CIVIL AND ENVIRONMENTAL ENGINEERING

Undergraduate Program Information

Mission Statement

The mission of the Civil Engineering Department for the undergraduate program is to offer a high-quality accredited Bachelor of Science (B.S.) degree that prepares our graduates for professional licensure leading to successful civil engineering careers in the industry and government, and for success in graduate education. Toward this end, the Civil Engineering Department will recruit and retain qualified and diverse faculty that are committed to student learning and development, and serve as role models to the undergraduate students.

Continued excellence in our undergraduate program is paramount to our mission by providing a strong technical foundation to our graduates for engineering design and problem solving; preparing quality graduates for licensure and professional careers in civil engineering; implementing modern and effective learning methods; maintaining close student-faculty learning interactions; and instilling life-long learning skills and goals for professional growth after graduation.

Program Educational Objectives

Within a few years after graduation, graduates of the Civil Engineering undergraduate program will:

1. Be successfully employed in civil engineering or related careers.
2. Be pursuing professional licensure, appropriate certifications, graduate degrees, and/or professional development activities by fostering life-long learning skills and strategies.
3. Be building on fundamental knowledge and applying technical skills across disciplines in civil engineering and related fields to make data-driven decisions using engineering judgement.
4. Be progressing as independent thinkers, ethical leaders, effective communicators, and collaborative professionals.

Program Criteria

The Civil Engineering curriculum is developed based on the program criteria established collaboratively by the Engineering Accreditation Commission (EAC) of ABET Inc. and the American Society of Civil Engineers (ASCE). The curriculum specifically prepares civil engineering students at the baccalaureate level to graduate with the ability to:

1. Apply:
   a. mathematics through differential equations, probability and statistics, calculus-based physics, chemistry, and either computer science, data science, or an additional area of basic science.
   b. engineering mechanics, materials science, and numerical methods relevant to civil engineering.
   c. principals of sustainability, risk, resilience, diversity, equity, and inclusion to civil engineering problems.
   d. the engineering design process in at least two civil engineering contexts.
   e. an engineering code of ethics to ethical dilemmas.
2. Solve complex engineering problems in at least four specialty areas appropriate to civil engineering.
3. Conduct experiments in at least two civil engineering contexts, as well as analyze and interpret the collected data and report the results.
4. Explain:
   a. concepts and principles in project management and engineering economics.
   b. professional attitudes and responsibilities of a civil engineer, including licensure and safety.

In accordance with the program criteria of ABET and ASCE, the Civil Engineering faculty responsible for teaching design-oriented courses are qualified in their respective professional areas by means of professional licensure, or a combination of education and design experience. Furthermore, the faculty are given responsibility and sufficient authority to define, revise, implement, and achieve program objectives.

Graduate Program Information

Mission Statement

The mission of the Civil Engineering Department regarding graduate education is to provide research-based and practice-oriented post-baccalaureate programs leading to Master of Science (M. S.), Master of Engineering (M. E.), and PhD degrees for students in the areas of environmental, geotechnical, structural, transportation, and water resources engineering. Toward this end, the Civil Engineering Department will recruit and retain qualified and diverse faculty that are committed to student learning and development, scholastic and research excellence, and professional service.

Continued excellence in our graduate program is paramount to our mission by providing advanced academic and technical foundations to our graduates; providing interdisciplinary and collaborative research opportunities and teaching experiences; implementing learning methods that promote critical-thinking and problem-solving; seeking external funding to support innovative research and graduate assistantships; and fostering an intellectual and creative environment that values diversity (of people, research and interests) and research ethics.

The Civil Engineering Department offers excellent opportunities for advanced study and professional training in several fields leading to the M.E. in Civil Engineering, M.S. in Civil Engineering, M.S. in Environmental Engineering, and Ph.D. degrees. Students work closely with the faculty on contemporary issues including, but not limited to, applications of machine / deep learning, bio-geotechnologies, evapotranspiration monitoring of crops and riparian vegetation, ground stabilization, groundwater recharge, high performance materials, non-destructive testing and evaluation, remote sensing, renewable energy, resilient infrastructure, reservoir evaporation monitoring, riparian rehabilitation, structural health monitoring, sustainable construction, and water treatment and reuse.

The department has excellent facilities for teaching and research purposes including laboratories for mechanical, chemical and biological research. In addition, the department conducts research at various field sites located throughout New Mexico in collaboration with local, state, and federal agencies. Noteworthy features of the graduate programs are the energetic, highly motivated faculty and the low student-faculty ratio. The department regularly has several ongoing research projects of various size and scope employing graduate and undergraduate students. Teaching and research assistantships are available to qualified students and office space is normally provided to M.S. thesis and PhD students.

Students enrolling for graduate studies in civil engineering must have received a bachelor's degree in engineering or one of the allied fields.

A candidate for the M.S. in Civil Engineering or M.S. in Environmental Engineering degree may choose either a thesis or a non-thesis track. The M.E. in Civil Engineering degree requires only coursework. When a student enrolls for the Ph.D. program, a doctoral committee is formed to assist the student in planning a program appropriate to the student's background and goals and to administer the required examinations. All Ph.D. candidates in civil engineering must have a demonstrated proficiency in English and two research tools. Mutual understanding between the Ph.D. candidate and his or her doctoral committee on the final nature of these two research tools will be on an individual basis.

Master's Accelerated Program

The Master's Accelerated Program (MAP) option provides students the opportunity to complete a B.S. in Civil Engineering and a master's degree (M.E. in Civil Engineering, M.S. in Civil Engineering or M.S. in Environmental Engineering) with 144 to 150 credit hours; the non-accelerated path requires 156 credit hours (B.S. requires 126 credit hours plus the M.E. or M.S. which require 30 credit hours each). Students accepted into this program will follow the normal path of the Civil Engineering undergraduate curriculum, of which up to 12 credit hours comprised of senior-level (> 450) and/or graduate-level (> 500) courses will be counted towards the master's degree; the MAP courses must be approved by the department head and completed with a grade of B or better. When students receive their bachelor's degree in Civil Engineering, there are 18 to 24 credit hours left for the master's degree which can be completed in 2 to 3 semesters for full-time students. Students must apply for admission during the final semester of their junior year and obtain prior approval by the department head to pursue the MAP option.

