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Department of Civil, Architectural and Environmental Engineering

- Programs available in Architectural Engineering, Civil Engineering, Construction Engineering and Management, Environmental Engineering, Geoenvironmental Engineering, Geotechnical Engineering, Public Works, Structural Engineering, and Transportation Engineering
- Convenient location and class times
- Just one class needed to renew P.E. and S.E. licenses
- Scholarships available for qualified part-time applicants

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WHY ILLINOIS INSTITUTE OF TECHNOLOGY?

Illinois Institute of Technology is a top provider of graduate-level education for professionals in technical fields. Our interdisciplinary approach is grounded in the reality of the working world, where teams of professionals from various disciplines work together to solve problems, develop new processes and improve productivity.

ADMISSION REQUIREMENTS

Cumulative undergraduate GPA minimum: 3.0/4.0

GRE minimum score:

For tests taken prior to Oct.1, 2002, M.S./MAS/Ph.D.: 1200 (combined)

For tests taken on or after Oct.1, 2002, M.S./MAS: 900 (quantitative + verbal) 2.5 (analytical writing)

For tests taken on or after Oct.1, 2002, Ph.D.: 1000 (quantitative + verbal) 3.0 (analytical writing)

TOEFL minimum: 550/213*

IELTS minimum: 6**

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of many factors considered.

Admission to graduate degree programs normally requires a Bachelor of Science degree in civil engineering from an institution accredited by Accreditation Board of Engineering and Technology (ABET). The master's programs in construction engineering and management and in architectural engineering also accept a bachelor's degree in architecture. Students who have completed an accredited program in a related field or in a foreign school may be admitted on a provisional status until any deficiencies in preparation are removed.

Every full-time graduate student is assigned a faculty adviser by the department chair at the time of initial registration. All part-time or non-degree students who have not been assigned an adviser and who intend to pursue a program toward a degree should contact the department chairman for counseling before registering for courses. Departmental seminars and colloquia are conducted on a regular basis each semester. All full-time graduate students are expected to register for CAE 593 each semester and attend these seminar meetings regularly.

* Paper-based test score/computer-based test score.

** International English Language Testing System is acceptable from areas where TOEFL testing is not available.

PROFESSIONAL MASTERS (no thesis required)

Eight Professional Master's Degree Programs Provide Specialized Preparation

The Department of Civil, Architectural and Environmental Engineering offers eight different professional master's programs specifically designed to provide advanced professional preparation in specialized areas of civil engineering practice. Each program requires 32-33 credit hours of course-only study. Because the programs are geared toward practical application in business and industry, no thesis or comprehensive exam is required.

Students complete a set of required core courses. Additional courses are selected from a broad range of electives chosen with an adviser to meet each student's specific objectives.

Master of Architectural Engineering (Core Courses)

CAE 471 Construction Planning and Scheduling
CAE 531 Physical Performance of Buildings
CAE 542 Acoustics and Lighting
CAE 574 Economic Decision Analysis in Civil Engineering
(Four fields of concentration)

Master of Construction Engineering and Management (Core Courses)

CAE 570 Legal Issues in Civil Engineering
CAE 574 Economic Decision Analysis in Civil Engineering
CAE 575 Systems Analysis in Civil Engineering
CAE 577 Construction Equipment Management

Master of Environmental Engineering

The requirements are the same as those for the M.S. in Environmental Engineering degree, with the following exceptions:

At least 18 credit hours must be taken in 500-level courses in environmental engineering, and the thesis work should be replaced by six to eight hours of coursework or a project.

The student may choose courses in any of the areas of specialization listed for the M.S. programs. Undergraduate courses may sometimes be used to fulfill graduate program requirements in order to overcome deficiencies or to broaden the candidate's background. The limit is 12 credit hours in courses numbered 400—499.

Master of Geotechnical Engineering (Core Courses)

CAE 562 Engineering Behavior of Soils
CAE 564 Design of Foundations, Embankments and Earth Structures

CAE 565 Rock Mechanics and Tunneling
CAE 566 Earthquake Engineering and Soil Dynamics

Master of Geoenvironmental Engineering (Core Courses)

CAE 562 Engineering Behavior of Soils
CAE 567 Physico-Chemical Behavior of Soils
CAE 589 Groundwater Hydrology and Sampling
CAE 590 Geotechnical Landfill Design and Maintenance

Master of Public Works (Infrastructure Engineering and Management) (Core Courses)

CAE 574 Economic Decision Analysis in Civil Engineering
CAE 575 Systems Analysis in Civil Engineering
PA 501 Introduction to Public Administration
PA 551 Public Works Management

Students may choose to take courses in several civil engineering areas or may decide to specialize in Construction Management, Structural Engineering, Geotechnical/Geoenvironmental Engineering, or Transportation Engineering.

Master of Structural Engineering (Core Courses)

MMAE 504 Engineering Analysis 1A
CAE 503 Advanced Structural Theory and Design
CAE 518 Advanced Reinforced Concrete
CAE 525 Advanced Steel and Composite Structures

Master of Transportation Engineering (Core Courses)

CAE 543 Demand Models for Urban Transportation
CAE 546 Public Transportation Systems
CAE 548 Transportation Systems Management
CAE 575 Systems Analysis in Civil Engineering

MASTER OF SCIENCE (32 credit hours and Thesis)

The department also offers two traditional master's programs with a thesis requirement.

MS in Civil Engineering

Five technical areas (construction, architectural, geoenvironmental, geotechnical, structural and transportation engineering) are included in the M.S. program. Degree candidates in the Master of Science program must complete a minimum of 32 credit hours, six to eight of which are for research and thesis. Up to 12 credit hours of 400-level undergraduate coursework [except CAE 431 (Steel and Timber Design) and CAE 432 (Concrete and Foundation Design)] may be included in the M.S. program with prior adviser approval. An oral defense of the thesis constitutes the comprehensive examination, and no additional written comprehensive examination is required.

MS in Environmental Engineering

The objective of this program is to enable the student to build a strong foundation in multiple areas of environmental engineering and to specialize in one area via research and thesis. Candidates are required to take a total of 32 credit hours, 15 credits of which must be for the environmental engineering core courses listed below, and six to eight credit hours must be in research and thesis work.

Core courses

ENVE 426* Statistical Tools for Engineers

ENVE 501 Environmental Chemistry

ENVE 506 Chemodynamics

ENVE 542 Physicochemical Processes in Environmental Engineering

ENVE 580 Hazardous Waste Engineering

* Students with background in statistics (before joining the graduate program) equivalent to ENVE 426 will be required to take ENVE 527 as a core course (in place of ENVE 426). Students should consult the course descriptions for details.

The student must have a minimum grade point average of 3.0/4.0 in the core areas. Aside from the core courses, coursework may be selected (with adviser approval) to satisfy the needs of the individual student or may be concentrated in one of the areas of specialization available in the department, including: Air Pollution Engineering; Chemical Engineering; Energy/Environment/Economics (E3); Environmental Chemistry; Environmental Resource Management; Hazardous Waste Engineering; and Water and Wastewater Engineering.

