



JOHNS HOPKINS  
UNIVERSITY

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Mechanical Engineering  
Department

# Undergraduate Advising Manual

for Bachelor of Science Degrees  
in Mechanical Engineering and  
Engineering Mechanics  
**Class of 2022 and later**

2019-2020

*Updated June 20, 2023*

# Department of Mechanical Engineering

## *The Johns Hopkins University*

### Accredited Undergraduate Programs in Mechanical Engineering and Engineering Mechanics

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# 1 INTRODUCTION

Welcome to the Johns Hopkins University's Department of Mechanical Engineering! In our time, we have seen once-diverse engineering fields merge and new technologies redefine industries. To keep abreast of rapid technological innovation, engineers must be able to continually update and renew their knowledge throughout their careers.



The task of preparing students for this environment is facilitated by our focus on fundamentals and the low student-to-faculty ratio of the Department of Mechanical Engineering. Educating a small, select group of students has permitted the development of a number of distinctive educational features such as a “capstone” design course that closely simulates professional practice, student participation in faculty research, close faculty-student interaction, and effective advising. By means of flexible programs grounded in fundamentals, we enable our graduates to pursue the lifelong education needed to excel in a rapidly changing world.

## 1.1 Objectives

In fulfilling our mission of preparing our graduates for the future, we start with the recognition that, at the root of the ever-growing variety of technological innovations lie scientific, engineering, and professional principles that are both a foundation for the student's understanding and a compass throughout his or her career.

A primary objective of the Mechanical Engineering curriculum is to emphasize the importance of these fundamental principles and to help students understand them and master their application. Laboratory experience is invaluable for this purpose and we provide meaningful hands-on experience in modern instructional and research laboratories, so that students gain the skills of acquiring, analyzing, and interpreting data.

Fundamental principles are as vital today as when they were first discovered. This aspect is illustrated by showing them “in action” in the more advanced courses devoted to contemporary applications.

The demands of advanced technology, economy, and efficiency put an ever-increasing premium on the quantitative aspects of engineering. For this reason, students must also be educated in the application of advanced mathematical and computational techniques in engineering analysis and design.

## 1.2 Programs

### 1.2.1 Academic Programs – Two Majors

The Department of Mechanical Engineering offers two distinct programs of study for undergraduates at Johns Hopkins: Mechanical Engineering and Engineering Mechanics.

The **Mechanical Engineering** program places an emphasis on mechanical and thermal-fluid systems analysis and design. Students develop a wide range of fundamental skills required of the mechanical engineering professional and choose upper-level technical electives for further in-depth study.

The **Engineering Mechanics** program is designed to provide students with a highly flexible but rigorous foundation in solid and fluid mechanics. Students choose an area of specialization in preparation for technical careers or for graduate and professional school.

The objectives indicated before are common to the two programs. In addition, they share the following features:

*Flexibility.* While the Engineering Mechanics curriculum is, by design, very flexible, both curricula offer several technical electives and allow students to pursue special interests in engineering, physics, biology, mathematics, management, and humanities. Double-majors and a 5-year Master's degree are also possible.

*Interdisciplinary approach.* Both programs require courses in the basic sciences and mathematics and other engineering disciplines (including electrical, civil and materials). Each program also offers elective opportunities in diverse areas such as the physical and mathematical sciences, aerospace engineering, biomedical engineering, and environmental engineering. Students have the opportunity to interact with a multidisciplinary faculty both in the classroom and in research laboratories.

*Preparation for professional practice.* The modern engineer must be well versed in communication and teamwork skills. These are developed in a number of courses that involve laboratory exercises, report writing, and oral presentations. In addition to the two-semester freshman introductory and senior capstone design courses, the students' development in solving design problems is cultivated and encouraged through design electives and special design projects assigned in many of the courses.

The requirements described in this guide are intended to ensure an excellent foundation in science, humanities and social sciences, engineering sciences and

engineering design methods, as well as preparation in the specializations of Mechanical Engineering and Engineering Mechanics. Both programs are accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>.

### **1.2.2 Program Educational Objectives and Student Outcomes**

Please see Section 6.3 for the B.S. Mechanical Engineering program and Section 7.3 for the B.S. Engineering Mechanics program for the Program Educational Objectives and Student Outcomes.

### **1.2.3 Research Programs**

The research programs in the Department of Mechanical Engineering are broad and varied:

- Energy and the Environment
- Fluid Mechanics and Thermal Processes
- Mechanics and Materials
- Micro/Nanoscale Science and Engineering
- Mechanical Engineering in Biology and Medicine
- Robotics, Systems, and Control



A comprehensive list of research topics and the faculty participating in them appear on the Mechanical Engineering website's Research page.

### **1.2.4 Undergraduate Research Opportunities**

The faculty welcomes undergraduate student participation in their research, which greatly enhances the educational experience beyond coursework. Opportunities are available during the academic semesters, intersession, and summer through independent study and research courses or through paid research positions.

Undergraduates at all levels are strongly encouraged to contact faculty members directly to participate in the Department's research programs.

### **1.2.5 "Laboratory Safety for Undergraduates" Course Required for Lab Courses**

All students taking courses with experimental labs must now take EN.990.100 Laboratory Safety for Undergraduates before registering for your courses. This two-hour online course should be completed 24 hours before your registration period begins so the SIS registration system will acknowledge the course's completion.

If you are registering for any of these, you must take EN.990.100:



- EN.530.115/116 MechE Freshman Laboratory I/II
- EN.530.205 Manufacturing Engineering Laboratory
- EN.560.211 Statics and Mechanics of Materials Lab
- EN.530.212 Mechanical Engineering Dynamics Lab
- EN.530.216 Mechanics Based Design Lab
- EN.530.232 Thermodynamics Lab
- EN.530.241 Electronics and Instrumentation
- EN.530.254 Manufacturing Engineering
- EN.530.329 Intro to Fluid Mechanics Lab
- EN.530.335 Heat Transfer Lab
- EN.530.344 Design and Analysis of Dynamic Systems Lab
- EN.530.352 Materials Selection
- EN.530.381 Engineering Design Process
- EN.530.403 (Fall) / EN.530.404 (Spring) Senior Design
- EN.530.446 Experimental Biomechanics

To take the course:

1. Open the [myJH Portal](#)
2. Select the *Education* sidebar tab
3. Select the *MyLearning* option
4. Enter *Laboratory Safety Introductory Course* in the search area
5. Select the course title, then *Add to Dev Plan*
6. Click *Next*, then click *Done* to begin the course.
7. If you need help, contact [help@jhmi.edu](mailto:help@jhmi.edu)

Please note that the course EN.990.100 will NOT be visible on your transcript even after you successfully complete it. It is administratively recorded in SIS, and will be read by SIS when pre-requisite checking your selected courses.

#### **1.2.6 “Laboratory Safety for Undergraduate Research Assistants” Course Required**

**Your safety in the lab is paramount**, more important than any research or academic benefit you obtain from doing research. The Whiting School has created a lab safety course, which provides a baseline level of safety knowledge – it is not comprehensive. Each laboratory has its own particular hazards and must train you on how to avoid them. The online course gives you a basic understanding of lab hazards and the vocabulary to learn more about safety in your lab.

**NOTE:** All students physically working in a laboratory where experiments are performed must complete this online course, whether or not the nature of their specific laboratory research is experimental or computational.

**Please complete the course online:**



- Go to the “myJHU” Portal at <http://my.jhu.edu> and sign in with your JHED ID and password.
- Under the Education sidebar tab—select the “myLearning” option.
- Select the “Course Catalog” tab on the left, and enter the text “Laboratory Safety for Undergraduate Research Assistants” in the “search” tab and select the “Add to My Plan” tab. Follow the additional instructions and it will be added to your plan.
- In the plan, select the course title’s link, which will take you to its window. Select the “take course” button and you will be able to being the course.

The course has 6 modules presented in a PDF file, with online exercises and an exam. The total course is about 45 pages and takes about 3 hours to complete.

When you have completed the course, Johns Hopkins will e-mail you a certificate. Your department or principal investigator will require you to present a copy of the certificate before beginning work in the laboratory.

If you have questions about laboratory safety or the course, contact Dr. Daniel Kuespert, Laboratory Safety Advocate, [dkuespert@jhu.edu](mailto:dkuespert@jhu.edu) or 410-516-5525.

### **1.2.7 “Responsible Conduct of Research Course” May Be Required**

Many undergraduate students participating in research will be required to take the “Responsible Conduct of Research” course.

- Students receiving payment for research or who are conducting research used to help complete degree requirements (such as in an Independent Research or Independent Study course) must first complete the online training course (AS.360.624) before conducting research and receiving payment or credit.
- Students receiving payment from NIH Training Grants must take the in-person training course (AS.360.625).

Information is available at <http://eng.jhu.edu/wse/page/conduct-of-research-training>. Successful completion of this course must be verified before a student’s diploma is issued.

## **1.3 Advising**

The Department’s faculty coordinator for undergraduate advising is the Director of Undergraduate Studies, Professor Steven Marra, whose office is in 123 Latrobe, telephone 410-516-0034, e-mail [marra@jhu.edu](mailto:marra@jhu.edu).

All undergraduate students must follow a program approved by their faculty advisors.

### **1.3.1 Visit Your Advisor Often**

Each student should see his or her advisor to plan a course schedule, change courses, and discuss degree requirements. It is important to determine an outline of the total four years of courses as early as possible. Students can also discuss issues related to academics or academic performance at any time.

Students must initiate a meeting with his or her advisor at least once – and preferably more – each semester.

A meeting approximately four weeks after classes begin provides a useful time to inform the advisor of potential difficulties in individual courses. Additional meetings occur in November and April during the two Advising Weeks, when decisions must be made on course registration for the following semester.

### **1.3.2 Advising Holds on Registration**

Advising Holds are placed on your registration record, which your advisor must release before you can register for classes. Advising Week is the week before registration begins for the next semester. The Advising Hold is released only after you review your course plans with your advisor. Please arrange an appointment with your advisor during Advising Week.

## **1.4 University Catalog**

The JHU University Catalog is a valuable resource for information on academic and administrative procedures, registration, grading, professional opportunities, and student life.

Please refer to it often, as it will answer many questions about policies and procedures. The catalog is available at <http://e-catalog.jhu.edu/>.

## **1.5 “Advising Johns Hopkins Students” Handbook for Parents**

The JHU Office of Academic Advising has created a companion website “Advising Johns Hopkins Students” at <https://studentaffairs.jhu.edu/parents-families>. Please encourage your parent(s) or guardian(s) to refer to this as it provides helpful information about suggestions to prepare for each of the four years of your student experience and beyond.

## 2 GENERAL REGULATIONS

### 2.1 *Course Grading – Letter Grades vs. S/U grades*

The Department of Mechanical Engineering requires that all courses counted toward the 126 credit requirement for either Mechanical Engineering or Engineering Mechanics be taken for a letter grade (that is, they may not be taken with the Satisfactory/ Unsatisfactory option).

#### 2.1.1 **Grades Below C- (Engineering, Math, and Science)**

The Department of Mechanical Engineering requires that grades of C- or better be obtained in all Engineering, Mathematics and Science courses. Grades of D+, D, or F will not be accepted, even though credits will appear in the transcript for D-level grades.

#### 2.1.2 **Grades Below C- (Humanities and Social Sciences)**

Though grades of C- or higher are preferred, the department will accept up to ten D+ or D graded credits toward graduation requirements for Humanities and Social Sciences courses.

