

# ENGINEERING MANAGEMENT, MASTER OF SCIENCE

<http://engineering.jhu.edu/msem/>

The Master of Science in Engineering Management (MSEM) degree program combines advanced course work in highly-specialized technical fields with a professional education in innovation, entrepreneurship, and management practices. Graduates of the program will be provided with the educational background to pursue professional management roles in industry.

## Facilities

The MSEM program has a dedicated seminar room housed in Wyman. Students are able to study, conduct research and build prototypes within this space.

## Graduate Requirements

*Please consult directly with the MSEM program director or MSEM program administrator to confirm the below requirements; changes may have occurred since this annual publication.*

Students in the MSEM program take the following to fulfill degree requirements:

- Five advanced courses in the engineering technical track (15 credits, with a minimum of 3 credits per course)
- Three full-semester fall management courses, a fall and spring MSEM Seminar course, and two half-semester required courses in the spring. Plus, students may choose from a list of approved half-semester courses to complete their elective, in addition to EN.662.643, The Practice of Consulting, taken during the intersession.
- No grade lower than C may be applied to the program (and only one C is permitted)
- Courses must be at the graduate level (600-level or higher)
- Departments sponsoring technical tracks may impose stricter requirements for course work within the track.
- Students are additionally required to complete EN.500.603 Graduate Orientation and Academic Ethics, and the Responsible Conduct of Research which do not count towards the degree requirements above.

At the discretion of the student's advisors, a Johns Hopkins MSEM student may be permitted to double-count up to two JHU courses, or apply graduate courses taken at JHU but not applied to a degree, in accordance with conditions in the WSE Policy on Double-Counting Courses.

## Advising

MSEM students will receive advising on the technical track from a designated faculty member affiliated with that track. MSEM students will be advised regarding the management track by members of the Center for Leadership Education faculty.

## Faculty

Faculty members teaching the technical track courses are listed in their respective engineering departments elsewhere in this catalogue. Faculty

members teaching the management track courses are listed in the Center for Leadership Education section of this catalogue.

## Program Requirements

### Management Track

The Center for Leadership Education has constructed a program tailored to the needs of future engineering managers. MSEM students will participate in a cohort program, which begins each fall, where all students in an entering class will take a suite of management courses together.

*Fall semester:* a cohort-based management curriculum consisting of three required courses and seminar: Strategies: Accounting & Finance, Strategies: Innovation and Growth and Professional Presentations.

*Immersion:* The Practice of Consulting during the January term.

*Spring Semester:* Two-half semester courses and seminar: Managing People and Resolving Conflicts, Leading Change

All MSEM students are required to attend the MSEM Seminar (fall & spring semesters) EN.662.811 M.S. in Engineering Management Seminar/EN.662.812 MSEM Seminar) course while enrolled in the program. This will meet monthly and addresses three important content areas: Innovation and design thinking; personal skills and development especially in the communication arena; and talks with practicing engineering managers. The Engineering Management program reserves the right to change the list of eligible courses at its discretion. MSEM students are also required to complete a half-semester management elective course (EN.663.xxx).

### Technical Tracks

In addition to fulfilling the management track requirements, MSEM students must complete the requirements for one of the technical tracks (5 courses, 15 credits total/3 credits per course). Technical Tracks do not appear on the transcript or diploma. These are:

- Biomaterials
- Chemical & Biomolecular Engineering
- Chemical Product Design
- Civil Engineering
- Communications Science
- Computer Science
- Cybersecurity
- Energy
- Environmental Systems Analysis, Economics and Public Policy
- Fluid Mechanics
- Materials Science and Engineering
- Mechanical Engineering
- Mechanics and Materials
- Nano-Biotechnology
- Nanomaterials and Nanotechnology
- Operations Research
- Probability and Statistics
- Smart Product and Device Design
- Systems Engineering
- Space Systems Engineering, Engineering for Professionals

**Please note:** the course requirements listed below are a general guide and are subject to change frequently. For degree requirements, please

refer to the program manager and the technical track advisor. Refer to the website for more information: <https://mse.engineering.jhu.edu/academics/technical-track/>

### Biomaterials

(Sponsored by the Department of Materials Science & Engineering (<https://e-catalogue.jhu.edu/engineering/materials-science-engineering/>))

#### Prerequisites

- UG calculus, chemistry, biology, physics and introductory biomaterials course equivalent to EN.510.316 Foundations of Biomaterials

Code	Title	Credits
<b>Required Courses</b>		
EN.510.607	Biomaterials II: Host response and biomaterials applications	3
EN.510.621	Biomolecular Materials I - Soluble Proteins and Amphiphiles	3
<b>Total Credits</b>		<b>6</b>

Substitutions for required courses can be made at the advisor's discretion.