Degrees for the Department

Bachelor Degree(s)

- Civil Engineering - Bachelor of Science in Civil Engineering (https://catalogs.nmsu.edu/nmsu/engineering/civil-environmental-engineering/civil-engineering-bachelor-science-civil-engineering/)

Master Degree(s)

- Civil Engineering - Master of Engineering (https://catalogs.nmsu.edu/nmsu/graduate-school/civil-engineering-master-engineering/)
- Civil Engineering - Master of Science in Civil Engineering (https://catalogs.nmsu.edu/nmsu/graduate-school/civil-engineering-master-science-civil-engineering/)
- Environmental Engineering - Master of Science in Environmental Engineering (https://catalogs.nmsu.edu/nmsu/graduate-school/environmental-engineering-master-science-environmental-engineering/)

Doctoral Degree(s)

- Engineering (Civil Engineering) - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/engineering-civil-engineering-doctor-philosophy/)

Minors for the Department

- Agricultural Engineering - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/engineering/civil-environmental-engineering/agricultural-engineering-undergraduate-minor/)
- Environmental Engineering - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/engineering/civil-environmental-engineering/environmental-engineering-undergraduate-minor/)
- Geotechnical Engineering - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/engineering/civil-environmental-engineering/geotechnical-engineering-undergraduate-minor/)
- Structural Engineering - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/engineering/civil-environmental-engineering/structural-engineering-undergraduate-minor/)
- Water Resource Engineering - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/engineering/civil-environmental-engineering/water-resource-engineering-undergraduate-minor/)

Department Faculty Members

Professors Bandini[1], Jáuregui[1] (Interim Dean of Engineering), Khandan[1] (Emeritus) Newtson (Department Head), Papelis (Director of Carlsbad Environmental Monitoring & Research Center), Reddi[1] (Interim Provost), Samani[1] (Emeritus), White[1] (Emeritus), Xu; **Associate Professors** Bawazir (Assoc. Department Head), Cho[1], Cortes, Wang, Y. Zhang[2] ; **Assistant Professors** Choe[1], Ingol Blanco, Li, Wan[1], Q. Zhang; **Professors of Practice** Al Aqtash, Mousavinezhad

U. Al Aqtash, Ph.D. (New Mexico State) – geotechnical engineering; P. Bandini, Ph.D. (Purdue) – geotechnical engineering; A. S. Bawazir, Ph.D. (New Mexico State) – agricultural/water resources engineering; H. Cho, Ph.D. (Texas A&M) – water resources engineering; D. Choe, Ph.D. (Texas A&M) – structural engineering; D. Cortes, Ph.D. (Georgia Tech) – geotechnical engineering; E. Ingol Blanco, Ph.D. (Texas-Austin) – water resources engineering; D. V. Jáuregui, Ph.D. (Texas-Austin) – structural engineering; N. N. Khandan, Ph.D. (Drexel) – environmental engineering; R. Li, Ph.D. (Florida State) – environmental engineering; S. Mousavinezhad, Ph.D. (New Mexico State) - structural engineering; C. Newtson, Ph.D. (Washington) – structural engineering; L. Papelis, Ph.D. (Stanford) – environmental engineering; L. N. Reddi, Ph.D. (Ohio State) – geotechnical engineering; Z. Samani, Ph.D. (Utah State) - water resources engineering; Z. Wan, Ph.D. (Pittsburgh) – structural engineering; H. Wang, Ph.D. (Lanzhou-China) – environmental/materials engineering; K. R. White, Ph.D. (Texas Tech) – structural engineering; P. Xu, Ph.D. (ENGREF, Paris, France) – environmental engineering; Q. Zhang, Ph.D. (Pittsburgh) – structural engineering; Y. Zhang, Ph.D. (Missouri-Columbia) – environmental engineering.

- [1]Professional Engineer (PE) in United States
  [2]Professional Engineer (PEng) in Canada

Agricultural Engineering Courses

A EN 459. Groundwater, Wells & Pumps
3 Credits (3)
Occurrence and movement of groundwater; design of water wells; selection and specification of pumps and power units. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 382 or consent of instructor.
Learning Outcomes

1. Understand the occurrence and movement of groundwater in aquifers, and extraction of it.
2. Ability to interpret pump specifications and data.
3. Select and detail power units for pumping systems.

A EN 478. Irrigation and Drainage Engineering
3 Credits (2+3P)
Design and operation of surface and sprinkler irrigation systems; pumping and conveyances; introduction to principles and practices of drainage systems and wells. May be repeated up to 3 credits.

Prerequisite: C- or better grade in C E 382 or consent of instructor.
Learning Outcomes
1. Students will be able analyze and design irrigation systems.

A EN 498. Special Topics
1-3 Credits
Special topics in agricultural engineering. May be repeated up to 3 credits.
Prerequisite: consent of instructor.
Learning Outcomes
1. Students will develop knowledge related to the specific agricultural engineering special topic selected for study.

Civil Engineering Courses

C E 109. Computer Drafting Fundamentals
3 Credits (2+2P)
Introduction to principles and fundamentals of drafting using both manual drawing techniques and computer-aided drafting (CAD) applications. Crosslisted with: DRFT 109 and E T 109. May be repeated up to 3 credits.
Learning Outcomes
1. Describe related career options/pathways.
2. Explain and apply common drafting terms, concepts, and conventions.
3. Utilize various AutoCAD commands and Coordinate Entry methods to produce accurate and precise Two-Dimensional drawings.
4. Setup AutoCAD working environment, drawings, styles, and applicable settings.
5. Navigate the AutoCAD user interface efficiently.
6. Apply different drafting methods, strategies, and processes.
7. Utilize AutoCAD to produce basic 2D CAD working drawings.
8. Measure utilizing scales accurately.
9. Create drawings with different scales and units. 1
10. Plot drawings produced in AutoCAD at various scales and on various sheet sizes. 1
11. Utilize the two Drawing Environments: Paper Space and Model Space. 1
12. Manage AutoCAD drawing files.

