Energy/Environment/Economics (E^3)

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The ongoing evolution of the energy system and related global, environmental and economic issues make necessary a new interdisciplinary approach to the education of energy-industry engineers and management professionals, as well as to the planning and performance of energy research and development. The petroleum, coal, natural gas, nuclear, renewable and electric utility industries and associated resource and raw material extraction, equipment design and manufacturing, and construction industries, are facing not only technological change and environmental constraints, but also drastic changes in the economic, institutional and trade environments in which they operate.

IIT's Energy/Environment/Economics (E^3) program was developed to respond to the rapidly changing needs of the energy industry by providing the interdisciplinary research and training required to produce a new breed of engineer-one who specializes in energy technologies and who understands the associated environmental issues and economic forces that drive technology choice.

E^3 specialization requires an interdisciplinary thesis in an E^3 area of research for M.S. and Ph.D. degrees, and an interdisciplinary graduate project for professional master's degrees. Graduate students in E^3 should also be enrolled in fundamental courses related to the topics of energy, environment and economics. E^3 is designed primarily for students majoring in chemical and environmental, mechanical and aerospace, or electrical engineering who are planning careers in energy-related fields. This interdisciplinary training prepares students to be not only creative and expert in a specialized area of energy extraction, conversion or utilization, but also to possess a broad knowledge base of different energy sources, environmental issues related to energy extraction, conversion and utilization, and of the impact of industrial ecology principles on the design and operation of energy systems. Furthermore, students will gain sufficient knowledge of economic and regulatory issues to enable them to make more viable technology choices.

Degrees Offered

Master of Chemical Engineering with E^3 specialization
M.S. in Chemical Engineering with E^3 specialization
Master of Electrical and Computer Engineering with E^3 specialization
M.S. in Electrical Engineering with E^3 specialization (thesis and non-thesis options)
Master of Environmental Engineering with E^3 specialization
M.S. in Environmental Engineering with E^3 specialization
Master of Mechanical and Aerospace Engineering with E^3 specialization
M.S. in Mechanical and Aerospace Engineering with E^3 specialization
Ph.D. in Chemical Engineering with E^3 specialization
Ph.D. in Environmental Engineering with E^3 specialization
Ph.D. in Electrical Engineering with E^3 specialization
Ph.D. in Mechanical and Aerospace Engineering with E^3 specialization

Research Centers, Facilities and Areas

Students should consult descriptions in the respective departments:

Chemical and Environmental Engineering
Electrical and Computer Engineering
Mechanical, Materials and Aerospace Engineering

Energy/Environment/Economics (E^3)

Admission Requirements

Students should consult listings in the respective departments:

Chemical and Environmental Engineering
Electrical and Computer Engineering
Mechanical, Materials and Aerospace Engineering

General Degree Requirements

Students pursuing a master's degree are required to take 30-32 credit hours beyond the requirements of a B.S. degree program. The Ph.D. program requires 84 credit hours beyond the Bachelor of Science. The curriculum consists of two components: department core courses that provide a strong background in basic principles of the chosen engineering field and E^3 specialization courses. The following section details the E^3 course requirements for M.S., professional master's, and Ph.D. degrees in chemical engineering, environmental engineering, mechanical and aerospace engineering, and electrical engineering. Selected E^3 undergraduate courses may be substituted for graduate courses with the approval of the designated adviser, if the total undergraduate credit hours for the professional master's or M.S. degree do not exceed departmental constraints.

Students are also required to attend interdisciplinary seminars during their first and/or second semesters, which are offered as part of the regular graduate seminars by the departments of Chemical and Environmental Engineering; Mechanical, Materials and Aerospace Engineering; and Electrical and Computer Engineering. A student completing a M.S. or Ph.D. thesis or professional master's project will be a member of an interdisciplinary research team consisting of professors and students from chemical, environmental, electrical and mechanical engineering backgrounds, working in a cross-disciplinary group project. Each interdisciplinary team must include professors from different departments.

Policies and procedures regarding admission, advising, financial aid and comprehensive examinations are established by the individual departments offering this program.

