

# MASTER OF SCIENCE IN MATERIALS SCIENCE AND ENGINEERING WITH SPECIALIZATION IN ENERGY/ ENVIRONMENT/ECONOMICS (E3)

The Energy/Environment/Economics (E3) 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.

E3 specialization requires an interdisciplinary thesis in an E3 area of research for M.S. and Ph.D. degrees, and an interdisciplinary graduate project for professional master's degrees. Graduate students in E3 should also be enrolled in fundamental courses related to the topics of energy, environment, and economics. E3 is designed primarily for students majoring in mechanical and aerospace, materials, chemical, environmental, 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.

## 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 72 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 E3 specialization courses. Selected E3 undergraduate courses may be substituted for graduate courses with the approval of the designated adviser, if the total undergraduate credit hours for the M.E. 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. 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, materials, 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.

## Curriculum

Code	Title	Credit Hours
<b>Core Courses</b>		(15)
CHE 543	Energy, Environment, and Economics	3
MMAE 468	Introduction to Ceramic Materials	3
MMAE 569	Advanced Physical Metallurgy	3
Select one of the following:		3
CHE 503	Thermodynamics	3
CHE 553	Advanced Thermodynamics	3
MMAE 520	Advanced Thermodynamics	3
Select a minimum of one course from the following:		3
CHE 541	Renewable Energy Technologies	3
CHE 566	Electrochemical Engineering	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
<b>Non-Core Courses</b>		(9)
Select a minimum of two courses from the following:		6
MMAE 470	Introduction to Polymer Science	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 561	Solidification and Crystal Growth	3
MMAE 563	Advanced Mechanical Metallurgy	3
MMAE 566	Problems in High-Temperature Materials	3

MMAE 571	Misrostructural Characterization of Materials	3
MMAE 573	Transmission Electron Microscopy	3
MMAE 579	Advanced Materials Processing	3
Select a minimum of one course from the following:		3
CHE 567	Fuel Cell Fundamentals	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3
<b>Thesis Research</b>		(6-8)
MMAE 591	Research and Thesis M.S.	6-8
<b>Electives</b>		(0-2)
Select elective courses as needed		0-2

**Minimum degree credits required: 32**

## E3 Courses

See descriptions under the respective department's course listings.

### Group A

Code	Title	Credit Hours
CHE 503	Thermodynamics	3
CHE 536	Computational Techniques in Engineering	3
CHE 541	Renewable Energy Technologies	3
CHE 542	Fluidization and Gas-Solids Flow Systems	3
CHE 565	Fundamentals of Electrochemistry	3
ECE 550	Power Electronic Dynamics and Control	3
ECE 551	Advanced Power Electronics	3
ECE 552	Adjustable Speed Drives	3
ECE 553	Power System Planning	3
ECE 554	Power System Relaying	3
ECE 555	Power Market Operations	3
ECE 557	Fault-Tolerant Power Systems	3
ECE 558	Power System Reliability	3
ECE 559	High Voltage Power Transmission	3
ECE 560	Power Systems Dynamics and Stability	3
ECE 561	Deregulated Power Systems	3
ECE 562	Power System Transaction Management	3
ECE 563	Computational Intelligence in Engineering	3
ECE 564	Control and Operation of Electric Power Systems	3
MMAE 517	Computational Fluid Dynamics	3
MMAE 520	Advanced Thermodynamics	3
MMAE 522	Nuclear, Fossil-Fuel, and Sustainable Energy Systems	3
MMAE 523	Fundamentals of Power Generation	3
MMAE 524	Fundamentals of Combustion	3
MMAE 525	Fundamentals of Heat Transfer	3
MMAE 526	Heat Transfer: Conduction	3

MMAE 527

Heat Transfer: Convection and Radiation

3

**Group B**

<b>Code</b>	<b>Title</b>	<b>Credit Hours</b>
CHE 541	Renewable Energy Technologies	3
CHE 560	Statistical Quality and Process Control	3
ENVE 501	Environmental Chemistry	3
ENVE 506	Chemodynamics	3
ENVE 542	Physiochemical Processes in Environmental Engineering	3
ENVE 551	Industrial Waste Treatment	3
ENVE 561	Design of Environmental Engineering Processes	3
ENVE 570	Air Pollution Meteorology	3
ENVE 577	Design of Air Pollution Control Devices	3
ENVE 578	Physical and Chemical Processes for Industrial Gas Cleaning	3
ENVE 580	Hazardous Waste Engineering	3