#### Electives

- Electives should be related to Materials Science and Engineering and must be approved by the DMSE graduate committee
- See list of pre-approved elective courses or courses off list by petition

#### List of Pre-approved Electives

Code	Title	Credits
EN.510.400	Introduction to Ceramics	3
EN.510.422	Micro and Nano Structured Materials & Devices	3
EN.510.426	Biomolecular Materials I - Soluble Proteins and Amphiphiles	3
EN.510.428	Material Science Laboratory I	3
EN.510.429	Materials Science Laboratory II	3
EN.510.430	Biomaterials Lab	3
EN.510.453	Materials Characterization	3
EN.510.604	Mechanical Properties of Materials	3
EN.510.605	Electrical, Optical and Magnetic Properties of Materials	3
EN.510.607	Biomaterials II: Host response and biomaterials applications	3
EN.510.657	Materials Science of Thin Films	3

Courses not on this list can be used at the advisor's discretion.

### Civil Engineering

(Sponsored by the Department of Civil Engineering (<https://e-catalogue.jhu.edu/engineering/civil-engineering/>))

The Civil Engineering track for the Master of Science in Engineering Management consists of five courses, with the following guidelines:

Code	Title	Credits
<b>Required Courses</b>		
EN.560.730	Finite Element Methods	3
EN.560.604	Introduction to Solid Mechanics	3
<b>Total Credits</b>		<b>6</b>

Substitutions for required courses can be made at the advisor's discretion.

#### Elective Courses

- Any three courses from 560.6xx or above, or 565.6xx or above (excluding seminar)

### Chemical and Biomolecular Engineering & CHEMICAL PRODUCT DESIGN

(Sponsored by the Department of Chemical and Biomolecular Engineering (<https://e-catalogue.jhu.edu/engineering/chemical-biomolecular-engineering/>))

Required Courses: any of the following courses:

- EN.540.673 Adv Chemical Reaction Eng in Practice (typically in the spring)
- EN.540.602 Metabolic Systems Biotechnology (typically held in the fall)
- EN.540.615 Interfacial Science w/App to Nano Systems (typically held in the fall)
- EN.540.632 Projects in Design: Pharmacokinetics (typically held in the fall)
- EN.540.681 Molecular Kinetics and Catalysis (typically held in the spring)

Substitutions for required courses can be made at the advisor's discretion.

### Communications Science

(Sponsored by the Department of Electrical & Computer Engineering (<https://e-catalogue.jhu.edu/engineering/electrical-computer-engineering/>))

Students may select any combination of 5 courses in communications and related fields from the list below.

Code	Title	Credits
EN.520.447	Information Theory	3
EN.520.646	Wavelets & Filter Banks	3
EN.520.651	Random Signal Analysis	4
EN.520.666	Information Extraction	3
<b>Total Credits</b>		<b>13</b>

Alternative selections for required courses are at the advisor's discretion.

### Computer Science

(Sponsored by the Department of Computer Science (<https://e-catalogue.jhu.edu/engineering/computer-science/>))

#### Curricular Requirements

Any five regular graduate courses approved by the advisor, 600-level or higher, from the Department of Computer Science, not including the senior thesis.

- Innovation and Design II does not count as a technical course for the Computer Science Track.
- MSEM Students in this track may take no more than three graduate-level courses in one semester.

### Cybersecurity

(Sponsored by the Information Security Institute)

Pre-Requisites:

- Entering students are expected to have completed a program of study equivalent to that required by at least an undergraduate minor in computer science and a computer science BS is recommended.
- Applicants from other disciplines must have coursework (or equivalent experience) in Computer System Fundamentals, Programming, Data Structures, and Discrete Math.
- If the necessary background courses are lacking, students must take undergraduate courses to possess these prerequisites. These courses will not count toward the MSEM degree but will appear on the transcript.