### 2.2 *Credit minimums at Johns Hopkins*

All students matriculating as freshmen must earn a minimum of 100 credits at Johns Hopkins University, even if they are not all used for a student's degree requirements or minors.

All students who transferred to Johns Hopkins from another institution must earn a minimum of 60 credits at Johns Hopkins University, even if they are not all used for a student's degree requirements or minors.

Please keep this in mind when using AP or IB credits or transferring credits from other schools.

### 2.3 *WSE Course-Level Guidelines*

In an effort to promote consistent course labeling, the course numbering guidelines found below are used throughout the University and the Whiting School of Engineering:

- 100: introductory/freshman-level coursework
- 200: sophomore-level coursework
- 300: junior-level coursework
- 400: senior-level coursework; typically permitted to apply to graduate degrees (at the discretion of the student's department)
- 500: undergraduate independent study, undergraduate research, and senior thesis coursework

- 600: graduate coursework; typically graded with letter grades
- 700: advanced graduate and topics courses; often offered P/F
- 800: graduate seminars, graduate independent study, graduate research and dissertation research coursework; nearly always offered P/F

## 2.4 *Courses taken at other Universities*

According to University regulations, no more than 12 credits completed prior to matriculation or in summer sessions at other accredited colleges or universities will be accepted.

Transfer students are not subject to this restriction. They must obtain credit for courses they wish to transfer during their first year at Hopkins. University regulations also require a minimum of two years' residence for a Hopkins degree.

Pre-approval is required to take a course at other accredited colleges or universities while enrolled as a Hopkins undergraduate student. Visit the Mechanical Engineering Undergraduate Advising webpage at <https://me.jhu.edu/undergraduate-studies/academic-advising-undergraduate/> → "Approval Required: Credit Overloads / Taking Classes Outside JHU" for information.

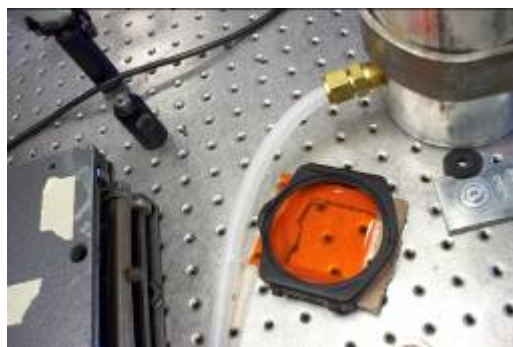
## 2.5 *Course Waivers – No Credits Earned*

As a result of mathematics placement testing or prior course experience in high school, some students may be allowed to begin their course sequences at a higher level than in the initially prescribed curriculum. For example, some students may initiate the math sequence at Calculus II instead of the traditional Calculus I start.

No academic credit is given for waivers. A waiver merely shifts the beginning level of course work. Students must earn the prescribed number of credits for each portion of their degree and work with their advisors to select appropriate classes.

## 2.6 *Advanced Placement*

Johns Hopkins University grants credit for many Advanced Placement (AP) and International Baccalaureate (IB) examinations, including calculus, chemistry, physics, computer science, economics, languages biology, environmental science, and statistics. Visit the Johns Hopkins Catalog's External Credit Policies page at <http://e-catalog.jhu.edu/undergrad->



[students/academic-policies/external-credit/#examcredittext](#) for information.

Many, but not all, AP credit can substitute for courses required for the B.S. degrees in Mechanical Engineering and Engineering Mechanics. A student's academic advisor or the Academic Program Manager can help determine which will count.

Official records of advanced placement examinations should be submitted to the Whiting School's Office of Academic Advising, 103 Shaffer Hall. AP scores will be entered on academic records upon receipt.

## **2.7 AP Physics C (Mechanics) Credit and EN.530.123 Intro to Mechanics I**

### **AP PHYSICS C (MECHANICS)**

Students who have earned a score of 4 or 5 on the AP Physics C (Mechanics) exam can receive four credits and are not required to take EN.530.123 Introduction to Mechanics I.

Students may not substitute AP credits for EN.530.124 Introduction to Mechanics II. All Mechanical Engineering majors must take this course, no matter what AP credits have been earned.

If a student takes a course that AP credits normally would replace, the AP credits will be lost. This is important to consider with the physics courses where taking EN.530.123 Introduction to Mechanics I will eliminate any earned AP Physics C (Mechanics) credits.

*(See the next page...)*

### **ADDITIONAL INTRODUCTORY PHYSICS CREDITS MUST BE TAKEN WITH AP PHYSICS C - MECHANICS CREDIT**

Students starting as Mechanical Engineering or Engineering Mechanics majors...

- ...in the freshman fall semester must take EN.530.124 Intro to Mechanics II in the freshman spring semester.
- ...after the freshman fall semester should consult with their faculty advisor as to which course to take, either EN.530.124 Intro to Mechanics II or AS.173.111 General Physics Laboratory I

### **AP PHYSICS C (ELECTRICITY and MAGNETISM)**

Students who have earned a score of 4 or 5 on the AP Physics C (Electricity and Magnetism) exam can receive four credits and are not required to take AS.171.102/108 General Physics II.

While the University allows waiver of the associated lab, AS.173.112 General Physics II Lab, individual departments can still require the lab. Mechanical Engineering requires AS.173.112 General Physics II Lab for all Mechanical Engineering and Engineering Mechanics majors, even when AP Physics C (Electricity and Magnetism) credits are earned.

## **IB PHYSICS**

The following credit is given for IB Physics:

- A score of 6 will grant 4 credits that will exonerate a student from taking EN.530.123 Introduction to Mechanics I. The courses EN.530.124 Intro to Mechanics II, AS. 171.102 General Physics II, and AS.173.112 General Physics Lab II must be taken.
- A score of 7 will grant 8 credits that will exonerate a student from taking EN.530.123 Introduction to Mechanics I and AS.171.102 General Physics II.
  - The courses EN.530.124 Intro to Mechanics II and AS.173.112 General Physics Lab II must be taken.
  - If a student takes EN. 530.123 Introduction to Mechanics I, 4 of the 8 IB credits will be forfeited, but the remaining 4 will still exonerate a student from taking AS.171.102 General Physics II.

### **2.8 AP Computer Science credit**

Students with no AP Computer Science credit or score lower than a “5” on the AP Computer Science exam must take one version of the 3-credit Gateway Computing course.

EN.530.114 Gateway Computing – MATLAB is preferred, but EN.530.112 Gateway Computing – JAVA and EN.530.113 Gateway Computing – Python are also acceptable.

Effective the Spring 2020 semester and later, students who scored a “5” on the AP Computer Science exam have the option to take either...

- One of the Gateway Computing courses, in which case their AP CS credits will be forfeited, or...
- EN.601.220 Intermediate Programming, EN.601.226 Data Structures, or another programming course of at least three credits approved by the student’s faculty advisor, in which case the AP Computer Science credits will

count toward the student's core computing requirement (replacing Gateway Computing).

## 2.9 *Independent Research and Independent Study*

Students may wish to explore topics beyond coursework or expand learning on a course topic.

Independent Research is a course under the direct supervision of a faculty member in which a student identifies and proposes research work. The Mechanical Engineering course numbers are:

- EN.530.501 Undergraduate Research
- EN.530.511 Group Undergraduate Research, for groups of 5 or more students working on the same research or project
- EN.530.597 Research - Summer

Independent Study is the result of creating a course of study focused on topics beyond coursework or expands on a topic in which further study is desired. The Mechanical Engineering course numbers are:

- EN.530.526 Independent Study - Spring
- EN.530.527 Independent Study - Fall
- EN.530.599 Independent Study - Summer

Other Whiting School departments also offer independent research and study, but have different course numbers.

Up to three credits can be earned in any one semester, summer, or intersession.

### **New Options to Count Independent Work**

**NEW as of Fall 2021:** Students can now count up to six credits of letter-graded independent work toward the B.S. Mechanical Engineering and Engineering Mechanics degrees as an elective in this manner:

- Up to three credits of undergraduate research (EN.530.501, EN.530.511, or EN.530.597)
- Up to three of independent study (EN.530.526, EN.530.527, or EN.530.599)

Students cannot count six credits of undergraduate research nor six credits of independent study.

### **More Information About Independent Work**

- Each credit should reflect 40 hours of work.
- **NEW as of Fall 2022:** Independent work done for academic credit may be paid or unpaid.



- No distribution credits are attached to independent work, though your advisor can designate a distribution through a Course Exception Waiver form on the Academic Advising page at <http://me.jhu.edu/undergraduate-studies/academic-advising-undergraduate/>. This is necessary to count the course toward an elective.
- Students must register in the first six weeks of the semester to earn independent research or study credit that semester. The University prohibits retroactive registration.
- Students taking three or more credits of undergraduate research are encouraged to present a research poster at the Johns Hopkins University's DREAMS Undergraduate Research Day each spring. Announcements will be sent in advance to arrange to submit the poster.

The Mechanical Engineering department strongly recommends that a student have a cumulative GPA of at least 3.0 to request approval to conduct independent research or independent study.

#### **Pre-Approval is Required**

Before embarking on a project, students must obtain pre-approval from their academic advisors by presenting a completed "Independent Academic Work" form in SIS.

- Sign in to SIS at [sis.jhu.edu](http://sis.jhu.edu).
- Go to the Registration menu and select "Online Forms."
- Select "Independent Academic Work."
- Complete and submit the form.
- The form will be sent to the student's faculty advisor via e-mail for approval.
- Once approved, the student will be enrolled for the appropriate course.

Research performed without this pre-approval will not be recognized and accredited.

#### **2.10 Student Classification and First Semester Grades**

The Whiting School of Engineering stipulates that students entering JHU from high school will be classified as "freshmen," regardless of the number of credits earned through Advanced Placement or other pre-college programs.

### **3 DOUBLE MAJORS AND MINORS**

Both Mechanical Engineering and Engineering Mechanics majors may elect to double major or to complete a minor from any department in the School of Engineering or the School of Arts and Sciences that offers one.

## Double Majors

Students wishing to pursue a double major must contact the Whiting School's Academic Advising office. Students must ensure that course requirements for both majors are met, and must visit faculty advisors from each major to obtain approval of the planned program.

## Major / Minors

Students wishing to pursue a minor should confer with the department through which the minor is offered to ascertain the exact requirements. Available minors appear on the following pages:

- Arts and Sciences: <http://advising.jhu.edu/completing-your-degree/declare-major-minor/>
- Engineering: <http://engineering.jhu.edu/fields-of-study/>

Note that students must declare a minor, not just simply take the classes that will help meet the minor requirements. Students taking minors will be assigned an advisor in the department offering the minor. Visit the Whiting School Academic Advising office to declare a minor.

*(See the next page...)*

## Robotics Minor

The field of Robotics integrates sensing, information processing, and movement to accomplish specific tasks in the physical world. As such, it encompasses several topics, including mechanics and dynamics, kinematics, sensing, signal processing, control systems, planning, and artificial intelligence. Applications of these concepts appear in areas like medicine, manufacturing, space exploration, disaster recovery, ordinance disposal, deep-sea navigation, home care, and home automation.



The faculty of the Laboratory for Computational Sensing and Robotics (LCSR), in collaboration with the academic departments and centers of the Whiting School of Engineering, offers a **Robotics Minor** in order to provide a structure in which undergraduate students at Johns Hopkins University can advance their knowledge in robotics while receiving recognition on their transcript for this pursuit.

