

# ENERGY AND MINERAL ENGINEERING

## Degree Requirements

All graduate students are expected to attend general Department seminars. Graduate students may be asked to contribute to the instructional programs of the Department by assisting with undergraduate laboratory and lecture courses.

### Master of Science (M.S.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (<https://gradschool.psu.edu/graduate-education-policies/>)

The M.S. degree program in Energy and Mineral Engineering is designed for students to gain advanced knowledge for research, analysis, and design in Energy and Mineral Engineering.

M.S. students must take at least two (2) courses (6 credits of core courses) from the list of prescribed (core) courses:

Code	Title	Credits
EME 501	Design Under Uncertainty in Energy and Mineral Systems	3
EME 511	Interfacial Physical-Chemical Systems, Processes, and Measurements	3
EME 521	Mathematical Modeling of Energy and Mineral Systems	3
EME 531	Thermodynamics of Energy and Mineral Systems	3
EME 551	Safety, Health and Environmental Risks in Energy and Mineral Production	3

An additional set of prescribed twelve (12) option credits (as a minimum) must be taken if the student chooses to pursue an EME disciplinary option (petroleum and natural gas engineering, mining and mineral process engineering, fuel science, or energy systems engineering). Students are not required to choose an option and may complete the base program in EME.

Students pursuing an M.S. degree in EME will be required to complete a prescribed culminating research experience and the minimum amount of credits associated with each experience, which include the completion of minimum core and option (if any) course requirements. The thesis and non-thesis M.S. culminating experience tracks are:

**THESIS-BASED M.S. in EME** (30 credits total): Students are required to complete a minimum of 30 credits total (at least 18 at the 500 or 600 level) including: 24 credits in course work, 6 thesis credits (EME 600 Thesis Research), and a thesis accepted by the adviser(s) and committee members, the head of the graduate program, and the Graduate School. The student must pass a thesis defense.

**NON-THESIS BASED M.S. in EME** (36 credits total): Students are required to complete a minimum of 36 credits in total (at least 24 at the 500 level) including: 33 credits in course work and 3 credits for the completion of a culminating research experience. Within the 33 credits of coursework, M.S. students must take at least two extra courses (6 credits) from the EME core course list (beyond the six credit M.S. core requirement) or

chosen graduate option (beyond the option's 12-credit minimum option requirement). The non-thesis culminating research experiences are:

- **Paper-based M.S.:** Students take three (3) credits of non-thesis research (EME 596 Individual Studies) and complete a satisfactory scholarly paper evaluated by adviser(s) and a reader.
- **Course-based M.S.:** Students take a capstone research course (EME 580 Methodology of Research in EME (3 cr.) where they will create a work product demonstrating evidence of analytical thinking and synthesis of knowledge in the Energy and Mineral Engineering field.

### Doctor of Philosophy (Ph.D.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (<https://gradschool.psu.edu/graduate-education-policies/>)

The Ph.D. program in Energy and Mineral Engineering emphasizes scholarly research and helps students prepare for research and related careers in industry, government and academe. The Ph.D. program in Energy and Mineral Engineering requires completing a minimum of twelve (12) post-M.S. course credits, which must include the completion of all minimum core and option (if any) course requirements, and twelve (12) research credits. For students without an M.S. degree, 24 additional course credits must be taken to complete a total of 36 course credits and 48 credits total overall. At least 18 credits of these must be at the 500 or 600 level. A student's Ph.D. committee can require additional course work based on the student's background and research plans.

Ph.D. students must take at least one (1) course (3 credits of core courses) from the following list of prescribed (core) courses. Ph.D. students without an M.S. are required to take three (3) courses (9 credits of core courses) from this list:

Code	Title	Credits
EME 501	Design Under Uncertainty in Energy and Mineral Systems	3
EME 511	Interfacial Physical-Chemical Systems, Processes, and Measurements	3
EME 521	Mathematical Modeling of Energy and Mineral Systems	3
EME 531	Thermodynamics of Energy and Mineral Systems	3
EME 551	Safety, Health and Environmental Risks in Energy and Mineral Production	3

An additional set of prescribed twelve (12) option credits (as a minimum) must be taken if the student chooses to pursue an EME disciplinary option (petroleum and natural gas engineering, mining and mineral process engineering, fuel science, or energy systems engineering). Students are not required to choose an option and may complete the base program in EME.

