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Johns Hopkins  UNIVERSITY

mseM Technical Track advisors guidebook



The Center for Leadership Education

Master of Science in Engineering Management
Technical Track Advisor Guide

Masters of Science in Engineering Management (MSEM)

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Welcome & History of MSEM at JHU!

Welcome to the Master of Science in Engineering Management program!

We are very happy you have agreed to be the advisor for your department’s MSEM technical track(s). The Master of Science in Engineering Management Program, or MSEM, is a cohort-based master’s program offered through the JHU Whiting School of Engineering. The program is designed to further engineering education while simultaneously providing preparation in management, leadership, and communication as well as other skills required for professional success.

In the advisor’s role for your department’s MSEM(s), you will evaluate applications and determine if the applicant is qualified for acceptance in the specified track. If the student is accepted, you will meet with him/her during each semester to advise the student about appropriate track courses and course loads.

The MSEM Program requires five (5) track courses along with a suite of required management courses and electives. Please note the MSEM double counting policy: because there are only five technical courses in this program, students are allowed to double count up to TWO graduate-level courses for their technical track with their technical advisor’s approval. These must be JHU graduate level courses taken as an undergraduate, but not counted toward the bachelor’s degree.

Please refer to the guidebook for questions regarding the program, your role as an advisor, and course information.

The History of MSEM at JHU:
The MSEM Program was sent to the Maryland Higher Education Commission (MHEC) in August 2008 and approved shortly thereafter. Our first students were accepted for the spring of 2009 and our first class of 13 students graduated in May 2010.

MSEM or MEM degrees are growing in popularity, but in 2009 only UMBC offered an Engineering Management degree locally. JHU MSEM was admitted to the Master of Engineering Management Programs Consortium (MEMPC) in 2016. Other members include Northwestern, Cornell, Dartmouth, Duke, Massachusetts Institute of Technology, Purdue, Tufts, and the University of Southern California.

In addition to our full-time, Homewood based program, the Whiting School of Engineering also offers as Master’s in Engineering Management through the Engineering for Professionals Program; this program is part-time for working professionals and many of the courses are online.

MSEM began with 12 technical tracks (formerly concentrations) and we have added several additional tracks (Systems Engineering, Cybersecurity, Space Systems Engineering, Energy). We anticipate other tracks in the future, among them BME, Computational Medicine, Electrical Engineering, and Robotics.

Faculty and Staff Directory

Director of CLE:
Pamela H. Sheff: Pamsheff@gmail.com

Director of MSEM:
Trevor Mackesey: tmackes1@jhu.edu

Full-Time CLE Faculty:
Nusaybah Abu-Mulaweh: nabumul1@jhu.edu
Lawrence Aronhime: aronhime@jhu.edu
Alissa Burkholder Murphy: alissa@jhu.edu
Marina Choy:mchoy3@jhu.edu
MC Coghlan: mcoghla2@jhu.edu
Shadi Esnaashari: sesnaas1@jhu.edu
Joseph Forte: jforte8@jhu.edu
Jenna Frye: jfyre8@jhu.edu
Ryan Hearty: rhearty1@jhu.edu
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Illysa Izenberg: izenberg@jhu.edu
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Annette Leps: aleps@jhu.edu
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Eric Rice: ericmrice@gmail.com
Andy Ross: aross55@jhu.edu
Mia Russell: mrusse29@jhu.edu
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Sarah Harrison Smith: ssmit263@jhu.edu

CLE Staff:
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Management Course Requirements for Degree Completion

|  |  |  |  |
| --- | --- | --- | --- |
| **Course No.** | **Course Title** | **Semester/Year** | **Credits** |
| 662.611 | Strategies: Accounting & Finance *– required cohort* | Fall  | 3 |
| 662.692 | Strategies for Innovation & Growth– *required cohort* | Fall | 3 |
| 663.618 | Professional Presentations – *required cohort* | Fall  | 3 |
| 662.643 | The Practice of Consulting – *required cohort* | Winter | 1.5 |
| 663.660 | Managing People/Resolving Conflict – *required cohort* | Spring | 1.5 |
| 663.671 | Leading Change – *required cohort* | Spring | 1.5 |
| 663.xxx | Elective (one elective is required) | Elective | 1.5 |
| 662.811 & 812 | MSEM Seminar – *required cohort* | Fall & Spring | 1 |