Information is available at <http://lcsr.jhu.edu/robotics-minor/>.

### Entrepreneurship and Management minor

**The minor in Entrepreneurship and Management** from the Center for Leadership Education focuses on business and management from a multidisciplinary viewpoint. It is designed to provide students with the knowledge and skills to become leaders in technology companies.

Students may opt to take these courses separately from their major course requirements, but most can be incorporated into the course requirements so that only as little as four extra courses would be required to complete the student's primary major plus the Entrepreneurship and Management minor.

It is important to work with your academic advisor to plan your course work plan so you can complete all courses, as you will take them over multiple years.

The table below illustrates how a student can complete the Mechanical Engineering or Engineering Mechanics major plus the Entrepreneurship and Management minor.

*(See the next page...)*

This course...	...counts toward both this E&M minor requirement...	...and this Mechanical Engineering or Engineering Mechanics requirement.
EN.553.310 or EN.560.348 Probability and Statistics	Statistics Option #2	Statistics
EN.660.105 Foundations of American Enterprise (Spring 2020 and earlier: Introduction to Business)	E&M Fundamentals #1	One allowed "S" course from a Whiting School department
EN.660.203 Financial Accounting	E&M Fundamentals #2	Extra Course #1
EN.660.250 Principles of Marketing	E&M Fundamentals #3	Extra Course #2

EN.660.361 Engineering Business and Management	Upper Level Elective #1	Core Engineering (MechE) or Technical Elective (EngMech)
CLE upper-level elective	Upper Level Elective #2	Extra Course #3
CLE upper-level elective	Upper Level Elective #3	Extra Course #4

*Table 1 – Entrepreneurship and Management minor course comparison*

View the Center for Leadership Education website at [https://engineering.jhu.edu/cle/programs-minors/em\\_minor/](https://engineering.jhu.edu/cle/programs-minors/em_minor/) for more information.

## 4 FREQUENCY OF ELECTIVE OFFERINGS

Elective courses are offered in specific semesters, and sometimes in alternating years. Below is a timeframe of elective course offerings listed in the anticipated order of next offering. These are subject to change due to instructor sabbaticals or unusual situations. Please confirm these offerings when planning your course schedule.

MECHANICAL ENGINEERING – ELECTIVE COURSES – ANTICIPATED OFFERINGS					
Semester	Design / Energy / Other	Robotics	Fluid Mechanics	Mechanics and Materials	Biomechanics
<b>Spring 2022 (confirmed)</b>	- EN.530.381 Engineering Design Process	- EN.530.421 Mechatronics	- EN.530.432 Jet and Rocket Propulsion	- EN.530.417 Fabricatology	- EN.530.410 Biomechanics of the Cell - EN.530.441 Intro to Biophotonics - EN.530.480 Image Processing and Visualization
<b>Fall 2022 (confirmed)</b>	- EN.530.310 Reverse Engineering and Diagnostics - EN.530.414 Computer Aided Design - EN.530.430 Applied Finite Element Analysis	- EN.530.420 Robot Sensors and Actuators - EN.530.424 / 624 Dynamics of Robots and Spacecraft - EN.530.469 / 669 Locomotion Mechanics – Recent Advances	- EN.530.417 / 627 Intermediate Fluid Mechanics - EN.530.483 / 683 Applied Computational Modeling in Aerodynamics and Heat Transfer (undergrad)	- EN.530.605 Mechanics of Solids and Materials (grad)	- EN.530.436 Bioinspired Science and Technology - EN.530.474 / 674 Effective and Economic Design for Biomedical Instrumentation - EN.520.495 Microfabrication Laboratory
<b>Spring 2023 (anticipated)</b>	- EN.530.381 Engineering Design Process - EN.530.464 / 664 Energy Systems Analysis	- EN.530.421 Mechatronics - EN.530.469 / 669 Locomotion Mechanics – Special Topics - EN.530.470 Space Vehicle Dynamics and Control	- EN.530.425 Mechanics of Flight - EN.530.427 / 627 Intermediate Fluid Mechanics	- EN.530.405 Mechanics of Advanced Engineering Structures - EN.530.438 / 638 Aerospace Materials	- EN.530.410 Biomechanics of the Cell - EN.530.436 Bioinspired Science and Technology - EN.530.441 Intro to Biophotonics - EN.530.480 Image Processing and Data Visualization

MECHANICAL ENGINEERING - ELECTIVE COURSES - ANTICIPATED OFFERINGS					
Semester	Design / Energy / Other	Robotics	Fluid Mechanics	Mechanics and Materials	Biomechanics
Fall 2023 (anticipated)	<ul style="list-style-type: none"> <li>- EN.530.310 Reverse Engineering and Diagnostics</li> <li>- EN.530.414 Computer Aided Design</li> <li>- EN.530.430 Applied Finite Element Analysis</li> </ul>	<ul style="list-style-type: none"> <li>- EN.530.420 Robot Sensors and Actuators</li> <li>- EN.530.424 / 624 Dynamics of Robots and Spacecraft</li> </ul>	<ul style="list-style-type: none"> <li>- EN.530.418 / 619 Aerospace Structures</li> <li>- EN.530.443 / 643 Fundamentals, Design Principles, and Applications of Microfluidic Systems</li> <li>- EN.530.483 / 683 Applied Computational Modeling in Aerodynamics and Heat Transfer</li> </ul>	<ul style="list-style-type: none"> <li>- EN.530.418 / 619 Aerospace Structures</li> </ul>	<ul style="list-style-type: none"> <li>- EN.530.443 Fundamentals, Design Principles, and Applications of Microfluidic Systems</li> <li>- EN.530.445 Introduction to Biomechanics</li> <li>- EN.530.448 Biosolid Mechanics</li> <li>- EN.530.468 / 668 Locomotion Mechanics: Fundamentals</li> <li>- EN.530.474 / 674 Effective and Economic Design for Biomedical Instrumentation</li> </ul>

Table 2 – Anticipated Elective Course Frequencies

For anticipated graduate course frequencies, see the graduate advising manuals in the Graduate Academic Advising page at <http://me.jhu.edu/graduate-studies/academic-advising-graduate/>.

## 5 HUMANITIES AND SOCIAL SCIENCE REQUIREMENTS

The Humanities and Social Sciences play an important role in an individual's education. The Whiting School of Engineering requires a minimum of six courses (each of at least three credits) in the Humanities or Social Sciences (catalog code H or S) distributions, and require one writing course and two courses at the 300-level or above.



Visit <http://e-catalog.jhu.edu/undergrad-students/academic-policies/requirements-for-a-bachelors-degree/> for two exceptions to the rule that each H/S distribution course be at least three credits.

### Look for the "H" or "S"!

When selecting courses, be sure the course includes either an "H" or "S" course area designation. Some may have both. Not all courses offered in the Krieger School of Arts and Sciences carry the designation.

**NOTE:** Some Center for Leadership Education (EN.660.xxx or EN.661.xxx) and Peabody School of Music (PY.xxx.xxx) courses carry “H” or “S” distributions, but many do not.

Courses that do not carry either an “H” or “S” course distribution will not be accepted for the degree’s Humanities and Social Sciences requirements.

Be sure to verify the desired course has an “H” or “S” before registering for the course.

## 5.1 Foreign Language Credit

### FIRST-YEAR FOREIGN LANGUAGE - ELEMENTS

~~Students taking elements of a first-year foreign language course can be counted for a humanities/social science course requirement even though it is not granted an H area designator only if the second semester course of the same first-year foreign language is successfully completed. Both courses would count toward the humanities/social science requirement.~~

**New in Fall 2022:** Students in the Whiting School of Engineering can substitute language elements (or “beginning/first year”) courses for humanities/social science courses.

Students taking elements of a first-year foreign language course can be counted for a humanities/social science course requirement even though it is not granted an H area designator.

### FIRST-YEAR FOREIGN LANGUAGE - SECOND SEMESTER

The second semester course of first-year foreign language taken by itself is always granted an H area designator. It can count toward a humanities/social science course requirement even when the first semester course is not taken.

For example, a student successfully completing AS.090.101 and AS.090.102 *Elementary German* would receive eight H credits. *Note that while four H credits would be given for AS.090.102 if taken alone, no H credits are given for AS.090.101 “elements” if taken alone.*

Visit the [E-catalog about language courses](#) for more information.

## 5.2 Writing Requirement

Whiting School of Engineering students must take two courses (totaling at least 6 credits) that are “writing intensive.” Mechanical Engineering and Engineering Mechanics majors must take two courses that develop writing skills essential for success as an engineer.

- **EN.530.404 Mechanical Engineering Senior Design Project II** (4 credits) is counted as one of the two courses.
- Effective April 13, 2022 for all undergraduate students, the second “writing intensive” course can be **any writing intensive course that carries an H (humanities) or S (social sciences) course area**. Most, if not all, “writing intensive” courses will be three or four credits. The courses AS.060.100



Introduction to Expository Writing and AS.060.113 / AS.060.114 Expository Writing will no longer be offered.

### **5.2.1 Take the Writing Intensive Course – Freshman Year Recommended**

The Expository Writing and Intro to Fiction and Poetry Writing programs reserve at least half of the seats for freshman each semester. While this ensures that most or all freshmen will be able to take the class, it may be problematic for upperclassmen to register. In fact, seniors are excluded from the courses unless special permission is granted by the writing programs.

Students are strongly encouraged to take the writing course in the freshman year.

### **5.2.2 A Note about AS.220.105 Intro to Fiction and Poetry Writing**

Note that the instructors of AS.220.105 Intro to Fiction and Poetry Writing emphasize the importance that students attend the very first class sessions, as the course's assignments are highly front-loaded. In other words, most of the courses' assignments are due early in the semester, with continued discussion and lecture throughout the semester. It is recommended that students not add this course during the "add/drop" period, especially after the second class.

## **5.3 Distribution and Depth Requirements**

The Humanities and Social Sciences are of great importance in broadening an engineering student's education and the development of an inquisitive and critical mind.

### **Six H/S Credits must be Upper-Level**

The free electives in Humanities and Social Science courses must be chosen to obtain sufficient depth. To achieve these objectives, at least six H/S credits must be taken as "upper level," at the 300-level or higher.

### **Intermediate Language could replace Upper-Level Credits**

With the student's advisor's approval, intermediate-level language courses (200-level or higher) may be taken to satisfy this depth requirement.

This is beyond what is described in Section 5.1, where the first two semesters of any elementary course in a foreign language could count toward the H/S requirement, as long as both semesters are successfully completed.

### H/S Courses in the Krieger School of Arts and Sciences

Though some courses in the Whiting School of Engineering may offer a course that carries an “H” or “S” course area, the department believes that H/S courses should be taught or supervised by full-time faculty in the Krieger School of Arts and



Sciences, who are the experts in humanities and social sciences. Students should be taking all H/S courses from the Krieger School except in extenuating circumstances that would necessitate taking a course elsewhere.

### No more than one “Whiting School” H/S Course may be taken

The department recognizes that some students’ may take an “H” or “S” course in the Whiting School of Engineering, including those seeking a Whiting School minor like Entrepreneurship and Management.

Mechanical Engineering and Engineering Mechanics majors may count no more than one course - or three credits - that are taught in the Whiting School (numbered EN.xxx.xxx) with an “H” or “S” course area towards this requirement.

