The Master of Science in Engineering Management (MSEM) degree program combines advanced course work in highly-specialized technical fields with a professional education in contemporary business, 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 Whitehead 105. 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 academic advisor to confirm the below requirements; changes may have occurred since this annual publication.

Students in the MSEM program take ten courses to fulfill degree requirements, with the following guidelines:

- Five advanced courses in the engineering/interdisciplinary track
- Three full-fall semester management courses, fall and spring MSEM Seminar courses, two half-semester required courses in the spring plus students may choose from a list of approved half-semester courses to complete their electives.
- No grade lower than C may be applied to the program
- Courses must be at the graduate level
- Departments sponsoring interdisciplinary tracks may impose stricter requirements for course work within the track.
- Students are additionally required to complete Academic Ethics (EN.500.603), which does not count towards the degree requirements above.

At the discretion of the student's advisors, an MSEM student may be permitted to double-count up to two JHU courses (one for the interdisciplinary track and one for the management concentration) or apply graduate courses taken at JHU or elsewhere 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 engineering/interdisciplinary track from a designated faculty member affiliated with that track. MSEM students will be advised regarding the management concentration by members of the Center for Leadership Education faculty.

Faculty
Faculty members teaching the interdisciplinary track courses are listed in their respective engineering departments elsewhere in this catalog. Faculty members teaching the management concentration courses are listed in the Center for Leadership Education section of this catalog.

Management Concentration
The Center for Leadership Education has constructed a five-course 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 the following a suite of management courses together.

In addition, all MSEM students are required to attend the MSEM Seminar EN.662.811 M.S. in Engineering Management Seminar/EN.662.812 MSEM Seminar) course while enrolled in the program. This will meet weekly 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.

Internship Option
MSEM Course # EN.662.802: Engineering Management Internship Assessment

This course involves the assessment of a student's internship experience via a report and oral presentation. The questions and general format of the report and presentation will be provided by the instructor (http://memp.pratt.duke.edu/sites/memp.pratt.duke.edu/files/EGRMGMT_551_External.doc). The report and presentation will be evaluated by the instructor and both must be approved to obtain credit for this course. One full course may count toward graduation.

Interdisciplinary Tracks
In addition to fulfilling the management concentration requirements, MSEM students must complete the requirements for one of the interdisciplinary tracks. These are:

- Biomaterials
- Chemical & Biomolecular Engineering
- Chemical Product Design
- Civil Engineering
- Communications Science
- Computer Science
- Cybersecurity
- 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
- Environmental Systems Analysis, Economics and Public Policy

Biomaterials
(Sponsored by the Department of Materials Science & Engineering (http://e-catalog.jhu.edu/departments-program-requirements-and-courses/engineering/materials-science-engineering))

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

Required Courses (3)
EN.510.606 Polymer Chemistry & Biology
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.510.607</td>
<td>Biomaterials II: Host response and biomaterials applications</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.621</td>
<td>Biomolecular Materials I - Soluble Proteins and Amphiphiles</td>
<td>3</td>
</tr>
</tbody>
</table>

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

Electives (2)
- 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.510.400</td>
<td>Introduction to Ceramics</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.403</td>
<td>Materials Characterization</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.405</td>
<td>Materials Science of Energy Technologies</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.422</td>
<td>Micro and Nano Structured Materials &amp; Devices</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.426</td>
<td>Biomolecular Materials I - Soluble Proteins and Amphiphiles</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.428</td>
<td>Material Science Laboratory I</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.429</td>
<td>Materials Science Laboratory II</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.430</td>
<td>Biomaterials Lab</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.604</td>
<td>Mechanical Properties of Materials</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.605</td>
<td>Electrical, Optical and Magnetic Properties of Materials</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.606</td>
<td>Polymer Chemistry &amp; Biology</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.607</td>
<td>Biomaterials II: Host response and biomaterials applications</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.611</td>
<td>Solid State Physics</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.612</td>
<td>Solid State Physics</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.657</td>
<td>Materials Science of Thin Films</td>
<td>3</td>
</tr>
</tbody>
</table>

