Civil and Environmental Engineering (CVEN)

Vision

A National Leader in Civil and Environmental Engineering Education in an environment of mutual trust, cooperation and commitment.

Departmental Mission

The primary mission of the Department of Civil and Environmental Engineering is to educate the future leaders and shapers of a profession in service to society. A second fundamental mission of the Department is the discovery, innovation, and development of new technologies and methods that improve the practice of civil and environmental engineering. A third mission is service to the nation and the profession. In accomplishing these missions we will directly serve the implementation of the Tulane Strategic Plan – "To be a truly distinctive research university in America's most original city." Inherent in our mission is to instill in each graduate, at all levels, a commitment to personal integrity, lifelong learning, and service to community.

Our responsibility to the undergraduates is to provide the environment, the resources, and the opportunity for them to achieve excellence in their undergraduate education, In concert with our mission to educate those who will lead and shape the future of engineering in the 21st Century are the basic tenants of the accreditation process of the Accreditation Board for Engineering and Technology (ABET).

Civil and Environmental Engineering Program Goals

In support of the department mission, the goals for both the Civil Engineering Program and the Environmental Engineering Program within this department are:

- To educate our students to a level of competence insuring the requisite skills for proper conception, planning, design, construction and operation of those public and private infrastructure projects that directly benefit the public welfare
- To develop in our graduates the ability to use critical thinking and creativity in insuring sustainable development for society
- To provide a total experience to our students leading to their moral, ethical, legal, and professional commitment to society as a whole
- To develop leadership skills for our graduates enabling them to work cooperatively with persons in other engineering disciplines and fields of endeavor for the common good of society
- To insure that our graduates will collectively apply their education in a manner which brings distinction to Tulane University and this department
- To have a world-class faculty renowned for its commitment to academic excellence

Values

Without a general commitment to shared values, no organization can expect fulfillment of its mission. The faculty of the Department of Civil and Environmental Engineering

wishes to carry out our mission in an environment espousing honesty, service, professionalism, academic excellence and trust.

Civil Engineering Program Objectives

Students who graduate from the Civil Engineering Program of Tulane University will be able and willing to:

- Apply the engineering thought process to design civil engineering components and systems.
- Demonstrate creativity, in the context of engineering problem-solving.
- Demonstrate proficiency in the structural, environmental, transportation, and geotechnical discipline areas of civil engineering.
- Demonstrate proficiency in mathematics, calculus-based physics, and general chemistry.
- Design and conduct experiments, and analyze and interpret data.
- Function as a contributing member of a multi-disciplinary team.
- Demonstrate an appreciation of the roles and responsibilities of civil engineers and the issues they face in professional practice.
- Use modern engineering tools to solve problems.
- Write effectively.
- Speak effectively.
- Demonstrate knowledge of contemporary issues.
- Understand the impact of engineering solutions in a global and societal context.
- Pursue continued intellectual and professional growth.

Environmental Engineering Program Objectives

Students who graduate from the Environmental Engineering Program of Tulane University will be able and willing to:

- Apply the engineering thought process to the solution of environmental problems.
- Demonstrate proficiency in advanced principles and practice tin the areas of water supply and resources, environmental systems modeling, wastewater management, hazardous waste management, and atmospheric systems and air pollution control.
- Apply knowledge of fundamental concepts of waste minimization and pollution prevention.

- Apply environmental systems and process modeling techniques.
- Design an environmental system, component, or process to meet desired needs.
- Design and conduct experiments, as well as to analyze and interpret data in more than one of the major environmental engineering focus areas.
- Understand the impact of engineering solutions in a global and societal context.
- Display an understanding of the roles and responsibilities of public institutions and private organizations in environmental management.
- Apply knowledge of mathematics, through differential equations, probability and statistics.
- Demonstrate proficiency in calculus-based physics, general chemistry, biology, fluid mechanics, and meteorology.
- Function as a contributing member of a multi-disciplinary team.
- Understand the basic tenants of professional practice and ethical responsibility.
- Write effectively.
- Speak effectively.
- Recognize the need for, and an ability to engage in life-long learning.
- Understand contemporary issues facing environmental engineers.
- Use the techniques, skills, and modern engineering tools necessary for engineering practice.