There are two examples where a 2-credit course and a 1-credit course combine to be accepted as three credits:

- EN.660.400 Practical Ethics for Future Leaders (2 credits) and EN.660.406 Practical Ethics for Future Leaders (1 credit)
- EN.660.400 Practical Ethics for Future Leaders (2 credits) and EN.520.404 Engineering Solutions in a Global, Economic, Environmental, and Societal Context (1 credit)

The following department codes, which occupy the first three digits of course numbers at Johns Hopkins (e.g. EN.530.xxx), are offered in the Whiting School and are subject to this restriction:

- EN.500 - General Engineering
- EN.510 - Materials Science and Engineering
- EN.520 - Electrical and Computer Engineering
- EN.530 - Mechanical Engineering
- EN.540 - Chemical and Biomolecular Engineering
- EN.553 - Applied Math and Statistics
- EN.560 - Civil Engineering
- EN.570 - Geography and Environmental Engineering
- EN.580 - Biomedical Engineering

- EN.601 - Computer Science
- EN.650 - Information Security Institute
- EN.660 - Entrepreneurship and Management / Center for Leadership Education
- EN.661 - Professional Communication
- EN.662 - Engineering Management
- EN.670 - Institute for Nanobiotechnology

# Bachelor of Science Degree in the Mechanical Engineering major

## 6 MECHANICAL ENGINEERING CURRICULUM

### 6.1 *Our Mission*

The mission of the B.S. in Mechanical Engineering degree program is to provide a rigorous educational experience that prepares a select group of students for leadership positions in the profession and a lifetime of learning. The faculty is committed to maintaining a modern and flexible curriculum which, building on a foundation of basic sciences and mathematics, develops a solid education in the mechanical engineering sciences. The aim of the Mechanical Engineering program is to build competence in the analysis, design and development of thermal, fluid, and mechanical systems; to promote a broad knowledge of the contemporary social and economic context, and to develop the communication skills necessary to excel.

### 6.2 *Introduction*

The program provides fundamental courses in thermal and mechanical systems. Both laboratory instruction and the senior design project allow all students hands-on experience. Each student's program of study is planned in consultation with his or her faculty advisor. Students are encouraged to develop depth in one or two areas chosen from:

- Aerospace Engineering
- Biomechanical Engineering
- Robotics
- Mechanics and Design
- Thermofluids and Thermofluid Systems.

The choice of academic interest is typically decided in the junior year after consultation with the faculty advisor. If you are ready to choose an academic interest prior to your junior year, please discuss your intentions with your advisor.

### 6.3 *Educational Objectives*

#### **B.S. Mechanical Engineering Program Educational Objectives**

Our primary objective is to educate an exceptional group of engineers who, after graduation, will be successful and on track to become leaders among their peers in the best graduate programs and/or in industry, government laboratories, academia, and other organizations.

## B.S. Mechanical Engineering Student Outcomes

Students graduating with a B.S. in Mechanical Engineering will have demonstrated...

- 1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- 2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- 3) an ability to communicate effectively with a range of audiences
- 4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- 5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- 6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- 7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## 6.4 Mechanical Engineering Curriculum

A program of no fewer than **126 credits** must be completed to be eligible for the bachelor's degree. All undergraduate students must follow a program approved by a faculty member in the department who is selected as the student's advisor.

The Mechanical Engineering curriculum is structured as follows:

*Science (13 credits; grades below C- not accepted)*

- EN.530.123 Introduction to Mechanics I
- EN.530.124 Introduction to Mechanics II (required for all students, even with AP credit)
- AS.171.102 (or AS.171.108) Physics II
- AS.173.112 Physics Lab II (required for all students, even with AP credit)
- AS.030.101 Introduction to Chemistry I

*Mathematics (19 credits; grades below C- not accepted)*

- AS.110.108 Calculus I
- AS.110.109 Calculus II
- AS.110.202 Calculus III (or AS.110.211 Honors Multivariable Calculus)
- EN.553.291 Linear Algebra/Differential Equations (or AS.110.201 Linear Algebra and AS.110.302 Differential Equations)

- Statistics Elective at the 300 level or above (e.g. EN.560.348 Probability and Statistics in Civil Engineering [no seniors] or EN.553.310 Probability and Statistics. AP Statistics will not be accepted as a substitute.)

*Humanities and Social Sciences (18 credits)*

- See Humanities and Social Sciences, Section 5

*Required Engineering Courses (50 credits; grades below C- not accepted)*

- EN.530.107/108 MechE Undergraduate Seminar I/II
- EN.530.111 Intro to MechE Design and CAD
- EN.500.114 Gateway Computing - MATLAB
  - EN.500.114 Gateway Computing - MATLAB is the strongly preferred computing option. Some students might take EN.500.112 Gateway Computing - Java to work toward a Computer Science or Robotics minor. Those students will then also have to take the one-credit online course EN.500.134 MATLAB Bootcamp to learn MATLAB.
- EN.530.115/116 Mechanical Engineering Freshman Laboratory I/II
- EN.560.201 and EN.560.211 Statics and Mechanics of Materials and Lab
- EN.530.202 and EN.530.212 Dynamics and Lab
- EN.530.215 and EN.530.216 Mechanics Based Design and Lab
- EN.530.231 and EN.530.232 MechE Thermodynamics and Lab
- EN.530.241 Electronics and Instrumentation or 520.230 Mastering Electronics
- Either
  - EN.530.254 Manufacturing Engineering
  - EN.530.204 Manufacturing Engineering Theory and EN.503.205 Manufacturing Engineering Laboratory
- EN.530.327 and EN.530.329 Introduction to Fluid Mechanics and Lab
- EN.530.334 and EN.530.335 Heat Transfer and Lab
- EN.530.343 and EN.530.344 Design and Analysis of Dynamic Systems / Lab
- EN.530.352 Materials Selection
- EN.660.361 Engineering Business and Management [or EN.660.105 Foundations of American Enterprise {Spring 2020 and earlier: Introduction to Business} **and** EN.660.341 Business Process and Quality Management.]

*Mechanical Engineering Electives (9 credits; grades below C- not accepted)*

- Three courses (300-level or higher) in mechanical engineering (EN.530.xxx) or any of the courses listed below:
  - EN.500.308 and/or EN.500.309 Multidisciplinary Design
  - EN.520.495 Microfabrication Laboratory
  - EN.580.451 Cell and Tissue Engineering

- EN.580.452 Cell and Tissue Engineering II

*Technical Electives (9 credits; grades below C- not accepted)*

- Two (E), (Q), or (N) courses at or above the 300-level, chosen from any combination of courses in engineering, basic sciences, or mathematics chosen in consultation with the student's advisor, *plus...*
- *Either* one more (E), (Q), or (N) course at or above the 300-level, *or* one of these computing options:
  - EN.601.220 Intermediate Programming
  - EN.601.226 Data Structures

**NOTE:** The EN.500.11x Gateway Computing and EN.500.13x Bootcamp computing courses **do not count** as a technical elective.

*Capstone Design (8 credits; grades below C- not accepted)*

- EN.530.403 and EN.530.404 Mechanical Engineering Senior Design I and II



#### 6.4.1 4-Year Course Planning - Help is Available

It is important to plan all four years of your coursework as early as possible, keeping in mind the frequency of courses offered so you can enroll in all courses required for your degree. Your faculty advisor and Academic Program Manager Mike Bernard offer help with such course planning. You are welcome to contact Mike to arrange a meeting.

#### 6.4.2 Definition of Electives

There are two types of electives in the Mechanical Engineering programs:

- **Mechanical Engineering Electives** are the following courses:
  - Courses with course number prefixes "EN.530" and are at the .300-level or higher.
  - EN.500.308 and/or EN.500.309 Multidisciplinary Engineering Design
  - EN.520.495 Microfabrication Laboratory
  - EN.580.451 Cell and Tissue Engineering
  - EN.580.452 Cell and Tissue Engineering II
- **Technical Electives** are any courses that carry a course area of E (engineering), Q (quantitative/math), or N (natural science) and are at the .300-level or higher. These could include Mechanical Engineering courses EN.530.xxx at the



.300-level or higher, as well. The department will accept up to one computing course as a technical elective. See Sections 6.4 and 7.4 for details.

### 6.4.3 Choosing Mechanical Engineering Electives

Students are encouraged to develop depth in one or two areas within mechanical engineering. Some examples of courses that could form the basis of concentrations are provided below. Note that many of the elective courses below are taught every other year. (Electives are in *italics*):

#### **Mechanics and Design**

- EN.530.310 *Reverse Engineering and Diagnostics*
- EN.530.352 *Materials Selection*
- EN.530.381 *Engineering Design Process*
- EN.530.405 *Mechanics of Solids and Structures*
- EN.530.414 *Computer-Aided Design*
- EN.530.418 *Aerospace Structures and Materials*
- EN.530.430 *Applied Finite Element Analysis*
- EN.530.455 *Additive Manufacturing*

#### **Robotics**

- EN.530.343/344 *Design and Analysis of Dynamic Systems and Lab*
- EN.530.414 *Computer-Aided Design*
- EN.530.420 *Robot Actuators and Sensors*
- EN.530.421 *Mechatronics*
- EN.530.424 *Dynamics of Robots and Spacecraft*
- EN.530.468/668 *Locomotion Mechanics: Fundamentals*
- EN.530.469/669 *Locomotion Mechanics: Recent Advances*
- EN.530.470 *Space Vehicle Dynamics and Control*
- EN.530.475 *Locomotion I: Mechanics*

#### **Thermo-fluids and Thermo-fluid Systems**

- EN.530.327/329 *Introduction to Fluid Mechanics and Lab*
- EN.530.334/335 *Heat Transfer and Lab*

- EN.530.418 *Aerospace Structures and Materials*
- EN.530.425 *Mechanics of Flight*
- EN.530.426 *Biofluid Mechanics*
- EN.530.427 *Intermediate Fluid Mechanics*
- EN.530.432 *Jet and Rocket Propulsion*
- EN.530.443 *Fundamentals, Principles, and Applications of Microfluidic Systems*
- EN.530.464 *Energy Systems Analysis*
- EN.530.483 *Computational Modeling in Aerodynamics and Heat Transfer*

#### **Biomechanics**

- EN.530.410 *Biomechanics of the Cell*
- EN.530.426 *Biofluid Mechanics*
- EN.530.436 *Bioinspired Science and Technology*
- EN.530.439 *Comparative Biomechanics*
- EN.530.441 *Introduction to Biophotonics*
- EN.530.445 *Introduction to Biomechanics*
- EN.530.446 *Experimental Biomechanics*
- EN.530.448 *Biosolid Mechanics*
- EN.530.473 *Molecular Spectroscopy and Imaging*
- EN.530.474 *Effective and Economic Design for Biomedical Instrumentation*
- EN.530.480 *Image Processing and Data Visualization*
- EN.530.495 *Microfabrication Laboratory*
- EN.580.451/452 *Cell and Tissue Engineering Laboratory I/II*

## 6.5 Aerospace Engineering Track

A student may specialize in Aerospace Engineering once a solid background in the fundamentals of Mechanical Engineering has been developed through the basic ME courses. This track requires knowledge and background in several fields including advanced dynamics, flight mechanics, propulsion, aerospace materials and structures, signal processing, control systems, astrophysics and space systems. Students pursuing the Aerospace Engineering Track are required to take **at least five** of the following courses.