C E 151. Introduction to Civil Engineering
3 Credits (3)
Problem solving and use of computer software for civil engineering applications. May be repeated up to 3 credits.
Prerequisite/Corequisite: MATH 1220G.
Learning Outcomes
1. Understand the Civil Engineering profession and curriculum.
2. Develop software skills for use in Civil Engineering education and professional practice.
3. Understand and apply the basics of professional and academic ethics.

C E 198. Special Topics
1-3 Credits
Special topics in civil engineering. May be repeated up to 6 credits.
Prerequisite: consent of department head.
Learning Outcomes
1. Students will develop knowledge related to the specific civil engineering special topic selected for study.

C E 233. Mechanics-Statics
3 Credits (3)
Engineering mechanics using vector methods. May be repeated up to 3 credits.
Prerequisite: C- or better grade in MATH 1521G or MATH 1521H, C- or better grade in PHYS 1310G and cumulative GPA of 2.0.
Learning Outcomes
1. Student will be able to apply concepts of equilibrium.

C E 234. Mechanics-Dynamics
3 Credits (3)
Kinematics and dynamic behavior of solid bodies utilizing vector methods. May be repeated up to 3 credits.
Prerequisite: A grade of C- or better grade in the following: C E 233 and PHYS 1310G and MATH 1521G or MATH 1521H.
Learning Outcomes
1. Student will be able to apply concepts of kinematics and accelerated motion.

C E 256. Environmental Engineering and Science
3 Credits (3)
Principles in environmental engineering and science: physical chemical systems and biological processes as applied to pollution control. Crosslisted with: ENVS 2111.
Prerequisite: (C- or better grade in CHEM 1215G) and (C- or better grade in MATH 1511G or ENGR 190).

C E 256 L. Environmental Science Laboratory
1 Credit (1P)
Laboratory experiments associated with the material presented in C E 256. May be repeated up to 1 credit. Same as ENVS 2111L.
Corequisite: C E 256.
Learning Outcomes
1. An understanding of experimental analyses related to environmental science

C E 298. Special Topics
1-3 Credits
Special topics in civil engineering. May be repeated up to 6 credits.
Prerequisite: consent of department head.
Learning Outcomes
1. Students will develop knowledge related to the specific civil engineering special topic selected for study.

C E 301. Mechanics of Materials
3 Credits (3)
Stress, strain, and elasticity of materials. May be repeated up to 3 credits.
Prerequisite: C- or better grade in ENGR 233.
Learning Outcomes
1. Calculate deformations, stresses, and strains of various types of members under loading.
2. Calculate principal stresses and strains.
3. Perform two-dimensional stress and strain transformation.
4. Analyze statically indeterminate structures using the method of consistent deformations.
5. Construct shear and moment diagrams for beam type structures.
6. Calculate beam deflections and rotations using various methods.
7. Determine buckling loads for elastic columns.

C E 311. Civil Engineering Materials
3 Credits (2+3P)

Introduction to the structure, physical properties, testing and mechanical behavior of civil engineering materials and components made from these materials. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 301.
Learning Outcomes
1. Students will understand the structure, properties, and roles of steel, aggregates, concrete, masonry, wood, and asphalt in civil engineering.

C E 315. Structural Analysis
4 Credits (3+3P)
Classical analysis of determinate and indeterminate structures; introduction to modern methods of structural analysis using computer programs. May be repeated up to 4 credits.
Prerequisite: C- or better grade in C E 301.
Learning Outcomes
1. Students will be able to compute internal resultants and deflections for trusses, beams, and frames.
2. Students will be able to analyze statically determinate and statically indeterminate structures.

C E 331. Fluid Mechanics and Hydraulics
3 Credits (3)
Fluid Mechanics and Hydraulics. Fundamentals and theory of fluid mechanics, compressible fluids, flow of incompressible fluids in open and closed conduits.
Prerequisite: C- or better grade in PHYS 1310G, C- or better grade in ENGR 233 or C E 233.
Learning Outcomes
1. Students learn how to read and interpret problem statements related to fluid mechanics and hydraulics, how to work in teams as well as apply critical thinking skills to solve problems.
2. Students develop an understanding of the theories and principles of hydraulics to understand hydraulic engineering components and subsystems.

C E 331 L. Fluid Mechanics and Hydraulics Laboratory
1 Credit (1P)
Fundamentals and Theory of Fluid Mechanic, compressible and incompressible flow of fluids in open and closed conduits.
Prerequisite/Corequisite: C E 331. Restricted to: C E majors.
Learning Outcomes
1. An understanding of fluid statics and dynamics as demonstrated by a series of hydraulic experiments.

C E 355V. Technology and the Global Environment
3 Credits (3)
A scientific basis for understanding changes in the global environment that result through the complex interactions of natural phenomena and the impacts of the activities of man. May be repeated up to 3 credits.
Prerequisite: junior or senior standing, and the general education requirements for math and natural sciences.
Learning Outcomes
1. An understanding of the natural and man-made factors that influence changes in the global environment.

C E 356. Fundamentals of Environmental Engineering
3 Credits (3)
Introduction to water treatment and water pollution and the analysis and design of selected treatment processes. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 256.
Learning Outcomes
1. Students will understand water treatment processes.
2. Students will understand wastewater treatment processes.

C E 357. Soil Mechanics
3 Credits (2+3P)
Engineering properties of soils, consolidation settlement, compaction, water flow through soils, geostatic stresses, soil shear strength, lateral earth pressure, and soil laboratory testing.
Prerequisite: GEOL 1110G and C E 301.
Learning Outcomes
1. The course covers the basic principles governing the mechanical behavior of soils.
2. Students will develop an understanding of soil mechanics, flow through porous media, and mass-volume relationships, as well as the laboratory methods for measuring the mechanical and index properties of soils.
3. Students will be able to interpret and use the laboratory test results for soil classification and for solving simple geotechnical engineering problems.