Curriculum – Civil Engineering

The civil engineering curriculum is administered by the Department of Civil and Environmental Engineering and is accredited by the Accrediting Board for engineering and Technology (ABET). This curriculum offers a broad, general coverage of the entire field of civil engineering, including an environmental engineering component. The civil engineering curriculum prepares the student for entry into the practice of civil engineering and forms a basis for graduate studies and research.

The civil engineering profession is dedicated to serving the basic needs of man and society. The structures in which we live and work, the transportation systems by which we travel, and the environment around us are the concerns of the civil engineer. Civil engineering education emphasizes the study of engineering principles and the application of scientific knowledge and technology for the betterment of mankind. A broad civil engineering education prepares the student to economically apply the laws, forces, and materials of nature to the design, construction, maintenance, and operation of works and structures. A basic civil engineering education prepares the student for a

career in design, research, or management and also provides a basis for further study in business, law or graduate civil engineering.

The program culminates with civil engineering design projects requiring the synthesis of concepts and their application in comprehensive design analysis and evaluations of modern civil engineering systems. In structural design, the student analyzes and designs a multi-story reinforced concrete structure and a steel structure in accordance with current design practice. Use is made of computer applications in both analysis and design. In environmental design, the student establishes design criteria through analysis of data and design objectives. These criteria are then applied to the design of systems intended to meet specified objectives. Specific projects involve a water or wastewater treatment system or environmental restoration of a hazardous waste site. In civil engineering design, the student is engaged in a comprehensive planning and design project involving urban planning and land development. The project includes a variety of realistic constraints such as economic factors, safety, reliability, aesthetics, ethics, and social impact. The projects involve the technical details of land subdivision, streets and highways, drainage, and structures and foundations. The projects are designed to develop student creativity and team participation. A final written report and oral presentation are required.

Sophomore Year

Fall Semester		*Credits*
CVEN 209	Engineering Math and Computer Methods	3
ELEN 201	Electric Circuits I	3
ENGR 241	Statics	3
MATH 221	Calculus III	4
Elective	Humanities or Social Science	3
	Fall Semester Total:	**16**
Spring Semester		
CVEN 204	Highway Geometrics and Surveying	4
ENGR 242	Dynamics	3
ENGR 243	Mechanics of Materials	3
MATH 224	Introduction to Applied Mathematics	4
Elective	Humanities or Social Science	3
	Spring Semester Total:	**17**

Junior Year

Fall Semester		
CVEN 341	Structural Analysis I	3
CVEN 371	Construction Materials	2
CVEN 381	Environmental Engineering I	4
ENGR 213	Thermodynamics	3
ENGR 344	Fluid Mechanics	3
Elective	Humanities or Social Science	3
	Fall Semester Total:	**18**
Spring Semester		
CVEN 342	Structural Analysis II	3
CVEN 348	Geoenvironmental Engineering	4
CVEN 346	Hydraulic Engineering	4
CVEN 380	Structural Steel	3
Elective	Humanities or Social Science	3
	Spring Semester Total:	**17**

Senior Year

Fall Semester

CVEN 421	Transportation Engineering	3
CVEN 443	Reinforced Concrete	3
CVEN 447	Foundation Engineering	3
CVEN 491	Structural Design I	3
Elective*	Technical	3
	Fall Semester Total	**15**

Spring Semester

CVEN 414	Engineering Professional Practice	1
CVEN 461	Civil Engineering Design	4
Elective*	Technical	3
Elective*	Technical	3
Elective	Humanities or Social Science	3
Elective	Humanities or Social Science	3
	Spring Semester Total	**17**
	Total Credits:	**134**

**Technical electives must be approved by the departmental faculty adviser.*

ROTC students may receive up to 6 credits for their ROTC courses.

Minors

There are established minors in business management and mathematics and an established second major in mathematics. Other minors may be arranged on request by mutual consent of the Department of Civil and Environmental Engineering and the department in which the minor is to be taken.

Curriculum – Environmental Engineering

The environmental engineering program is administered by the Department of Civil and Environmental Engineering. The environmental engineering curriculum was born of the need to provide professional engineers for the solution of our nation's and world's environmental problems.

The undergraduate environmental engineering curriculum is designed for students interested in the professional practice of environmental engineering as well as for those students who are interested in a teaching or research career. The areas covered include water and wastewater engineering, hazardous waste engineering and air pollution control engineering. The students are encouraged to take elective courses in the area of environmental science, chemical engineering and public health engineering.