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

Civil Engineering
(Sponsored by the Department of Civil Engineering (http://e-catalog.jhu.edu/departments-program-requirements-and-courses/engineering/civil-engineering))

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

Required Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.560.730</td>
<td>Finite Element Methods</td>
<td>3</td>
</tr>
<tr>
<td>EN.560.604</td>
<td>Introduction to Solid Mechanics</td>
<td>3</td>
</tr>
</tbody>
</table>

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

Elective Courses
- Any two courses from 560.6xx or above, or 565.6xx or above (excluding seminar)

Chemical and Biomolecular Engineering
(Sponsored by the Department of Electrical & Computer Engineering)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.540.671</td>
<td>Advanced Thermodynamics in Practice</td>
<td>3</td>
</tr>
<tr>
<td>EN.540.604</td>
<td>Transport Phenomena in Practice</td>
<td>3</td>
</tr>
<tr>
<td>EN.540.673</td>
<td>Advanced Chemical Reaction Engineering in Practice</td>
<td>3</td>
</tr>
</tbody>
</table>

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

Elective Courses: Any two courses from 540.6xx or above, or 545.6xx or above (excluding seminar)

Courses not on this list can be approved at the advisor’s discretion.

Chemical Product Design
(Sponsored by the Department of Chemical and Biomolecular Engineering (https://engineering.jhu.edu/chembe))

Students must take five courses:
Two semesters of Product Design 540.690-691
Two ChemBE Courses (540.6xx)
One approved elective in Engineering, Science, Math, or Applied Math

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

Communications Science
(Sponsored by the Department of Electrical & Computer Engineering (http://e-catalog.jhu.edu/departments-program-requirements-and-courses/engineering/electrical-computer-engineering))

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

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.520.435</td>
<td>Digital Signal Processing</td>
<td>3</td>
</tr>
<tr>
<td>EN.520.447</td>
<td>Information Theory</td>
<td>3</td>
</tr>
<tr>
<td>EN.520.646</td>
<td>Wavelets &amp; Filter Banks</td>
<td>3</td>
</tr>
<tr>
<td>EN.520.651</td>
<td>Random Signal Analysis</td>
<td>4</td>
</tr>
<tr>
<td>EN.520.652</td>
<td>Filtering and Smoothing</td>
<td>3</td>
</tr>
<tr>
<td>EN.520.666</td>
<td>Information Extraction</td>
<td>3</td>
</tr>
<tr>
<td>EN.520.735</td>
<td>Sensory Information Processing</td>
<td>3</td>
</tr>
</tbody>
</table>

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

Computer Science
(Sponsored by the Department of Computer Science (http://e-catalog.jhu.edu/departments-program-requirements-and-courses/engineering/computer-science))

Curricular Requirements
- Any five regular graduate courses approved by the advisor, 400-level or higher, from the Department of Computer Science, not including the senior thesis. Three 1-credit graduate courses may be combined to constitute one regular graduate course.

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.

Fluid Mechanics
(Sponsored by the Department of Mechanical Engineering)
Any five courses in Fluid Mechanics or closely related discipline, at the 400-level or higher, as approved by the Faculty advisor. At least two of the required track courses must be at the 600-level or higher.

Materials Science & Engineering
(Sponsored by the Department of Materials Science & Engineering)
Prerequisites
- UG calculus, chemistry and physics; biology is recommended

Required Courses (1)
EN.510.601 Structure Of Materials 3

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

Electives (4)
- See list of pre-approved elective courses or courses off list by petition

Recommended Structure
- Electives:

  List of Pre-approved Electives
  
<table>
<thead>
<tr>
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<th>Title</th>
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<tr>
<td>EN.510.400</td>
<td>Introduction to Ceramics</td>
<td>3</td>
</tr>
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<td>EN.510.422</td>
<td>Micro and Nano Structured Materials &amp; Devices</td>
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<td>Biomolecular Materials I - Soluble Proteins and Amphiphiles</td>
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<tr>
<td>EN.510.606</td>
<td>Polymer Chemistry &amp; Biology</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.607</td>
<td>Biomaterials II: Host response and biomaterials applications (PR: EN.510.316 or permission)</td>
<td>3</td>
</tr>
</tbody>
</table>

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

Mechanical Engineering
(Sponsored by the Department of Mechanical Engineering)
Any five courses in Mechanical Engineering or closely related discipline at the 400-level or higher, as approved by the Faculty advisor. At least two of the required technical courses must be at the 600-level or higher.

