

# CIVIL ENGINEERING

## Undergraduate Program Information

The curriculum in civil engineering is designed to provide a solid background and is so arranged that students may, in their senior year, specialize in one or more of the areas of concentration in civil engineering listed. Several minors in various fields of interest within civil engineering are also available for students to expand the depth of their knowledge.

### Mission

The mission of the Civil Engineering Department is to offer a high quality and accredited degree that prepares our graduates for professional licensure leading to successful civil engineering careers in industry and government or for success at the graduate level. Toward this end, the Civil Engineering Department will recruit and maintain a diverse, highly skilled faculty.

### Program Educational Objectives

In support of the mission, the Civil Engineering Department adopts the following program educational objectives:

1. Prepare our graduates to achieve professional engineering licensure and productivity in a civil engineering setting.
2. Prepare our graduates to be future leaders and public sector employees in civil engineering fields.
3. Prepare our graduates to pursue and complete a graduate level degree.
4. Maintain and further develop a high quality accredited civil engineering program that is competitive with comparable programs throughout the nation.

### 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 knowledge of mathematics through differential equations, calculus-based physics, general chemistry, and probability and statistics to assess uncertainty.
2. Analyze and solve problems in various areas of civil engineering.
3. Conduct experiments associated with civil engineering, as well as analyze and interpret the collected data.
4. Design a system, component, or process in various civil engineering contexts considering sustainability.
5. Explain basic concepts related to project management, business, public policy, and leadership.
6. Analyze issues related to professional ethics and explain the importance of professional licensure.

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 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

Provide research-based, post-baccalaureate programs leading to Master of Engineering (M.E.), Master of Science (M.S.), and Doctor of Philosophy (Ph.D.) degrees for students pursuing advanced practice-oriented or academic careers in the areas of structural, geotechnical, water resources, transportation, and environmental engineering.

### Vision Statement

The program goal is to enhance social well-being by modernizing civil infrastructure for improved performance, efficiency, reliability, and resilience. Through a combination of coursework plus applied and fundamental research, the program aims to produce graduates capable of developing innovative, sustainable, and cost-effective infrastructure for the next generation.

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 the Ph.D. degrees. Students work closely with the faculty on contemporary issues including, but not limited to, ground stabilization, high performance materials, intelligent transportation systems, remote sensing, renewable energy, resilient infrastructure, structural health monitoring, sustainable construction, traffic modeling and simulation, and water treatment and reuse.

The department has excellent facilities including some 15 teaching and/or research laboratories with facilities for mechanical, chemical and biological research. The outstanding feature of the program is the energetic, highly motivated faculty and the low student-faculty ratio. The department currently has several ongoing research projects of various size and scope employing graduate students. Office space is normally provided for those students pursuing an advanced degree. Teaching and research assistantships are available to qualified students.

Students enrolling for graduate work 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. Environmental Engineering degree may choose either a thesis or a non-thesis track and the M.E. in Civil Engineering degree requires only coursework. When a student enrolls for the Ph.D., 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 148 credit hours; the non-accelerated path requires 154 credit hours (B.S. requires 124 credit hours plus the M.E. or M.S. which require 30 credit hours each). Students accepted into this program follow the normal Civil Engineering undergraduate curriculum during their freshmen, sophomore, and junior level semesters, and the first semester of their senior year. In their final undergraduate semester, students take two graduate courses (> 500) in place of two

undergraduate electives (> 450). Alternatively, students may petition for the two undergraduate electives to be counted as substitutes for the two graduate courses. In either case, the courses must be approved by the department head and completed with at least a grade of B. At this point, students receive their B.S. in Civil Engineering degree and the M.E. in Civil Engineering, M.S. in Civil Engineering or M.S. in Environmental Engineering degree can be completed with 24 credit hours within 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 before starting the MAP option.