Capping the program are design projects requiring a synthesis of concepts studied in the curriculum with an application based on comprehensive design analysis and evaluation. The several design courses at the senior level are aimed at emphasizing an integrated approach in the prevention and mitigation of environmental problems. In addition to computer modeling, the curriculum includes laboratory courses to provide experience in chemical and biological remediation, geoenvironmental engineering and hydraulics. The curriculum includes courses from the Chemical Engineering Department. Courses such as Unit Operations and Stoichiometry are designed to help the students to understand the fundamentals of chemical and biological processes suitable for application in environmental engineering.

Sophomore Year

Fall Semester		*Credit*
CVEN 207	Introduction to Environmenta Engineering	2
CENG 211	Stoichiometry	3
ENGR 241	Statics	3
CHEM 241	Organic Chemistry	3
CHEM 243	Organic Chemistry Lab	1
MATH 221	Calculus III	4
	Fall Semester Total:	**16**
Spring Semester		
ENGR 242	Dynamics	3
ENGR 243	Mechanics of Materials	3
CENG 232	Unit Operations I	3
CHEM 250	Environmental Chemistry	3
MATH 224	Introduction to Applied Mathematics	4
	Spring Semester Total:	**16**

Junior Year

Fall Semester		
CVEN 209	Engineering Math and Computer Methods	3
CVEN 381	Environmental Engineering	3
ENGR 213	Thermodynamics	3
ELEN 201	Electric Circuits I	3
Elective	Humanities or Social Science	3
Elective	Humanities or Social Science	3
	Fall Semester Total:	**18**
Spring Semester		
CVEN 348	Geoenvironmental Engineering	4
CVEN 346	Hydraulic Engineering	4
CENG 334	Unit Operations III	3
CVEN 382	Environmental Engineering Lab	3
Elective	Humanities or Social Science	3
	Spring Semester Total:	**17**

Senior Year

Fall Semester		
CVEN 424	Design of Physical and Chemical Treatment Systems	4
CVEN 451	Groundwater Hydrology	3
CVEN 436	Meteorology and Air Pollution	3
Elective*	Technical	3
Elective	Humanities or Social Science	3
	Fall Semester Total:	**16**
Spring Semester		
CVEN 414	Engineering Professional Practice	1
CVEN 438	Design of Air Pollution Control Systems	3
CVEN 452	Environmental Engineering Design	4
Elective*	Technical	3
Elective	Humanities or Social Science	3
Elective	Humanities or Social Science	3
	Spring Semester Total:	**17**
	Total Credits:	**134**

** Technical electives must be approved by the faculty advisors. A list of acceptable electives is available in the Department.*

ROTC students may receive up to 6 credits for their ROTC courses.

Faculty and Course Descriptions

Office: Suite 206, Civil Engineering Building

Phone: (504) 865-5778

Fax: (504) 862-8941

Professors

Robert Nolan Bruce, Jr., P.E., Ph.D., University of Illinois, 1962; Civil Engineering, Catherine and Henry Boh Professor of Civil Engineering, Structural Engineering, Reinforced and Prestressed Concrete, Behavior of Bridge Structures, Prestressed Piling and Splices, Structural Applications of Autoclaved Aerated Concrete.

John H. Grubbs, P.E., Ph.D., Rensselear Polytechnic Institute, 1986, Civil and Environmental Engineering, Water and Wastewater Engineering, Computer Aided Design, Structural Systems, Mechanical Systems.

John Louis Niklaus, PE., Ph.D., University of Washington, 1967; Civil Engineering, Computer Applications in Civil Engineering, Computer Graphics, Transportation Engineering, Urban Planning.

Associate Professors

Reda Mohamed Aly Bakeer, P.E., Ph.D., Syracuse University, 1985; Civil Engineering, Geotechnical and Geoenvironmental Engineering, Numerical Analysis and Computer Methods in Engineering, Soil-Structure Interaction, Soil Dynamics, Expert Systems.

Sanjoy Kumar Bhattacharya, P.E., Ph.D., Drexel University, 1985; Civil Engineering, Bioremediation, Hazardous Waste Management, Water and Wastewater Treatment, Industrial Waste Treatment, Biological Waste Treatment, Global Environmental Changes.

