Civil Engineering

M.Eng. in Civil Engineering (https://catalog.und.edu/graduateacademicinformation/departmentalcoursesprograms/engineering/civilengineering/ce-meng/)

M.S. in Civil Engineering (https://catalog.und.edu/graduateacademicinformation/departmentalcoursesprograms/engineering/civilengineering/ce-ms/)

Ph.D. in Civil Engineering (https://catalog.und.edu/graduateacademicinformation/departmentalcoursesprograms/engineering/civilengineering/ce-phd/)

CE 501. Mechanics of Materials II. 3 Credits.
Theories of stress and strain in two and three dimensions; transformation of stresses and strains in two and three dimensions; tensor notation; linear and nonlinear stress strain behavior; thermal stresses; isotropic, orthotropic, and anisotropic material behavior; yield criteria and theories of failures under combined stresses; energy methods; torsion of noncircular and thin walled sections; unsymmetrical bending; shear center; curved beams. Prerequisite: ENGR 203. On demand.

CE 502. Structural Stability. 3 Credits.
Concept of stability; equilibrium and energy methods; stability of columns, beam columns, and frames; inelastic buckling; stability by slope deflection and matrix methods; use of codes for the stability design of aluminum and steel columns and frames; torsional and lateral torsional buckling of beams and beam columns. Prerequisite: Background/knowledge of mechanics of materials; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. On demand.

CE 503. Structural Dynamics. 3 Credits.
Single-degree and multi-degree of freedom systems; continuous systems; free and forced vibrations; harmonic and periodic excitations; viscous and non-viscous damping; pulse excitations; numerical methods for dynamic response; earthquake response of linear elastic buildings; structural dynamics in building codes. Prerequisite: Background/knowledge of mechanics of materials and dynamics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. On demand.

CE 514. Foundation Engineering. 3 Credits.
Soil improvements and ground modifications, soil exploration and sampling, bearing capacity, spread footings, mat foundations, settlement analysis, drilled shaft and pile foundations, foundations on difficult soil. Prerequisite: Background/knowledge of soil mechanics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 517. Transportation Asset Management. 3 Credits.
Course focused on the principles of transportation asset management with an emphasis on pavement management system (PMS). Network- and project-level pavement management processes will be discussed, but the emphasis will be on network-level. Bridge management system will also be covered. Prerequisite: Background/knowledge of mechanics of materials and statistics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F, even years.

CE 518. Pavement Engineering. 3 Credits.
Structural pavement design concepts for flexible and rigid pavements; traffic and environmental loading factors; material characterization; hot mix asphalt design and analysis concepts, SuperPave mix design method, stresses and strains in flexible and rigid pavements, joints and load transfer of rigid pavements, fast track concrete, and construction issues. Prerequisite: Background/knowledge of soil mechanics; additional information is available in the CE Graduate Student Handbook on the CE Department website and graduate student blackboard site; consent of instructor for undergraduate students. F.

CE 519. Sustainable Pavements. 3 Credits.
Sustainability concepts; overview of mix design, structural design, and construction methods of pavements; warm mix asphalts; recycling of asphalt and concrete pavements, perpetual pavement concepts, specialty pavements, environmental, economic, and social impacts of highway pavements. Prerequisite: Background/knowledge of soil mechanics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 521. Hydrology. 3 Credits.
Course topics include measurement, interpretation, analysis and application of hydrologic data; precipitation, evaporation and transpiration; runoff hydrographs; routing methods; groundwater; and snow hydrology. Computer applications. Prerequisite: Background/knowledge of fluid mechanics and hydraulic engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F.

CE 523. Hydraulic Engineering. 3 Credits.
Fluid statics and dynamics; open channel flow; transitions and controls; hydraulic structures; hydraulic machinery; hydraulic power conversion; and hydraulic modeling. Prerequisite: Background/knowledge of fluid mechanics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 524. Open Channel Hydraulics. 3 Credits.
Study of advanced topics in open channel hydraulics. Computer applications. Prerequisite: Background/knowledge of hydraulic engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F.

CE 525. Surface Hydrology. 3 Credits.
Extreme rainfalls and flood frequency analysis, regionalization; runoff generations, routings, and basin modeling; urban storm water design; GIS and remote sensing applications in hydrology; recent techniques and development in surface hydrology. Prerequisite: Background/knowledge of hydrology; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 526. Applied Hydraulics. 3 Credits.
Study of advanced topics on the hydraulics and design of water systems including water supply, water storage, drainage, and flow controls. Prerequisite: Background/knowledge of hydraulic engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. On demand.

CE 531. Environmental Engineering I. 3 Credits.
Environmental quality, water quality modeling, water wastewater treatment systems, sludge processing, solid wastes, hazardous wastes, environmental law. Prerequisite: Background/knowledge of fluid mechanics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 532. Environmental Engineering II. 3 Credits.
Water distribution networks, mass curve analysis, wastewater collection systems, pumping systems for water and wastewater, system design project, computer-assisted design, confined spaces. Prerequisite: Background/knowledge of fluid mechanics; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F.

CE 533. Industrial Wastes. 3 Credits.
Industrial processes and waste characterization, regulatory law, specialized treatment systems, hazardous wastes, economic analysis; plant tours of potato, sugar, meat, dairy, paper and pulp products and metal plating industries. Prerequisite: CE 431.