Students must take the following management & technical courses for degree completion:

* *Required:* five advanced courses in a declared technical track of engineering, or applied science. Typically, students begin by taking one technical course in the fall semester, 2-3 technical courses in the spring semester, and complete the technical requirement in their final fall semester.
* *Fall semester:* a cohort-based management curriculum consisting of four required courses:

Strategies: Accounting & Finance

Strategies: Innovation and Growth

Professional Presentations

MSEM Seminar

* *Immersion*: The Practice of Consulting during the January term.
* *Spring Semester*: Two-half semester courses & Seminar:

 Managing People and Resolving Conflicts
 Leading Change
 MSEM Seminar
* *Electives:* one required elective selected from the Professional Development Program seven-week modules. Students may choose as many electives as they can comfortably complete. In addition, 663.653 Innovation and Design also serves as a management elective, and 663.657 Innovation and Design II can serve as a course from the Technical Track (with the approval of your advisor). CS and AMS tracks do not apply.

Whiting School of Engineering Degree Requirements:
All Whiting School of Engineering master’s degree candidates must meet the requirements found below:

* Every student must register for a minimum of two semesters as a full-time graduate student.
* Full time students are required to take a minimum of nine credits per semester.
* Every student must provide certification by a department or program committee that all departmental or committee requirements have been fulfilled.
* All courses applied to the master’s degree must be at the 600-level or higher. 400-level courses require advisor approval (approvals must be sent to the MSEM program coordinator).
* Every student must earn the master’s degree within five consecutive academic years (10 semesters). Only semesters during which a student has a university-approved leave of absence are exempt from the ten-semester limit.

Specific Requirements to MSEM:

## Candidates must complete all of the required courses.

## Only one C will apply toward the degree (no grade lower than a C will apply).

## All courses must be at the 600-level or higher (exceptions require advisor approval).

## Departments sponsoring technical tracks may impose stricter requirements for coursework with the track.

## With permission of the technical advisor, a JHU alumni, MSEM student may double-count **two** JHU courses or apply undergraduate or graduate courses taken at JHU, but not applied to a degree (in accordance with conditions in the [WSE Policy on Double-Counting Courses](https://engineering.jhu.edu/education/graduate-studies/graduate-academic-policies-procedures/)).

Advising:
Students are required to obtain approval for all engineering track course choices from their technical advisor. The MSEM director, Pamela Sheff, or MSEM coordinator will advise students on management courses. Technical advisors will have the authority and responsibility of placing holds, releasing holds, and clearing students’ technical courses for acceptance at the time of graduation. In order to allow flexibility within the tracks, advisors have the authority to approve changes and/or substitutions to any courses in their track that they deem acceptable and appropriate.

Graduation:
Students will receive individual course check-sheets for verification each semester. Track advisors will receive check-sheets for approval and signature in the weeks before graduation.

Admissions Process:

* MSEM applicants will submit their applications via Slate
\*\*NOTE: Slate is new application system that started in place for Fall 2019 applicants
* Students must have or be in the process of earning an undergraduate engineering degree, or a STEM degree from an accredited school
* Students submit:
	+ Application and application fee
	+ Official GRE and TOEFL scores (JHU undergrads exempt from this requirement)
	+ Unofficial transcripts
	+ Statement of Purpose
	+ 3 letters of recommendation
	+ Resume

GRE: Johns Hopkins undergraduates who apply to the program are not required to take the GRE.

TOEFL/IELTS: International students must earn a minimum 100 internet-based TOEFL score OR score a minimum 7 on the IELTS.

The MSEM Admissions Committee reviews all completed applications and monitors Slate to make sure the credentials have been received. While test scores and GPAs are important, we evaluate the entire application; letters of recommendation factor highly in the decision. Typically, GRE scores for accepted students are in the high 160’s for quantitative and high 150’s for verbal scores.