Assistant Professors

Glen R. Boyd, PE., Ph.D., Clemson University, 1991 Environmental Systems Engineering

Laura J. Steinberg, Ph.D., Duke University, 1993; Environmental Engineering, Water and Wastewater Engineering, Water Quality Modeling, Statistical Modeling.

CVEN 204 Highway Geometrics and Surveying (4) Lecture 3, laboratory 3.

Prerequisite: CPSC 101 or equivalent. This course is divided into three components: 1) An introduction to civil engineering design graphics using AutoCAD and computer-aided design computations using various computer software packages (EXCEL, COGO, PC-Plus, etc.); 2) An introduction to the concepts of surveying instruments and measurements; 3) An introduction to the principles of highway engineering and traffic analysis. Surveying field work is conducted in elementary surveying operations. A highway geometric design project is assigned to introduce the students to the elements of the civil engineering design process.

CVEN 207 Introduction to Environmental Engineering (2) Lecture 2.

This course introduces students to methods used for environmental engineering design, and provides coverage of a broad range of environmental engineering applications. Topics include engineering decision-making, ethical analysis, water quality, solid waste, air pollution, and wastewater treatment.

CVEN 209 Engineering Math and Computer Methods (3) Lecture 3.

Prerequisite: CPSC 101 or equivalent. Applications of numerical analysis and computer programming techniques to practical civil and environmental engineering problems. Review of the required mathematical background is presented with emphasis on numerical modeling and computer oriented solutions. Topics covered include precision and accuracy, errors, roots of equations, solution of linear algebraic equations, statistics and curve fittings, numerical integration and differentiation and solution of differential equations. Students are required to develop their own computer programs.

CVEN 341 Structural Analysis I (3) Lecture 3.

Prerequisites: ENGR 241, ENGR 243. Development of the fundamental principles of statics and materials in relation to structures of a statically determinate nature. Types of structures and types of loads. Reactions, shears, and moments. Truss types and stability. Truss analysis. Influence lines for beams. Moving loads. Statically determinate structural members as used in bridges, buildings, and other structures. Introduction to specifications and the structural requirements of building codes. Introduction to statically indeterminate structures.

CVEN 342 Structural Analysis II (3) Lecture 3.

Prerequisites: CVEN 341, CVEN 371, ENGR 243. Indeterminate structures. Deformations of structures and structural members. Visualization of elastic shape, radius of curvature, and curvature between moment and curvature. Moment-area theorems and corollaries. Conjugate beam analogy. Unit load method. Slope deflection. Moment distribution. Lateral load analysis. Two-cycle moment distribution. Matrix analysis. Combination of gravity load moments and shears, and wind load moments and shears on framed structures: Deflections. Computer applications.

CVEN 346 Hydraulic Engineering (4) Lecture 3, Laboratory 3.

Prerequisite: ENGR 344. Flow in channels, energy concepts, momentum concepts, hydraulic jump, flow under a sluice gate, frictional resistance to flow, flow measuring devices, selection and testing of rotodynamic pumps, measurement and instrumentation, dimensional analysis, hydraulics of wells, movement of ground water, hydraulic structures.

CVEN 348 Geoenvironmental Engineering (3) Lecture 3, laboratory 1.

Prerequisites: CENG 331, ENGR 243. Introduction to behavior and properties of soils. A brief overview of geological processes explains the formation of rocks and soils. The major topics covered are: basic engineering properties of soils, soil classification, shear strength, stress distribution in soil masses, seepage, consolidation, and slope stability analysis. The laboratory component includes experiments to classify soils, to determine their mechanical properties, and to assess their suitability as construction materials. Emphasis will be placed on environmental problems with soils.

CVEN 371 Construction Materials (2) Lecture 1, Laboratory 3.

Prerequisite: ENGR 243. A basic consideration of forces and factors which control the strength, behavior, and stability of material in the solid state; followed by a more specific consideration of the characteristic properties of metals, concrete, asphalt, and wood. The laboratory is devoted to the testing of materials under various types of loading.

Tension, compression, shear, torsion, bending, buckling, hardness, impact, creep and fatigue tests are demonstrated.

CVEN 380 Structural Steel (3) Lecture 3. -

Prerequisites: CVEN 341, CVEN 371, ENGR 243. Corequisite: CVEN 342. A basic course covering the fundamental theories and principles necessary for the design of component parts of steel structures. The design of beams, columns and their connections is treated in detail with emphasis on allowable stress design. The course also includes an introduction to plastic analysis and design.