**Note:** In the B.S. program, courses numbered with the course prefix “EN.530” at the .300-level or higher can be counted toward Mechanical Engineering electives. All courses below – including EN.530.3xx+ courses - can be counted as Technical Elective requirements.

### **SPRING 2022 (confirmed) and SPRING 2024 (anticipated)**

- EN.530.432 Jet and Rocket Propulsion (Spring 2022 and Spring 2024)
- EN.530.427 or EN.530.627 Intermediate Fluid Mechanics (Spring 2024 only)

### **FALL 2022 (confirmed) and FALL 2024 (anticipated)**

- EN.530.424 or EN.530.624 Dynamics of Robots and Spacecraft
- EN.530.427 or EN.530.627 Intermediate Fluid Mechanics (Fall 2022 only)
- EN.530.483 or EN.530.683 Applied Computational Modeling in Aerodynamics and Heat Transfer
- AS.171.321 Introduction to Space Science and Technology
- AS.270.318 Remote Sensing of the Environment

### **SPRING 2023 and SPRING 2025 (anticipated)**

- EN.530.425 Mechanics of Flight
- EN.530.427 or EN.530.627 Intermediate Fluids
- EN.530.438 or EN.530.638 Aerospace Materials
- EN.530.470 Space Vehicle Dynamics and Control

### **FALL 2023 and FALL 2025 (anticipated)**

- EN.530.418 or EN.530.619 Aerospace Structures (formerly Aerospace Structures and Materials)
- EN.530.424 or EN.530.624 Dynamics of Robots and Spacecraft
- EN.530.483 or EN.530.683 Applied Computational Modeling in Aerodynamics and Heat Transfer
- AS.171.321 Introduction to Space Science and Technology

Any five of the courses listed above are required. A sixth course amongst this list, though not required is highly recommended.

Other courses relevant to - but which do not count toward - the Aerospace Track:

- AS.171.118 Stars and the Universe
- EN.525.445 Modern Navigation Systems

For information on these courses and the frequency of course offerings, please consult the Registrar's course listings at <https://studentaffairs.jhu.edu/registrar/students/course-schedule/>. Courses for the Engineering Program for Professionals (525.xxx) can be found at <http://ep.jhu.edu/schedule>.

### Internships in Aerospace Engineering

Students in the Aerospace Engineering Track are encouraged to participate in internships in organizations involved with aerospace engineering. Opportunities within the university include the Applied Physics Laboratory (Satellites), the Center for Astrophysical Sciences (CAS) and the Space Telescope Science Institute (Hubble Space Telescope). In addition, local companies and institutions, such as Northrop Grumman (which is formally affiliated with the Mechanical Engineering department as an Industrial Partner), NASA Goddard, Lockheed Martin, Orbital Sciences and other private corporations offer excellent opportunities for internships.

### 6.6 Biomechanics Track

A student may specialize in Biomechanics once a solid background in the fundamentals of Mechanical Engineering has been developed through the basic Mechanical Engineering courses. Students pursuing the Biomechanics Track within Mechanical Engineering are required to take **at least four** courses. Two among the four should be chosen from the biomechanics-oriented courses, indicated by an asterisk (\*).

#### **SPRING 2022 (confirmed) and SPRING 2024 (anticipated)**

- EN.530.410 Biomechanics of the Cell\*
- EN.530.426 Biofluid Mechanics\* (not offered in Spring 2022, anticipated for Spring 2024)
- EN.530.441 Introduction to Biophotonics\*
- EN.530.469 or EN.530.669 Locomotion Mechanics: Recent Advances\* (not offered in Spring 2022, anticipated for Spring 2024)
- EN.530.672 Biosensing and BioMEMS\*
- EN.580.457 Intro to Rehabilitation Engineering: Design Lab (Biomedical Engineering)

#### **FALL 2022 (confirmed) and FALL 2024 (anticipated)**

- EN.520.495 Microfabrication Laboratory
- EN.530.436 or EN.530.636 Bioinspired Science and Technology

- EN.530.446 Experimental Biomechanics\*
- EN.530.468 or EN.530.668 Locomotion Mechanics: Fundamentals (Fall 2024 only)
- EN.530.469 or EN.530.669 Locomotion Mechanics: Recent Advances\* (Fall 2022 only)
- EN.530.473 Molecular Spectroscopy and Imaging
- EN.530.474 or EN.530.674 Effective and Economic Design for Biomedical Instrumentation
- EN.580.451 Cell and Tissue Engineering Laboratory
- EN.580.456 Introduction to Rehabilitation Engineering (prerequisites EN.580.421 and EN.580.422 Systems Bioengineering I/II – which both have recommended pre-requisites and co-requisites)

#### **SPRING 2023 and SPRING 2025 (anticipated)**

- EN.530.410 Biomechanics of the Cell\*
- EN.530.441 Intro to Biophotonics\*
- EN.530.469 or EN.530.669 Locomotion Mechanics: Recent Advances\*
- EN.580.451 Cell and Tissue Engineering Laboratory
- EN.580.457 Intro to Rehabilitation Engineering: Design Lab (Biomedical Engineering)

#### **FALL 2023 and FALL 2025 (anticipated)**

- EN.520.495 Microfabrication Laboratory
- EN.530.443 or EN.530.643 Fundamentals, Design Principles and Applications of Microfluidic Systems
- EN.530.445 Introduction to Biomechanics\*
- EN.530.448 Biosolid Mechanics\*
- EN.530.468 or EN.530.668 Locomotion Mechanics: Fundamentals
- EN.530.474 Effective and Economic Design for Biomedical Instrumentation
- EN.580.451 Cellular and Tissue Engineering Laboratory
- EN.580.456 Introduction to Rehabilitation Engineering (prerequisites EN.580.421 and EN.580.422 Systems Bioengineering I/II – which both have recommended pre-requisites and co-requisites)

### **6.7 Tracks – Grades and When they Count**

#### **6.7.1 Letter Grades only for Courses Counting Toward a Track**

Any course being counted toward a track, whether or not the course is necessary for the degree requirements, must be taken for a letter grade. S/U grades are not accepted for track courses.

### **6.7.2 Track Courses Counting toward Degrees**

As long as an eligible course is taken in a student's first four years (or eight semesters) as an undergraduate student it will count toward a track. This includes any eligible course being counted for the B.S. degree, or double-counted for the combined B.S. and M.S.E. degrees, or being counted exclusively for the M.S.E. degree.

Students who are earning only B.S. degrees but need a ninth or tenth semester to complete the degree can use eligible courses taken in those semesters to count toward a track.

Those earning their B.S. degrees at the end of the fourth year (or eighth semester) and return to earn the M.S.E. degree cannot take classes in the ninth semester and beyond to earn a track.

### **6.7.3 Recognition**

Upon completion of the Aerospace or Biomechanics track, the department will send a letter of congratulations of this achievement.

The department recently received clarification from the Whiting School of Engineering that with Maryland Higher Education Commission requirements, we can no longer list track achievements in transcript notes. We are happy to provide a letter to another institution, potential employer, or other entity a letter describing the track and how a student achieved it.

## 6.8 Sample Mechanical Engineering Programs

### Sample Mechanical Engineering Program for students beginning with Calculus I

**This is but one version of ways to complete the program. Total Credits - B.S. Degree in Mechanical Engineering - 126**

\* - Students are encouraged to take AS.110.302 Differential Equations (4) and AS.110.201 Linear Algebra (4) instead of the combined EN.553.291 L.A./D.E. course (4) if they can work the additional four credits into their schedule. An advantage of taking the courses separately is that AS.110.302 Differential Equations can be counted as a Technical Elective.

\*\* - Students must take either

A) EN.660.361 Engineering Business and Management or

B) EN.660.105 Foundations of American Enterprise (formerly Introduction to Business) and EN.660.341 Business Process and Quality Management.

▲ - EN.530.343/344 Design and Analysis of Dynamic Systems (DADS) and Lab requires prior completion of EN.530.202/212 Dynamics with a minimum C- grade.

<b>FRESHMAN YEAR</b>			
AS.110.108 Calculus I	4	AS.110.109 Calculus II	4
EN.530.107 MechE Undergrad Seminar I	0.5	EN.530.108 MechE Undergrad Seminar II	0.5
EN.530.111 Intro to MechE Design & CAD	2	EN.500.114 Gateway Computing	3
EN.530.115 MechE Freshman Lab I	1	EN.530.116 MechE Freshman Lab II	1
EN.530.123 Intro to Mechanics I	3	EN.530.124 Intro to Mechanics II	2
AS.030.101 Intro to Chemistry I	3	H/S (2) Elective	3
H/S (1) Writing – 220.105, 060.100/113/114	3	H/S (3) Elective	3
<b>Total credits</b>	<b>16.5</b>	<b>Total credits</b>	<b>16.5</b>
<b>SOPHOMORE YEAR</b>			
AS.110.202 Calculus III	4	EN.553.291 L.A./D.E. *	4
EN.560.201/211 Statics / Lab	3+1	EN.530.202/212 Dynamics / Lab	3+1
EN.530.231/232 Thermodynamics / Lab	3+1	EN.530.215/216 Mechanics Based Design	3+1
AS.171.102 or .108 General Physics II	4	EN.530.241 Electronics & Instrumentation	4
AS.173.112 General Physics II Lab	1		
<b>Total credits</b>	<b>17</b>	<b>Total credits</b>	<b>16</b>
<b>JUNIOR YEAR</b>			
EN.530.327/329 Intro. Fluid Mech / Lab	3+1	EN.530.334/335 Heat Transfer / Lab	3+1
EN.530.352 Materials Selection	4	EN.530.343/344 DADS / Lab ▲	3+1
EN.530.254 (or 530.204/205 Manufacturing Engineering Theory/Lab)	2+1	MechE Elective (1)	3
Statistics Elective	3/4	Technical Elective (1)	3
		H/S (4) Elective	3
<b>Total credits</b>	<b>14/15</b>	<b>Total credits</b>	<b>17</b>
<b>SENIOR YEAR</b>			
EN.530.403 Senior Design Project I	4	EN.530.404 Senior Design Project II	4
Eng. Business and Mgmt. options**	3	MechE Elective (3)	3
MechE Elective (2)	3	Technical Elective (3)	3
Technical Elective (2)	3	Upper-level H/S (6) Elective	3
Upper-level H/S (5) Elective	3		
<b>Total credits</b>	<b>16</b>	<b>Total credits</b>	<b>13</b>

## Sample *Mechanical Engineering* Program for students beginning with Calculus II

**This is but one version of ways to complete the program. Total Credits - B.S. Degree in Mechanical Engineering – 126**

\* - Students are encouraged to take AS.110.302 Differential Equations (4) and AS.110.201 Linear Algebra (4) instead of the combined EN.553.291 L.A./D.E. course (4) if they can work the additional four credits into their schedule. An advantage of taking the courses separately is that AS.110.302 Differential Equations can be counted as a Technical Elective, as long as it is not being counted as one of the courses helping to meet the required 19 math credits.

\*\* - Students must take either

A) EN.660.361 Engineering Business and Management or

B) EN.660.105 Foundations of American Enterprise (formerly Introduction to Business) and EN.660.341 Business Process and Quality Management.