Master of Chemical Engineering with E^3 specialization

32 credit hours
Project

This program has the same requirements as the M.S. degree program, except that, in place of eight credit hours of M.S. thesis research, students are required to register for two to five credits of special projects research (CHE 594), plus additional E^3 courses with the approval of their adviser.

Master of Science in Chemical Engineering with E^3 specialization

32 credit hours
Thesis

Students pursuing the M.S. in Chemical Engineering with E^3 specialization are required to take CHE 543 and select at least one course from Group A and one course from Group B (see course listing on pages 209-219), and register for up to eight credit hours of M.S. thesis preparation (CHE 591) in an interdisciplinary E^3 area. In addition, the students are required to take all required core courses for the M.S. in Chemical Engineeering degree.

Students may apply up to 12 credit hours of 400-level courses to the M.S. degree requirements with their adviser's approval.

Energy/Environment/Economics (E^3)

Master of Environmental Engineering with E^3 specialization

32 credit hours
Project

This program has the same requirements as the M.S. degree program, except that in place of eight credit hours of M.S. thesis research, students are required to register for two to five credits of special project research (ENVE 594), plus additional E^3 courses with the approval of their adviser.

Master of Science in Environmental Engineering with E^3 specialization

32 credit hours
Thesis

Candidates for the M.S. in Environmental Engineering with E^3 specialization are required to take ENVE 544 and complete the required core courses for the M.S. in Environmental Engineering degree. In addition, students must complete one course from Group A, and one from Group B (see course listings on page 209-210).

Students are also required to register for up to eight credit hours of M.S. thesis research (ENVE 591) in an interdisciplinary E^3 area. Students may apply up to two 400-level courses to the M.S. degree requirements with their adviser's approval.

Master of Mechanical and Aerospace Engineering with E^3 specialization

30 credit hours
Thesis

Candidates for the Master of Mechanical and Aerospace Engineering are required to take CHE 543 and the following three courses:

MMAE 504	Engineering Analysis Ia
MMAE 505	Numerical Methods in Engineering
MMAE 550	Experimental Methods in Mechanical Engineering

In addition, the E^3 specialization under MMAE requires 16 credit hours selected from the following Group A courses on pages 209-210:

MMAE 520	Advanced Thermodynamics
MMAE 521	Statistical Thermodynamics
MMAE 522	Air Conditioning Analysis
MMAE 523	Fundamentals of Power Generation
MMAE 524	Fundamentals of Combustion
MMAE 525	Fundamentals of Heat Transfer
MMAE 526	Heat Transfer: Conduction
MMAE 527	Heat Transfer: Convection and Radiation
MMAE 538	Computational Techniques in Finite Element Methods
MMAE 539	Nonlinear Finite Element Analysis

E^3 requirements include two additional credit hours for MMAE 594 (Project for Professional Master Students).

Master of Science in Mechanical and Aerospace Engineering with E^3 specialization

32 credit hours
Project

Candidates for the M.S. in Mechanical and Aerospace Engineering with E^3 specialization are required to take CHE 543 and two courses: MMAE 501 (Engineering Analysis Ia) and MMAE 502 (Engineering Analysis II). Also required under the thermal sciences area of MMAE are MMAE 520 (Advanced Thermodynamics) and any three of the following Group A courses:

MMAE 521	Statistical Thermodynamics
MMAE 522	Air Conditioning Analysis
MMAE 523	Fundamentals of Power Generation
MMAE 524	Fundamentals of Combustion
MMAE 525	Fundamentals of Heat Transfer
MMAE 526	Heat Transfer: Conduction
MMAE 527	Heat Transfer: Convection and Radiation

Also required are one course from Group B and six to seven credit hours of MMAE 591 (Thesis).

Master of Electrical and Computer Engineering with E^3 specialization

30 credit hours
Non-thesis option

This program has the same requirements as the M.E.C.E. degree program, except that students are required to register for three to six credits of special project research (ECE 594), plus CHE 543, two courses from the electrical engineering courses listed in Group A, one course from Group B, and two power and control courses. At least 24 ECE credits are required.