CVEN 381 Environmental Engineering (3) Lecture 3.

Physical, chemical, and biological characteristics of water and waste water. Stoichiometry, reaction kinetics, and material balances. Movement of contaminants in the environment. Physical, chemical and biological treatment methods.

CVEN 382/383 Environmental Engineering Laboratory (3-Envr, 1-Civil) Lab 3

Prerequisite: CVEN 381. This laboratory course is a natural follow-on to CVEN 381. Concepts discussed in CVEN 381 are replicated in the laboratory. Water quality is - measured in terms of physical, chemical, and biological quality. Additional requirements are given to environmental students.

CVEN 408 Water Quality Modeling (3) Lecture 3.

Prerequisite: MATH 224. The equations and assumptions (chemical, physical, biological, and mathematical) underlying water quality models are studied. The students apply the models to a variety of hydrologic settings, including lakes, rivers, bays, and estuaries. Loadings of water quality parameters are modeled as steady-state, step functions, and transient loadings. Contaminant fate and transport processes affecting nutrients, bacteria, sediments, and toxics are studied in the course.

CVEN 414 Engineering Professional Practice (1) Lecture 1.

Guest and faculty speakers focus on problems and situations encountered in professional engineering practice. Ethics in engineering is interwoven throughout the course. The students are also required to give short presentations.

CVEN 421 Transportation Engineering (3) Lecture 3.

Introduction to technological, economic, and social aspects of transportation systems. Planning, design, construction, maintenance, and operation of facilities for air, water, rail, and highway transportation systems. Problems of urban transportation. Consideration of urban-transportation planning models. Analysis of traffic problems and traffic control systems. Computer modeling of transportation systems.

CVEN 424 Design of Physical and Chemical Treatment Systems (4) Lecture 3, design laboratory 1.

Prerequisite: Senior standing. Design of sedimentation tanks, filtration systems, coagulation process, adsorption and ion exchange process, membrane processes, chemical oxidation, disinfection, aeration and gas transfer, and sludge treatment. Design problems are open ended; appropriate estimates of data are required.

CVEN 433 Biological Principles of Environmental Engineering (3) Lecture 3.

Prerequisite: Senior standing. Introduction to the fundamentals of biochemistry, microbiology and organic chemistry. The biochemistry component will examine degradation pathways of proteins, carbohydrates and fats. The effects of bacteria, viruses, algae and other organisms important to water, wastewater and hazardous waste

treatment is discussed in the microbiology section. The organic chemistry unit will cover the physical and chemical properties of environmentally important compounds.

CVEN 436 Meteorology and Air Pollution (3). Lecture 3.

Introduction to the basic principles of meteorology and its relation to problems associated with air pollution. The major topics include atmospheric composition and structure, atmospheric stability and dynamics, air pollution phenomena and control devices, global change and policy/regulations related to air pollution. A real-world design problem requires the use of air pollution modeling programs.

CVEN 438 Design of Air Pollution Control Systems (3). Lecture 3.

Advanced topics related to the design of control systems of air pollutants from mobile and stationary sources. Human health effects and federal guidelines regulating exposures are addressed. Federal regulations impacting environmental emissions and occupational safety are emphasized in student problem solving. Specific design problems are required related to vapor and particulate matter control.

CVEN 443 Reinforced Concrete (3) Lecture 3.

Prerequisites: CVEN 342, CVEN 371, ENGR 243. This course includes a study of the basic mechanics and performance of reinforced concrete with an emphasis on ultimate-strength design methods. Attention is given to the economic and scientific proportioning of those component parts which form the complete concrete structure. The design of slabs, beams, columns and foundations is treated in detail.

CVEN 447 Foundation Engineering (3) Lecture 3.

Prerequisite: CVEN 344. Design of foundations and earth retaining structures. Major areas covered are design of shallow and deep foundations, theory of lateral earth pressure and design of retaining walls, temporary earth retaining structures and excavations. New technologies for soil and site improvement such as geosynthetics are introduced. Classwork includes a foundation design project.

CVEN 451 Groundwater Hydrology(3) Lecture 3.

Prerequisite: CHEM 107, 108, MATH 121, 122 or equivalent. Occurrence of water in the near-surface environment; saturate and unsaturated flow in aquifers; aquifer characterization; well hydraulics; and groundwater chemistry.