Undergraduate courses may sometimes be used to fulfill graduate program requirements. The limit is six credit hours in courses numbered 400—499. A thesis may be completed outside the department only by special arrangement with the department chair. The successful M.S. degree candidate will complete a thesis based on research as well as an oral defense of the thesis, under the direction of the thesis examining committee.

DOCTORAL PROGRAMS

The **Ph.D. in Civil Engineering** (96 credit hours) is awarded in recognition of a high level of mastery in the field of civil engineering and upon demonstration of a distinct ability to make substantial creative contributions to knowledge in the field. The Ph.D. recipient will be capable of a continuing effort toward the advancement of knowledge and continuing achievement in research and other scholarly activities. This program is appropriate for students with master's degrees in civil engineering

CIVIL, ARCHITECTURAL AND ENVIRONMENTAL ENGINEERING

who are interested in pursuing an academic or industrial research career. The doctoral degree can be pursued in any of the four major areas: Construction, Structural, Geotechnical, and Transportation Engineering.

The full-time doctoral program generally consists of two complete years of academic preparation, followed by one year of full-time research in residence at IIT. To be admitted to candidacy, students must successfully complete a qualifying examination; the department may waive this requirement for students who hold an M.S. degree from IIT in the same field. This examination should be completed within a year of entry into the program. After a student is admitted to candidacy, the department appoints a permanent committee consisting of at least two faculty members of the department and representatives of faculty in the minor fields. The advisory committee may permit the student to initiate research at any time after admission to candidacy when, in the committee's opinion, he or she has achieved adequate preparation. Academic preparation normally includes the equivalent of one year of coursework, with civil engineering as the major field, as well as preparation in such minor fields as applied mathematics or solid mechanics.

The student should discuss the choice of a research adviser with the advisory committee before making his or her selection. The research adviser, if not already a member of the committee, will be added at this time. The research project must be in harmony with the interests of the faculty and with the facilities of the department. Off-campus research for the dissertation is possible if and only if approved by the entire faculty advisory committee. In those cases, the student must register for CAE 691 during each semester in which the thesis is being prepared. The comprehensive examination must be completed at least one year prior to the date of graduation.

The **Ph.D. in Environmental Engineering** (84 credit hours) is awarded in recognition of mastery in environmental engineering and upon demonstration of an ability to make substantial creative contributions to knowledge in environmental engineering. The recipients of these degrees will be capable of a continuing effort toward advancement of knowledge and achievement in research while pursuing an academic or industrial research career. The program should satisfy the following requirements: environmental engineering study, 30—40 percent; research, 40—50 percent; other fields of study, 10—30 percent. The coursework must include up to 18 credits of core environmental engineering courses.

For the Ph.D. in Environmental Engineering, in addition to the core courses listed in Master of Science in Environmental Engineering, students must take ENVE 527 Statistical Analysis of Systems.

CERTIFICATE PROGRAMS

Certificate programs require only 9 – 12 credit hours that may be selected from a variety of classes. For professionals with experience in civil engineering or a related field, certificate programs offer a fast way to increase knowledge and skills in a specific area. The department offers certificate programs in: Air Resources, Architectural Engineering, Construction Management, Earthquake and Wind Engineering, Environmental Engineering, Fire Protection and Safety Engineering, Geoenvironmental Engineering, Hazardous Waste Engineering, Infrastructure Engineering and Management, Transportation Systems Planning, and Waste and Wastewater Treatment.

Architectural Engineering

The purpose of this program is to provide additional education in Architectural Building systems Engineering, primarily for professions in the building engineering fields.

Required Course(s):

CAE 531 Physical Performance of Buildings
AND three courses from the following group:
CAE 461 Plumbing and Fire Protection Design
CAE 464 HVAC Design

CAE 507 Control of Sound and Vibrations in Buildings
CAE 509 Analysis and Design of Acoustic Spaces
CAE 521 Building Illumination Design
CAE 524 Design of Building Enclosures
CAE 526 Energy Conservation Design in Buildings
CAE 528 Communication and Electrical Systems in Buildings
CAE 542 Acoustics and Lighting
CAE 597 Special Topics in Architectural Engineering

Construction Management (Select four):

CAE 470 Construction Methods and Cost Estimating
CAE 471 Construction Planning and Scheduling
CAE 472 Construction Site Operation
CAE 473 Construction Project Administration
CAE 570 Legal Issues in Civil Engineering
CAE 571 Advanced Construction Scheduling and Control
CAE 572 Construction Cost Accounting and Control
CAE 573 Computer Applications in Construction
CAE 574 Economic Decision Analysis in Civil Engineering
CAE 575 Systems Analysis in Civil Engineering
CAE 577 Construction Equipment Management
CAE 578 Construction Claims Management

Air Resources

This program explores outdoor air quality, causes of outdoor air pollution, and investigative and diagnostic techniques used in outdoor air quality control. Students must take three courses (nine credits) to complete the certificate.

Required Course(s):

ENVE 570 Air Pollution Meteorology

AND two courses from the following group:

ENVE 502 Atmospheric Chemistry
ENVE 572 Ambient Air Monitoring
ENVE 575 Control of Toxic Air Pollution
ENVE 577 Design of Air Pollution Control Devices
ENVE 578 Physical and Chemical Processes for Industrial Gas Cleaning

Earthquake and Wind Engineering Design

Required Course(s) (Select four):

CAE 410 Introduction to Wind and Earthquake Engineering
CAE 420 Introduction to Dynamics of Structures
CAE 431 Steel and Timber Design
CAE 432 Concrete and Foundation Design
CAE 504 Seismic Retrofit and Earthquake Hazard Reduction
CAE 518 Advanced Reinforced Concrete
CAE 525 Advanced Steel and Composite Structures
CAE 582 Structural Wind and Earthquake Engineering

Geoenvironmental Engineering

Required Course(s):

CAE 567 Physicochemical Behavior of Soils
CAE 589 Ground Water Hydrology and Sampling
CAE 590 Geotechnical Landfill Design and Maintenance

AND one course from the following group:

ENVE 480 Solid Waste Engineering
ENVE 580 Hazardous Waste Engineering
ENVE 585 Groundwater Contamination and Pollutant Transport

Hazardous Waste Engineering

This program is an introduction to the characterization of hazardous waste sites, common and innovative remediation techniques, and current issues in hazardous waste engineering. Students must take three courses (nine credits) to complete the certificate.

Required course(s):

ENVE 580 Hazardous Waste Engineering

AND two of the following courses:

ENVE 506 Chemodynamics
ENVE 542 Physicochemical Processes in Environmental Engineering
ENVE 577 Design of Air Pollution Control Devices
ENVE 585 Groundwater Contamination

Indoor Air Quality

This program covers sick building syndrome, the causes of indoor air pollution, and investigative and diagnostic techniques used in controlling indoor air quality. Students must take three courses (nine credits) to complete the certificate.