When an applicant has been accepted by us, we then forward a PDF of the combined student file for review and evaluation to you. After you review the application, please email the decision to us. If you approve an application, the CLE admissions committee will interview the applicant. Grad Admissions will then send the student the appropriate letter of acceptance or denial.

MSEM Technical Tracks & Advisors

Currently, our technical tracks and their sponsoring departments are:

|  |  |  |
| --- | --- | --- |
| **Department** | **Advisor & Email** | **Tracks** |
| Applied Mathematics & Statistics | James Spall: jspall1@jhu.eduAmitabh Basu: abasu9@jhu.eduZachary Lubberts: zlubber1@jhu.eduDonniell Fishkind: dfishki1@jhu.edu Daniel Naiman: dnaiman2@jhu.eduBeryl Castello: beryl.castello@jhu.eduBen Grimmer: grimmer@jhu.eduAvanti Athreya: dathrey1@jhu.eduFred Torcaso: fred.torcasi@jhu.eduFadil Santosa: fsantos9@jhu.edu | Operations Research Probability & StatisticsData Science |
| Chemical & Biomolecular Engineering | John Edisondayakaran@jhu.edu  | Chemical & Biomolecular Engineering, Chemical Product Design |
| Civil & Systems Engineering | Thomas Gernaytgeray@jhu.edu  | Civil Engineering |
| Computer Science | Kevin Duh kevinduh@cs.jhu.edu | Computer Science |
| Computer Science/Information Security Institute | Anton Dahbura antondahbura@jhu.edu | Cyber Security  |
| Electrical & Computer Engineering | Mark Foster: mark.foster@jhu.edu Vishal Patel: vpatel36@jhu.edu Enrique Mallada: mallada@jhu.edu Jin Kang: jkang@jhu.edu Pedro Irazoqui: pip@jhu.edu Mahyar Fazlyab: mahyarfazlyab@jhu.edu John Goutsias: goutsias@jhu.edu | Electrical and Computer Engineering |
| Environmental Health & Engineering | Energy:Scot Miller: smill191@jhu.edu Environmental Systems: Peter DeCarlo: pdecarl1@jhu.edu  | Environmental Systems Analysis, Economics & Public Policy, Energy |
| Materials Science & Engineering | Timothy Weihs weihs@jhu.edu | Biomaterials, Materials Science & Engineering, Mechanics & Materials, Nano-Biotechnology, Nanomaterials & Nanotechnology |
| Mechanical Engineering | Gretar Tryggvason gtryggv1@jhu.edu | Mechanical Engineering |
| Space Systems Engineering, Engineering for Professionals Program | Helmut Seiferthelmet.seifert@jhuapl.edu | Space Systems Engineering  |
| Systems Engineering (Civil & Systems Engineering) | Gonzalo Pitagpita1@jhu.edu | Systems Engineering |

MSEM Technical Track Requirements

**Biomaterials:** *(Sponsored by the Department of Materials Science & Engineering)*

Prerequisites: (5)
Undergraduate calculus, chemistry, biology, physics, and introductory biomaterials course equivalents to 510.316.

Required Courses: (3)
*Approval of substitutions for required courses are at the discretion of the technical advisor.*
510.606 Chemical and Biological Properties of Materials (PR: UG Chemistry & biology or permission)
510.607 Biomaterials II (PR: 510.606 Biomaterials I or equivalent)
510.621 Structure and Thermodynamics of Biomolecules

Electives: (2)
Electives should be related to Materials Science and Engineering and must be approved by the DMSE graduate committee.