CE 535. Hazardous Waste Management. 3 Credits.
Regulations, generation, storage, transportation, disposal, classification, fate and transport of contaminants, environmental audits, pollution prevention and management facilities, remediation alternatives, physical-chemical treatment, bioremediation, stabilization/solidification, thermal processes. Prerequisite: CE 306 and CHEM 121.

CE 536. Environmental Engineering III. 3 Credits.
Water chemistry in unit Operation and process design for water and wastewater treatment; physical, chemical, and biological systems; plant design project, computer-assigned design analysis. Prerequisite: Background/knowledge of introductory environmental engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F.

CE 537. Environmental Engineering IV. 3 Credits.
Advanced theory and special methods in municipal and industrial water and wastewater processes including treatment plant control, equipment studies, nutrient removal, contaminant fate and transport, and toxic pollutants control. Prerequisite: Background/knowledge of introductory environmental engineering; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 551. Plate and Slab Structures. 3 Credits.
Classical plate bending theory, rectangular and circular plates, slab analysis by energy and numerical methods, anisotropic plates, large deflection theory, buckling of thin plates. Prerequisite: ENGR 203 and CE 351.

CE 552. Thin Shell Structures. 3 Credits.
Differential geometry of shell theory, membrane and bending theories of shells, shells of revolution, stress analysis of domes, pressure vessels, and storage tanks, numerical methods, buckling of shells. Prerequisite: ENGR 203 and CE 351.

CE 555. Prestressed Concrete-Analysis and Design. 3 Credits.
Materials and systems of pre-stressing; pre-stress losses; pre-tensioned and post-tensioned members; design of pre-stressed concrete beams by service load and ultimate strength methods; flexural design of composite beams and slabs; anchorage zone stresses and reinforcement; shear and torsion. Prerequisite: Background/knowledge of reinforced concrete; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. On demand.

CE 556. Numerical and Matrix Methods of Structural Analysis. 3 Credits.
Methods of successive approximations and numerical procedures for solution of complex structural problems, matrix formulation of structural problems, flexibility and stiffness methods of analysis. Prerequisite: CE 351.

CE 557. Advanced Steel Design. 3 Credits.
Design and analysis of simple structural connections including both moment and shear connections; design and analysis of eccentric structural connections, plate girders, and composite structures; design and analysis for seismic loads; ASD and LRFD design. Prerequisite: Background/knowledge of steel design; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. F.

CE 558. Theory of Plasticity. 3 Credits.
Rigorous study of classical theory of plasticity. Classical continuum mechanics concepts of stress and strain and elastic behavior discussed. Progressing into plastic behavior in materials, mathematical formulation of elasto-plastic constitutive relationship, practical engineering limit analysis, and application of plasticity theories in analysis using computer programs. Prerequisite: Background/knowledge of steel design; additional information is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. S.

CE 559. Plate and Slab Structures. 3 Credits.
Classical plate bending theory, rectangular and circular plates, slab analysis by energy and numerical methods, anisotropic plates, large deflection theory, buckling of thin plates. Prerequisite: ENGR 203 and CE 351. S, odd years.

CE 562. Graduate Seminar in Civil Engineering. 1 Credit.
Conference and reports on current developments in Civil Engineering. Prerequisite: Admission to Civil Engineering Graduate Program. Repeatable to 3.00 credits. S/U grading. F,S,SS.

CE 590. Special Topics. 1-6 Credits.
Investigation of special topics dictated by student and faculty interests. May be repeated up to a total of 6 credits. Prerequisite: Department approval. Repeatable to 6.00 credits.

CE 591. Civil Engineering Research. 1-12 Credits.
May be repeated to a maximum of 12 credits. Repeatable to 12.00 credits.

CE 595. Design Project. 3-6 Credits.
A three to six credit course of engineering design experience involving individual effort and formal written report. Repeatable to 6 credits. Prerequisite: Restricted to the Master of Engineering student candidate and subject to approval by the student's advisor. Repeatable to 6.00 credits.

CE 597. Graduate Cooperative Education. 1-2 Credits.
A practical work experience with an employer closely associated with the student's academic area. Arranged by mutual agreement among student, department, and employer. Prerequisite: Approval of CE Graduate Director or major advisor. Repeatable to 4.00 credits. S/U grading. On demand.

CE 599. Doctoral Research. 1-15 Credits.
Research contributing to the discovery and dissemination of knowledge and/or technology in Civil Engineering and contributing to the student's doctoral dissertation. Prerequisite: Admission to the PhD in Civil Engineering Program. Repeatable. F,S,SS.

CE 996. Continuing Enrollment. 1-12 Credits.
Repeatable. S/U grading.

CE 997. Independent Study. 2 Credits.
.

CE 998. Thesis. 1-9 Credits.
Development and documentation of scholarly activity demonstrating proficiency in Civil Engineering at the master's level. Repeatable to 9 credits. Repeatable to 9.00 credits.

CE 999. Dissertation. 1-18 Credits.
PhD student doctoral dissertation. Prerequisite: Admission to the PhD in Civil Engineering Program. Repeatable to 18.00 credits. S/U grading. F,S,SS.