Mechanics and Materials
(Sponsored jointly by the Department of Mechanical Engineering and the Department of Materials Science & Engineering)
Prerequisites
- UG calculus, chemistry, biology, physics and introductory biomaterials course equivalent to EN.510.316

Required Courses (3)
EN.510.403 Materials Characterization 3
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 & Materials 3
EN.510.602 Thermodynamics Of Materials 3
EN.530.612 Computational Solid Mechanics 3

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

Nano-Biotechnology
(Sponsored by the Department of Materials Science & Engineering)
Prerequisites
- UG calculus, chemistry, biology, physics and introductory biomaterials course equivalent to EN.510.316
Master of Science in Engineering Management

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

Electives (2)
- 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

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.510.422 Micro and Nano Structured Materials Devices</td>
<td>3</td>
<td>EN.510.607 Biomaterials II: Host response and biomaterials applications</td>
<td>3</td>
</tr>
</tbody>
</table>

Electives: suggest one

Electives in Spring: suggest two

Total Credits: 5

List of Pre-approved Electives

| EN.510.400 Introduction to Ceramics | 3 |
| EN.510.403 Materials Characterization | 3 |
| EN.510.405 Materials Science of Energy Technologies | 3 |
| EN.510.422 Micro and Nano Structured Materials Devices | 3 |
| EN.510.426 Biomolecular Materials I - Soluble Proteins and Amphiphiles | 3 |
| EN.510.429 Material Science Laboratory II | 3 |
| EN.510.430 Biomaterials Lab | 3 |
| EN.510.428 Material Science Laboratory I | 3 |
| EN.510.604 Mechanical Properties of Materials | 3 |
| EN.510.605 Electrical, Optical and Magnetic Properties of Materials | 3 |
| EN.510.606 Polymer Chemistry & Biology | 3 |
| EN.510.607 Biomaterials II: Host response and biomaterials applications | 3 |
| EN.510.611 Solid State Physics | 3 |
| EN.510.612 Solid State Physics | 3 |
| EN.510.657 Materials Science of Thin Films | 3 |

Operations Research

| EN.510.426 Introduction to Stochastic Processes | 4 |
| EN.510.427 Stochastic Processes and Applications to Finance | 4 |
| EN.510.433 Monte Carlo Methods | 3 |

Prerequisites

- UG calculus, chemistry, and physics

Required Courses

| EN.510.422 Micro and Nano Structured Materials & Devices | 3 |

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

Electives (3)
- 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

Nanomaterials and Nanotechnology

(Sponsored by the Department of Materials Science & Engineering (http://e-catalog.jhu.edu/departments-program-requirements-and-courses/engineering/materials-science-engineering))

Prerequisites

- Calculus-based background in Probability and Statistics. Students wishing to strengthen their background in this area may enroll in EN.553.420 Introduction to Probability and/or EN.553.430 Introduction to Statistics, but these courses may not be used in fulfillment of this track's requirements.

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

Elective Courses (2)

Any two 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.

| EN.570.496 Urban and Environmental Systems | 3 |
| EN.553.426 Introduction to Stochastic Processes | 4 |
| EN.553.427 Stochastic Processes and Applications to Finance | 4 |
| EN.553.433 Monte Carlo Methods | 3 |
EN.553.463 Network Models in Operations Research 4
EN.553.762 Nonlinear Optimization II 3

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

**Probability and Statistics**
(Sponsored by the Department of Applied Mathematics & Statistics [http://e-catalog.jhu.edu/departments-program-requirements-and-courses/engineering/applied-mathematics-statistics])

**Admissions Requirements**
1. One upper-division undergraduate course in probability (equivalent to EN.553.420 Introduction to Probability)
2. One upper-division undergraduate course in mathematical statistics (equivalent to EN.553.430 Introduction to Statistics)

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

**Additional Requirements**
- An overall GPA of 3.0 must be maintained in courses used to meet the program’s technical requirements. At most two course grades of C or C+ are allowed to be used, and the rest of the course grades must be B- or better.
- Students must satisfy the department’s graduate student computing requirement.
- With advisor’s approval, one non-departmental course containing appropriate mathematical or statistical content can be counted to satisfy the five course requirement.