List of Pre-Approved Electives:
*Courses not on this list are at the advisor’s discretion.*

510.400 Introduction to Ceramics

510.403 Materials Characterization

510.405 Materials Science of Energy Technologies

510.422 Micro- and Nano-structured Materials and Devices

510.426 Biomolecular Materials I – Soluble Proteins and Amphiphiles

510.428 Materials Science Laboratory I

510.429 Materials Science Laboratory II

510.430 Biomaterials Lab

510.431 Biocompatibility of Materials

510.456 Introduction to Surface Science

500.619 Fundamental Physics and Chemistry of Nanomaterials

510.604 Mechanical Properties of Materials

510.605 Electronic, Optical and Magnetic Properties of Materials

510.606 Polymer Chemistry & Biology

510.607 Biomaterials II: Host Response and Biomaterials Applications

510.608 Electrochemistry

510.611 Solid State Physics

510.612 Solid State Physics

510.622 Micro- and Nano-structured Materials and Devices

510.624 X-Ray Scattering, Diffraction and Imaging

610.657 Transmission Electron Microscopy: Principle & Practice

**Chemical & Biomolecular Engineering:** *(Sponsored by the Department of Chemical & Biomolecular Engineering)*

Required Courses: (5) \*must be 600-level
Approval of substitutions for required courses are at the discretion of the technical advisor.
Core Requirements:

1. EN.540.671 Advanced Thermodynamics in Practice
2. EN.540.604 Advanced Transport Phenomena in Practice
3. EN.540.673 Chemical Reaction Engineering in Practice\*\*

**\*\*New policy change** regarding the Core 3 course requirement:

* **Effective for students entering Fall 2021 or later**, any of the following six courses can count towards Core 3, regardless of undergraduate background:
	+ EN.540.673 Adv Chemical Reaction Eng in Practice (now to be held in Spring 2023 and future Springs)
	+ EN.540.602 Metabolic Systems Biotechnology (typically held in Fall, not held Fall 2022)
	+ EN.540.615 Interfacial Science w/ App to Nano Systems (typically held in Fall)
	+ EN.540.632 Projects in Design: Pharmacokinetics (typically held in Fall)
	+ EN.540.638 Adv Topics in Pharmacokinetics and Pharmacodynamics I (typically held in Spring)
	+ EN.540.681 Molecular Kinetics and Catalysis (typically held in Spring)

**Civil Engineering:** *(Sponsored by the Department of Civil & Systems Engineering)*

Two Required Courses: (2)

* 560.604 Introduction to Solid Mechanics
* Either 560.619 Advanced Structural Analysis **OR**565.616 Applied Finite Element Methods (online)
Applied Finite Element Methods

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

Three Elective Courses: (3)

* One course from 560.6xx or above (excluding seminar)
* Any two courses from 560.6xx or above, or 565.6xx or above (excluding seminar)

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

**Chemical Product Design:** *(Sponsored by the Department of Chemical & Biomolecular Engineering)*

Required Courses: (5) \*must be 600-level
Approval of substitutions for required courses are at the discretion of the technical advisor.
Core Requirements:

1. EN.540.671 Advanced Thermodynamics in Practice
2. EN.540.604 Advanced Transport Phenomena in Practice
3. EN.540.673 Chemical Reaction Engineering in Practice\*\*

**\*\*New policy change** regarding the Core 3 course requirement:

* **Effective for students entering Fall 2021 or later**, any of the following six courses can count towards Core 3, regardless of undergraduate background:
	+ EN.540.673 Adv Chemical Reaction Eng in Practice (now to be held in Spring 2023 and future Springs)
	+ EN.540.602 Metabolic Systems Biotechnology (typically held in Fall, not held Fall 2022)
	+ EN.540.615 Interfacial Science w/ App to Nano Systems (typically held in Fall)
	+ EN.540.632 Projects in Design: Pharmacokinetics (typically held in Fall)
	+ EN.540.638 Adv Topics in Pharmacokinetics and Pharmacodynamics I (typically held in Spring)
	+ EN.540.681 Molecular Kinetics and Catalysis (typically held in Spring)

**Computer Science:** *(Sponsored by the Department of Computer Science)*The student must take **at least 5** courses to satisfy the technical coursework requirement.  These courses may be distributed as follows:

* **At least 4** graduate-level CS courses
	+ At least 3 must be taught by the WSE CS Department (course numbers 601.6xx, 601.7xx)
	+ Please find the WSE CS Department course listing and syllabus here: <https://www.cs.jhu.edu/academic-programs/undergraduate-studies/undergraduate-and-graduate-course-information/>

One course (605.6xx or 605.7xx) may be selected from a list of EP courses preapproved by the WSE CS Department. [Please find a list of pre-approved EP courses here.](https://msem.engineering.jhu.edu/wp-content/uploads/2022/01/Pre-approved-EP-courses-CS-1.docx)

* **At most 1** graduate-level WSE elective course, with the approval of the CS advisor
	+ The student must present a formal, written rationale for selecting any non-CS course, together with a copy of the course syllabus. The rationale should include a clear statement of the relationship to the student’s career goals.  It should also explain the computational aspects of the course.
	+ The written rationale, syllabus, and advisor’s approval will be kept with the student’s MSEM records.
	+ Approval is completely at the discretion of the CS advisor.
	+ Approval of any individual student’s elective course will not create a precedent guaranteeing that other students will be able to count the same course toward their 5 course requirement

**Note:** No more than three graduate-level courses may be taken in one semester by MSEM students in this track.
Also, EN.663.657 Innovation and Design II does not count toward the CS track.

**Cybersecurity:** *(Sponsored by the Department of 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 BS in computer science is recommended. Applicants from other disciplines must have coursework (or equivalent experience) in Computer Science 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.
Required Courses:
*Approval of substitutions for required courses are at the discretion of the technical advisor.*
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 courselists;
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.

**Data Science:** *(Sponsored by the Department of Applied Mathematics & Statistics)*

Students must take the two required courses from the list below and three electives.
Required Courses:
EN.553.636 Introduction to Data Science
EN.553.688 Computing for Applied Mathematics

Three (3) of the following courses:EN.553.613 Applied Statistics and Data Analysis
EN.553.635 Bayesian Statistics
EN.553.630 Mathematical Statistics
EN.553.633 Monte Carlo Methods
EN.553.639 Time Series Analysis
EN.553.662 Optimization for Data Science
EN.553.602 Research and Design in Applied Mathematics: Data Mining

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

**Electrical and Computer Engineering:** *(Sponsored by the Department of Electrical & Computer Engineering)*

When electing a track in ECE, here are additional options as to what you can pursue:
1) Human Language Technologies
2) Photonics and Device Physics
3) Microsystems and Computer Engineering
4) Machine Learning and Artificial Intelligence
5) Signal Processing and Sensory Processing

Students must take a least five (5) courses to satisfy the technical requirement. These courses may be distributed as follows:

At least 2 graduate-level (600-level or higher) ECE courses (course numbers EN.520.xxx)
At most 3 graduate-level WSE courses from other departments

Whiting School of Engineering for Professionals courses (WSE EP Courses) can count towards either of these requirements. WSE EP courses that will count as EP courses have course numbers EN.525.xxx. Other WSE EP courses can be approved as ECE courses at the discretion of the technical advisor.

WSE EP Courses in Engineering Management (EN.595.xxx) do not count towards the technical requirement.

WSE courses from the Center for Leadership Education (course numbers EN.66x.xxx) do not count towards the technical course requirement.

**Energy:** *(Sponsored by the Department of Environmental Health & Engineering)*

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
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)*

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.570695 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

Other courses in Environmental Economics, Systems, or Policy, as approved by the advisor.

Additional Notes:
The student’s advisor must approve all courses
All courses must be at the 400-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.

**Materials Science & Engineering:** *(Sponsored by the Department of Materials Science & Engineering)*
Pre-requisites: (3)
UG calculus, chemistry and physics; biology is recommended

Required Courses: (1)
*Approval of substitutions for required courses are at the discretion of the technical advisor.*
510.601 Structures of Materials (PR: UG calculus, chemistry and physics or permissions)

Electives: (4)
Electives related to Materials Science and Engineering are approved by the DMSE graduate committee.
Approval of alternative courses are at the discretion of the advisor.