Curricular Requirements (5):

- A combination of five graduate courses, 600-level or higher, are taken from the Information Security Institute required as below:
  - Two courses from the Core Technology and/or the Elective Technology course lists;
  - One Core Policy course and one Core Management course;
  - The fifth course from any of the above course categories.
- No more than three graduate-level courses by the Information Security Institute may be taken in one semester by an MSEM student in this track.

**Energy**

(Sponsored by the <https://publichealth.jhu.edu/departments/environmental-health-and-engineering/>) Department of <https://e-catalogue.jhu.edu/engineering/mechanical-engineering/> Environmental Health & Engineering (<https://ehe.jhu.edu/>)

Required Courses:

*Approval of substitutions for required courses are at the discretion of the technical advisor.*

Energy Technology Group: choose at least 1

- 030.404 Electrochemical Systems for Energy Conversion and Storage
  - 510.453 Materials Science of Energy Technologies
  - 510.627 Photovoltaics and Energy Devices
  - 540.619 Projects in Design: Alternative Energy
  - 540.630 Thermodynamics, Statistical Mechanics and Kinetics
- Systems Management Group: choose at least 1

- 520.629 Networked Dynamical Systems
  - 530.664 Energy Systems Analysis
  - 570.607 Energy Policy and Planning Models
  - 570.697 Risk and Decision Analysis
- Electives: (choose up to 3)

- 030.403 Optoelectronic Materials and Devices: Synthesis, Spectroscopy, and Applications
- 271.402 Water, Energy and Food
- 410.777 Biofuels
- 425.604 Energy and Climate Finance
- 420.616 Environmental Consequences of Conventional Energy Generation
- 425.601 Principles and Applications of Energy Technology
- 425.625 Solar Energy: Science, Technology and Policy
- 425.640 The Future of the US Electric System in a Carbon-Constrained World
- 530.629 Simulation and Analysis of Ocean Wave Energy Systems
- 570.657 Air Pollution
- 570.695 Environmental Health and Engineering Systems Design
- 615.448 Alternative Energy Technology
- 680.697 Global Energy Fundamentals

- 680.714 Energy, Environment and Development in Developing Countries
- 680.730 Global Electricity Markets
- 680.790 Principles of Energy Economics and Finance
- 680.792 The Water, Energy and Food Nexus
- 680.855 Life Cycle Assessment
- 680.852 Energy Poverty
- 810.761 Energy in the Americas: Conflict, Cooperation and Future Prospects

Other elective courses must be approved at the advisor's discretion.

**ENVIRONMENTAL SYSTEMS ANALYSIS, ECONOMICS AND PUBLIC POLICY:**

(Sponsored by the Department of Environmental Health & Engineering (<https://publichealth.jhu.edu/departments/environmental-health-and-engineering/>))

Required Courses: (3)

*Approval of substitutions for required courses are at the discretion of the technical advisor.*

**Economics** (preferably with calculus). This requirement may be waived by their advisor if the student has already had an intermediate microeconomics course. A list of qualifying courses is available from the advisor.

**Mathematics of Decision Making:** EN.570.695 Environmental Health and Engineering Systems Design

**Policy & Design Making:** EN.570.697 Risk and Decision Analysis OR EN.570.607 Energy Policy and Planning Models

Electives: (4)

*Courses not on this list are at the advisor's discretion.*

- 570.618 Multiobjective Programming and Planning

Additional Notes:

The student's advisor must approve all courses  
All courses must be at the 600-level or above.  
No more than one course in Environmental Engineering may be used to fulfill the track and only with careful consultation with the student's advisor.

Other elective courses must be approved at the advisor's discretion.

**Fluid Mechanics**

(Sponsored by the Department of Materials Science & Engineering (<https://e-catalogue.jhu.edu/engineering/full-time-residential-programs/degree-programs/materials-science-engineering/>))

Any five courses in Fluid Mechanics or closely related discipline, at the 600-level or higher, as approved by the Faculty advisor.