**Smart Product and Device Design**
(Sponsored jointly by the Department of Mechanical Engineering [http://e-catalog.jhu.edu/departments-program-requirements-and-courses/engineering/mechanical-engineering] and the Department of Electrical & Computer Engineering [http://e-catalog.jhu.edu/departments-program-requirements-and-courses/engineering/electrical-computer-engineering])

**Required Courses**
- EN.530.646 Robot Devices, Kinematics, Dynamics, and Control 4
- EN.530.414 Computer-Aided Design 3
- EN.520.491 CAD Design of Digital VLSI Systems I (Juniors/Seniors) 3
- EN.530.421 Mechatronics 3

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

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

**Environmental Systems Analysis, Economics and Public Policy**
(Sponsored by the Department of Environmental Health and Engineering [http://e-catalog.jhu.edu/departments-program-requirements-and-courses/engineering/environmental-health-engineering])

**Required Courses (3)**
At least one course from each of the three following groups:

- **Economics** (with calculus)— This requirement may be waived if the student has already had an intermediate microeconomics course accepted by their advisor

- **Mathematics of Decision Making**—acceptable courses include
  - EN.570.495 Environmental Health and Engineering Systems Design
  - EN.570.497 Risk and Decision Analysis

- **Policy**—EN.570.607 Energy Policy and Planning Models

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

**Elective Courses (2)**
Any of the courses listed in the Mandatory list (see Part A above)

- EN.570.496 Urban and Environmental Systems 3
- EN.570.618 Multiobjective Programming and Planning 3
- EN.570.676 Stochastic Programming 3

Other courses in environmental economics, systems, or policy, as approved by the advisor.

**Systems Engineering**
(Sponsored by the Department of 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:

- 560.6xx or above, or 565.4xx or above (excluding seminar)
- 645.6xx or above (EP Systems Engineering)
- 570.495 Mathematical Foundations for Public Decision Making
- 550.661 Foundations of Optimization
- 570.497 Risk and Decision Analysis
- 570.608 Uncertainty Modeling for Policy & Management Decision Making
- 550.400 Mathematical Modeling and Consulting
- 570.493 Economic Foundations For Public Decision Making
- 570.496 Math Models/Urban System
- 570.607 Energy Planning and Policy Modeling
- 663.653 Innovation and Entrepreneurship
- 663.657 Innovation and Entrepreneurship II

**Additional Notes**
- All courses must be approved by the student’s advisor.
- All course must be at the graduate level
- Students with a background in quantitatively rigorous economics sufficient for the economics requirement to be waived must still take five (5) courses in this track.
- 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. Candidate courses in environmental engineering include:
  - EN.570.446 Biological Process of Wastewater Treatment
  - EN.570.490 Solid Waste Engineering and Management
  - EN.570.491 Hazardous Waste Engineering and Management
  - EN.570.647 Hydrologic Transport in the Environment
  - EN.570.657 Air Pollution, etc.
- No more than one C may be used toward the degree in this track.
For current faculty and contact information go to http://eng.jhu.edu/wse/cle/page/our_people

**Faculty**

**Program Directors**

Pamela Sheff  
Director of the Master of Science in Engineering Management Program  
& Senior Lecturer: business and technical communication, marketing, public relations, science and scientific writing, oral presentations, entrepreneurship.

**Senior Lecturer**

Lawrence Aronhime  
Senior Lecturer

Annette Leps  
Senior Lecturer. accounting, finance, management.

Julie Reiser

Eric Rice

William Smedick

**Lecturer**

Trevor Mackesey  
Lecturer