List of Pre-Approved Electives:

510.400 Introduction to Ceramics
510.402 Dynamics of Soft Materials
510.403 Materials Characterization
510.422 Micro- and Nano-structured Materials and Devices
510.426 Biomolecular Materials I – Soluble Proteins and Amphiphiles
510.428 Materials Science Laboratory I
510.429 Materials Science Laboratory II
510.430 Biomaterials Lab
500.619 Fundamental Physics and Chemistry of Nanomaterials
510.601 Structure of Materials
510.602 Thermodynamics of Materials
510.603 Phase Transformation of Materials
510.604 Mechanical Properties of Materials
510.605 Electronic, Optical and Magnetic Properties of Materials
510.607 Biomaterials II: Host Response and Biomaterials Applications
510.608 Electrochemistry
510.610 Fundamentals of Biomaterials
510.615 Physical Properties of Materials
510.621 Biomolecular Materials I – Soluble Proteins and Amphiphiles
510.622 Micro- and Nano-structured Materials and Devices
510.624 X-Ray Scattering, Diffraction and Imaging
510.630 Molecular Simulation of Materials
510.636 Biomaterials for Cell Engineering
510.640 Stealth Science & Engineering
510.643 Chemistry & Physics of Polymers
510.658 Electroanalytical Chemistry & Energy Conversion
510.665 Transmission Electron Microscopy Principle & Practice

**Mechanical Engineering:** *(Sponsored by the Department of Mechanical Engineering)*

Required Courses: (5)
*Approval of substitutions for required courses are at the discretion of the technical advisor.*
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 & the Department of Materials Science & Engineering)*

Required Courses: (3)
*Approval of substitutions for required courses are at the discretion of the technical advisor.*
510.601 Structure of Materials
510.604 Mechanical Properties of Materials
530.605 Mechanics of Solids & Materials

Electives: (2)
*Alternative selections are at the discretion of the advisor.*

Any two of the following courses, approved by the faculty advisor:
510.403 Materials Characterization
510.428 Materials Science Laboratory I
530.405 Mechanics of Advanced Engineering Structures
530.414 Computer-Aided Design
530.416 Advanced Mechanical Design
530.418 Aerospace Structures and Materials
530.454 Manufacturing Engineering
510.602 Thermodynamics of Materials
510.603 Phase Transformation of Materials
530.612 Computational Solid Mechanics

**Nano-Biotechnology:** *(Sponsored by the Department of Materials Science & Engineering)*

Pre-requisites: (5)
UG Calculus, Chemistry, Biology, Physics and Introductory Biomaterials course equivalent to 510.316.

Required Courses: (3)
*Approval of substitutions for required courses are at the discretion of the technical advisor.*
510.422 Micro and Nano Structured Materials and Devices
510.607 Biomaterials II: Host Response and Biomaterials Applications (PR: 510.316 Biomaterials I)
670.619 Biopolymers Synthesis

Electives: (2)
Electives should be related to Materials Science and Engineering and must be approved by the DMSE graduate committee.

Elective courses on the list below can be approved at the advisor’s discretion.

List of Pre-approved Electives:

510.400 Introduction to Ceramics
510.403 Materials Characterization
510.405 Materials Physics
510.422 Micro-and Nano-structured Materials and Devices
510.426 Biomolecular Materials I – Soluble Proteins and Amphiphiles
510.428 Materials Science Laboratory I
510.429 Materials Science Laboratory II
510.430 Biomaterials Lab
510.431 Biocompatibility of Materials
510.456 Introduction to Surface Science
500.619 Fundamental Physics and Chemistry of Nanomaterials
510.604 Mechanical Properties of Materials
510.605 Electronic, Optical and Magnetic Properties of Materials
510.606 Polymer Chemistry & Biology
510.607 Biomaterials II: Host Response and Biomaterials Applications
510.608 Electrochemistry
510.611 Solid State Physics
510.612 Solid State Physics
510.622 Micro- and Nano-structured Materials and Devices
510.624 X-Ray Scattering, Diffraction and Imaging
610.657 Transmission Electron Microscopy: Principle & Practice

**Nanomaterials and Nanotechnology:** *(Sponsored by the Department of Materials Science & Engineering)*

Pre-requisites: (3)
UG Calculus, Chemistry, and, Physics.