**Materials Science & Engineering**

(Sponsored by the Department of Materials Science & Engineering (<https://e-catalogue.jhu.edu/engineering/materials-science-engineering/>))

**Prerequisites**

- UG calculus, chemistry and physics; biology is recommended

Code	Title	Credits
<b>Required Courses</b>		
EN.510.601	Structure Of Materials	3
<b>Total Credits</b>		<b>3</b>

Substitutions for required courses can be made at the advisor's discretion.

### Electives

- See list of pre-approved elective courses or courses off list by petition

### Recommended Structure

Code	Title	Credits
<b>List of Pre-approved Electives</b>		
EN.510.400	Introduction to Ceramics	3
EN.510.422	Micro and Nano Structured Materials & Devices	3
EN.510.426	Biomolecular Materials I - Soluble Proteins and Amphiphiles	3
EN.510.428	Material Science Laboratory I	3
EN.510.429	Materials Science Laboratory II	3
EN.510.430	Biomaterials Lab	3
EN.510.453	Materials Characterization	3
EN.510.604	Mechanical Properties of Materials	3
EN.510.605	Electrical, Optical and Magnetic Properties of Materials	3
EN.510.607	Biomaterials II: Host response and biomaterials applications	3
EN.510.657	Materials Science of Thin Films	3

Alternative selections can be made at the advisor's discretion.

### Mechanical Engineering

(Sponsored by the Department of Mechanical Engineering (<https://e-catalogue.jhu.edu/engineering/mechanical-engineering/>))

#### Required Courses

Any five courses in Mechanical Engineering or closely related discipline at the 600-level or higher, as approved by the Faculty advisor.

Alternative selections can be made at the advisor's discretion.

### Mechanics and Materials

(Sponsored by the Department of Materials Science & Engineering (<https://e-catalogue.jhu.edu/engineering/materials-science-engineering/>))

Code	Title	Credits
<b>Required Courses</b>		
EN.510.601	Structure Of Materials	3
EN.510.604	Mechanical Properties of Materials	3

Substitutions for required courses can be made at the advisor's discretion.

#### Elective Courses

Any three (3) of the following courses, approved by the faculty advisor:

Code	Title	Credits
EN.510.428	Material Science Laboratory I	3
EN.530.405	Mechanics of Advanced Engineering Structures	3
EN.530.414	Computer-Aided Design	3
EN.530.418	Aerospace Structures	3
EN.510.602	Thermodynamics Of Materials	3
EN.510.603	Phase Transformations of Materials	3

Alternative selections can be made at the advisor's discretion.

### Nano-Biotechnology

(Sponsored by the Department of Materials Science & Engineering (<https://e-catalogue.jhu.edu/engineering/materials-science-engineering/>))

#### Prerequisites

- UG calculus, chemistry, biology, physics and introductory biomaterials course equivalent to Foundations of Biomaterials (EN.510.316)

Code	Title	Credits
<b>Required Courses</b>		
EN.510.422	Micro and Nano Structured Materials & Devices	3
EN.510.607	Biomaterials II: Host response and biomaterials applications <sup>1</sup>	3
<b>Total Credits</b>		<b>6</b>

<sup>1</sup> PR: EN.510.316 Foundations of Biomaterials or permission

Substitutions for required courses can be made at the advisor's discretion.

#### Electives

- Electives should be related to Materials Science and Engineering and must be approved by the DMSE graduate committee
- See list of pre-approved elective courses or courses off list by petition

### Recommended Structure

Fall	Credits Spring	Credits
EN.510.422	3 EN.510.607	3
Electives: suggest one	Electives: suggest one	
<b>3</b>		<b>3</b>
<b>Total Credits 6</b>		

### List of Pre-approved Electives

Code	Title	Credits
EN.510.400	Introduction to Ceramics	3
EN.510.422	Micro and Nano Structured Materials & Devices	3
EN.510.426	Biomolecular Materials I - Soluble Proteins and Amphiphiles	3
EN.510.428	Material Science Laboratory I	3
EN.510.429	Materials Science Laboratory II	3
EN.510.430	Biomaterials Lab	3
EN.510.453	Materials Characterization	3
EN.510.604	Mechanical Properties of Materials	3
EN.510.605	Electrical, Optical and Magnetic Properties of Materials	3
EN.510.607	Biomaterials II: Host response and biomaterials applications	3
EN.510.657	Materials Science of Thin Films	3

Alternative selections can be made at the advisor's discretion.