## Degrees for the Department

### Bachelor Degree(s)

Civil Engineering (Environmental) - Bachelor of Science in Civil Engineering

Civil Engineering (General) - Bachelor of Science in Civil Engineering

Civil Engineering (Geotechnical) - Bachelor of Science in Civil Engineering

Civil Engineering (Structural) - Bachelor of Science in Civil Engineering

Civil Engineering (Water Resources) - Bachelor of Science in Civil Engineering

### Master Degree(s)

Civil Engineering - Master of Engineering

Civil Engineering - Master of Science in Civil Engineering

Environmental Engineering - Master of Science in Environmental Engineering

### Doctoral Degree(s)

Engineering (Civil Engineering) - Doctor of Philosophy

## Minors for the Department

Agricultural Engineering - Undergraduate Minor

Environmental Engineering - Undergraduate Minor

Structural Engineering - Undergraduate Minor

**Professor David V. Jauregui<sup>1</sup>, Department Head**

**Professor J. Phillip King<sup>1</sup>, Associate Department Head**

**Professors** Jauregui<sup>1</sup>, Khandan<sup>1</sup>, King<sup>1</sup>, Martin<sup>1</sup>, Newtonson<sup>1</sup>, Papelis, Reddi<sup>1</sup> (Dean of College of Engineering), Samani<sup>1</sup>, White<sup>1</sup> (Emeritus), Xu; **Associate Professors** Bandini<sup>1</sup>, Bawazir, Cortes, Wang, Weldon; **Assistant Professors** Dehghan-Niri, Ray, Zhang<sup>1</sup>

*P. Bandini, Ph.D. (Purdue) – geotechnical engineering; A. S. Bawazir, Ph.D. (New Mexico State) – agricultural/water resources engineering; D. Cortes, Ph.D. (Georgia Tech) – geotechnical engineering; E. Dehghan-Niri, Ph.D. (SUNY-Buffalo) – structural engineering; D. V. Jáuregui, Ph.D. (Texas-Austin) – structural engineering; N. N. Khandan, Ph.D. (Drexel) – environmental engineering; J. P. King, Ph.D. (Colorado State) – agricultural/water resources engineering; P. T. Martin, Ph.D. (Nottingham, UK) – transportation engineering; C. Newtonson, Ph.D. (Washington) – structural engineering; L. Papelis, Ph.D. (Stanford) – environmental engineering; T. Ray, Ph.D. (SUNY-Buffalo) – structural engineering; L. N. Reddi, Ph.D. (Ohio State) – geotechnical engineering; Z. Samani, Ph.D. (Utah State) –*

*agricultural/water resources engineering; B. Weldon, Ph.D. (Notre Dame) – structural engineering; H. Wang, Ph.D. (Lanzhou-China); K. R. White, Ph.D. (Texas Tech) – structural engineering; P. Xu, Ph.D. (ENGREF, Paris, France) – environmental engineering; Y. Zhang, Ph.D. (Missouri-Columbia) – environmental engineering.*

<sup>1</sup> Registered Professional Engineer

## Civil Engineering Courses

### C E 109. Computer Drafting Fundamentals

**3 Credits (2+2P)**

Same as DRFT 109, E T 109, SUR 109.

### 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(s)/Corequisite(s):** MATH 1220G.

### C E 198. Special Topics

**1-3 Credits**

May be repeated for a maximum of 6 credits.

**Prerequisite:** consent of department head.

### C E 233. Mechanics-Statics

**3 Credits (3)**

Engineering mechanics using vector methods. May be repeated up to 3 credits.

**Prerequisite(s):** MATH 1521G or MATH 1521H, PHYS 1310G and cumulative GPA of 2.0.

### 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. Crosslisted with: M E 234.

**Prerequisite(s):** C E 233, MATH 1521G or MATH 1521H, PHYS 1310G.

### 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(s):** CHEM 1215G and MATH 1511G.

### C E 256 L. Environmental Science Laboratory

**1 Credit (1P)**

Laboratory experiments associated with the material presented in C E 256. Same as ENVS 2111L.

**Corequisite(s):** C E 256.

### C E 298. Special Topics

**1-3 Credits**

May be repeated for a maximum of 6 credits.

**Prerequisite:** consent of department head.

### C E 301. Mechanics of Materials

**3 Credits (3)**

Stress, strain, and elasticity of materials. May be repeated up to 3 credits.

