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 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 academic advisor to confirm the below requirements; changes may have occurred since this annual publication.

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

- Five advanced courses in the engineering technical track
- Three full-semester fall management courses, a fall and spring MSEM Seminar course, 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
- 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.

Technical Tracks
In addition to fulfilling the management track requirements, MSEM students must complete the requirements for one of the technical tracks (5 courses). 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.
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 Biomaterials I

<table>
<thead>
<tr>
<th>Code</th>
<th>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>

Total Credits 6

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
<table>
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<tr>
<th>Code</th>
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</tr>
<tr>
<td>EN.510.403</td>
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<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>Material Science Laboratory II</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.430</td>
<td>Biomedical Materials 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.510.607</td>
<td>Biomaterials II: Host response and biomaterials applications</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 (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:

<table>
<thead>
<tr>
<th>Code</th>
<th>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>

Total Credits 6

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

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

Students must take five courses:
- Two semesters of Chemical and Biomolecular Engineering 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 (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.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<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>Foundations of Probabilistic Machine Learning</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>
</tbody>
</table>

Total Credits 19

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 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
510.405 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

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

ENVIRONMENTAL SYSTEMS ANALYSIS, ECONOMICS AND PUBLIC POLICY:
(Sponsored by the Department of (https://e-catalogue.jhu.edu/engineering/mechanical-engineering)/Environmental Health & Engineering (https://ehe.jhu.edu/))

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

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
### Engineering Management, Master of Science

#### Required Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.510.601</td>
<td>Structure Of Materials</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits 3**

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

#### List of Pre-approved Electives

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<td>EN.510.426</td>
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<td>Materials Science of Thin Films</td>
<td>3</td>
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</table>

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

#### Mechanical Engineering

*(Sponsored by the Department of Mechanical Engineering [link]*)

**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 jointly by the Department of Mechanical Engineering [link] and the Department of Materials Science & Engineering [link]*)

**Required Courses**

<table>
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<tr>
<td>EN.510.601</td>
<td>Structure Of Materials</td>
<td>3</td>
</tr>
<tr>
<td>EN.510.604</td>
<td>Mechanical Properties of Materials</td>
<td>3</td>
</tr>
</tbody>
</table>

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:

- EN.510.400 Introduction to Ceramics
- EN.510.403 Materials Characterization
- EN.510.405 Materials Science of Energy Technologies
- EN.510.422 Micro and Nano Structured Materials & Devices
- EN.510.426 Biomolecular Materials I - Soluble Proteins and Amphiphiles
- EN.510.428 Material Science Laboratory I
- EN.510.429 Materials Science Laboratory II
- EN.510.430 Biomaterials Lab
- EN.510.604 Mechanical Properties of Materials
- EN.510.605 Electrical, Optical and Magnetic Properties of Materials
- EN.510.607 Biomaterials II: Host response and biomaterials applications

#### Recommended Structure

**Fall**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.510.422</td>
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<td>3</td>
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<tr>
<td>EN.510.607</td>
<td>Biomaterials II: Host response and biomaterials applications</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits 6**

#### Nano-Biotechnology

*(Sponsored by the Department of Materials Science & Engineering [link]*)

**Prerequisites**

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

**Required Courses**

<table>
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<th>Title</th>
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<td>Biomaterials II: Host response and biomaterials applications</td>
<td>3</td>
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</tbody>
</table>

**Total Credits 6**

1 PR: EN.510.316 Biomaterials I 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**

<table>
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<td>EN.510.607</td>
<td>Biomaterials II: Host response and biomaterials applications</td>
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</tr>
</tbody>
</table>

**Total Credits 6**

#### List of Pre-approved Electives

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<tr>
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<td>Materials Science of Thin Films</td>
<td>3</td>
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</tbody>
</table>
# Engineering Management, Master of Science

## Materials Science of Thin Films

- **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

<table>
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<tr>
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</thead>
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<tr>
<td>EN.510.422</td>
<td>Micro and Nano Structured Materials &amp; Devices</td>
<td>3</td>
</tr>
</tbody>
</table>

### Total Credits 3

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

<table>
<thead>
<tr>
<th>fall</th>
<th>Credits Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.510.422 (Required)</td>
<td>3 Required: none</td>
<td></td>
</tr>
</tbody>
</table>

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

Electives in Spring: suggest two

### Total Credits 3

## List of Pre-approved Electives

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</table>

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

## Operations Research

*(Sponsored by the Department of Applied Mathematics & Statistics [https://e-catalogue.jhu.edu/engineering/applied-mathematics-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

### 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 Introduction to Probability)
- One upper-division undergraduate course in mathematical statistics (equivalent to EN.553.430 Introduction to Statistics)

### Credits

<table>
<thead>
<tr>
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<th>Title</th>
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</tr>
</thead>
<tbody>
<tr>
<td>EN.510.400</td>
<td>Introduction to Probability</td>
<td></td>
</tr>
<tr>
<td>EN.510.403</td>
<td>Theoretical Probability and Stochastic Processes</td>
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</tr>
<tr>
<td>EN.510.405</td>
<td>Mathematical Statistics</td>
<td></td>
</tr>
<tr>
<td>EN.510.422</td>
<td>Probability and Statistics</td>
<td></td>
</tr>
<tr>
<td>EN.510.426</td>
<td>Risk Theory and Management</td>
<td></td>
</tr>
<tr>
<td>EN.510.428</td>
<td>Financial Engineering and Structured Products</td>
<td></td>
</tr>
</tbody>
</table>

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

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
-----|-------|------
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) | 3
EN.530.421 | Mechatronics | 3

Total Credits 10

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.570.496 | Urban and Environmental Systems | 3.0
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/)