CVEN 452 Environmental Engineering Design (4) Lecture 3, design laboratory 1.

Prerequisite: Senior standing. Detailed design of engineered systems for environmental protection. Design problems are open-ended and require students to determine the data that are needed, obtain the data when available, or make appropriate estimates in the absence of data. Designs include water, wastewater and hazardous waste treatment facilities.

CVEN 454 Environmental Impact Assessment (3) Lecture 3.

Prerequisite: Senior standing. This course prepares students to work as a member of an interdisciplinary team preparing an Environmental Impact Statement or Environmental Impact Assessment. Students are taught methods for quantifying the impact of engineering projects on water quality, air quality, soil, the noise environment, and the socio-economic environment. The evolution of the National Environmental Policy Act and its implementation are discussed. The role of public participation is emphasized. Readings include the course text and actual EIS's.

CVEN 461 Civil Engineering Design (4) Lecture 2, design laboratory 3.

Prerequisite: Senior standing. A comprehensive planning and design project involving planning and land development; traffic and transportation design; and structural design. The project includes a variety of realistic constraints such as economic factors, safety,

reliability, aesthetics, ethics, and social impact. The projects involve the technical details of land subdivision, streets and highways, structures and foundations. Also included are economic feasibility and project scheduling.

CVEN 491 Structural Design 1(3) Lecture 2, design laboratory 3.

Prerequisites: CVEN 342, CVEN 380, CVEN 443, CVEN 447 (CVEN 443 and CVEN 447 may be taken concurrently). This course is a synthesis of analytical and design concepts which have been presented throughout the undergraduate curriculum. Student projects include the preparation of design analysis and drawings for several major structures in accordance with current design practice. Typical designs include multistory steel buildings and highway bridges. Projects include the evaluation and selection of alternative framing methods, materials and types of foundations. Inspection trips are scheduled to nearby construction projects and fabricating plants when possible.

CVEN 492 Structural Design II (3) Lecture 2, design laboratory 3.

Prerequisite: CVEN 491. A continuation of course CVEN 491 and also a synthesis of analytical and design concepts. Projects include the design of at least one major structure in accordance with current design practice. Typical designs include multistory reinforced concrete buildings or alternative team projects. Extensive use is made of microcomputer applications in both the analysis and design stages. Team projects, if assigned, conclude with formal oral presentations. Inspection trips are scheduled to nearby construction projects when possible.

CVEN 601 Advanced Indeterminate Structures 1(3) Lecture 3.

Prerequisite: CVEN 342. This course provides the student with the basic fundamentals necessary to analyze those types of structures which cannot be completely analyzed by the use of the laws of static equilibrium alone. Methods covered are; deflection method, strain energy, Castigliano's Theorems, theorem of three moments, slope deflection, moment distribution, column analogy, etc. The effects of varying moment of inertia, sidesway, varying end conditions, and elastic supports are to be considered for various structures.

CVEN 602 Writing for Engineers

This course teaches students to write with clarity and polish. Organization of ideas, persuasive argumentation, and clarity of thought are emphasized and practiced with writing assignments and analyses. Applications to research papers, biographical sketches, engineering reports, and correspondence are emphasized.

CVEN 603 Advanced Reinforced Concrete (3) Lecture 3.

Prerequisites: CVEN 342, CVEN 443. Advanced topics in mechanics and behavior of reinforced concrete. Continuous beams, one-way and two-way slabs. Limit analysis and design. Shear friction, deep beams. Introduction to prestressed concrete. Coverage includes both the ultimate-strength and working-strength design methods.

CVEN 606 Prestressed Concrete (3) Lecture 3.

Prerequisite: Approval of instructor. Mechanics and behavior of prestressed concrete structures. Behavior and analysis of precast pretensioned concrete members. Behavior and analysis of post-tensioned members. Details of precast concrete connections. Continuous beams and frames, slabs, and axially loaded members. Deflections. Precast construction.

CVEN 608 Water Quality Modeling (3) Lecture 3.

Prerequisite: MATH 224. The equations and assumptions (chemical, physical, biological, and mathematical) underlying water quality models are studied. The students apply the models to a variety of hydrologic settings, including lakes, rivers, bays, and estuaries. Loadings of water quality parameters are modeled as steady state, step functions, and

transient loadings. Contaminant fate and transport processes affecting nutrients, bacteria, sediments, and toxics are studied in the course.