**Prerequisite(s):** C E 233 or M E 236.

### 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.

**Prerequisite:** C E 301.

**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.

**Prerequisite(s):** C E 301.

**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. Restricted to: CE majors.

**Prerequisite(s):** PHYS 1310G, C E 233.

**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(s)/Corequisite(s):** C E 331. Restricted to: C E majors.

**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.

**Prerequisites:** junior or senior standing, and the general education requirements for math and natural sciences.

**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.

**Prerequisite(s):** C E 256.

**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(s):** C E 160 or GEOL 1110G, and C E 301.

**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(s):** C E 331 and C E 331 L.

**C E 398. Special Topics****1-3 Credits**

May be repeated for a maximum of 6 credits.

**Prerequisite:** consent of department head.

**C E 444. Elements of Steel Design****3 Credits (3)**

Analysis and design of tension members, beams, columns, and bolted and welded connections.

**Prerequisite(s)/Corequisite(s):** C E 311. Prerequisite(s): C E 315.

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

Design and mechanics of structural reinforced concrete members.

**Prerequisite(s)/Corequisite(s):** C E 311. Prerequisite(s): C E 315.

**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.

**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.

**Prerequisite(s)/Corequisite(s):** C E 311. Prerequisite(s): C E 315.

**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.

**Prerequisite(s):** C E 357.

**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(s):** C E 357.

**Prerequisite(s)/Corequisite(s):** C E 457.

**C E 469. Structural Systems****3 Credits (3)**

Design of structural systems for buildings and bridges. May be repeated up to 3 credits.

**Prerequisite(s):** C E 444 or C E 445.

**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.

**Prerequisite(s):** C E 357 and C E 452, or consent of instructor.

**C E 471. Transportation Engineering****3 Credits (3)**

Highway and traffic design and systems.

**Prerequisite(s):** MATH 2530G.

**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(s)/Corequisite(s):** MATH 371, C E 357.

**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.

**Prerequisite(s):** C E 357.

**C E 481. Civil Engineering Capstone Design****3 Credits (3)**

Culminating multidisciplinary project-oriented capstone design. Ethics, professional development, global issues.

**Prerequisite(s)/Corequisite(s):** C E 457, C E 471, C E 477. Prerequisite(s): C E 356, C E 382, and either C E 444 or C E 445.

**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(s)/Corequisite(s):** C E 477. Prerequisite(s): C E 382.

**C E 483. Surface Water Hydrology****3 Credits (3)**

Hydrologic cycle and relationships between rainfall and surface water runoff.

**Prerequisite:** C E 331 or consent of instructor.

**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. May be repeated up to 3 credits.

**Prerequisite(s):** C E 357, C E 382.

**C E 498. Special Topics****1-3 Credits**

May be repeated for a maximum of 9 credits.

**Prerequisite:** consent of department head.

**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. Same as M E 501.

**Prerequisites:** C E 301, MATH 392.

**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 once for a total of 6 credits.

**Prerequisite:** consent of instructor/committee.

**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.

**Prerequisite:** consent of instructor/committee.

**C E 505. Advanced Mechanics of Concrete****3 Credits (3)**

Advanced structural mechanics applicable to concrete structures. Topics include: nonlinear-inelastic modeling and analysis of reinforced concrete structures, seismic behavior of reinforced concrete structures, and deformation of members under various loads. To be taught along with C E 605.

**Prerequisite(s):** C E 445.

**C E 506. Advanced Soil Mechanics****3 Credits (3)**

Stress and strain analyses in soil, stress paths; drained and undrained shear strengths of granular soils and clays, consolidation, liquefaction, soil improvement.

**Prerequisite:** C E 457 or consent of instructor.

**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.

**Prerequisite(s):** C E 357.

**Prerequisite(s)/Corequisite(s):** C E 457.

**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.

**Prerequisite(s):** C E 357 or Instructor Consent.

**C E 509. Deep Foundations****3 Credits (3)**

Behavior, analysis and design of pile and pier foundations subjected to axial and lateral loads.

**Prerequisite:** C E 457 or consent of instructor.

**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(s):** C E 311 or CHME 361 or Consent of Instructor.

**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.

**Prerequisite:** graduate standing or consent of instructor.

**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.

**Prerequisite:** C E 382 or consent of instructor.

**C E 544. Advanced Design of Steel Structures****3 Credits (3)**

Connection design; beam, column, and beam-column stability and design; and seismic frame design.