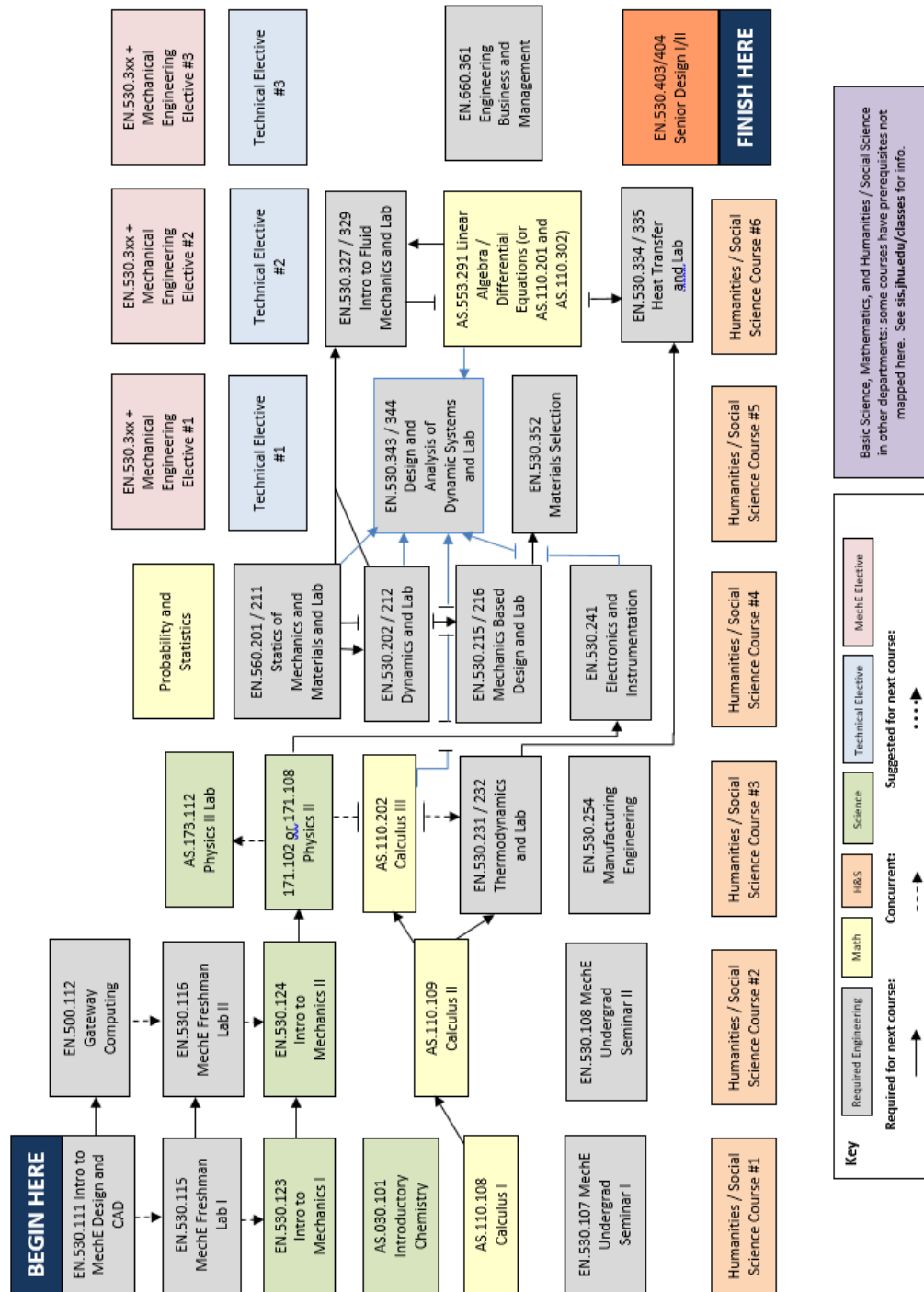
▲ - EN.530.343/344 Design and Analysis of Dynamic Systems and Lab (DADS) requires prior completion of EN.530.202/212 Dynamics with a minimum C- grade.

<b>FRESHMAN YEAR</b>			
AS.110.109 Calculus II	4	AS.110.202 Calculus III	4
EN.530.107 MechE Undergrad Seminar I	0.5	EN.530.108 MechE Undergrad Seminar II	0.5
EN.530.111 Intro to MechE Design & CAD	2	EN.500.114 Gateway Computing	3
EN.530.115 MechE Freshman Lab I	1	EN.530.116 MechE Freshman Lab II	1
EN.530.123 Intro to Mechanics I	3	EN.530.124 Intro to Mechanics II	2
AS.030.101 Intro to Chemistry I	3	H/S (2) Elective	3
H/S (1) Writing – 220.105, 060.100/113/114	3	H/S (3) Elective	3
<b>Total credits</b>	<b>16.5</b>	<b>Total credits</b>	<b>16.5</b>
<b>SOPHOMORE YEAR</b>			
EN.560.201/211 Statics / Lab	4	EN.553.291 L.A./D.E. *	4
EN.530.231/232 Thermodynamics / Lab	3+1	EN.530.202/212 Dynamics Lab	3+1
AS.171.102 or .108 General Physics II	4	EN.530.215/216 Mechanics Based Design	3+1
AS.173.112 General Physics II Lab	1	EN.530.241 Electronics & Instrumentation	3+1
Mathematics elective or eligible AP credit	4		
<b>Total credits</b>	<b>16</b>	<b>Total credits</b>	<b>16</b>
<b>JUNIOR YEAR</b>			
EN.530.327/329 Intro. Fluid Mech / Lab	3+1	EN.530.334/335 Heat Transfer / Lab	3+1
EN.530.352 Materials Selection	3+1	EN.530.343/344 DADS / Lab ▲	3+1
EN.530.254 (or 530.204/205 Manufacturing Engineering Theory/Lab)	2+1	H/S (4) Elective	3
Statistics elective	3/4	Technical Elective (1)	3
		MechE Elective (1)	3
<b>Total credits</b>	<b>15/16</b>	<b>Total credits</b>	<b>17</b>
<b>SENIOR YEAR</b>			
EN.530.403 Eng. Design Project I	4	EN.530.404 Eng. Design Project II	4
MechE Elective (2)	3	MechE Elective (3)	3
Technical Elective (2)	3	Technical Elective (3)	3
Upper-level H/S (5) Elective	3	Upper-level H/S (6) Elective	3
Eng. Business and Mgmt. options**	3		
<b>Total credits</b>	<b>16</b>	<b>Total credits</b>	<b>13</b>



## 6.9 Mechanical Engineering Course Dependency Map

Mechanical Engineering major – Course Dependency Map – Class of 2022 and later



# Bachelor of Science Degree in the Engineering Mechanics major

## 7 ENGINEERING MECHANICS CURRICULUM

### 7.1 *Our Mission*

The mission of the B.S. in Engineering Mechanics degree program is to provide a rigorous educational experience that prepares a select group of students for leadership positions in the profession and a lifetime of learning. The faculty is committed to maintaining a modern and flexible curriculum which, building on a foundation of basic sciences and mathematics, develops a solid education in the mechanical engineering sciences. The aim of the Engineering Mechanics program is to build competence in the analysis, design and modeling of fluid and mechanical systems, to promote a broad knowledge of the contemporary social and economic context, and to develop the communication skills necessary to excel.

### 7.2 *Introduction*

The Engineering Mechanics program concentrates on the scientific fundamentals of the behavior of solids and fluids. The program is designed to be highly flexible while providing the student with a broad scientific and technical background in the mechanical sciences.

The curriculum is intended to enable graduates to explore fundamental questions in many fields of engineering. Emphasis is placed on the basic sciences (mathematics, physics, and chemistry) and on the analysis, modeling, and design aspects of solid and fluid engineering systems. Although specific core courses are required, the student is encouraged and guided by his or her advisor to select an individual program of study, within ABET guidelines, according to the student's particular goals. This program of study may range from a general study of mechanics or engineering science to specialized programs such as robotics, fluid dynamics, environmental engineering, mechanics of solids, experimental mechanics, dynamical systems, mechanics of materials, or biomechanics.

This flexibility makes the program ideal for double-majors and for those wishing to tailor a strong foundation for graduate work in a wide range of disciplines. All mathematics elective and technical elective courses must be at the .300-level or higher, unless approved by your faculty advisor.

### 7.3 *Engineering Mechanics Educational Objectives*

#### **B.S. Engineering Mechanics Program Educational Objectives**

Our primary objective is to educate an exceptional group of engineers who, after graduation, will be successful and on track to become leaders among their peers in the best graduate programs and/or in industry, government laboratories, academia, and other organizations.

#### **B.S. Engineering Mechanics Student Outcomes**

Students graduating from the B.S. in Engineering Mechanics will have demonstrated...

- 1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- 2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- 3) an ability to communicate effectively with a range of audiences
- 4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- 5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- 6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- 7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

*Please see the next page...*

## 7.4 Engineering Mechanics Biomechanics Track

Engineering Mechanics (EM) is a highly flexible program, which is ideal for students who want to specialize in any area of mechanics, including biomechanics.



The essence of mechanics is the interplay between forces and motion. In biology, mechanics is important at the macroscopic, cellular, and subcellular levels. At the macroscopic length scale biomechanics of both soft and hard tissues plays an important role in computer-integrated surgical systems and technologies (e.g., medical robotics). At the cellular level, issues

such as cell motility and chemotaxis can be modeled as mechanical phenomena. At the subcellular level, conformational transitions in biological macromolecules can be modeled using molecular dynamics simulation (which is nothing more than computational Newtonian mechanics), statistical mechanics, or using coarse-grained techniques that rely on principles from the mechanics of materials. In addition, much of structural biology can be viewed from the perspective of kinematics (e.g., finding spatial relationships in data from the Protein Data Bank).

Each student who pursues the Biomechanics track within the EM major, in consultation with his or her EM advisor, will choose a set of six elective bio-oriented courses that best matches the student's interests. Many electives from other departments are acceptable.

## 7.5 Engineering Mechanics Electives

The electives for the EM major are structured as follows:

**Engineering Science Electives (12 credits, all upper-level undergraduate - .300-level or higher)**

- One course in solid mechanics
- One course in fluid mechanics
- One course in dynamics
- One course in materials

**Engineering Mechanics Electives (3 credits, all upper-level undergraduate - .300-level or higher)**

- One additional course in the area of mechanics (i.e., fluids, solids, or dynamics)

**Technical Electives (18 credits, all upper-level undergraduate - .300-level or higher)**

- Chosen from .300-level courses in engineering and the sciences in consultation with the student's faculty advisor.

**Example bio-oriented courses, which can be applied to the electives include (but are not limited to):**

- AS.020.305 Biochemistry
- AS.020.346 Immunobiology
- AS.020.363 Developmental Biology
- AS.020.380 Chromatin, Chromosomes, and The Cell Nucleus
- AS.250.353 Computational Biology
- EN.530.410 Biomechanics of the Cell
- EN.530.426 Biofluid Mechanics
- EN.530.436 Bioinspired Science and Technology
- EN.530.441 Introduction to Biophotonics
- EN.530.443 Fundamentals, Design Principles and Applications of Microfluidic Systems
- EN.530.445 Introductory Biomechanics
- EN.530.446 Experimental Biomechanics
- EN.530.448 Biosolid Mechanics
- EN.580.456 Introduction to Rehabilitation Engineering
- EN.530.468 Locomotion Mechanics: Fundamentals
- EN.530.469 Locomotion Mechanics: Special Topics
- EN.530.473 Molecular Spectroscopy and Imaging
- EN.530.474 Effective and Economic Design for Biomedical Instrumentation
- EN.530.485 Physics and Feedback in Living Systems
- EN.530.495 Microfabrication Laboratory
- EN.540.409 Dynamic Modeling and Control
- EN.530.671 Statistical Mechanics in Biological Systems
- EN.530.672 Biosensing and BioMEMS

This is not an exhaustive list and not all of these courses must be taken. Rather, students who pursue the Biomechanics track will take at least six courses such as those listed above. These six should be concentrated either at the cellular/subcellular length scale or in macroscopic biomechanics. Note that given the flexibility of the Engineering Mechanics program, it would be possible for students to satisfy both of these kinds of tracks simultaneously if they apply all of their elective courses towards this end.