Required Course(s):

ENVE 546 Industrial Hygiene

ENVE 576 Indoor Air Pollution

AND one course from the following group:

ENVE 426 Statistical Tools for Engineers **OR**
ENVE 527 Statistical Analysis of Systems
ENVE 575 Control of Toxic Air Pollution
MAE 452 Air Conditioning and Refrigeration
BIOL 514 Toxicology

Infrastructure Engineering and Management

Required Course(s):

PA 501 Introduction to Public Administration

PA 551 Public Works Management

AND two courses from the following group:

CAE 408 Bridge and Structural Design
CAE 508 Bridge Inspection, Rehabilitation, Repair and Management
CAE 419 Transportation Engineering and Design
CAE 541 Pavement Evaluation and Management
CAE 486 Soil and Site Improvement
CAE 590 Geotechnical Landfill Design and Maintenance
CAE 471 Construction Planning and Scheduling
CAE 574 Economic Decision Analysis in Civil Engineering
ENVE 405 Environmental Impact Assessment
ENVE 551 Design of Sanitary Engineering Process

Transportation Systems Planning

Required Course(s) (Select four):

CAE 419 Highway and Engineering Design
CAE 430 Probability Concepts in Civil Engineering Design
CAE 543 Demand Models for Urban Transportation
CAE 544 Urban Transportation Planning

CAE 549 Transportation Economics, Development and Policy
CAE 575 Systems Analysis in Civil Engineering

Waste and Wastewater Treatment

This program is an introduction to the biological and physical/chemical processes used in water and wastewater treatment, and the design of water and wastewater treatment processes. Students must take three courses (nine credits) to complete the certificate.

Required Course(s):

ENVE 513 Biotechnological Processes in Environmental Engineering

ENVE 542 Physicochemical Processes in Environmental Engineering

AND one of the following courses:

ENVE 551 Industrial Waste Treatment

ENVE 555 Industrial Waste Treatment Design Criteria

ENVE 561 Design of Sanitary Engineering Processes

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COURSE DESCRIPTIONS

Numbers in parentheses indicate class, lab and credit hours, respectively.

CAE 503

Advanced Structural Theory and Design

Introduction to the mechanics of solids. Energy methods and the calculus of variations. Ritz/Galerkin approximation methods. Introductory discussions on elastic stability and plate analyses. Prerequisite: CAE 310. Corequisite: MMAE 504. (4-0-4)

CAE 504

Seismic Retrofit and Earthquake Hazard Reduction

Selection of site-dependent earthquake for retrofit. Strength and ductility of aging structures. Cyclic behavior and modeling of structures under seismic loading. Performancebased retrofit criteria. Evaluating earthquake vulnerability of existing buildings and bridges. Upgrading lateral load-carrying systems. Conceptual basis for seismic isolation and energy-absorbing techniques and their applications in earthquake hazard reduction in existing bridges and buildings. Selection of retrofit methods. Case studies of seismic retrofit of typical buildings, bridges and industrial facilities using strength upgrading, energy dissipation devices and base isolation. Prerequisite: CAE 420, CAE 582 or instructor's consent. (4-0-4)

CAE 505

Infrastructure Rehabilitation Engineering

Repair and rehabilitation of existing deteriorated infrastructure building structures and facilities. Course will include identification of problems, investigative techniques, non-destructive testing methods, discussion of repair materials, and strengthening and preparation of rehabilitation documents. (2-0-2)

CAE 506

Building Envelope Rehabilitation Engineering

Repair and rehabilitation of existing building exterior envelopes. The course will include problem identification, investigative techniques, repair methods, preparation of remedial design documents, and general management of rehabilitation projects. Types of constructions include buildings, exterior walls, facades, cladding, roofing, plazas and others. (2-0-2)

CAE 507

Control of Sound and Vibration in Buildings

Basic sound physics and sound propagation in enclosed spaces. Sound and vibration sources in and out of buildings. Theories of sound transmission through building elements. Effects of noise and vibration on man and buildings, criteria

and standards. Design of noise control systems. Calculation of airborne and impact sound insulation. Noise and vibration control implementations in various indoor spaces, such as residential units, offices, schools and mechanical rooms. Prerequisite: CAE 542 or instructor's Consent. (3-0-3).

CAE 508

Bridge Inspection, Rehabilitation, Repair and Management

Elements of bridge management, rating and inspection process. Lifecycle, project-level and network-level analyses, condition assessment, case studies, and repair, retrofit and replacement alternatives, and their relation to infrastructure management. (3-0-3)

CAE 509

Analysis and Design of Acoustic Spaces

This course will discuss the design of acoustic spaces such as conference rooms, classrooms, lecture halls, music halls, theater, churches, recording studio, and home theater. Course covers the selection and determination of appropriate steady state, spatial, and temporal acoustic measures such as background noise levels, reverberation time, speech transmission index, and interaural cross correlation, as well as the selection of building materials and layout of rooms to meet those requirements. Prerequisite: CAE 542 or instructor Consent. (3-0-3).

CAE 510

Dynamics of Fire

Introduction to fire, physics and chemistry, and mass and heat transfer principles, fire fluid mechanic fundamentals, fundamentals and requirements of the burning of materials (gases, liquids, and solids), fire phenomena in enclosures such as pre-flashover and post-flashover. Prerequisites: MMAE 310 or MMAE 313 or CAE 302, MMAE 322 or CAE 309 or instructor's consent. (Students who have taken the undergraduate course equivalent, CAE 424, may not take this course for credit.) (3-0-3)

CAE 511

Fire Protection of Buildings

Fundamentals of building design for fire and life safety. Emphasis on a systematic design approach. Basic considerations of building codes, fire loading, fire resistance, exit design, protective systems, and other fire protection systems. For architects and engineers not majoring in fire protection and safety engineering. (Students who have taken the undergraduate course equivalent, CAE 425, may not take this course for credit). (3-0-3)

CAE 512

Computer Modeling of Fire

Introduction to fire heat transfer processes and fire testing materials; application of a set of quantitative engineering tools (fire models) to construct a description of conditions that occur or might occur during the course of a fire; life and structural impacts from hostile fires in buildings. Prerequisites: CAE 424 or instructor's consent. (Students who have taken the undergraduate course equivalent, CAE 426, may not take this course for credit.) (3-0-3)

CAE 518

Advanced Reinforced Concrete

Mechanical properties of hardened concrete, including creep phenomena. Ultimate strength of columns, beams and beam-columns. Introduction to limit analysis of frames and yieldline analysis of plates. Prerequisite: CAE 432. (3-0-3)

CAE 520

Buckling of Structures

Review of simple column buckling for various conditions. Basic considerations of stable and unstable equilibrium. Determination of buckling loads of columns with variable cross-section. Analysis of elastic stability of framed structures. Approximate solutions of more complicated problems by various numerical and energy methods. Analysis of lateral and torsional stability of beams and beam-columns. Stability in the inelastic range of columns. Buckling of plates and cylindrical shells. Prerequisites: CAE 310, CAE 431. Corequisite: MMAE 504. (4-0-4)

CAE 521

Building Illumination Design

An intensive study of the calculation techniques and qualitative aspects of good luminous design. Topics covered include photometric quantities and color theory, visual perception, standards, daylight and artificial illumination systems, radiative transfer, fixture and lamp characteristics, control devices and energy conservation techniques. Design problems, field measurements, computer and other models will be used to explore the major topics. Prerequisite: instructor's consent. (Students who have taken the undergraduate course equivalent, CAE 467, may not take this course for credit.) (3-0-3)

CAE 522

Structural Model Analysis

Theory of measurements, statistics, similitude and model laws and the usefulness of structural models. Displacement and strain measurement techniques. Theory and practice of indirect model analysis. Theory and practice of direct model

techniques, including photoelasticity and moire methods.