CVEN 610 Environmental Statistics (3) Lecture3.

Prerequisite: MATH 301 or equivalent. This course prepares students for independent study in statistics for application to their graduate research projects. Statistical methods of importance to environmental engineers and scientists are studied. Topics include advanced linear regression, design of experiments, sampling design, and spatial analysis. Applications to actual environmental problems are stressed, and the students are introduced to the software package SPLUS.

CVEN 611 Spatial Analysis Principles (3) Lecture 3.

Prerequisite: Approval of instructor. This course provides students with an understanding of computer-based spatial analysis and the role it plays in enhancing our ability to solve civil and environmental engineering problems. Spatial and image analysis techniques at a macro level are described. Students are exposed to solution methodologies for selected problems. Analytical tools used in class include geographic information systems (GIS), 2-D spatial modeling, image processing, inferential techniques, geostatistics, databases, and volume rendering of subsurface stratigraphy.

CVEN 613 Advanced Soil Mechanics (3) Lecture 3.

Prerequisite: Approval of instructor. An overview of the origin, nature, fabric, structure and classification of soils is presented. The water effects on soils including: capillarity, shrinkage, swelling, permeability and the concept of effective stresses principle are covered as fundamentals to soil behavior. Stresses in soil, stress-strain relationships, stress paths, and failure criteria are discussed in detail. The course provides an emphasis on the topics of consolidation and shear strength of soils. Finally, these two topics are presented within a common framework as an introduction to Critical State Soil Mechanics.

CVEN 614 Advanced Foundation Engineering (3) Lecture 3.

Prerequisite: Approval of instructor. Advanced topics in foundation engineering. The first part is devoted to the design of various types of shallow footings such a~ isolated, strip, and mat foundations. The second part emphasizes the design of deep foundations including piles, piers, shafts, and caissons. Special topics such as beams on elastic foundations, micropiles, soil nailing, and foundations on expansive soils are discussed.

CVEN 615 Soil and Site Improvement (3) Lecture 3.

Prerequisite: Approval of instructor. The study of soil and ground modification techniques. Methods to improve marginal soils and sites are presented, including: compaction, deep densification, dynamic consolidation, chemical stabilization, admixtures such as cement; asphalt and fly ash, pre-consolidation, biological stabilization, thermal stabilization, grouting, and earth reinforcement. The course also covers dewatering, wick and sand drains, electro-osmosis and other hydraulic modification techniques.

CVEN 616 Earth Structures (3) Lecture 3.

Prerequisite: Approval of instructor. Aspects of embankments and retaining structures design. Particular attention is given to excavations and embankments in poor soil conditions. The course includes an overview of slope stability analyses and design of earth dams. Computer programs are used to solve some of the assignments and a design project is required.

CVEN 617 Matrix Structural Analysis (3) Lecture 3.

Prerequisite: CVEN 342. A review of matrix algebra as it pertains to the analysis of statically indeterminate structures. A study of forces and the associated generalized

deflections of a structure which is defined in a system of discrete coordinates. The forces and deflections are related to each other through a set of influence coefficients called stiffness coefficients and flexibility coefficients. Both stiffness (displacement) and flexibility (force) methods are to be applied to the analysis of various structures.

CVEN 620 Ground Water Contaminant Fate and Transport (3) Lecture 3.

Prerequisite: Approval of instructor. Principles of mass transport and contaminant hydrogeology. Topics will include a review of mathematics and flow equations for flow, sources of ground water contamination, contaminant transport in saturated media, transformation, retardation and attenuation of solutes, flow and mass transport in the vadose zone, multiphase flow, inorganic and organic chemicals in ground water, monitoring and remediation strategies.

CVEN 624 Waste Disposal Facilities (3) Lecture 3.

Prerequisite: Approval of instructor. The classic containment approach to solid waste disposal is presented from the design and construction perspectives, including: subsurface characterization, soil properties and requirements, site preparation and improvement. Other design topics include: clay and geosynthetic liner systems, landfill covers and flow control systems. More innovative approaches to solid waste disposal are also covered such as: deep well injection, in-situ treatment and beneficial reuse of waste materials.

CVEN 626 Water Quality and Resources Management (3) Lecture 3.

Prerequisite: Senior standing. This course provides an overview of water quality and water resources issues and introduces practical applications of environmental engineering principles for addressing water quality concerns.