## 7.6 Engineering Mechanics Course Requirements

*Basic Science (16 credits; grades of below C- not accepted)*

- A Physics course suite that covers mechanics:  
*Recommended option:* EN.530.123/124 Introduction to Mechanics I/II  
*Another option:* AS.171.101 or AS.171.107 Physics I, and AS.173.111 Physics Lab I
- AS.171.102 or AS.171.108 Physics II, and AS.173.112 Physics Lab II
- AS.030.101 Introduction to Chemistry I
- Another basic science elective

The mathematics requirements for the engineering mechanics program are either “Mathematics with a focus on applications” or “Mathematics with a focus on fundamentals.”

*(Either...) Mathematics with a focus on applications:*

*(23 credits; grades below C- not accepted)*

- AS.110.108 Calculus I
- AS.110.109 Calculus II
- AS.110.202 Calculus III (or AS.110.211 Honors Multivariable Calculus)
- EN.553.291 Linear Algebra/Differential Equations or [AS.110.212 Honors Linear Algebra or AS.110.201 Linear Algebra, plus AS.110.302 Differential Equations, the latter which can count as the “Another Mathematics Elective” below]
- Another Mathematics Elective
- Statistics Elective at the .300-level or above (e.g. EN.560.348 Probability and Statistics in Civil Engineering [no seniors] or EN.553.310 Probability and Statistics. AP Statistics is not accepted)

*(or...) Mathematics with a focus on fundamentals:*

*(23 credits; grades below C- not accepted)*

- AS.110.108 Calculus I
- AS.110.109 Calculus II
- AS.110.211-AS.110.212 Honors Multivariable Calculus and Linear Algebra
- AS.110.302 Differential Equations with Applications
- Statistics Elective at the 300 level or above (e.g. EN.560.348 Probability and Statistics in Civil Engineering [no seniors] or EN.553.310 Probability and Statistics. AP Statistics is not accepted)

*Humanities: (18 credits)*

- See Humanities, Section 5 – six courses at least three credits each.

*Required Engineering Courses (minimum of 27 credits; grades of D+, D, or D- not accepted)*

I) **INTRODUCTORY COURSES:** The Mechanical Engineering introductory courses are the strongly recommended choice for introductory engineering but other options are accepted.

- EN.530.111 Introduction to MechE Design and CAD
- EN.500.114 Gateway Computing - MATLAB
  - EN.500.114 Gateway Computing - MATLAB is the strongly preferred computing option. Some students might take EN.500.112 Gateway Computing - Java to work toward a Computer Science or Robotics minor. Those students will then also have to take the one-credit online course EN.500.134 MATLAB Bootcamp to learn MATLAB.
- EN.530.115/EN.530.116 MechE Freshman Laboratory I/II,

If choosing alternate **introductory freshman engineering** options, students must take one of these courses:

- EN.500.101 What is Engineering (recommended)
- EN.520.137 Introduction to Electrical and Computer Engineering
- EN.570.108 Introduction to Environmental Engineering
- EN.580.202 Biomedical Engineering in the Real World (Biomedical Engineering double majors only)

II) **OTHER REQUIRED ENGINEERING COURSES:**

- EN.560.201 / .211 Statics and Mechanics of Materials and Lab
- EN.530.202/ .212 Dynamics and Lab
- EN.530.215 Mechanics Based Design or EN.530.405 Mechanics of Solids and Structures
- EN.530.216 Mechanics Based Design Lab
- EN.530.231/ .232 Thermodynamics Lecture and Lab
- EN.530.327/ .329 Introduction to Fluid Mechanics Lecture and Lab

*Engineering Science Electives (12 credits; grades below C- not accepted)*

- One course at or above the 300-level in each of these disciplines:
  - mechanics of solids
  - mechanics of fluids
  - materials
  - dynamics

*Engineering Mechanics Elective (3 credits; grades below C- not accepted)*

- One course at or above the 300-level in the area of engineering mechanics

*Technical Electives (minimum of 18 credits; grades below C- not accepted)*

- Four (E), (Q), or (N) courses at or above the 300-level, chosen from any combination of courses in engineering, basic sciences, or mathematics chosen in consultation with the student's advisor are required, *plus...*
- *Either* one more (E), (Q), or (N) course at or above the 300-level, *or* one of these computing options:
  - EN.601.220 Intermediate Programming
  - EN.601.226 Data Structures

**NOTE:** The EN.500.11x Gateway Computing and EN.500.13x Bootcamp computing courses **do not count** as a technical elective.

*Capstone Design (8 credits)*

- EN.530.403 and EN.530.404 Mechanical Engineering Senior Design I and II

## **7.7 Engineering Mechanics Elective Courses**

*Solid mechanics courses may be chosen from courses such as:*

- EN.530.405 Mechanics of Solids and Structures\*
- EN.530.414 Computer-Aided Design
- EN.530.448 Biosolid Mechanics
- EN.530.730 Finite Element Methods
- EN.560.320 Structural Design
- EN.560.330 Foundation Design

*Fluid mechanics courses may be chosen from courses such as:*

- EN.530.425 Mechanics of Flight
- EN.530.426 Biofluid Mechanics
- EN.530.427 Intermediate Fluid Mechanics
- EN.570.301 Environmental Engineering I: Fundamentals

*Dynamics courses may be chosen from courses such as:*

- EN.530.343/EN.530.344 Design and Analysis of Dynamic Systems and Lab
- EN.530.424 Dynamics of Robots and Spacecraft
- EN.530.420 Robot Sensors and Actuators
- EN.553.391 Dynamical Systems

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\* If not used to satisfy the Required Engineering Courses.



*Materials courses may be chosen from courses such as:*

- EN.530.352 Materials Selection
- EN.510.311 Structure of Materials
- EN.510.312 Thermodynamics of Materials
- EN.510.313 Mechanical Properties of Materials
- EN.510.314 Electronic Properties of Materials
- EN.510.315 Physical Chemistry of Materials

A program of no fewer than 126 credits must be completed to be eligible for the bachelor's degree. All undergraduate students must follow a program approved by a faculty member in the department who is selected as the student's advisor.

## 7.8 Sample Engineering Mechanics Programs

### Sample Engineering Mechanics Program for students beginning with Calculus I taking the recommended mechanical engineering freshman course suite.

**This is but one version of ways to complete the program. Total Credits - B.S. Degree in Engineering Mechanics – 126**

\* - Students are encouraged to take AS.110.302 Differential Equations (4) and AS.110.201 Linear Algebra (4) instead of the combined EN.553.291 L.A./D.E. course (4) if the additional four credits can fit into the schedule. An advantage of taking the courses separately is that AS.110.302 Differential Equations can count as a Technical Elective.

★ - Alternate introductory course sequence: 500.101 What is Engineering (3) or other acceptable introduction to engineering course, one of the introduction to computing course options, plus AS.171.101 or AS.171.107 Physics I (4), and AS.173.111 Physics I Lab (1)

The Engineering Mechanics program requires six full courses (18 credits) in Humanities and Social Sciences, and requires one writing course, and two courses at the 300 level or above.

<b>FRESHMAN YEAR</b>			
AS.110.108 Calculus I	4	AS.110.109 Calculus II	4
EN.530.107 MechE Undergrad Seminar I	0.5	EN.530.108 MechE Undergrad Seminar II	0.5
EN.530.111 Intro to MechE Design & CAD★	2	EN.500.114 Gateway Computing★	3
EN.530.115 MechE Freshman Lab I★	1	EN.530.116 MechE Freshman Lab II ★	1
EN.530.123 Intro to Mechanics I★	3	EN.530.124 Intro to Mechanics II ★	2
H/S Writing Elective (1) 220.105, 060.100/113/114	3	H/S Elective (2)	3
AS.030.101 Intro to Chemistry I	3	Basic Science Elective	3
<b>Total credits</b>	<b>16.5</b>	<b>Total credits</b>	<b>16.5</b>
<b>SOPHOMORE YEAR</b>			
AS.110.202 or .211 Calculus options	4	EN.553.291 LA/DE *	4
EN.560.201/211 Statics / Lab	3+1	EN.530.202/212 Dynamics / Lab	3+1
EN.530.231/232 Thermodynamics / Lab	3+1	EN.530.215/216 Mech Based Design / Lab	3+1
AS.171.102 or AS.171.108 General Physics II	4	H/S Elective (3)	3
AS.173.112 General Physics II Lab	1		
<b>Total credits</b>	<b>17</b>	<b>Total credits</b>	<b>15</b>
<b>JUNIOR YEAR</b>			
EN.530.327/329 Fluid Mechanics / Lab	3+1	ES Elective (solids)	3
Technical Elective (1)	3	ES Elective (dynamics)	3
Technical Elective (2)	3	Technical Elective (3)	3
Statistics Elective	3/4	Technical Elective (4)	3
H/S Elective (4)	3	Mathematics Elective	4
<b>Total credits</b>	<b>16/17</b>	<b>Total credits</b>	<b>16</b>
<b>SENIOR YEAR</b>			
EN.530.403 Senior Design Project I	4	EN.530.404 Senior Design Project II	4
EM Elective	3	Technical Elective (5)	3
ES Elective (materials)	3	Technical Elective (6)	3
EM Elective (fluids)	3	Upper-level H/S Elective (6)	3
Upper-level H/S Elective (5)	3		
<b>Total credits</b>	<b>16</b>	<b>Total credits</b>	<b>13</b>

**Sample *Engineering Mechanics* Program for students beginning with Calculus II taking the recommended mechanical engineering freshman course suite.**

**This is but one version of ways to complete the program. Total Credits - B.S. Degree in Engineering Mechanics – 126**

\* - Students are encouraged to take AS.110.302 Differential Equations (4) and AS.110.201 Linear Algebra (4) instead of the combined EN.553.291 L.A./D.E. course (4) if the additional four credits can fit into the schedule. An advantage of taking the courses separately is that AS.110.302 Differential Equations can count as a Technical Elective, as long as it is not being counted as one of the courses helping to meet the required 23 math credits.