Prerequisite: CAE 503. (4-0-4)

CAE 523

Statistical Analysis of Engineering Data

Review of probability, random variables, distribution models, estimation of statistical parameters and testing validity of distribution models. Analysis of variance (ANOVA), hypothesis testing, correlation analysis, multiple range tests, pairwise comparisons, data compilation using unconventional sources, such as using simulations, expert opinion and cycle-counting methods. Prerequisite: MATH 252 or equivalent. (3-0-3)

CAE 524

Design of Building Enclosures

Study of wall, window, and roof design. Consideration for the factors that influence the design of building exteriors including the control of heat flow, air and moisture penetration, building movements and deterioration. Study of the principle of rain screen walls and energy conserving design. Analytical techniques and building codes are discussed. Prerequisites: CAE 331 or CAE 531. (3-0-3).

CAE 525

Advanced Steel and Composite Structures

Torsion and web openings. Behavior and design of rigid and semirigid beam-to-column connections and base plates. Inelastic behavior of steel and composite members and systems under severe cyclic loading. Design of steel-concrete composite and hybrid systems. P-delta effect and design consideration for system stability. Design of special and ordinary moment-resisting frames. Design of concentrically and eccentrically braced frames. Design of bracing for stability. Plate girders. Fatigue and fracture. Prerequisites: CAE 431 or equivalent. (4-0-4)

CAE 526

Energy Conservation Design in Buildings

Identification of the optimal energy performance achievable with various types of buildings and service systems. Reduction of infiltration. Control systems and strategies to achieve optimal energy performance. Effective utilization of daylight, heat pumps, passive and active solar heaters, heat storage and heat pipes in new and old buildings. Prerequisite: instructor's consent. (Students who have taken the undergraduate course equivalent, CAE 465, may not take this course for credit.) (3-0-3)

CAE 527

Control of Building Environmental Systems

Introduction to automatic control systems. Control issues related to energy conservation, indoor air quality and thermal comfort in buildings. Classification of HVAC control systems. Control system hardware: selection and sizing of sensors, actuators and controllers. Practical HVAC control systems; elementary local loop and complete control systems. Designing and tuning of controllers. Building automation systems. Case studies. Computer Applications. Prerequisite: instructor's consent or CAE 528 or CAE 466 or concurrent registration. (Students who have taken an equivalent undergraduate course may not take this course for credit.) (3-0-3)

CAE 528

Communication and Electrical Systems in Buildings

Study of the analysis and design of electrical systems in buildings utilizing the National Electrical Code. The topics include basic circuits, ac and dc, single phase and three-phase power, transients, capacitance and inductance, branch circuits, panel boards, motors, system sizing, and electrical distribution in buildings. Study of the design and specification of communication systems in buildings, including fire alarm, security, sound, and telephone. Prerequisite: instructor's consent. (Students who have taken the undergraduate course equivalent, CAE 466, may not take this course for credit.) (3-0-3)

CAE 530

Finite Element Method of Analysis

Continuation of CAE 442. Covers advanced and special topics in finite element analysis such as finite element- boundary element method, plates, and shell analysis using finite elements and stochastic finite elements. Prerequisite: CAE 442. (3-0-3)

CAE 531

Physical Performance of Buildings

Study of the environmental exterior and interior influences (rain, snow, humidity, temperature, wind, sun, etc.) on the physical performance of buildings and the implications of these influences on building design. Study of indoor thermal environment and thermal comfort of building occupant is offered as well. (Students who have completed the undergraduate equivalent may not take this course for credit.) (3-0-3)

CAE 532

Analysis of Plates and Shells

Exact and approximate stress analysis of elastic, isotropic plates of various shapes acted upon by forces in their plane, as well as transverse forces. Stability of plates with various

edge conditions, orthotropic plates, elastically supported plates and simple cylinders. Approximate methods such as finite differences, finite elements and the methods of Ritz and Galerkin. Corequisite: MMAE 504. (4-0-4)

CAE 533

Theory and Analysis of Thin Shells

Differential geometry of surfaces. Elastic theory of general shells with nonorthogonal curvilinear coordinates. Specialization to cylindrical shells, shells of revolution and translational shells. Exact and approximate solutions applied to the bending membrane theories of thin shells. Approximate methods including finite differences, finite elements and methods associated with Ritz, Galerkin, Puchler and Gaeckler. Corequisite: MMAE 504. (3-0-3)

CAE 534

Computational Techniques in Finite Element Analysis

Survey of numerical methods as applied to FEM software. Database management, equation solvers, eigenvalue routines and schemes for direct integration (both implicit and explicit), all as employed in the development of a finite element program. Topics covered also include band and front minimizers, static and dynamic substructuring via superelements and sensitivity studies. Same as MMAE 538. Prerequisite: CAE 442 or MMAE 451. (3-0-3)

CAE 535

Nonlinear Finite Element Analysis

FEM as applied to nonlinear problems. Contact problems, the mechanics of large deformation, full and updated Lagrange formulations, review of plasticity, solution algorithms, Eulerian approaches, application to FEM to limit analysis. Same as MMAE 539. Prerequisite: CAE 442 or MMAE 507. Corequisite: MMAE 504. (3-0-3)

CAE 537

Homeland Security Concerns in Building Design

Review of blast effects produced by solid phase weapons and their effects on structures and people. Estimation of the risk of a terrorist attack and the corresponding threat. Review of simplified methods for the analysis and design of structures to meet homeland security concerns and procedures to minimize casualties. Analysis of post event fires and how to prevent them. Review of security measure to minimize the effects of blast on buildings and people. (3-0-3)

CAE 539

Introduction to Geographic Information Systems

Geographic information system (GIS) technology allows databases that display and query information in new ways. This course will teach general GIS and GPS skills and concepts, useful to students and practitioners in a variety of

disciplines. Students will complete a final GIS project relevant to their field of study. This hands-on class will use ESRI's ArcView and Spatial Analyst products, as well as Trimble GeoExplorer GPS units. (3-0-3)

CAE 540

Asphalt Concrete Mix Design

Types of asphalt and physical properties of asphalt. Types of mixes: dense graded, open graded, base courses and maintenance mixes. Types of pavement structures and hot mix asphalt placement. Aggregate physical properties, tests and blending. Maintenance and rehabilitation materials. Mixture design procedures, including Marshall and Hveem procedures and weight-volume relationships. Evaluation of mixture properties, engineering property's importance to performance, resilient modulus, fatigue and creep testing and thermal cracking properties. Laboratory included. (2-3-3)

CAE 541

Pavement Evaluation and Management

Pavement management systems (PMS) concepts, network definition, condition survey, pavement condition index (PCI), non-destructive deflection testing (NDT), measurement of roughness and skid resistance, micropaver PMS, PMS implementation, project and network-level management, maintenance alternatives, development of annual and long-range work plans. Prerequisite: instructor's consent. (3-0-3)