C E 382. Hydraulic and Hydrologic Engineering
3 Credits (3)
Analysis and design of hydraulic systems, including pipe networks, open channels, regulating structures, and pumping systems. Surface water and groundwater hydrology, analysis and design. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 331, C E 331 L.
Learning Outcomes
1. Student will be able to analyze hydraulic systems such as pipes, pumps, and open channels.

C E 398. Special Topics
1-3 Credits
Special topics in civil engineering. May be repeated up to 6 credits.
Prerequisite: consent of department head.
Learning Outcomes
1. Students will develop knowledge related to the specific civil engineering special topic selected for study.

C E 435. Technical Communication for Engineers
3 Credits (3)
The course addresses the fundamentals of communicating technical information that is clear, concise, and concrete to a wide variety of stakeholder types.
Learning Outcomes
1. Ability to write in a way that is clear.
2. Ability to write in a way that is concise.
3. Ability to write in a way that is concrete.

C E 444. Elements of Steel Design
3 Credits (3)
Analysis and design of tension members, beams, columns, and bolted and welded connections. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 315.
Prerequisite/Corequisite: C E 311.
Learning Outcomes
1. Students will be able to design structural steel elements (compression, tension, and flexural members) and connections.

C E 445. Reinforced Concrete Design
3 Credits (3)

Design and mechanics of structural reinforced concrete members. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 315.
Prerequisite/Corequisite: C E 311.
Learning Outcomes
1. Students will be able to analyze and design reinforced concrete structural elements subjected to loads.
2. Students will be able compute development lengths of reinforcing steel.
3. Students will understand the importance of meeting code requirements in their designs.

C E 452. Geohydrology
3-4 Credits (3+1P)
Origin, occurrence, and movement of fluids in porous media and assessment of aquifer characteristics. Development and conservation of ground water resources, design of well fields. Crosslisted with: ENVS 452 and GEOL 452.
Prerequisite(s): Junior or Senior.
Learning Outcomes
1. An understanding of the movement of water in porous media and its effects on aquifers.
2. An understanding of the development and conservation of ground water resources.

C E 454. Wood Design
3 Credits (3)
Theory and design of wood structural members and systems subjected to gravity and lateral loads. Taught every other year, alternates with C E 455, Masonry Design. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 315.
Prerequisite/Corequisite: C E 311.
Learning Outcomes
1. Students will have a working knowledge of wood materials commonly used in structural applications.
2. Students will be able to design wood structural members and components.
3. Students will be able design basic connections between wood structural members.

C E 455. Masonry Design
3 Credits (3)
Theory and design of masonry structural members and systems subjected to gravity and lateral loads. Taught every other year, alternates with C E 454.
Prerequisite: C- or better grade in C E 315.
Prerequisite/Corequisite: C E 311.
Learning Outcomes
1. Introduce students to topics in masonry design that are commonly encountered in structural engineering.
2. Provide the background needed to understand the code requirements applicable to problems in masonry design.

C E 457. Foundation Design
3 Credits (2+3P)
Application of principles of classical soil mechanics to the design of shallow and deep foundations, and the fundamentals of geotechnical site investigation. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 357.
Learning Outcomes
1. Students will be able to apply geotechnical engineering principles to the analysis and design of shallow and deep foundations.
2. Students will be able to compute foundation settlement.

C E 460. Site Investigation
3 Credits (2+2P)
Investigation and characterization of surficial and subsurface geologic materials and ground water for civil engineering projects. Includes exploration program, drilling and sampling, rock and soil classification and logging, groundwater monitoring, profiles, and preparation of geotechnical reports.
Prerequisite: C- or better grade in C E 357.
Prerequisite/Corequisite: C E 457.
Learning Outcomes
1. Develop approach to scoping and conducting a subsurface investigation.
2. Develop an understanding of geotechnical complexity and how to use the graded approach.
3. Use soil mechanics and foundation design skills to perform geotechnical analyses and develop recommendations needed by the project team to provide client(s) with needed facilities.
4. Understand field and laboratory tools and techniques used to develop suitable data for subsurface analyses and geotechnical report recommendations.
5. Understand the observational approach, how to use it, and how to avoid its misuse.
6. Develop skills needed to prepare geotechnical letter reports and complete geotechnical investigation reports.

C E 469. Structural Systems
3 Credits (3)
Design of structural systems for buildings and bridges. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 444 or C E 445.
Learning Outcomes
1. Students will understand the scope of structural design projects.
2. Students will understand how a structural design project, representative of entry-level work in practice, is performed.

C E 470. Design of Municipal and Hazardous Waste Landfills
3 Credits (3)
Solid waste and application of geotechnical engineering principles and methods to the site selection and design of municipal and hazardous waste landfills. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 357 and C E 452, or consent of instructor.
Learning Outcomes
1. Students will understand the importance of site selection for municipal and hazardous waste landfills.
2. Students will understand the elements of design for municipal and hazardous waste landfills.

C E 471. Transportation Engineering
3 Credits (3)
Highway and traffic design and systems. Students must be in junior or senior standing to enroll. May be repeated up to 3 credits.
Prerequisite: C- or better in MATH 1521G.
Learning Outcomes
1. Provide understanding of the principles of transportation engineering with a focus on highway engineering and traffic analysis.

2. Provide basic skill set that will allow a student to address most of the transportation problems that are likely to appear in professional practice and on the Fundamentals of Engineering exam (FE) and the Principles and Practice of Engineering exam (PE).
3. Provide foundation for future coursework in transportation should a student wish to pursue further coursework in the fields.