### Nanomaterials and Nanotechnology

(Sponsored by the Department of Materials Science & Engineering (<https://e-catalogue.jhu.edu/engineering/materials-science-engineering/>))

**Prerequisites**

- UG calculus, chemistry, and physics

Code	Title	Credits
<b>Required Courses</b>		
EN.510.422	Micro and Nano Structured Materials & Devices	3
<b>Total Credits</b>		<b>3</b>

Substitutions for required courses can be made at the advisor's discretion.

**Electives**

- Electives should be related to Materials Science and Engineering and must be approved by the DMSE graduate committee
- See list of pre-approved elective courses or courses off list by petition

**Recommended Structure**

Fall	Credits	Spring	Credits
EN.510.422 (Required)	3	Required: none	
See list of pre-approved elective courses or courses off list by petition		Electives in Spring: suggest two	
		<b>3</b>	<b>0</b>
<b>Total Credits 3</b>			

**List of Pre-approved Electives**

Code	Title	Credits
EN.510.400	Introduction to Ceramics	3
EN.510.422	Micro and Nano Structured Materials & Devices	3
EN.510.426	Biomolecular Materials I - Soluble Proteins and Amphiphiles	3
EN.510.428	Material Science Laboratory I	3
EN.510.429	Materials Science Laboratory II	3
EN.510.430	Biomaterials Lab	3
EN.510.453	Materials Characterization	3
EN.510.604	Mechanical Properties of Materials	3
EN.510.605	Electrical, Optical and Magnetic Properties of Materials	3
EN.510.607	Biomaterials II: Host response and biomaterials applications	3
EN.510.657	Materials Science of Thin Films	3

**Operations Research**

(Sponsored by the Department of Applied Mathematics & Statistics (<https://e-catalogue.jhu.edu/engineering/applied-mathematics-statistics/>))

Substitutions for required courses can be made at the advisor's discretion

Any five courses from the following list, or a substitution as approved by the student's track advisor. As course offerings vary over time, an updated list of acceptable courses will be maintained on the MSEM program website.

Code	Title	Credits
EN.553.426	Introduction to Stochastic Processes	4
EN.553.427	Stochastic Processes and Applications to Finance	4
EN.553.433	Monte Carlo Methods	4

EN.553.463	Network Models in Operations Research	4
EN.553.762	Nonlinear Optimization II	3
EN.553.761	Nonlinear Optimization I	3
EN.553.766	Combinatorial Optimization	3
EN.570.697	Risk and Decision Analysis	3
EN.553.400	Mathematical Modeling and Consulting	4
EN.570.607	Energy Policy and Planning Models	3
EN.553.626	Introduction to Stochastic Processes	4
EN.553.627	Stochastic Processes and Applications to Finance	4
EN.553.628	Stochastic Processes and Applications to Finance II	4
EN.553.633	Monte Carlo Methods	4
EN.553.663	Network Models in Operations Research	4
EN.553.639	Time Series Analysis	3
EN.553.641	Equity Markets and Quantitative Trading	3
EN.553.642	Investment Science	4
EN.553.644	Introduction to Financial Derivatives	4
EN.553.645	Interest Rate and Credit Derivatives	4
EN.553.646	Risk Measurement/Management in Financial Markets	4
EN.553.647	Quantitative Portfolio Theory and Performance Analysis	4
EN.553.648	Financial Engineering and Structured Products	4

Alternative selections can be made at the advisor's discretion.

Innovation and Design II does not count as a technical course.