CAE 542

Acoustics and Lighting

General introduction to the aural and visual environment. Subjective and objective scales of measurement. Laws of psychophysics. Introduction to vibration. The hearing mechanism. Transfer of sound. Passive control of noise in buildings, transmission loss. Absorption and reverberation time. Active control of the aural environment. Visual perception. Photometry, brightness, luminance and illumination. Natural lighting of buildings. Artificial lighting. Prerequisite: PHYS 221. (Students who have taken the undergraduate course equivalent, CAE 334, may not take this course for credit.) (3-0-3)

CAE 543

Demand Models for Urban Transportation

Fundamental theory of supply and demand, transportation economics, network equilibrium, land use and transportation equilibrium. Demand models: trip generation, geographical distribution, mode split, route assignment, the direct-demand model and disaggregate-behavioral demand models. Special properties of models. Relationships among models. Prerequisite: CAE 416 or instructor's consent. (3-0-3)

CAE 544

Urban Transportation Planning

Exploration of the goals of urban transportation. Program planning in relating transportation technology to social, economic and environmental systems. Systems analysis in forecasting travel demand and evaluating alternatives in transportation planning. (4-0-4)

CAE 545

Traffic Operations and Flow Theory

Studies of space and time distribution of speed and other traffic characteristics in the transportation network. Macro- and microtraffic flow theories. Simulation in traffic systems. Application of flow theories to traffic control and operations. (3-0-3)

CAE 546

Public Transportation Systems

Operational and economic characteristics of urban systems. Transit planning process: demand for transit, transit routing, transit scheduling, network design. Improvements of existing systems and exploration of new technologies. (3-0-3)

CAE 547

Advanced Traffic Engineering

Data collection, statistical analysis and interpretation of traffic information. Advanced traffic engineering topics, such as signaling, street-and-highway capacity analysis; accident and safety research. Prerequisite: CAE 419 or instructor's consent. (3-0-3)

CAE 548

Transportation Systems Management

Transportation as a system. Problems of traffic congestion, land use/transportation intersection; intersection control; freeway and arterial incident management; safety considerations; evaluation of strategies; case studies. Prerequisite: CAE 419 or instructor's consent. (3-0-3)

CAE 549

Transportation Economics, Development and Policy

Application of managerial, micro and macroeconomic concepts to transportation systems. Investment and impact analysis. Transport policy as it relates to social, economic and environmental issues. Legislative actions affecting transport issues. Prerequisite: CAE 419 or instructor's consent. (3-0-3)

CAE 551

Prestressed Concrete

Theory and design of prestressed concrete members and structure. Applications to both simple and continuous girders and frames subjected to stationary or moving loads. Prestressed cylindrical shells. Prerequisite: CAE 432. (3-0-3)

CAE 552

Heating and Refrigeration

Heating load analysis, including building shapes, construction type, infiltration, occupancy effects, and daily load variations. Computer applications for thermal load analysis. Water Heating Systems, Steam Heating Systems, Electrical Heating, Central Heating, Heating of Low and High-rise Buildings, Selection of Heaters, Boilers, Pumps, Piping Design. Computer Applications. Reciprocating Refrigeration. Refrigerant, Refrigeration Cycle, Evaporator, Compressor, Condenser, Thermostatic expansion valves, refrigeration system control equipment, motor and motor control equipment, refrigeration accessories, calculation of refrigeration piping and absorption systems. Computer Applications. Prerequisite: Thermodynamics, Heat Transfer, Fluid Mechanics or instructor's consent. (4-0-4)

CAE 553

Measurement and Instrumentation in Architectural Engineering

Experimental Statistics and Data Analysis. Dynamic measurement. Measurement of Thermal Characteristics (Conductivity, diffusivity, etc). Fluid-Property Measurement (Pressure, Temperature, etc). Fluid Flow measurement (Flow, Viscosity, etc). Blower door and Tracer Gas Techniques. Duct leakage Measurement. Prerequisite: Thermodynamics, Fluid Mechanics and Heat Transfer or instructor's consent. (3-0-3)

CAE 555

Transportation Systems Evaluation

Concepts and principles of transportation economic analysis, transportation costs and benefits, user and nonuser consequences, needs studies, finance and taxation, methods of evaluation of plans and projects, cost effectiveness, environmental impact assessment. Prerequisites: CAE 419 or instructor's consent. (3-0-3)

CAE 560

Plastic Methods

Fundamental concepts of plasticity in the design of steel structures. Principle of plastic hinges. Upper and lower-bound theorems. Alternating plasticity and incremental collapse. Analysis and design of single story and multistory framed structures. Prerequisites: CAE 503, CAE 431. (4-0-4)

CAE 561

Structural Reliability and Probabilistic Bases of Design

Fundamentals of probability theory and stochastic processes; statistical analysis of engineering data; probabilistic modeling of structural loads and material properties. Reliability analysis and design of structure, reliability-based design criteria. Evaluation of existing design codes. Safety analysis of

structures under fatigue loads. Fault and event tree analysis. Prerequisite: CAE 307 or instructor's consent. (3-0-3)

CAE 562

Engineering Behavior of Soils

Soil mineralogy and soil fabric, soilwater electrolyte system, dispersive clay, stress and strain analyses, elastic equilibrium in soil masses, plastic equilibrium in soil of masses, in situ and laboratory stress paths, shear strength of sands and clays, thermal properties of soils, critical state soil mechanics principles, nonlinear pseudoelastic and elastoplastic constitutive models. Corequisite: CAE 563. Prerequisite: CAE 323. (4-0-4)

CAE 563

Advanced Soil Mechanics Laboratory

Advanced aspects of soil property measurement with application to design and analysis, system characteristics on soil sediment, pinhole test for identifying dispersive clays, consolidation, triaxial compression and triaxial extension with porewater measurement, cyclic triaxial test, permeability with back pressure, determination of critical void ratio. Corequisite: CAE 562. Prerequisite: CAE 323. (1-3-1)

CAE 564

Design of Foundations, Embankments and Earth Structures

Consolidation phenomena, derivation of bearing capacity equations, beams and slabs on soils, piles and pile groups, compaction, earth pressure theories and pressure in embankment, slope stability analyses, retaining structures, embankment design, soil structure interaction during excavation, design of anchors for landslide stabilization and retaining structures and instrumentation. Prerequisites: CAE 323, CAE 457. (4-0-4)

CAE 565

Rock Mechanics and Tunneling

Rock classification for engineering purposes, mechanical behavior of rocks, in situ stresses in rock, stresses around underground openings, rock slope engineering, design of underground structures, design of deep support excavation and tunnels, primary and secondary linings of tunnels, mined shafts, instrumentation. Prerequisite: CAE 457. (4-0-4)

CAE 566

Earthquake Engineering and Soil Dynamics

Earthquakes and their intensity, influence of ground motion, review of 1-DOF and M-DOF systems, wave propagation theories, vibration due to blast and shock waves, design earthquake motion, dynamic properties of soils, soil liquefaction, bearing capacity during earthquakes and design of machine foundations, isolation of foundations, pile

foundation, and dynamic analysis, earth pressure during earthquakes on retaining structures and embankment.