C E 477. Engineering Economics and Construction Management
3 Credits (3)
Engineering economics, construction and project management. May be repeated up to 3 credits.
Prerequisite/Corequisite: C- or better grade in C E 357.
Learning Outcomes
1. Understand time value of money and be able to perform economic analyses on engineering problems to determine whether a given project is worthwhile or to prioritize multiple alternatives based on present worth.
2. Understand the mathematical and ethical implications of benefit/cost and internal rate of return analyses
3. Estimate durations and requirements of individual construction tasks.
4. Develop construction schedules using Critical Path Method (CPM) Analysis.
5. Understand the legal and ethical concerns involved in economic analysis and construction engineering.

C E 479. Pavement Analysis and Design
3 Credits (3)
Covers stresses and deflections in pavement layers, material characterization, flexible and rigid pavement design by AASHTO, and rehabilitation concepts. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 357.
Learning Outcomes
1. Students will be able to analyze and design flexible and rigid pavements.

C E 481. Civil Engineering Capstone Design
3 Credits (3)
Culminating multidisciplinary project-oriented capstone design. Ethics, professional development, global issues. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 356, C- or better grade in C E 382, and a C- or better grade in either C E 444 or C E 445.
Prerequisite/Corequisite: C E 457, C E 471, C E 477.
Learning Outcomes
1. Students will understand the scope of civil engineering design projects.
2. Students will understand how a civil engineering project, representative of entry-level work in practice, is performed.

C E 482. Hydraulic Structures
3 Credits (3)
Engineering design of water-regulating structures. Capstone design course. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 382.
Prerequisite/Corequisite: C E 477.
Learning Outcomes
1. Students will understand the scope of interdisciplinary civil engineering design projects.
2. Students will understand how a hydraulic design project, representative of entry-level work in practice, is performed.

C E 483. Surface Water Hydrology
3 Credits (3)
Hydrologic cycle and relationships between rainfall and surface water runoff. May be repeated up to 3 credits.
Prerequisite: C- or better grade in C E 331 or consent of instructor.
Learning Outcomes
1. Students will understand the hydrologic cycle and basic principles of hydrology.

C E 485. Design of Earth Dams
3 Credits (3)
Engineering design applied to site selection, foundation inspection and treatment, hydrology and hydraulics, stability, and seepage analysis. Economic and environmental factors.
Prerequisite: C E 357, C E 382.
Learning Outcomes
1. Course introduces the students to small earthen dam siting, design and construction based on the knowledge and skills acquired in earlier coursework.
2. Course incorporates engineering standards and realistic constraints and prepares students for entry-level work.
3. Students work in teams to design a small earthen dam.

C E 490. Introduction to Artificial Intelligence for Civil Engineers
3 Credits (3)
Introduces various machine learning methods for solving various civil engineering problems. Topics include: supervised & unsupervised machine learning; classification and linear regressions; K-nearest neighbor; decision tree, bagging, & boosting; random forest; and support-vector machines.
Prerequisite: C- or better grade in STAT 371.
Learning Outcomes
1. Identify appropriate data analysis methods for various civil engineering problems.
2. Perform various Machine Learning (ML) analyses to solve civil engineering problems.
3. Evaluate various forms of Machine Learning (ML) analysis results.

C E 497. Senior Seminar
1 Credit (1)
Selected topics on the civil engineering profession and orientation for professional practice. Preparation for the FE exam. Students must be able to submit their application for degree while enrolled in this course.
Learning Outcomes
1. Prepare students for professional and ethical aspects of employment or graduate studies.

C E 498. Special Topics
1-3 Credits
Special topics in civil engineering. May be repeated up to 9 credits.
Prerequisite: consent of department head.
Learning Outcomes
1. Students will develop knowledge related to the specific civil engineering special topic selected for study.

C E 501. Advanced Mechanics of Materials
3 Credits (3)
Study of stress and strain in two and three dimensions, theories of failure, stress concentrations, unsymmetrical bending, curved beams, beams on elastic foundations, column theories, torsion, thick-wall cylinders. May be repeated up to 3 credits. Same as M E 501.
Prerequisite: C E 301, MATH 392.

Learning Outcomes

1. Students will understand the three-dimensional stress and strain, constitutive relationships, and yield criteria in the field of theoretical mechanics.
2. Students will understand the mechanics of torsion, non-symmetric bending, curved beams, and column buckling.
3. Students will have a basic understanding of stress concentrations, fracture mechanics, and plate behavior.

C E 502. Advanced Mechanics of Steel Structures
3 Credits (3)
Advanced structural mechanics applicable to steel structures. Includes inelastic behavior, plastic analysis, column and frame stability and torsion.
Prerequisite: C E 444.
Learning Outcomes

1. Introduce students to advanced topics in structural mechanics of steel structures that are commonly encountered in structural engineering
2. Provide the background needed to understand the code requirements applicable to problems in plastic design of steel structures

C E 503. Special Design and Analysis Program
3-6 Credits
Design and analysis covering subject matter of an approved 450 undergraduate departmental course plus an additional report or project. Course may be subtitled in the Schedule of Classes. May be repeated up to 6 credits.
Prerequisite: consent of instructor/committee.
Learning Outcomes

1. Students will develop knowledge related to the specific civil engineering design or analysis topic selected for study.

C E 504. Advanced Engineering Design
3 Credits (3)
Advanced engineering design covering subject matter of a selected capstone undergraduate design course plus an additional report or project. May be subtitled. May be repeated up to 3 credits.
Prerequisite: consent of instructor/committee.
Learning Outcomes

1. Students will develop knowledge related to the specific civil engineering design topic selected for study.

C E 507. Design of Earth Retaining Structures
3 Credits (3)
Lateral earth pressure theory, soil-reinforcement interaction, and analysis and design of rigid and flexible earth retaining structures for support of fills and excavations, including retaining walls, mechanically stabilized earth (MSE) walls, sheet pile walls, anchored walls, tiebacks and soil nailing. May be repeated up to 3 credits.
Prerequisite: C E 357.
Prerequisite/Corequisite: C E 457.
Learning Outcomes