CVEN 630 Engineering Use of Geosynthetics (3) Lecture 3.

Prerequisite: Approval of instructor. Use of geosynthetics in geo-environmental applications. The course introduces the concept of improving soil strength by using geotextiles and geogrids. Field applications such as reinforcing earth embankments, roads, and waste containment facilities are discussed. The course covers the use of geotextiles, geomembrane and wick drains to control water flow and seepage.

CVEN 631 Dynamics of Structures (3) Lecture 3.

Prerequisite: CVEN 342. Mathematical formulation of the differential equations of equilibrium of various structures. Numerical solution of simple systems. Closed form solution of equations of equilibrium for single and multi-degree systems. Natural frequencies and mode shapes of the structures are obtained from the solution of the eigenvalue problems. Normal mode method of analysis is introduced. An overview of soil/structure interaction will be presented.

CVEN 634 Design of Air Pollution Control Systems (3) Lecture 3.

Prerequisite: Approval of instructor. With a brief introduction to the regulatory aspects of air pollution this course emphasizes the design approaches used for air pollution control systems. The health effects of air pollution are also discussed. Students are required to write a term paper.

CVEN 636 Environmental Restoration and Nuclear Waste Storage Facility (3) Lecture 3.

Prerequisite: Approval of instructor. A review of the behavior of underground and above the ground concrete or steel structural facilities, with case studies for long-term disposal of radioactive waste.

CVEN 644 Industrial Waste Treatment (3) Lecture 3.

Prerequisite: Approval of instructor. The application of standard engineering techniques to specific industrial wastes. Best available treatment techniques which are discussed

include waste surveys, waste reduction, neutralization, equalization, and joint treatment. Individual student reports are required in which the current state-of-the-art treatment for particular industrial wastes is presented.

CVEN 648 Biological Treatment Processes (3) Lecture 3.

Principles of bio-remediation; limitations, advantages of combining with other processes. Case studies are integrated into the course. Students are required to write a term paper.

CVEN 651 Groundwater Hydrology(3) Lecture 3.

Prerequisite: CHEM l07~ 108, MATH 121, 122 or equivalent. Occurrence of water in the near-surface environment; saturated and unsaturated flow in aquifers; aquifer characterization; well hydraulics; and groundwater chemistry.

CVEN 654 Environmental Impact Assessment (3) Lecture 3.

Prerequisite: Senior standing. This course prepares students to work as a member of an interdisciplinary team preparing an Environmental Impact Statement or Environmental Impact Assessment. Students are taught methods for quantifying the impact of engineering projects on water quality, air quality, soil, the noise environment, and the socio-economic environment. The evolution of the National Environmental Policy Act and its implementation are discussed. The role of public participation is emphasized. Readings include the course text and actual EIS's.

CVEN 660 Theory of Elastic Stability (3) Lecture 3.

Prerequisite: Approval of instructor. Introduction to the principles, theory and design methods that are the basis for the stability analysis of beam columns, frames, built-up columns, rings and arches.

CVEN 673 Design of Engineering Systems (3) Lecture 3.

Prerequisite: Approval of instructor. Introduction of operations research and construction management principles. Discussion of linear, dynamic, integer, and non-linear programming and their application to civil engineering problems. Computer methods such as SIMPLEX are used to analyze operational and management problems in civil engineering projects.

CVEN 674 Management of Engineering Projects (3) Lecture 3.

Prerequisite: Approval of instructor. An introduction to advanced techniques for solving complex problems encountered in the management of large systems of men, machines, materials and capital. The analysis of networks and the use of PERT and CPM in solving project management problems are covered. Classwork includes homework on related problems and a major design project of an actual civil engineering scheduling problem.

CVEN 681 Advanced Steel Design (3) Lecture 3.

Prerequisite: Approval of instructor. Current load and resistance factor steel design specifications are considered and are related to the basic behavior of the structure and component parts. Both allowable-stress design and plastic design concepts are covered with primary emphasis given to limit-state design. Topics include steel properties, tension and compression members, beams, connections, and composite design.

CVEN 683 to Bridge Engineering (3) Lecture 3.

The course covers topics related to bridge engineering with emphasis on modern highway bridges. The course covers the design of reinforced concrete, prestressed concrete and steel bridges. The students are required to design each of these types of highway bridges.