Prerequisites: CAE 323, CAE 420. (4-0-4)

CAE 567

Physicochemical Behavior of Soils

The nature of soils. Weathering and soil formation processes. Soil mineralogy. Surface and colloidal chemistry. Structures of water near clay mineral surfaces. Electrolyte solutions. Theories of cation and anion exchange. Adsorption of inorganic chemicals in soils. Organic matter in soils.

Adsorption of organic chemicals in soils. Methods to determine petroleum products in soils. Effect of contaminants on permeability of clays. Leachate-clay liner compatibility.

Prerequisites: CAE 323, ENVE 501. (3-0-3)

CAE 568

Transportation Asset Management

Process and techniques for managing preservation and expansion of highway transportation facilities such as pavements, bridges, as well as system usage. Five component management systems are examined: pavements, bridges, roadway maintenance, safety and congestions. The methodology for overall transportation asset management is discussed. The primary emphasis is on data collection, life cycle cost analysis, priority setting and optimization, program development strategies, risk and uncertainty modeling and institutional issues. Prerequisite: CAE 419 or instructor's consent. (3-0-3)

CAE 569

Advanced Heating, Ventilating, and Air-Conditioning

Engineering design and performance analysis procedures for complex commercial building systems, including energy conservation techniques, and a design project. This course will include specific subjects such as spray chambers, cooling towers, Extended Surface Heat Exchangers and also hybrid ventilation. A design of a real commercial Heating, Ventilating, and Air-Conditioning Systems is a major part of this course.

Prerequisite: CAE 464 or equivalent, CAE 309 or equivalent, CAE 302 or equivalent (3-0-3)

CAE 570/CAE 770

Legal Issues in Civil Engineering

Basics of the legal system, including contracts, torts, land zoning and property ownership. Working knowledge of the law to avoid and mitigate potential legal problems that frequently occur in construction. Contractor liability. Mechanics liens, litigation and arbitration. International construction law, hazardous waste issues and labor law. Prerequisite: CAE 473. (3-0-3)

CAE 571

Advanced Construction Scheduling and Control

Review of project management principles and network methodologies. Interfacing computerized cost estimating with network scheduling. Claims management with networks. Evaluation and selection criteria for commercially available project-management software. Linear scheduling systems for projects with repetitive characteristics. Acyclic network models. Introduction to expert systems in construction scheduling and control. Prerequisite: CAE 471. (3-0-3)

CAE 572

Construction Cost Accounting and Control

Review of basic accounting principles and techniques— purchasing, accounts payable, invoicing, accounts receivable, general ledger, payrolls and indirect costs. Job costing and budgeting. Recording and reporting procedures in construction projects— invoices, subcontractor applications for payment, labor time cards, unit completion reports, change orders. Cost-coding systems for construction activities. Variance reporting procedures. Project closeout. Class exercise using computer program. Prerequisites: CAE 470, CAE 570. (3-0-3)

CAE 573

Computer Applications in Construction

Knowledge engineering, human and automated knowledge acquisition and knowledge representation. Inferencing mechanisms. Decisionmaking under uncertainty. Introduction to very high-level programming languages (LISP and Prolog). Review of commercially available expert system shells and development tools for artificial neural network and case-based reasoning applications. Class exercise to construct a system prototype for a civil engineering problem. Prerequisite: CAE 430. (3-0-3)

CAE 574

Economic Decision Analysis in Civil Engineering

Basic economic concepts, including interest calculations, computation of alternatives, replacements, depreciation and depletion, and tax considerations. Evaluation of public projects, the effect of inflation, decision making under risk and/or uncertainty, economic decision models. Case studies from the civil engineering industry. Prerequisite: CAE 430 or MATH 475. (3-0-3)

CAE 575

Systems Analysis in Civil Engineering

Management and system concepts, linear and dynamic programming, system modeling by activity networks. Maximal-flow and shortest-path analysis, flow graphs, decision-tree analysis, stochastic network modeling, queuing analysis, and analysis of inventory systems. Case studies from the civil

engineering industry. Prerequisites: CAE 430, CAE 471. (3-0-3)

CAE 576

Advanced Construction Accounting and Finance

Review of sole proprietorships, partnerships, corporations, limited liability companies, federal regular income tax and alternative minimum tax, state income tax, inventories, cash-flow statements, analysis of financial statements. Percentage of completion with look-back and completed contract methods of long-term contract accounting, cost-allocation and equipment-cost-recovery deductions, under federal regular income tax, alternative minimum tax and state income tax rules. International construction issues, including foreign taxes, currencies, tax treaties, income exclusion. Construction claims and effects on accounting. Government construction. Introduction to financing, privatization, nonlump-sum contracts, joint ventures and audits, in accounting and the construction process. Prerequisite: CAE 572. (3-0-3)

CAE 577

Construction Equipment Management

Factors affecting the selection of construction equipment. Descriptions, operating methods, production rates, unit costs related to excavating equipment. Power shovels, draglines, clam shells, and trenching machines. Engineering fundamentals. Moving construction equipment, including trucks, wagons, scrapers, dozers, soil-stabilization and compaction equipment. Belt conveyors, compaction and drilling equipment, pile driving equipment, pumps and crushers. Prerequisite: CAE 472. (3-0-3)

CAE 578

Construction Claims Management

Types of contract claims, delays, acceleration, and scope issues. Underlying legal theories of construction contracts and claims, defenses to claims, prophylactic claims measures. The claims process within the contract, extra-contractual basis for claims. Resolution of claims by ADR techniques, the formal litigation process. AIA, AGC, and federal claims provisions. Other types claims associated with construction projects such as a surety bond claims and various insurance claims (CGL, Builder's Risk, workers comp, etc). Prerequisite: CAE 473. (3-0-3)

CAE 580

Intelligent Transportation Systems

A seminar course on intelligent transportation systems (ITS). the concept of ITS involves the use of rapidly emerging information and communication technologies in mitigating congestion and attendant problems. This course provides an introduction to various aspects of ITS and focuses on ITS planning, technology, and evaluation. In addition, such topics

as deployment, financing and management are also discussed. Prerequisites: CAE 419, CAE 545 or instructor's consent. (3-0-3)

CAE 581

Algorithms in Transportation

Modeling and analysis of transportation network problems through design, analysis and implementation of algorithms. Emphasis is on the use of quantitative techniques of operations research to model system performance. The course covers fundamental data structures, complexity analysis, memory management, recursive programs, application of graph theory and network analysis to transportation problems, analytical formulations and solution algorithms for traffic assignment problems and dynamic traffic assignment. Prerequisites: CAE 312, CAE 575 or instructor's consent. (3-0-3)

CAE 582

Structural Wind and Earthquake Engineering

Introduction to nature of wind, aerodynamic wind-loading and design. Strong ground motion phenomenon. Investigation of the response of structures to dynamic and pseudodynamic wind, earthquake, shock waves and other deterministic and probabilistic loadings. Design criteria for buildings and nuclear power stations, special topics in lifeline earthquake engineering. Prerequisite: CAE 420, MMAE 406, or instructor's consent. (4-0-4)