1. Students will be able to design retaining walls and other earth retaining structures.

C E 508. Advanced Soil Behavior
3 Credits (3)
The course covers particle-scale phenomena that govern the macro-scale behavior of soils. Topics covered in the class include classical concepts as well as contemporary advances in soil mechanics. The students will develop a fundamental understanding of soil-water interaction, theories of contact level deformation, and mass and energy transport through granular media. Consent of Instructor required. May be repeated up to 3 credits.
Prerequisite: C E 357 or Instructor Consent.
Learning Outcomes

1. Students will develop an in-depth understanding of advanced soil mechanics topics.

C E 509. Deep Foundations
3 Credits (3)
Behavior, analysis and design of pile and pier foundations subjected to axial and lateral loads. May be repeated up to 3 credits.
Prerequisite: C E 457 or consent of instructor.
Learning Outcomes

1. Students will be able to analyze and design pile and pier foundations.

C E 510. Introduction to Nondestructive Testing
3 Credits (3)
This course explores the application of different Nondestructive Testing (NDT) methods in material characterization and product qualification.
Prerequisite: C E 311 or CHME 361 or Consent of Instructor.
Learning Outcomes

1. Students will develop a working knowledge of non-destructive test methods that utilize acoustic, electrical, and/or imaging principles.

C E 514. Numerical Methods in Civil Engineering
3 Credits (3)
Mathematical, numerical, and programming foundations of applied numerical methods with a focus on Civil and Environmental Engineering applications using MATLAB.
Learning Outcomes

1. To provide necessary background and skills to use MATLAB as a programing language for engineering problem solving.
2. To introduce classical and some modern methods for civil engineering numerical problem solving.
3. Develop numerical algorithms and programs for solving civil engineering problems involving: (1) multi-dimensional integration, (2) multivariate differentiation, (3) ordinary differential equations, (4) partial differential equations, (5) optimization (6) parameter estimation methods such as linear and nonlinear least square methods.

C E 515. Finite Element Methods
3 Credits (3)
Introduces the finite element method. Topics may include beam, frame, plane stress, plane strain, axisymmetric, and 3-D stress elements. Includes static and dynamic analysis. Uses readily available finite-element software. May be repeated up to 3 credits.
Prerequisite: graduate standing or consent of instructor.
Learning Outcomes

1. Students will be able to formulate and use the finite element method to solve problems in solid mechanics.

C E 531. Open Channel Hydraulics
3 Credits (3)
Theoretical and applied hydraulics of open channels, with emphasis on nonuniform flow, rapidly varied flow, and wave formation. May be repeated up to 3 credits.
Prerequisite: C E 382 or consent of instructor.

Learning Outcomes

1. Students will have in-depth knowledge of advanced topics related to open channel hydraulics.

C E 535. Technical Communication for Engineers
3 Credits (3)
The course addresses the fundamentals of communicating technical information that is clear, concise, and concrete to a wide variety of stakeholder types. Same as C E 435 with differentiated assignments for graduate students.
Learning Outcomes

1. Ability to write in a way that is clear
2. Ability to write in a way that is concise
3. Ability to write in a way that is concrete

C E 544. Advanced Design of Steel Structures
3 Credits (3)
Connection design; beam-column analysis and design; composite construction; and plate girder design.
Prerequisite: C E 444.
Learning Outcomes

1. Introduce students to advanced topics in steel design that are commonly encountered in structural engineering
2. Provide the background needed to practice structural steel design
3. Provide the background needed to understand the code requirements applicable to difficult problems in structural steel design

C E 545. Advanced Concrete Design
3 Credits (3)
Advanced topics in ultimate strength design of reinforced concrete that include: concrete footings, retaining structures, short and long columns, torsion members, deep beams and shear walls, two-way slabs, and shear and moment transfer at slab-column connections.
Prerequisites: C E 445.
Learning Outcomes

1. Introduce students to advanced topics in reinforced concrete design that are commonly encountered in structural engineering
2. Provide the background needed to practice structural concrete design
3. Provide the background needed to understand the code requirements applicable to difficult problems in structural concrete design

C E 547. Bridge Engineering
3 Credits (3)
Topics related to prestressed concrete, reinforced concrete and steel bridge design according to the AASHTO specifications; bridge analysis and evaluation.
Prerequisite: C E 444 or C E 445.
Learning Outcomes

1. Introduce students to topics in bridge design that are commonly encountered in structural engineering
2. Provide the background needed to understand the code requirements applicable to problems in bridge design

C E 554. Wood Design
3 Credits (3)
Theory and design of wood structural members and systems subjected to gravity and lateral loads. Design project required. Taught every other year, alternates with C E 555 - Masonry Design. May be repeated up to 3 credits.
Learning Outcomes

1. Students will have a working knowledge of be able to design wood materials commonly used in structural applications members and components.
2. Students will be able to design wood structural members and components.
3. Students will be able design basic connections between wood structural members.

C E 555. Masonry Design
3 Credits (3)
Theory and design of masonry structural members and systems subject to gravity and lateral loads. Design project required. Taught every other year, alternates with C E 554.
Learning Outcomes

1. Introduce students to advanced topics in masonry design that are commonly encountered in structural engineering.
2. Provide the background needed to practice masonry design.
3. Provide the background needed to understand the code requirements applicable to difficult problems in masonry design.

C E 557. Water Resources Development
3 Credits (3)
Students function as members of a consulting panel and prepare reports on major water resources development problems. Political, financial, and social aspects of water resources development are considered as well as scientific and technical details. May be repeated up to 3 credits.
Learning Outcomes

1. Students will have a working knowledge of important topics related to development of water resources.

C E 571. Structural Dynamics
3 Credits (3)
Response of elastic structure to dynamic loading. Moving load, earthquake and blast loading.
Prerequisite: ENGR 234 and C E 315.
Learning Outcomes

1. Introduce students to topics in structural dynamics that are commonly encountered in structural engineering
2. Provide the background needed to understand the code requirements applicable to problems in seismic and blast-resistant design

C E 579. Ground Improvement
3 Credits (3)
The objective of this course is to introduce common ground improvement techniques, including mechanical (compaction, soil reinforcement, preloading and accelerated consolidation) and chemical (cementing, ion-replacement, polymer bonding) stabilization methods, as well as seepage and dewatering. Emphasis will be placed on developing an understanding of the underlying physical and chemical processes involved in each case. May be repeated up to 3 credits.
Prerequisite: C E 357.
Learning Outcomes

1. Students will understand a wide variety of ground improvement techniques and the physical and chemical principles involved with each technique.

