques, elasto-plastic formulation with a tangent stiffness approach, seepage analysis, flow-deformation, coupled analysis, models for soil-structure interaction, solution accuracy and reliability.  
Prerequisites: CE F326; graduate standing.  
Recommended: MATH F302.  
Lecture + Lab + Other: 3 + 0 + 0  

CE F637  Earthquakes: Seismic Response of Structures  
3 Credits  
Offered As Demand Warrants  
Fundamentals of structural earthquake engineering: strong ground motion phenomena; dynamic analysis of structural systems for seismic motion; response spectrum and time history methods, design of structural systems for lateral forces; shear walls and diaphragms; moment-resisting frames, braced frames; current design criteria and practice; connection details, serviceability requirement; story drift, non-structural building elements; soil-structure interaction.  
Prerequisites: ES F210.  
Lecture + Lab + Other: 3 + 0 + 0  

CE F640  Prestressed Concrete  
3 Credits  
Offered As Demand Warrants  
Prerequisites: CE F331; CE F433.  
Recommended: Graduate standing.  
Lecture + Lab + Other: 3 + 0 + 0  

CE F646  Structural Composites  
3 Credits  
Offered As Demand Warrants  
The basics of structural composite theory. Basic design procedures related to structural composite members and the structural analysis of members made of various materials to create laminates or sandwich panels will be covered.  
Prerequisites: ES F331; CE F331.  
Lecture + Lab + Other: 3 + 0 + 0  

CE F650  Bridge Engineering  
3 Credits  
Offered As Demand Warrants  
Covers structural systems, loading and analysis by influence lines. Slab and girder bridges considering composite design, prestressed and concrete bridges and how these bridges are designed and rated using AASHTO specifications.  
Prerequisites: CE F432; CE F433.  
Lecture + Lab + Other: 3 + 0 + 0  

CE F661  Advanced Water Resources Engineering  
3 Credits  
Offered Spring Odd-numbered Years  
Engineering hydraulics and hydrology including use of standard computer models to solve water resource engineering problems.  
Recommended: Permission of instructor.  
Lecture + Lab + Other: 3 + 0 + 0
CE F662  Open Channel and River Engineering  
3 Credits  
Offered Spring Even-numbered Years  
Principles of open channel flow, specific energy, hydraulic jump, 
transitions and controls, uniform and non-uniform flows, steady and 
unsteady flows, numerical solution for unsteady flows. River engineering, 
stream channel mechanics, and mechanics of sedimentation.  
Recommended: Permission of instructor.  
Lecture + Lab + Other: 3 + 0 + 0

CE F663  Groundwater Dynamics  
3 Credits  
Offered Fall Odd-numbered Years  
Fundamentals of geohydrology, hydraulics of flow through porous media, 
well hydraulics, groundwater pollution and groundwater resources 
development.  
Corequisites: CE F344.  
Stacked with CE F463.  
Lecture + Lab + Other: 3 + 0 + 0

CE F664  Sediment Transport  
3 Credits  
Offered Spring Even-numbered Years  
Fundamentals of sediment transport processes in rivers, oceans and 
reservoirs. Bed-load and suspended-load transports. Mechanics of 
Prerequisites: Graduate standing.  
Lecture + Lab + Other: 3 + 0 + 0

CE F665  Introduction to Watershed Hydrology  
3 Credits  
Offered As Demand Warrants  
A broad view of the water cycle at the watershed scale and introduction 
to the quantitative relations between components of the water cycle. 
Emphasis is placed on precipitation, evapotranspiration, water in soils 
and stream response to water-input events.  
Prerequisites: MATH F253X, PHYS F211X.  
Lecture + Lab + Other: 3 + 0 + 0

CE F682  Ice Engineering  (a)  
3 Credits  
Offered As Demand Warrants  
The factors governing design of marine structures, which must contend 
with the presence of ice. Topics include ice growth, ice structure, 
mechanical properties and their dependence on temperature and 
structure, creep and fracture, mechanics of ice sheets, forces on 
structures, and experimental methods.  
Prerequisites: ES F331, MATH F253X, training or experience in soil 
mechanics.  
Lecture + Lab + Other: 3 + 0 + 0

CE F684  Arctic Utility Distribution  (a)  
3 Credits  
Offered As Demand Warrants  
Practices and considerations of utility distribution in Arctic regions. 
Emphasis on proper design to include freeze protection, materials, energy 
conservation and system selection.  
Prerequisites: ES F341.  
Lecture + Lab + Other: 3 + 0 + 0

CE F685  Topics in Frozen Ground Engineering  (a)  
3 Credits  
Offered As Demand Warrants  
Selected frozen ground foundation engineering problems will be explored 
in depth including refrigerated foundations and pile foundations.  
Prerequisites: CE F424 or CE F624.  
Lecture + Lab + Other: 3 + 0 + 0

CE F690  Seminar  
1-3 Credits  
Lecture + Lab + Other: 0 + 0 + 0

CE F698  Non-thesis Research/Project  
1-6 Credits  
Lecture + Lab + Other: 0 + 0 + 0

CE F699  Thesis  
1-15 Credits  
Lecture + Lab + Other: 0 + 0 + 0