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/)

Graduate Certificate in Water Resources Engineering (https://catalog.und.edu/graduateacademicinformation/departmentalcoursesprograms/engineering/civilengineering/ce-wre/)

CE 501. Mechanics of Materials II. 3 Credits.
This course covers stress and strain theories in two and three dimensions, including transforming stresses and strains. Topics include tensor notation, linear and nonlinear stress-strain behavior, thermal stresses, and material behavior in isotropic, orthotropic, and anisotropic materials. The course also addresses yield criteria and failure theories under combined stresses, energy methods, torsion of noncircular and thin-walled sections, unsymmetrical bending, the shear center, and curved beams. CE 501 cannot be taken after completing CE 401. 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. S, odd years.

CE 502. Structural Stability. 3 Credits.
This course covers the concept of stability and the application of equilibrium and energy methods in structural analysis. Topics include the stability of columns, beam-columns, frames, and inelastic buckling. It also explores stability analysis using slope-deflection and matrix methods and the use of codes for the stability design of aluminum and steel columns and frames. Additional topics include torsional and lateral-torsional buckling of beams and beam-columns. CE 502 cannot be taken after completing CE 402. 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.
Introduction to vibration and dynamics, single degree freedom free vibration, single degree freedom forced vibration, harmonic and periodic excitations; pulse, introduction to viscous and non-viscous damping system, dynamic system identification, numerical methods to determine dynamic response; determination of earthquake response of linear elastic buildings; dynamics of generalized single degree of freedom systems, dynamics of shear buildings, dynamics of multi-degree of freedom systems, modal superposition, modal spectral analysis, structural dynamics in US building code. CE 503 cannot be taken after completing CE 403. Prerequisite: Background/knowledge of computer applications in engineering, structural mechanics and dynamics; additional info is available in the CE Graduate Student Handbook on the CE Department website and the CE graduate student blackboard site. On demand.

CE 509. Traffic Engineering: Operations. 3 Credits.
The course is designed to provide information on basic characteristics of traffic, including drivers, vehicles, volumes, speeds, delay, origins and destinations, traffic control devices, intersection performance, capacity, techniques for making traffic engineering investigations, techniques of conducting traffic studies, traffic laws and ordinances, regulations, design and application of signal systems, curb parking control, and CAV technologies impact on road capacities and mobility. CE 509 cannot be taken after completing CE 409. Prerequisite: Background/knowledge of transportation 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 513. Traffic Safety. 3 Credits.
This course introduces students to fundamental concepts in traffic safety analysis, equipping them with the skills to assess and improve safety in transportation systems. Students will write a research paper on a topic related to traffic safety and develop the ability to analyze crash data using different methodologies. CE 513 cannot be taken after completing CE 413. Prerequisite: Background/knowledge of transportation 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 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 515. Asphalt Mix Design and Construction. 3 Credits.
This course focuses on the characterization of asphalt materials and mixtures, hot mix asphalt design, analysis, construction concepts, and the Superpave mix design method. It will also discuss balanced mix design, pavement distress mechanisms and performance testing, and recent developments in asphalt technology. CE 515 cannot be taken after completing CE 415. Prerequisite: Background/knowledge of soil mechanics and transportation 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 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.
To introduce students to structural pavement design concepts for flexible and rigid pavements, traffic and environmental loading factors, material characterization, stresses and strains in flexible and rigid pavements, joints and load transfer of rigid pavements, and construction issues. CE 518 cannot be taken after completing CE 418. 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.
To introduce students to pavement sustainability concepts, an overview of mix design, structural design, and construction methods of pavements promoting sustainability concepts, including warm mix asphalts, recycling of asphalt and concrete pavements, perpetual pavements, and specialty pavements. Assessing the environmental, economic, and social impacts of highway pavements by implementing sustainability concepts will also be introduced. In addition to the instructor's lectures, students are required to participate in the presentation and discussion of assigned course material. CE 519 cannot be taken after completing CE 419. 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. CE 524 cannot be taken after completing CE 424. 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. CE 525 cannot be taken after completing CE 425. 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. CE 526 cannot be taken after completing CE 426. 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. Principles of Water and Wastewater Treatment. 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 Design. 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 Chemistry. 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. Unit Operations in Water and Wastewater Treatment. 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.
Prestressing motivation and history, prestressed concrete and high strength steel properties, pre-tensioned and post-tensioned members, allowable stress analysis and design of prestressed members in flexure, flexural ultimate design of composite and non-composite beams, pre-stress losses, determination of deflection in prestress beams, shear design of prestressed beams, end zone reinforcement. CE 555 cannot be taken after completing CE 455. 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.
This course covers the design and analysis of simple structural connections, including moment and shear connections, eccentric structural connections, plate girders, and composite structures. It also includes the design and analysis of seismic loads, emphasizing both Allowable Stress Design (ASD) and Load Resistance Factor Design (LRFD). CE 557 cannot be taken after completing CE 457. 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 558. Theory of Plasticity. 3 Credits.
This course rigorously explores classical plasticity theory, encompassing key concepts in continuum mechanics such as stress, strain, and elastic behavior. It progresses to studying plastic behavior in materials, the mathematical formulation of elastoplastic constitutive models, and practical engineering applications, including limit analysis. Students will also apply plasticity theories in computational analysis using specialized software. CE 558 cannot be taken after completing CE 458. 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 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. 1-15 Credits.
Investigation of special topics dictated by student and faculty interests. May be repeated up to a total of 15 credits. Prerequisite: Department approval. Repeatable to 6.00 credits. F,S,SS.

CE 591. Civil Engineering Research. 1-15 Credits.
May be repeated to a maximum of 15 credits. Repeatable to 12.00 credits. F,S,SS.

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. 1-18 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.
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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.