C E 581. Ground Water Hydrology
3 Credits (3)
Mathematical treatment of water flow in porous media. Emphasis on hydraulics of water movement, including pumping and recharge wells, drainage, and water quality. May be repeated up to 3 credits.

Prerequisite: MATH 392, G EN 452, and C E 382, or consent of instructor.

Learning Outcomes

1. Students will understand advanced topics related to flow in porous media and other issues related to ground water hydrology.

C E 582. Statistical Hydrology
3 Credits (3)

Application of statistical techniques to hydrologic data, including distributions, hypothesis testing, linear models, non-parametrics, and time-series and stochastic models. May be repeated up to 3 credits.

Learning Outcomes

1. Students will understand applications of statistical methods within the field of hydrology.

C E 585. Slope Stability Analysis and Design
3 Credits (3)

Design of earth slopes, causes of instability, limit equilibrium methods, slope reinforcement (geosynthetics soil nailing, tiebacks), seismic analysis, rock slope stability. Consent of instructor required.

Learning Outcomes

1. Be familiar with the implications of drainage conditions and pore water pressure in the soil as they relate to soil shear strength and slope stability.
2. Be able to recognize the differences between short-term and long-term analyses (total versus effective stress analyses) applied to slope stability.
3. Be able to perform hand calculations of slope stability for very simple cases.
4. Be familiar with the set of input data usually required to perform stability analyses using software.
5. Be able to design soil slopes with various soil profiles and geometry and reinforcement using slope stability software.
6. Recognize and understand the effects of geologic and groundwater conditions on the stability of soil slopes.
7. Understand the mechanisms by which the most common methods of slope stabilization work (tie-backs, soil nailing, geosynthetics).

C E 590. Advanced Artificial Intelligence for Civil Engineers
3 Credits (3)

Deep learning methods for solving civil engineering problems. Topics include: introduction, backpropagation, training, regulations, and techniques of Neural Networks (NN); image processing using Convolutional Neural Networks (CNN); time-series data analysis using Recurrent Neural Networks (RNN); Gated Recurrent Units; and introduction to Transfer Learning.

Prerequisite: STAT 371 and MATH 392.

Learning Outcomes

1. Identify appropriate data analysis methods and utilize mathematical formulations of Deep Learning (DL) for various civil engineering problems.
2. Perform various Deep Learning (DL) analyses to solve civil engineering problems.
3. Evaluate various forms of Deep Learning (DL) analysis results.

C E 596. Special Topics
1-3 Credits

Graduate level special topics in civil engineering. May be repeated up to 6 credits.

Prerequisite: consent of department head.

Learning Outcomes

1. Students will develop knowledge related to the specific civil engineering special topic selected for study.

C E 598. Special Research Programs
1-3 Credits

Individual investigations either analytical or experimental. May be subtitled. Maximum of 3 credits per semester. May be repeated up to 99 credits.

Learning Outcomes

1. Students will develop knowledge related to the specific civil engineering research topic selected for investigation.

C E 599. Master's Thesis
1-15 Credits

Thesis. May be repeated up to 88 credits.

Learning Outcomes

1. Students will progress toward completion of a research thesis.

C E 600. Doctoral Research
1-15 Credits

Research. May be repeated up to 88 credits.

Learning Outcomes

1. Students will progress toward completion of their doctoral research.

C E 604. Advanced Engineering Topics
3 Credits (3)

In depth study of a topic at the forefront of civil or environmental engineering. Journal papers will be critically reviewed and students will be asked to write an analysis of the topic and present their thoughts orally. May be repeated up to 3 credits.

Learning Outcomes

1. Students will develop knowledge related to the specific civil engineering special topic selected for study.

C E 614. Advanced Numerical Methods in Civil Engineering
3 Credits (3)

Advanced mathematical, numerical, and programming for applied numerical methods with a focus on Civil and Environmental Engineering applications using MATLAB. Same as C E 514 with differentiated material and assignments for C E 614 students.

Learning Outcomes

1. To provide necessary background and skills to use MATLAB as a programing language for engineering problem solving.
2. To introduce classical and some modern methods for civil engineering numerical problem solving.
3. Develop numerical algorithms and programs for solving civil engineering problems involving: (1) multi-dimensional integration, (2) multivariate differentiation, (3) ordinary differential equations, (4) partial differential equations, (5) optimization (6) parameter estimation methods such as linear and nonlinear least square methods, and (7) time series analysis such as Fourier transform, wavelet, and basic filtering.

C E 682. Topics in Hydrodynamics II
3 Credits (3)

Selected topics in hydrometeorology, including the transfer of water and energy between the land surface and the lower atmosphere.

Learning Outcomes

1. This course helps lay the foundation for theoretical concepts useful in measurement, analysis and estimation of evaporation/evapotranspiration. Students learn some of the theoretical concepts and relationships useful in the phenomenon of evaporation as well

as gain some field experience on measurement of evapotranspiration and open water evaporation.

C E 698. Special Research Programs
1-3 Credits
May be subtitled. May be repeated up to 9 credits.
Learning Outcomes
1. Students will gain knowledge related to the research topic selected for study.

C E 700. Doctoral Dissertation
1-15 Credits
Dissertation. May be repeated up to 88 credits.
Learning Outcomes
1. Students will progress toward completion of a research dissertation.