**Probability and Statistics**

(Sponsored by the Department of Applied Mathematics & Statistics (<https://e-catalogue.jhu.edu/engineering/applied-mathematics-statistics/>))

**Admissions Requirements**

- One upper-division undergraduate course in probability (equivalent to EN.553.420 Probability)
- One upper-division undergraduate course in mathematical statistics (equivalent to EN.553.430 Mathematical Statistics)

**Curricular Requirements**

Any five (5) of the following courses, approved by the faculty advisor:

553.613	Applied Statistics and Data Analysis I
553.614	Applied Statistics and Data Analysis II
553.620	Introduction to Probability
553.626	Introduction to Stochastic Processes
553.627	Stochastic Processes and Applications to Finance I
553.628	Stochastic Processes and Applications to Finance II
553.629	Introduction to Research in Discrete Probability
553.630	Introduction to Statistics
553.632	Bayesian Statistics
553.633	Monte Carlo Methods
553.636	Introduction to Data Science
553.639	Time Series Analysis
553.688	Computing for Mathematics
553.692	Mathematical Biology
553.693	Mathematical Image Analysis
553.720	Probability Theory I
553.721	Probability Theory II
553.722	Introduction to Stochastic Calculus

553.723 Markov Chains
553.727 Large Deviation Theory
553.729 Topics in Probability: Random Graphs and Percolation
553.730 Statistical Theory I
553.731 Statistical Theory II
553.732 Bayesian Statistics
553.733 Advanced Topics in Bayesian Statistics
553.734 Introduction to Nonparametric Estimation
553.735 Topics in Statistical Pattern Recognition
553.736 System Identification and Likelihood Methods
553.737 Distribution-free Statistics and Resampling Methods
553.738 High-Dimensional Approximation, Probability and Statistical Learning
553.739 Statistical Pattern Recognition Theory & Methods
553.740 Machine Learning I
553.741 Machine Learning II
553.742 Statistical Inference on Graphs
AS.110.653 Stochastic Differential Equations: An Introduction with Applications

Innovation and Design II does not count as a technical course. Substitutions are the discretion of the advisor.

### Smart Product and Device Design

(Sponsored jointly by the Department of Mechanical Engineering (<https://e-catalogue.jhu.edu/engineering/mechanical-engineering/>) and the Department of Electrical & Computer Engineering (<https://e-catalogue.jhu.edu/engineering/electrical-computer-engineering/>))

Code	Title	Credits
<b>Required Courses</b>		
EN.530.646	Robot Devices, Kinematics, Dynamics, and Control	4
EN.530.414	Computer-Aided Design	3
or EN.520.491	CAD Design of Digital VLSI Systems I (Juniors/Seniors)	
EN.530.421	Mechatronics	3
<b>Total Credits</b>		<b>10</b>

Substitutions for required courses can be made at the advisor's discretion.

### Elective Courses

Any two (2) courses approved by the faculty advisor.

### Systems Engineering

(Sponsored by the Department of Systems Engineering (<https://ep.jhu.edu/programs-and-courses/programs/systems-engineering/>))

Required Courses:

- Two courses with course numbers from EN.560.640-EN.560.659 or EN.560.740-EN.560.759, or choose one from both
- *Substitutions for courses can be made at the advisor's discretion.*

### Elective Courses

Three courses from any combination of the following:

Code	Title	Credits
EN.560.6xx or above, or EN.565.4xx or above (excluding seminar)		
EN.645.6xx or above (EP Systems Engineering)		
EN.553.761	Nonlinear Optimization I	3
EN.570.497	Risk and Decision Analysis	3.0

EN.553.400	Mathematical Modeling and Consulting	4
EN.570.607	Energy Policy and Planning Models	3.0
EN.663.653	Innovation and Design I	3.0
EN.663.657	Innovation and Design II	3.0

- For systems engineering track students only: 605.607 Agile Software Development will count as a management elective.

### SPACE SYSTEMS ENGINEERING, ENGINEERING FOR PROFESSIONALS PROGRAM

(Sponsored by the Engineering for Professionals Program)

Required Courses:

- 675.600 Systems Engineering for Space
- 675.601 Fundamentals of Engineering Spaces Systems I

### Elective Courses

Three courses from any combination of 675.xxx

- *Substitutions for courses can be made at the advisor's discretion.*

For current faculty and contact information go to [http://eng.jhu.edu/wse/cle/page/our\\_people](http://eng.jhu.edu/wse/cle/page/our_people) ([http://eng.jhu.edu/wse/cle/page/our\\_people/](http://eng.jhu.edu/wse/cle/page/our_people/))