Acceptance into the Ph.D. degree program in Energy and Mineral Engineering is based on the student's performance on the Ph.D. qualifying examination administered by the Graduate Faculty of the EME graduate program. The Ph.D. Qualifying Examination in EME will measure the student's fundamental knowledge of subjects covered in the program and interest area(s) of the individual candidate. It is intended to determine whether a student has the preparation, intellectual capacity, and professional attitude to complete a Ph.D. program successfully.

A Ph.D. comprehensive examination is required of all Ph.D. candidates and should be taken after substantial completion of all Ph.D. course work requirements. To earn the Ph.D. degree, doctoral students must also write a dissertation that is accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School. In addition, the student must pass a final oral examination (the dissertation defense).

## Options

EME students are not required to choose a graduate option and may complete the base program in EME. However, M.S. and Ph.D. students of the EME graduate program who desire disciplinary identity may choose from among the following available graduate options:

- Energy systems engineering (ESysE)
- Fuel science (FSc)
- Mining and mineral process engineering (MMPE)
- Petroleum and natural gas engineering (PNGE)

The mandatory minimum course requirement for each of these options is 12 credits (4 courses) selected from the list of option-specific courses provided below. Student may apply the option to either the M.S. or Ph.D. degrees, or both, provided that new and appropriate substitute courses are taken as approved by the EME graduate program officer.

### Energy Systems Engineering Option

Code	Title	Credits
<b>Required Courses</b>		
Select 12 credits from the following:		12
EME 522	Computational Methods for Electric Power Systems Analysis	
EME 523	Stochastic Optimization Methods of Energy and Environmental Systems	
EME 524	Machine Learning for Energy and Mineral Engineering Problems	
EME 526	Solar Utility and Portfolio Management	
EME 527	Stochastic Modeling of Spatial Variability in Energy and Environmental Systems	
ENNEC 540	Economic Analysis of Energy Markets	
IE 505	Linear Programming	
IE 516	Applied Stochastic Processes	
<b>Total Credits</b>		<b>12</b>

### Fuel Science Option

Code	Title	Credits
<b>Required Courses</b>		
Select 12 credits from the following:		12
CHE 544	General Transport Phenomena	
or CHE 546	Transport Phenomena II	
EME/MATSE 570	Catalytic Materials	
or CHE 536	Heterogeneous Catalysis	
FSC 503	Analytical Methods in Fuel Science	
or CHE 510	Surface Characterization of Materials	
FSC 504	Problems in Fuels Engineering	
FSC 506	Carbon Reactions	

ME 523	Numerical Solutions Applied to Heat Transfer and Fluid Mechanics Problems	
<b>Total Credits</b>		<b>12</b>

### Mining and Mineral Process Engineering Option

Code	Title	Credits
<b>Required Courses</b>		
Select 12 credits from the following:		12
MNG 512	Valuation of Mineral Properties and Mining Projects	
MNG 541	Surface Mine Equipment Selection Analysis	
MNG 554	Rock Mechanics Design	
MNPR 505	Particle Separation	
MNPR 507	Hydrometallurgical Processing	
<b>Total Credits</b>		<b>12</b>

### Petroleum and Natural Gas Engineering Option

Code	Title	Credits
<b>Required Courses</b>		
Select 12 credits from the following: <sup>1</sup>		12
PNG 501	Flow in Porous Media	
PNG 502	Coupled Flow and Deformation in Porous Media	
PNG 512	Numerical Reservoir Simulation	
PNG 518	Design of Miscible Recovery Projects	
PNG 520	Thermodynamics of Hydrocarbon Fluids	
PNG 526	Well Stimulation	
PNG 530	Natural Gas Engineering	
PNG 555	Unconventional Resources Analysis	
PNG 566	Reservoir Characterization	
PNG 577	Production and Completions Engineering	
PNG 597	Special Topics (when taught, may be used to partially satisfy the PNGE option minimum credit requirement)	
<b>Total Credits</b>		<b>12</b>

<sup>1</sup> PNG 596 Individual Studies credits may not be used within this option course credit count.