CE F112  Elementary Surveying  3 Credits  Offered Fall
Basic plane surveying: use of transit, level, theodolite and total station. Traverses, public land system, circular curves, cross-sectioning and earthwork.
Prerequisites: MATH F152X.
Lecture + Lab + Other: 2 + 3 + 0
Grading System: Letter Grades with option of Plus/Minus

CE F302  Fundamentals of Transportation Engineering  3 Credits  Offered Spring
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.
Prerequisites: CE F112 or MIN F202; sophomore standing.
Lecture + Lab + Other: 3 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus

CE F326  Introduction to Geotechnical Engineering and Foundations  4 Credits  Offered Fall
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.
Prerequisites: ES F331 (may be taken concurrently); GE F261.
Crosslisted with GE F326.
Lecture + Lab + Other: 3 + 3 + 0
Grading System: Letter Grades with option of Plus/Minus

CE F331  Structural Analysis  3 Credits  Offered Spring
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 an introduction to matrix methods.
Prerequisites: ES F208; ES F331.
Lecture + Lab + Other: 2 + 0 + 3
Grading System: Letter Grades with option of Plus/Minus

CE F332  Design of Highways and Streets  3 Credits  Offered Fall Even-numbered Years
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.
Prerequisite: CE F302.
Lecture + Lab + Other: 3 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus
CE F408  Transportation Safety Analysis
3 Credits
Offered Fall Odd-numbered Years
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.
Prerequisites: CE F302.
Lecture + Lab + Other: 3 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus

CE F412  Elements Photogrammetry
3 Credits
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Lecture + Lab + Other: 0 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus

CE F420  Groundwater Engineering
3 Credits
Offered Fall
Fundamentals of groundwater occurrence, hydrology, resource development, water quality, monitoring and remediation. Field methods and modeling.
Prerequisites: CE F326, GE F326; ES F341.
Crosslisted with GE F420.
Lecture + Lab + Other: 2 + 3 + 0
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

CE F424  Permafrost Engineering
3 Credits
Offered Spring
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.
Stacked with CE F624.
Lecture + Lab + Other: 3 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

CE F434  Timber Design
3 Credits
Offered Fall
Prerequisites: CE F331; ES F331.
Lecture + Lab + Other: 3 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus

CE F438  Design of Engineered Systems
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; COM F131X or COM 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
Grading System: Letter Grades with option of Plus/Minus

CE F442  Water and Wastewater Treatment Design
3 Credits
Offered Spring
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
Grading System: Letter Grades with option of Plus/Minus
CE F443 Air Pollution Management
3 Credits
Offered Spring Odd-numbered Years
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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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 caissons.
Prerequisites: CE F422.
Lecture + Lab + Other: 3 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus

CE F424 Permafrost Engineering
3 Credits
Offered Spring
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.
Lecture + Lab + Other: 3 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus
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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

CE F640  Prestressed Concrete
3 Credits
Offered As Demand Warrants
Prerequisites: CE F331; CE F433.
Recommended: Graduate standing.
Lecture + Lab + Other: 3 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus
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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

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
Grading System: Letter Grades with option of Plus/Minus

CE F663  Groundwater Hydrology
3 Credits
Offered Fall Even-numbered Years
Fundamentals of groundwater aquifer formations, groundwater flow, resource development, management and protection.
Cross-listed with GE F663.
Lecture + Lab + Other: 3 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus

CE F664  Sediment Transport
3 Credits
Offered Spring Even-numbered Years
Prerequisites: Graduate standing.
Lecture + Lab + Other: 3 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus

CE F665  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
Grading System: Letter Grades with option of Plus/Minus

CE F666  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
Grading System: Letter Grades with option of Plus/Minus

CE F667  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
Grading System: Letter Grades with option of Plus/Minus

CE F668  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
Grading System: Letter Grades with option of Plus/Minus

CE F669  Seminar
1-3 Credits
Lecture + Lab + Other: 0 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus
Repeatable for Credit: May be taken unlimited times for up to 99 credits

CE F670  Non-thesis Research/Project
1-6 Credits
Lecture + Lab + Other: 0 + 0 + 0
Grading System: Letter Grades with option of Plus/Minus
Repeatable for Credit: May be taken unlimited times for up to 99 credits
CE F699 Thesis
1-15 Credits
Lecture + Lab + Other: 0 + 0 + 0
Grading System: Pass/Fail Grades
Repeatable for Credit: May be taken unlimited times for up to 99 credits