**Prerequisites:** C E 444 and C E 468.

**C E 545. Advanced Concrete Design****3 Credits (3)**

Prestressed concrete, ultimate strength theory, design of shell structures.

**Prerequisites:** C E 445 and C E 468.

**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.

**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.

**C E 571. Structural Dynamics****3 Credits (3)**

Response of elastic structure to dynamic loading. Moving load, earthquake and blast loading.

**Prerequisite:** C E 468 or consent of instructor.

**C E 572. Earthquake Engineering****3 Credits (3)**

Earthquake characteristics; seismic loads; elastic and inelastic response; analysis and design of buildings for earthquakes.

**Prerequisites:** graduate standing and consent of instructor.

**C E 573. Transportation Analysis****3 Credits (3)**

Transportation analysis of land-based transportation modes. Crosslisted with: C E 473.

**Prerequisite(s):** C E 471.

**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.

**Prerequisite(s):** C E 357.

**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.

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

**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.

**C E 596. Special Topics****1-3 Credits**

May be repeated for a maximum of 6 credits.

**Prerequisite:** consent of department head.

**C E 598. Special Research Programs****1-3 Credits**

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

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

Thesis.

**C E 600. Doctoral Research****1-15 Credits**

Research.

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

In depth study of a topic at the forefront of environmental engineering & science. Journal papers will be critically reviewed and students will be asked to write an analysis of the topic and present their thoughts orally.

**C E 615. Advanced Finite Element Methods****3 Credits (3)**

Finite element method with emphasis on stress analysis. May include development and use of plane stress, plane strain, and 3-D and shell elements. Includes static, dynamic, and nonlinear analysis.

**Prerequisite:** graduate standing.

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

Selected topics in flow-in open channels, flow-through porous media, and transport of sediments and contaminants. May be repeated for a maximum of 6 credits.

**Prerequisite:** consent of instructor.

**C E 698. Special Research Programs****1-3 Credits**

May be subtitled. May be repeated for a maximum of 9 credits.

**C E 700. Doctoral Dissertation****15 Credits**

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 carbonate equilibrium solubility, buffering and redox conditions. Crosslisted with: ENVE 550.

**Prerequisite(s):** C E 256.

**ENVE 451. Unit Processes/Operation of Water Treatment****3 Credits (3)**

Theory and applications with unit processes in environmental engineering. Physical and chemical treatment methods are emphasized. Crosslisted with: ENVE 551.

**Prerequisite(s):** C E 356.

**ENVE 452. Unit Processes/ Operation of Wastewater Treatment****3 Credits (3)**

Theory and applications with unit processes in environmental engineering. Biological treatment methods are emphasized. Crosslisted with: ENVE 552.

**Prerequisite(s):** C E 356.

**ENVE 456. Environmental Engineering Design****3 Credits (3)**

Design of chemical, physical and biological operations and processes involved in water and wastewater treatment.

**Prerequisite(s):** C E 356.

**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.

**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.

**Prerequisite(s):** Senior or graduate standing.

**ENVE 504. Advanced Environmental Engineering Design**

**3 Credits (3)**

Advanced engineering design covering subject matter of Environmental Engineering capstone undergraduate design course plus an additional report or project. May be subtitled. Consent of Instructor required.

**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 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. May be repeated up to 3 credits.

**ENVE 598. Special Research Programs**

**1-3 Credits**

Individual investigations either analytical or experimental. May be repeated up to 6 credits.

**ENVE 599. Master's Thesis**

**15 Credits**

Thesis. May be repeated for a maximum of 6 credits.

**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. May be repeated up to 3 credits. Consent of Instructor required.

**Prerequisite(s):** ENVE 557 and consent of instructor.

## **Agricultural Engineering Courses**

**A EN 459. Design of Water Wells/Pumping Systems**

**3 Credits (3)**

Design of water wells; selection and specification of pumps and power units.

**Prerequisite:** C E 382.

**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.

**Prerequisite:** C E 382 or consent of instructor.

**A EN 498. Special Topics**

**1-3 Credits**

May be repeated for a maximum of 6 credits.

**Prerequisite:** consent of instructor.

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