<table>
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<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>
</tr>
</thead>
<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. Traverses, public land system, circular curves, cross-sectioning and earthwork.</td>
<td>Prerequisites: MATH F152X.</td>
<td>2 + 3 + 0</td>
</tr>
<tr>
<td>CE F302</td>
<td>Fundamentals of Transportation Engineering</td>
<td>3</td>
<td>Spring</td>
<td>Introduction to multimodal transportation systems and the factors that influence the planning, design and operation of transportation systems. Highway systems are emphasized, with keen focus on issues related to Northern climates.</td>
<td>Prerequisites: CE F112 or MIN F202; sophomore standing.</td>
<td>3 + 0 + 0</td>
</tr>
<tr>
<td>CE F326</td>
<td>Introduction to Geotechnical Engineering and Foundations</td>
<td>4</td>
<td>Fall</td>
<td>Identification and classification of soils; physical and mechanical properties of soil; subsurface exploration; movement of water through soil; soil deformation. Bearing capacity of shallow foundations and piles, and stability of retaining walls. Laboratory testing techniques, and introduction to soil issues related to cold regions.</td>
<td>Prerequisites: ES F331 (may be taken concurrently); GE F261.</td>
<td>3 + 3 + 0</td>
</tr>
<tr>
<td>CE F331</td>
<td>Structural Analysis</td>
<td>3</td>
<td>Spring</td>
<td>Introduces techniques for the analysis of statically determinate and indeterminate structures to include beams, trusses and frames. Reviews internal force resultants, shear and moment diagrams, deflections, internal stresses. Discusses indeterminate analysis of structures, including methods of consistent deflections and slope-deflection. Provides and introduction to matrix methods.</td>
<td>Prerequisites: ES F208; ES F331.</td>
<td>2 + 0 + 3</td>
</tr>
<tr>
<td>CE F334</td>
<td>Properties of Materials</td>
<td>3</td>
<td>Spring</td>
<td>Properties of engineering materials. Bonding, crystal and amorphous structures. Relationships between microstructure and engineering properties. Modification of properties and environmental serviceability. Concrete and asphalt mixes.</td>
<td>Prerequisites: ES F331.</td>
<td>2 + 3 + 0</td>
</tr>
<tr>
<td>CE F341</td>
<td>Introduction to Environmental Engineering</td>
<td>4</td>
<td>Fall</td>
<td>Introduces fundamentals of environmental engineering theory and application including topics in water chemistry, mass balance, heat transfer, water/wastewater quality and treatment, air quality engineering, and design of natural/engineered processes for contaminant removal. Laboratory activities supplement lecture material and provide an introduction to statistical analyses, data interpretation and preparation of reports.</td>
<td>Prerequisites: CHEM F106X; or graduate standing.</td>
<td>3 + 3 + 0</td>
</tr>
<tr>
<td>CE F344</td>
<td>Water Resources Engineering</td>
<td>3</td>
<td>Fall</td>
<td>Fundamentals of engineering hydrology and hydraulic engineering. Water cycle and water balance, precipitation, evaporation, runoff, statistical methods, flood control, open channels and groundwater.</td>
<td>Prerequisites: ES F341.</td>
<td>3 + 0 + 0</td>
</tr>
<tr>
<td>CE F401</td>
<td>Arctic Engineering</td>
<td>3</td>
<td>Fall</td>
<td>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.</td>
<td>Prerequisites: Senior standing in engineering or a BS in engineering.</td>
<td>3 + 0 + 0</td>
</tr>
<tr>
<td>CE F405</td>
<td>Design of Highways and Streets</td>
<td>3</td>
<td>Fall, Even-numbered Years</td>
<td>Design and analysis of streets and highways with an emphasis on safety and efficiency. Design topics include: surveys, vertical and horizontal alignments, cross sections, and gravel roads. Analysis topics include: flow and gap acceptance theory, impact and safety analysis, signal timing and coordination.</td>
<td>Prerequisites: CE F302.</td>
<td>3 + 0 + 0</td>
</tr>
<tr>
<td>CE F408</td>
<td>Transportation Safety Analysis</td>
<td>3</td>
<td>Fall, Odd-numbered Years</td>
<td>Analysis of streets and highways with an emphasis on safety. Analysis of alternatives and control strategies with respect to crash probabilities. Statistical models for safety analysis; crash data collection, database management and data analysis; safety improvement programs; statistical modeling; and before-and-after studies.</td>
<td>Prerequisites: CE F302.</td>
<td>3 + 0 + 0</td>
</tr>
<tr>
<td>CE F420</td>
<td>Groundwater Engineering</td>
<td>3</td>
<td>Fall</td>
<td>Fundamentals of groundwater occurrence, hydrology, resource development, water quality, monitoring and remediation. Field methods and modeling.</td>
<td>Prerequisites: CE F326, GE F326; ES F341.</td>
<td>2 + 3 + 0</td>
</tr>
</tbody>
</table>
CE F422  Foundation Engineering  
3 Credits  
Offered Fall  
Reviews slope stability analysis. Introduces bearing capacity of soils and effects of settlements on structure; discusses design of footings and rafts, pile and pier foundations, retaining walls and anchored bulkheads, foundations on frozen soils, and construction problems in foundation engineering. 
Prerequisites: CE F326; ES F301. 
Lecture + Lab + Other: 3 + 0 + 0

CE F424  Permafrost Engineering  
3 Credits  
Offered Fall  
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, thermal analysis methods of soil freezing and thawing, foundations design alternatives, pipelines, roads and airfields in permafrost regions. 
Prerequisites: CE F326. 
Recommended: CE F422; GE F384. 
Stacked with CE F624. 
Lecture + Lab + Other: 3 + 0 + 0