CAE 586

Seismic Design of Building and Bridge Structures

Several specific topics on seismic design of steel and reinforced concrete building and bridge structures are covered. In addition, fundamentals and experiences in seismic design are presented through design examples. Specific emphasis is placed on using various design codes relevant to design of buildings and bridges. Prerequisites: CAE 431 and CAE 432 or Instructor's consent. (3-0-3)

CAE 583

Special Topics on Earthquake and Wind Engineering

This course covers special topics on earthquake and wind design for buildings and bridges. The course covers eight topics. These topics are independent of each other and cover a variety of engineering applications in earthquake and wind engineering. Prerequisite: instructor's consent (2- 0-2)

CAE 587

Numerical Methods in Geotechnical Engineering

Constitutive laws of granular and cohesive material, introduction to coupling of water and soil phase in solution, application to problems of consolidation procedures with finite element method. Prerequisites: CAE 562, CAE 442. (3-0-3)

CAE 588

Theory of Plasticity

Plastic strain, yield criteria, ideal plasticity, hardening and softening, flow theories, Levy-Mises and Prandtl-Reuss relations, Hencky's theory, Drucker's criterion. Modern theories of noncoaxiality. Applications to structures and soils. Same as MMAE 529. Prerequisite: MMAE 530. (4-0-4)

CAE 589

Groundwater Hydrology and Sampling

Groundwater geology and flow, aquifer and aquitar response of ideal aquifer to pumping. Chemical properties and principles, including source of contamination and estimation of saturated hydraulic conductivity. Principles of exploration and sampling, methods of subsurface explorations, groundwater observation techniques. Prerequisites: CAE 323 and CAE 301 or ENVE 401. (3-0-3)

CAE 590

Geotechnical Landfill Design and Maintenance

Regulatory and legal issues, site selection and assessment, geotechnical- subsurface investigation, clay mineralogy and clay-water-electrolyte system, linear and leachate-control-systems design, stability of landfill slopes, cover design, construction and operation, final use and remediation design. Prerequisite: CAE 323. (3-0-3)

CAE 591

Research and Thesis for M.S. Degree

CAE 593

Civil Engineering Seminar

Reports on current research. Graduate students are expected to register and attend. (1-0-0)

CAE 597

Special Problems

Subject matter will vary with the interests and background of students and instructor. Design or research problems may be assigned from the areas of construction, geotechnical, geoenvironmental, structural or transportation engineering. Prerequisite: Graduate coursework in the problem subject matter. (Credit: Variable)

CAE 599

Graduate Workshop

(0-0-0)

CAE 691

Research and Thesis for Ph.D. Degree

(Credit: Variable)

ENVE 485

Pollution Prevention

(Note: This course will be renamed Industrial Ecology.) (Co-listed with EM 507) Industrial Ecology is the study of material and energy flows from industrial and consumer activities, and the related regulatory, political, economic, technical, and social issues. Industrial ecologists strive to bring environmental concerns into harmony with economic development. The course includes several projects and readings on current topics such as life cycle analysis (LCA), design for the environment (DFE), and environmental management systems. (3-0-3)

ENVE 501

Environmental Chemistry

Chemical processes in environmental systems, with an emphasis on equilibrium conditions in aquatic systems. The types of processes examined include acid-base, dissolution-precipitation, air-water exchange and oxidation-reduction reactions. Methods presented for describing chemical speciation include analytical and graphical techniques, as well as computer models. Core course. (3-0-3)

ENVE 502

Atmospheric Chemistry

The fundamentals and applied aspects of the photochemical processes that drive the daytime chemistry of the lower atmosphere are discussed. Basic chemistry of photochemical smog, acid deposition, and fate of gaseous and airborne toxic chemicals in the atmosphere are presented. An in-depth review of the experimental techniques employed in fundamental and applied studies of reaction in real and simulated atmospheres is also provided. Prerequisites: ENVE 463, ENVE 501. (2-0-2)

ENVE 503

Water and Wastewater Analysis

Standard and advanced analytical techniques for measuring water quality and efficiencies of water and wastewater treatment processes. Course covers both theoretical and applied aspects of standard methods and advanced techniques for trace metal and organic analyses. Prerequisite: ENVE 501 or consent of instructor. (2-3-3)

ENVE 504

Advanced Techniques in Environmental Analysis

Principles and applications of chemistry appropriate to environmental surveillance and control. Includes pesticide analysis, trace metal identification, and automated photometric techniques. Prerequisite: ENVE 501 or consent of instructor. (2-3-3)

ENVE 505

Principles of Water Chemistry

Examination of current research theories and state-of-the-art in subjects pertinent to the chemical aspects of environmental science. Includes chemistry of humic substances and of pesticides in natural waters; physical, chemical and biological fates of trace metals and organic pollutants, and chemistry of biological nutrients. Prerequisite: ENVE 501 or consent of instructor. (3-0-3)

ENVE 506

Chemodynamics

The dynamics of pollutant transfer in biogeochemical systems of the earth. The overall objective of this course is to introduce fundamental science and engineering principles needed to formulate creative, comprehensive solutions to transport problems; critically evaluate proposed solutions to transport problems; and acquire and integrate new information to build on these fundamentals. Core course. (3-0-3)

ENVE 509

Special Topics in Environmental Chemistry

Lectures and field studies on topics pertinent to the chemical aspects of environmental systems. May be repeated with change of course content, up to a maximum of six credits. Prerequisite: Consent of instructor. (Credit: 1—3 hours.)

ENVE 510

Environmental Biodynamics

Properties and characteristics of microorganisms as they relate to water quality and to treatment processes. Batch population growth characteristics. Microbial degradation of organic compounds. Microbial pathogens of waterborne diseases and microbial indicators. Biogeochemical relations. (3-1 4)

ENVE 512

Special Topics in Environmental Biology

Selected laboratory techniques pertinent to the biological aspects of environmental engineering. May be repeated with change of course content, up to a maximum of six credits. Prerequisite: Consent of instructor. (Credit: 1—3 hours.)

ENVE 513

Biotechnological Processes in Environmental Engineering

Fundamentals and applications of biological mixed culture processes for air, water, wastewater and hazardous waste treatment. Topics include biochemical reactions, stoichiometry, enzyme and microbial kinetics, detoxification of toxic chemicals, and suspended growth and attached growth treatment processes. The processes discussed include activated sludge process and its modifications, biofilm processes including trickling filters and biofilters, nitrogen and phosphorous removal processes, sludge treatment processes

including mesophilic and thermophilic systems, and natural systems including wetlands and lagoons. Prerequisite: ENVE 542 or consent of instructor. (3-0-3)

ENVE 520

Environmental Monitoring and Assessment

Modeling and monitoring methods for the prediction and assessment of environmental impacts due to changes in the physical, chemical and biological environment. Comparative studies of methodologies to assess immediate and extended effects, including trends in space and time due to changes in anthropogenic systems. Dynamics of environmental changes, inventory methods and priority impact criteria. Same as ENVE 405. (3-0-3)

ENVE 525

Advanced Water Resources

Water resources engineering, including hydrology, quality standards, groundwater flow and surface hydraulics. Optimization and allocation of water resources. Prerequisite: ENVE 401. (3-0-3)