Environmental Engineering Courses

ENVE 450. Aquatic Chemistry
3 Credits (3)
Theoretical aspects of physical chemistry applied to the solution of environmental engineering problems. Emphasis on acid-base reactions, precipitation-dissolution reactions, complexation, and redox reactions. Same as ENVE 550.
Prerequisite: C- or better grade in C E 256.
Learning Outcomes
1. Students will be able to use fundamental principles of physical chemistry as applied to acid-base, precipitation-dissolution, complexation, and redox reactions to determine the composition of waters, including natural waters and waters encountered in water and wastewater treatment processes.

ENVE 451. Unit Processes/Operation of Water Treatment
3 Credits (3)
Theory and applications of unit processes in environmental engineering. Physical and chemical water treatment methods are emphasized. Crosslisted with: ENVE 551.
Prerequisite: C- or better grade in C E 356.
Learning Outcomes
1. Students will be able to use fundamental reactor design principles to design unit operations for water treatment, including sedimentation, coagulation, flocculation, filtration, and disinfection.

ENVE 452. Unit Processes/Operation of Wastewater Treatment
3 Credits (3)
Theory and applications of unit processes in environmental engineering. Biological wastewater treatment methods are emphasized. Crosslisted with: ENVE 552.
Prerequisite: C- or better grade in C E 356.
Learning Outcomes
1. Students will be able to use fundamental reactor design principles to design unit operations for wastewater treatment, including sedimentation, aerobic and anaerobic microbial treatment, and disinfection.

ENVE 456. Environmental Engineering Design
3 Credits (3)
Design of chemical, physical, and biological operations and processes involved in water and wastewater treatment. Student can also be a graduate student to enroll if they have not completed C E 356.
Prerequisite: C- or better grade in C E 356.
Learning Outcomes
1. Students will be able to incorporate knowledge from previously taken engineering design and economics courses to complete an environmental design and solve a real world problem.
2. Students will be able to communicate and explain their solution approach to a variety of audiences using different communication methods.

ENVE 459. Environmental Microbiology
3 Credits (3)
An introduction to the diverse roles of microorganisms in natural and engineered environments. The topics include cellular architecture, energetics, and growth; population and community dynamics; water and soil microbiology; biogeochemical cycling; and microorganisms in biodegradation and bioremediation of contaminants. Students must be a Senior or in Graduate Standing to enroll.
Learning Outcomes
1. Students will be able to demonstrate the significance of microbial processes in natural and engineered processes.

ENVE 487. Air Pollution Control Systems Design
3 Credits (3)
An introduction to sources and nature of air pollution, regulations, and risk analysis. Detailed study of air pollution control technologies and design of air pollution control equipment. Students must be a Senior or in graduate standing to enroll.
Learning Outcomes
1. Students will be able to explain the source and nature of air pollution.
2. Students will be able to relate air pollution to regulations using a risk analysis approach.
3. Students will be able to design air pollution control systems.

ENVE 504. Advanced Environmental Engineering Design
3 Credits (3)
Advanced engineering design covering the subject matter of the Environmental Engineering capstone undergraduate design course plus an additional report or project. May be subtitled. Consent of instructor required.
Learning Outcomes
1. Students will be able to incorporate knowledge from previously taken engineering design and economics courses to complete an environmental design and solve a real world problem.
2. Students will be able to communicate and explain their solution approach to a variety of audiences using different communication methods.

ENVE 550. Aquatic Chemistry
3 Credits (3)
Theoretical aspects of physical chemistry applied to the solution of environmental engineering problems. Emphasis on carbonate equilibria solubility, buffering and redox conditions. May be repeated up to 3 credits. Consent of Instructor required. Crosslisted with: ENVE 450.
Prerequisite(s): C E 256.

ENVE 551. Unit Processes/Operation of Water Treatment
3 Credits (3)
Theory and applications with unit processes in environmental engineering. Physical / chemical treatment methods emphasized. May be repeated up to 3 credits. Crosslisted with: ENVE 451.
Prerequisite(s): C E 356.

ENVE 552. Unit Processes/Operation of Wastewater Treatment
3 Credits (3)

Theory and applications with unit processes in environmental engineering. Biological treatment methods emphasized. May be repeated up to 3 credits. Crosslisted with: ENVE 452.
Prerequisite(s): Consent of instructor.

ENVE 556. Advanced Water Treatment and Reuse
3 Credits (3)
Overview of both the theoretical and practical aspects of advanced water treatment technologies and water reuse applications. Basic design features of the processes are presented, with emphasis on the underlying principles, including why and how a process works, what the significant variables are, and what the limitations of the process are. Problem solving skills and technical communication skills are emphasized.
Prerequisite: ENVE 551.
Learning Outcomes
1. Students will be able to design advanced water treatment processes, including membrane filtration, electrodialysis, ion exchange, advanced oxidation, photolysis, and distillation.
2. Students will gain knowledge in water reuse applications including water quality criteria, regulations, and implementation issues.

ENVE 557. Surface Water Quality Modeling
3 Credits (3)
Modeling the impacts of waste disposal practices on surface waters. Emphasis on fate and transport of bacteria, dissolved oxygen, nutrients, and toxicants in rivers, lakes, and tidal waters. Students must be in Graduate standing to enroll.
Learning Outcomes
1. The students will be able to use mathematical models to model the transport of constituents important for water quality, such as bacteria, viruses, nutrients, contaminants, and oxygen, in aqueous environments.

ENVE 598. Special Research Programs
1-3 Credits
Individual investigations either analytical or experimental. May be repeated up to 6 credits.
Learning Outcomes
1. Students will develop knowledge related to the specific environmental engineering special topic selected for research.

ENVE 599. Master's Thesis
15 Credits
Thesis. May be repeated up to 88 credits.
Learning Outcomes
1. Students will progress toward completion of their research thesis.

ENVE 630. Fate and Transport of Environmental Contaminants
3 Credits (3)
Modeling of transport phenomena in natural and engineered systems for predicting the fate of contaminants in the air, soil, sediment, and water compartments of the ecosystem.
Prerequisite: ENVE 557.
Learning Outcomes
1. The students will be able to use mathematical models to model the transport of contaminants in gas, aqueous, and soil environments.

Department Contact Information

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