CE F432  Steel Design  
3 Credits  
Offered Fall  
Introduces structural design philosophies and current practices related to steel design. Utilizes the AISC Specification to discuss the design of basic structural elements in steel including tension members, fasteners, welds, column buckling, beam behavior, beam-columns, and composite floor systems. 
Prerequisites: CE F331; ES F331. 
Lecture + Lab + Other: 2 + 3 + 0

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, one-way slabs, and axial members. Crack control, anchorage, development lengths and deflections are 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 F438  Design of Engineered Systems  
(O, W)  
3 Credits  
Offered Spring  
Capstone design experience where students demonstrate understanding of system design principles using service learning projects with civil and environmental engineering focus. Practical applications of fundamental engineering concepts such as codes and standards, ethics and safety, and liability and legal principles. Emphasis on teamwork, leadership and oral communication with diverse audiences. 
Prerequisites: Civil engineering major with senior standing; COJO F131X or COJO F141X; WRTG F111X; WRTG F211X; WRTG F212X; WRTG F213X or WRTG F214X; A minimum of two upper-division CE design courses, such as CE F405, CE F408, CE F422, CE F432, CE F433, CE F434, CE F442 or CE F445. 
Lecture + Lab + Other: 3 + 0 + 0

CE F442  Water and Wastewater Treatment Design  
3 Credits  
Offered Fall  
Presents design methods for pollution control and remediation in water systems. Applies theories and engineering principles for the design of physical, chemical, and biological processes for the treatment of water and wastewater. 
Prerequisites: CE F341, CHEM F106X or graduate standing. 
Lecture + Lab + Other: 3 + 0 + 0

CE F443  Air Pollution Management  
3 Credits  
Offered Spring  
Major principles and problems associated with air quality, stationary and moving sources, air pollution effects; major air pollution legislation and compliance calculations; meteorology and modeling of pollutant concentrations near a source; greenhouse gas emissions and climate change; control equipment and design of control strategies for specific air pollution problems. 
Prerequisites: CHEM F106X; 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 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.
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 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 Permafrost Engineering
3 Credits
Offered Fall
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, thermal analysis methods of soil freezing and thawing, foundations design alternatives, pipelines, roads and airfields in permafrost regions.
Prerequisites: Training or experience in soil mechanics.
Stacked with CE F424.

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, nonsymmetrical 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 theories of elastic and inelastic buckling are studied with practical implementation to slender structural members. Both lateral and local buckling concepts will be examined. Lateral torsional buckling of beams; buckling of beam-columns and frame members; and buckling of members with various cross-section shapes are extensively discussed.
Prerequisites: CE F331; CE F432; MATH F302.
Lecture + Lab + Other: 3 + 0 + 0

CE F634  Structural Dynamics
3 Credits
Offered As Demand Warrants
The theories of structural dynamics are studied with an emphasis on analysis and design of civil engineering structures under various dynamic loading. Topics include single and multiple degree-of-freedom systems subjected to free vibration, harmonic excitations and earthquakes. The basic concepts related to seismic design of structures will be discussed.
Prerequisites: ES F208, 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, elastoplastic 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 are provided. Topics include earthquake engineering; current seismic design criteria and practice; structural analysis for seismic load; design of lateral force resisting systems such as moment frames, braced frames and shear walls; design of diaphragms; and design of non-structural components.
Prerequisites: ES F208, 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
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<tr>
<td>CE F662</td>
<td>Open Channel and River Engineering</td>
<td>3</td>
<td>Spring Even-numbered Years</td>
<td>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.</td>
<td>3 + 0 + 0</td>
</tr>
<tr>
<td>CE F663</td>
<td>Groundwater Hydrology</td>
<td>3</td>
<td>Fall Even-numbered Years</td>
<td>Fundamentals of groundwater aquifer formations, groundwater flow, resource development, management and protection.</td>
<td>3 + 0 + 0</td>
</tr>
<tr>
<td>CE F665</td>
<td>Introduction to Watershed Hydrology</td>
<td>3</td>
<td>As Demand Warrants</td>
<td>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.</td>
<td>3 + 0 + 0</td>
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<tr>
<td>CE F682</td>
<td>Ice Engineering</td>
<td>3</td>
<td>As Demand Warrants</td>
<td>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.</td>
<td>3 + 0 + 0</td>
</tr>
<tr>
<td>CE F684</td>
<td>Arctic Utility Distribution</td>
<td>3</td>
<td>As Demand Warrants</td>
<td>Practices and considerations of utility distribution in Arctic regions. Emphasis on proper design to include freeze protection, materials, energy conservation and system selection.</td>
<td>3 + 0 + 0</td>
</tr>
<tr>
<td>CE F685</td>
<td>Topics in Frozen Ground Engineering</td>
<td>3</td>
<td>As Demand Warrants</td>
<td>Selected frozen ground foundation engineering problems will be explored in depth including refrigerated foundations and pile foundations.</td>
<td>3 + 0 + 0</td>
</tr>
<tr>
<td>CE F686</td>
<td>Arctic Hydrology and Hydraulic Engineering</td>
<td>3</td>
<td>As Demand Warrants</td>
<td>Aspects of hydrology and hydraulics unique to engineering problems of the north. Although the emphasis will be on Alaskan conditions, information from Canada and other circumpolar countries will be included in the course.</td>
<td>3 + 0 + 0</td>
</tr>
</tbody>
</table>