Master of Science in Electrical Engineering with E^3 specialization

32 credit hours
Thesis option

Candidates for the M.S. in Electrical Engineering are required to take CHE 543 and must select two courses from the electrical engineering courses listed in Group A (see course listings on pages 209-210) and one course from Group B. In addition, students are required to take two power and control courses, and at least one course from each of two minor areas of study: communication theory and signal processing, network electronics and electromagnetics, or computer engineering. The students also are required to register for six to eight credit hours of M.S. thesis research (ECE 591) in an interdisciplinary E^3 area and one advanced math course (unless this requirement was met in the B.S. degree). Students may apply up to 12 credit hours of 400-level courses toward the M.S. degree with their adviser's approval.

Doctor of Philosophy with E^3 specialization

84 credit hours
Qualifying exam
Comprehensive exam
Dissertation and oral defense

Students interested in the Ph.D. program in all disciplines (chemical, environmental, mechanical, materials and aerospace, and electrical engineering) are required to take at least 84 credit hours beyond the B.S. degree requirements, including CHE 543 and at least five E^3 courses (four from both groups A and B; see course listings on pages 209-210) upon the recommendation of their thesis adviser. Registration for approximately 32 hours of Ph.D. thesis research in E^3 areas of study is also required. Candidates must pass written qualifying and comprehensive examinations and must defend their thesis in an oral examination. The Ph.D. committee for E^3 students must include at least one E^3 professor from outside the student's department.

E^3 Courses

See descriptions under the respective department course listings.

Group A

CHE 505
Fluid Properties

CHE 512
Heat Transfer

CHE 518
Mass Transfer

CHE 524
Industrial Catalysis

CHE 536
Computational Techniques in Engineering

CHE 540
Flow Through Porous Media and Fundamentals of Reservoir Engineering

CHE 541
Renewable Energy Technologies

CHE 542
Fluidization and Gas-Solids Flow Systems

CHE 544
Kinetic Theory of Multiphase Flow

CHE 563
Separation Processes

CHE 565
Electrochemical Engineering

CHE 576
Industrial Chemistry: Catalytic and Thermal Reactions and Processes

ECE 550
Power Electronics Dynamics and Control

ECE 551
Advanced Power Electronics

ECE 552
Adjustable Speed Drives

ECE 553
Power Systems Planning

ECE 554
Power Systems Relaying

Energy/Environment/Economics (E^3)

ECE 555
Market Operations in Electric Power Systems

ECE 557
Fault Tolerant Power Systems

ECE 558
Power Systems Reliability

ECE 559
High Voltage Power Transmission

ECE 560
Power Systems Dynamics and Stability

ECE 561
Deregulated Power Systems

ECE 562
Power System Transaction Management

ECE 563
Computational Intelligence in Engineering

ECE 564
Control and Operation of Electric Power Systems

MMAE 517
Computational Fluid Dynamics

MMAE 520/CHE 503
Advanced Thermodynamics

MMAE 521
Statistical Thermodynamics

MMAE 522
Air Conditioning Analysis

MMAE 523
Fundamentals of Power Generation

MMAE 524
Fundamentals of Combustion

MMAE 525
Fundamentals of Heat Transfer

MMAE 526
Heat Transfer: Conduction

MMAE 527
Heat Transfer: Convection and Radiation

MMAE 538
Computational Techniques in Finite Element Methods

MMAE 539
Nonlinear Finite Element Analysis

Group B

CHE 541
Renewable Energy Technologies

CHE 560
Statistical Quality and Process Control

CHE 587
Particle Processing and Characterization

EM 507
Industrial Ecology

ENVE 501
Environmental Chemistry

ENVE 506
Chemodynamics

ENVE 520
Environmental Monitoring and Assessment

ENVE 527
Statistical Analysis of Systems

ENVE 542
Physicochemical Processes in Environmental Engineering

ENVE 545
Environmental Regulations and Risk Assessment

ENVE 551
Industrial Waste Treatment

ENVE 561
Design of Sanitary Engineering Processes

ENVE 563
Systems Engineering: Waste Facility Design and Operation

ENVE 570
Air Pollution Meteorology

ENVE 573
Air Pollution Engineering

ENVE 577
Design of Air Pollution Control Devices

ENVE 578
Physical and Chemical Processes for Industrial Gas Cleaning

ENVE 580
Hazardous Wastes Engineering

ENVE 585
Groundwater Contamination and Pollutant Transport