Required Courses: (2)
*Approval of substitutions for required courses are at the discretion of the technical advisor.*
510.422 Micro and Nano Structured Materials and Devices
510.619 Biopolymers Synthesis

Electives: (3)
Electives should be related to Materials Science and Engineering and must be approved by the DMSE graduate committee.

Elective courses on the list below can be approved at the advisor’s discretion.

List of Pre-approved Electives:

510.400 Introduction to Ceramics
510.403 Materials Characterization
510.405 Materials Physics
510.422 Micro-and Nano-structured Materials and Devices
510.426 Biomolecular Materials I – Soluble Proteins and Amphiphiles
510.428 Materials Science Laboratory I
510.429 Materials Science Laboratory II
510.430 Biomaterials Lab
510.431 Biocompatibility of Materials
510.456 Introduction to Surface Science
500.619 Fundamental Physics and Chemistry of Nanomaterials
510.604 Mechanical Properties of Materials
510.605 Electronic, Optical and Magnetic Properties of Materials
510.606 Polymer Chemistry & Biology
510.607 Biomaterials II: Host Response and Biomaterials Applications
510.608 Electrochemistry
510.611 Solid State Physics
510.612 Solid State Physics
510.622 Micro- and Nano-structured Materials and Devices
510.624 X-Ray Scattering, Diffraction and Imaging
610.657 Transmission Electron Microscopy: Principle & Practice

**Operations Research:** *(Sponsored by the Department of Applied Mathematics & Statistics)*
Required Courses: (3)
*Approval of substitutions for required courses are at the discretion of the technical advisor.*

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

553.761 Nonlinear Optimization I

553.762 Nonlinear Optimization II

553.766 Combinatorial Optimization

570.697 Risk and Decision Analysis

570.608 Uncertainty Modeling for Policy & Management Decision Making

570.695 Mathematical Foundations for Public Decision Making

553.600 Mathematical Modeling and Consulting

570.693 Economic Foundations for Public Decision Making

570.696 Urban and Environmental Systems

570.607 Energy Planning and Policy Models

553.626 Introduction to Stochastic Processes

553.627 Stochastic Processes and Applications to Finance

553.628 Stochastic Processes and Applications to Finance

553.633 Monte Carlo Methods

553.663 Network Models in Operations Research

553.639 Time Series Analysis

553.641 Equity Markets and Quantitative Trading

553.642 Investment Science

553.644 Introduction to Financial Derivatives

553.645 Interest Rate and Credit Derivatives

553.646 Risk Measurement/Management in Financial Markets

553.647 Quantitative Portfolio Theory and Performance Analysis

553.648 Financial Engineering and Structured Products

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

**Probability and Statistics:** *(Sponsored by the Department of Applied Mathematics & Statistics)*
Admissions Requirements
One upper-division undergraduate course in probability and one in mathematical statistics (equivalent to 550.420 Introduction to Probability and 550.430 Introduction to 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

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

Innovation and Design II does not count as a technical course in Probability and Statistics

**Systems Engineering:** *(Sponsored by the Department of Civil & Systems Engineering)*

Required Courses: (3)
*Approval of substitutions for required courses are at the discretion of the technical advisor.*
Two courses with course numbers from EN.560.640—EN.560.659 **OR** choose one from both.

Electives: (2)
*Courses not on this list are at the advisor’s discretion.*
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
\*\*663.657 Innovation and Design II, if taken EN.663.653, and with advisor approval only.

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

**Space Systems Engineering:** *(Sponsored by the Engineering for Professionals Program)*

Required Courses: (2)
*Approval of substitutions for required courses are at the discretion of the technical advisor.*
675.600 Systems Engineering for Space
675.601 Fundamentals of Engineering Space Systems I

Electives: (3)
*Courses not on this list are at the advisor’s discretion.*
Three courses from any combination of 675.xxx.