ENVE 527

Statistical Analysis of Systems

Multivariate probability distributions. Inference about mean, variance. Multivariate linear regression and response surface analysis. components analysis, factor analysis, canonical correlation analysis. Clustering, discrimination and classification. Selected advanced topics such as survey design, design of experimental techniques, statistical methods for discrete and binary variables, time series analysis, partial least squares techniques. Prerequisites: CHE 426, ENVE 426. Same as CHE 533. (3-0-3)

ENVE 528

Modeling of Environmental Systems

To introduce students to mathematical modeling as a basic tool for problem solving in engineering and research. Environmental problems will be used as examples to illustrate the procedures of model development, solution techniques and computer programming. These models will then be used to demonstrate the application of the models, including simulation, parameter estimation and experimental design. The goal is to show that mathematical modeling is not only a useful tool, but also an integral part of process engineering. (3-0-3)

ENVE 532

Special Topics in Environmental Engineering

Lectures and discussion on topics pertinent to the engineering aspects of environmental systems. May be repeated with change of course up to a maximum of six credits. Prerequisite: Consent of instructor. (Credit: 1—3 hours.)

ENVE 542

Physicochemical Processes in Environmental Engineering

Fundamentals and applications of physicochemical processes used in air, water, wastewater and hazardous waste treatment systems. Topics include reaction kinetics and reactors, particle characterization, coagulation and flocculation, sedimentation, filtration, membrane separation, adsorption and absorption. Prerequisite: ENVE 404 or consent of instructor. Co-requisite: ENVE 501 or consent of instructor. Core course. (3-0-3)

ENVE 544

Energy, Environment and Economics

The linkage of energy, environmental and economic issues. The impact of energy supply and end-use on human well-being and the ecosystem. A comprehensive approach to the resolution of resource, technical, economic, strategic, environmental, socio- and geopolitical problems of the energy industries. Pathways to a sustainable global energy system. Same as CHE 543. (3-0-3)

ENVE 545

Environmental Regulations and Risk Assessment

One third of the course is a review of current environmental regulations, including the Clean Air Act, Clean Water Act, Toxic Substances Control Act, Resource Conservation and Recovery Act, CERCLA, and the Pollution Prevention Act. The rest of the course deals with the fundamentals of risk assessment, including hazard identification, dose-response assessment, exposure assessment and risk characterization for public health and ecosystems. (3-0-3)

ENVE 546

Industrial Hygiene

An introduction to toxicology, exposure routes and physiological classification of toxicants. Epidemiological considerations, measurement methods, strategies and calculations. Modeling of exposures and evaluation of controlling parameters. Ventilation methods of control. Physical stressors of sound, heat, vibration and lifting. Methods for measurement and calculation of exposure/compliance levels. (3-0-3)

ENVE 551

Industrial Waste Treatment

Industrial waste sources and characteristics, significance of industrial wastes as environmental pollutants; applications of standard and special treatment processes, including physical. Prerequisite: ENVE 513, ENVE 542 or consent of instructor. (3-0-3)

ENVE 555

Industrial Waste Treatment Design Criteria

Theoretical and laboratory development treatment systems

design criteria. Evaluation and selection of unit treatment processes. Application of design procedures for selected representative industrial wastewater. Prerequisites: ENVE 513, ENVE 542 or consent of instructor. (2-3-3)

ENVE 561

Design of Environmental Engineering Processes

Design of water and wastewater treatment systems. System economics and optimal design principles. Prerequisite: ENVE 513, ENVE 542 or consent of instructor. (3-0-3)

ENVE 563

Systems Engineering: Waste Facility Design and Operation

Fundamentals of systems engineering applied to wastewater facility design and operation. Modeling, simulation, optimization, techniques for biological and physicochemical treatment processes. Process analysis and control simulations, cost optimization. Prerequisite: ENVE 404 or consent of instructor. (3-0-3)

ENVE 570

Air Pollution Meteorology

Physical processes associated with the dispersion of windborne materials from industrial and other sources. Atmospheric motion, including turbulence and diffusion, mathematical models and environmental impact assessment. Global climate change, ozone depletion, acid rain are studied. Prerequisite: ENVE 513, ENVE 542 or consent of instructor. (3-0-3)

ENVE 572

Ambient Air Monitoring

Ambient air sampling and pollutant analysis. Methods for collection and identification of gaseous and particulate pollutants. Air monitoring survey design, instrument calibration, interpretation of atmospheric data. Prerequisites: ENVE 501, ENVE 570. (2-3-3)

ENVE 573

Air Pollution Engineering

Air pollution sources and source control, chemistry and meteorology of the atmosphere, atmosphere diffusion and stack performance, equipment and engineering processes for air emission control. Prerequisite: ENVE 463. (3-0-3)

ENVE 574

Stack Sampling and Analysis

Current practices of measuring pollutants emitted from stationary sources. Methods of collection and analysis of stack effluents, including field-sampling techniques and data evaluation. (2-3-3)

ENVE 575

Control of Toxic Air Pollution

Definition of toxic air pollutants; sources of toxic air pollutants; emissions measurement, air dispersion and deposition models; risk assessment and risk management; ecological risk analysis, gaseous toxic air pollutant control technologies; fugitive emissions control. Pollution prevention. Prerequisite: Consent of instructor. (3-0-3)

ENVE 576

Indoor Air Pollution

Indoor air pollution sources, indoor pollutant levels, monitoring instruments and designs; indoor pollution control strategies: source control, control equipment and ventilation; energy conservation and indoor air pollution; exposure studies and population time budgets; effects of indoor air pollution; risk analysis; models for predicting source emission rates and their impact on indoor air environments. Prerequisite: ENVE 405, ENVE 520 or consent of instructor. (3-0-3)

ENVE 577

Design of Air Pollution Control Devices

Principles and modern practices employed in the design of engineering systems for the removal of pollutants. Design of control devices based on physical and chemical characteristics of polluted gas streams. Prerequisite: ENVE 463. (3-0-3)

ENVE 578

Physical and Chemical Processes for Industrial Gas Cleaning

Application of physical and chemical processes in the design of air treatment systems; fundamentals of standard and special treatment processes. Prerequisite: ENVE 463. (3-0-3)

ENVE 580

Hazardous Wastes Engineering

Sources and characteristics of hazardous wastes, legal aspects of hazardous waste management, significance of hazardous wastes as air, water and soil pollutants. Principles and applications of conventional and specialized hazardous waste control technologies. Prerequisites: ENVE 501 and ENVE 506, or consent of instructor. Core course. (3-0-3)

ENVE 585

Groundwater Contamination and Pollutant Transport

Applications of groundwater flow principles, transport phenomena, and chemical and biological processes to problems of groundwater contamination. Simulation model and case studies of current topics. (3-0-3)

ENVE 590

Environmental Engineering Seminar

Presentations on recent developments in the field by academic and industrial visitors. (1-0-1)

ENVE 591

Research and Thesis for M.S. Degree

ENVE 594

Special Projects

Advanced projects involving computer simulation, modeling or laboratory work. (Credit: 1—6 hours.)

ENVE 597

Special Problems

Independent study and project. (Variable credit.)

ENVE 691

Research and Thesis for Ph.D. Degree