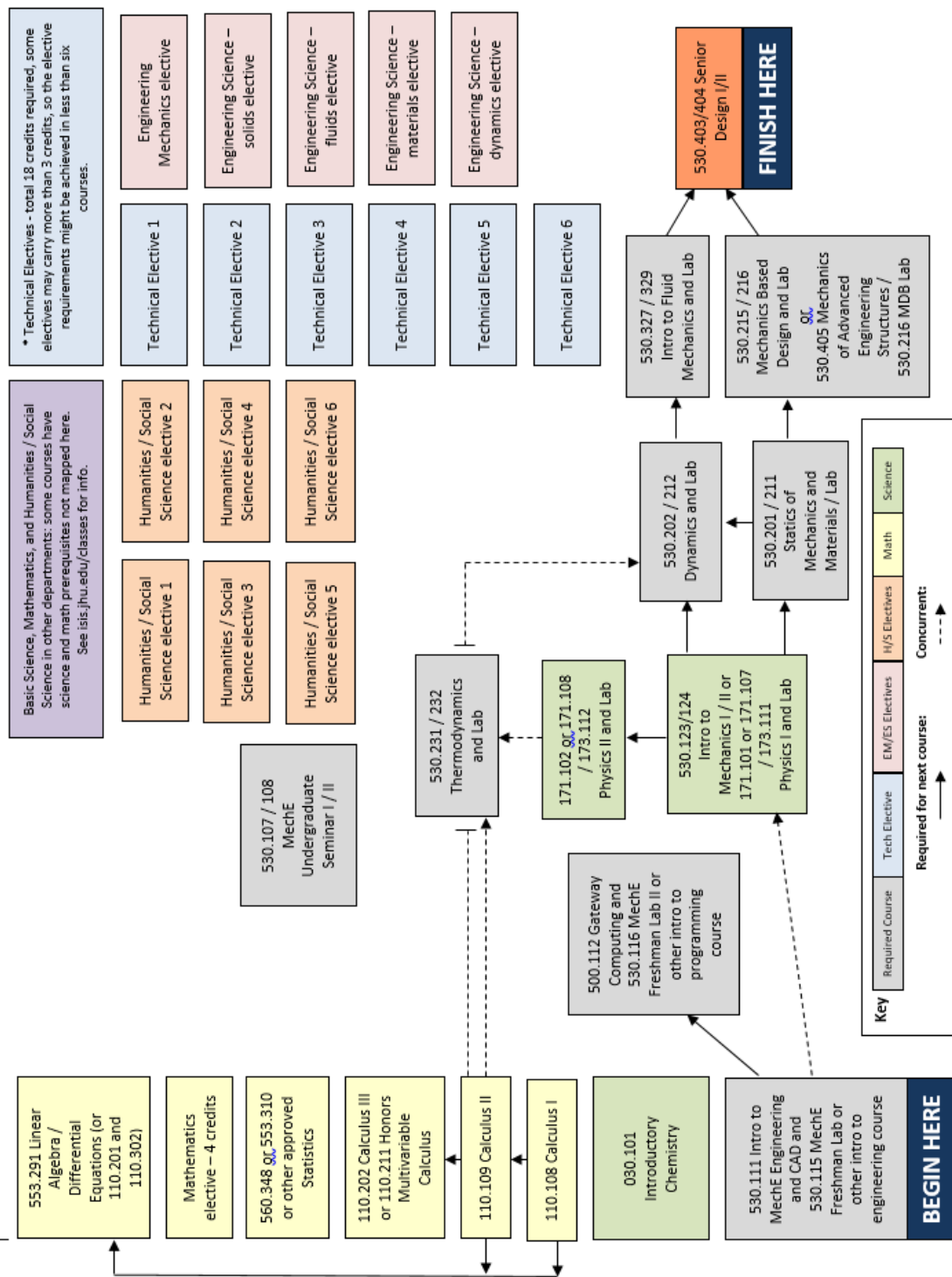
★ - Alternate introductory course sequence: 500.101 What is Engineering (3) or other acceptable introduction to engineering course, one of the introduction to computing course options, plus AS.171.101 or AS.171.107 Physics I (4), and AS.173.111 Physics I Lab (1)

The Engineering Mechanics program requires six full courses (18 credits) in Humanities and Social Sciences, and requires one writing course, and two courses at the 300 level or above.

<b>FRESHMAN YEAR</b>			
AS.110.109 Calculus II	4	AS.110.202 or .211 Calculus options	4
EN.530.107 MechE Undergrad Seminar I	0.5	EN.530.108 MechE Undergrad Seminar II	0.5
EN.530.111 Intro to MechE Design and CAD★	2	EN.500.114 Gateway Computing★	3
EN.530.115 MechE Freshman Lab I ★	1	EN.530.116 MechE Freshman Lab II ★	1
EN.530.123 Intro to Mechanics I★	3	EN.530.124 Intro to Mechanics II ★	2
H/S Writing Elective (1) 220.105, 060.100/113/114	3	H/S Elective (2)	3
AS.030.101 Intro to Chemistry I	3	Basic Science Elective	3
<b>Total credits</b>	<b>16.5</b>	<b>Total credits</b>	<b>16.5</b>
<b>SOPHOMORE YEAR</b>			
Math elective or Calculus I credit	4	EN.553.291 LA/DE *	4
EN.560.201 Statics / Lab	3+1	EN.530.202/212 Dynamics / Lab	3+1
EN.530.231/232 MechE Thermodynamics / Lab	3+1	EN.530.215/216 Mech Based Design / Lab	3+1
AS.171.102 or AS.171.108 General Physics II	4	H/S Elective (3)	3
AS.173.112 General Physics II Lab.	1		
<b>Total credits</b>	<b>17</b>	<b>Total credits</b>	<b>15</b>
<b>JUNIOR YEAR</b>			
EN.530.327/329 Intro. Fluid Mechanics / Lab	3+1	ES Elective (dynamics)	3
Statistics elective	4	ES Elective (solids)	3
Technical Elective (1)	3	Technical Elective (3)	3
Technical Elective (2)	3	Technical Elective (4)	3
H/S Elective (4)	3	Math Elective (2)	4
<b>Total credits</b>	<b>17</b>	<b>Total credits</b>	<b>16</b>
<b>SENIOR YEAR</b>			
EN.530.403 Eng. Design Project I	4	EN.530.404 Eng. Design Project II	4
Technical Elective (5)	3	EM Elective	3
ES Elective (materials)	3	H/S Elective (6)	3
ES Elective (fluids)	3	Technical Elective (6)	3
H/S Elective (5)	3		
<b>Total credits</b>	<b>16</b>	<b>Total credits</b>	<b>13</b>

## 7.9 Engineering Mechanics Course Dependency Map

### Engineering Mechanics major – Course Dependency Map – Class of 2022 and later



## 8 Senior Design

The Senior Design Project, a unique two-semester course, is the capstone of Johns Hopkins' Mechanical Engineering program. In the class, students, working in small teams, tackle specific design challenges presented by industry, government, and non-profit organizations. The sponsors provide each team with the funds for materials, access to world-class resources, and the technical contacts. Ultimately, each team conceptualizes a novel solution to the sponsor's problem and then designs, constructs, and tests a real-world prototype.

The course requires students to draw upon the four years of knowledge and experience they have gained in their engineering studies and put it to practical use. Throughout the year, they produce progress reports as they design, build, and test the devices they are developing. Combining engineering theory, budgeting, and time management with interactions with real clients, the senior design project is critical to students' preparation for the transition from school to the workplace.

Visit these pages for more information:

- Main page - <https://me.jhu.edu/undergraduate-studies/senior-design/>
- Information for Juniors to prepare for Senior Design - <https://me.jhu.edu/undergraduate-studies/senior-design/senior-design-info-juniors/>

Initial communication to Juniors about Senior Design preparations may occur as early as the early-Fall semester of the Junior year, but no later than early-Spring of that year.

## 9 Engineering for Professionals – Good Courses for Electives

Many interesting and relevant online Mechanical Engineering and other engineering courses are available via our [Engineering for Professionals program](#).

- Some Engineering for Professionals courses can be counted toward the elective sections of our bachelor's degrees. Up to two can count toward the master's degree.
- Visit the [EP Courses page](#) to find available courses. The page can be filtered to select [Mechanical Engineering courses](#).
- Please discuss proposed Engineering for Professionals courses with our faculty advisor to confirm that they would qualify for your degree.
- The course registration process is different from the standard registration in the Student Information System (SIS). For instructions to register, visit the

## 10 Study Abroad

The University offers opportunities to study abroad through the Office of Study Abroad in Levering Hall through one-semester exchange and other study programs. Pre-approved programs are available for Mechanical Engineering students at various universities that fit our curriculum, typically in the first semester of the junior year. Other programs can be crafted for other universities and semesters, as long as students begin planning early.

When considering a study abroad program, requirements like knowledge of the local language must be taken into account. Further information is available from the Study Abroad website at [http://web.jhu.edu/study\\_abroad/index.html](http://web.jhu.edu/study_abroad/index.html).

### 10.1 *Comillas Pontifical University - Madrid*

The Comillas Pontifical University in Madrid, Spain offers an international engineering program in their ICAI School of Engineering. The program offers two full-load semesters of engineering courses, along with additional courses in Spanish language, and European and Spanish culture. Courses may be taken in English and Spanish.

Johns Hopkins University has an academic collaboration agreement with Comillas and strongly encourages students to consider participation in this program. View their site at <http://www.upcomillas.es> for additional information.

## 11 Graduation and Commencement

We celebrate the accomplishment of your graduation in a number of ways.

### 11.1 *Honors*

There are three methods to recognize our department's outstanding students:

- Membership in Pi Tau Sigma
- Honors upon graduation
- Convocation awards

### 11.2 Pi Tau Sigma

Juniors and seniors who demonstrate high academic and service achievement can be inducted into the Tau Alpha Chapter of Pi Tau Sigma, the national honorary mechanical engineering fraternity. Members, who are inducted twice yearly, are invited to participate in service-oriented events that benefit the entire Mechanical Engineering community.

### 11.3 Departmental Honors and University Honors

Upon graduation, all students earning a cumulative grade point average of 3.50 or higher are granted Departmental Honors and University Honors. Honorees are recognized at Commencement as well as on their transcripts and permanent University records.



### 11.4 Convocation

The department recognizes outstanding students at the Whiting School's annual Convocation awards ceremony in early May.

- The **James F. Bell Award** recognizes outstanding research and scholarly achievement in mechanical engineering.
- The **Creel Family Teaching Assistant Award** recognizes the best teaching assistants in Mechanical Engineering.
- The **Charles A. Miller Award** recognizes outstanding academic achievement by an undergraduate in mechanical engineering.
- The **Robert George Gerstmyer Award** recognizes outstanding undergraduate achievement in mechanical engineering.
- The **American Society of Mechanical Engineering award** is given in recognition of outstanding effort and accomplishment on behalf of the JHU ASME student chapter.
- The **William N. Sharpe, Jr. Award for Student Involvement**, named after Professor Emeritus William N. Sharpe, recognizes significant leadership or achievement in extracurricular activities.

These awards are usually awarded every year, but occasionally an award may not be offered. Other awards not listed here may occasionally be awarded.



## 12 Senior Exit Interviews

A requirement for graduation is the Senior Exit Interview. Several weeks before commencement, seniors are required to complete an online Senior Exit Interview survey and arrange an exit interview with the Department Head or designated faculty or staff.

## 13 The Fundamentals of Engineering Professional Exam

Consider taking the "Fundamentals of Engineering" (FE) Exam, which is available through the National Council of Examiners for Engineering and Surveying (NCEES) for all U.S. states! The computer-based exam is available year-round.

The benefits of professional licensure:

- Demonstrates that you've accomplished a recognized standard of professional excellence,
- Distinguishes you from others in your profession,
- Provides career options and opportunities that you might not otherwise have,
- Serves as a protection of public health, safety, and welfare by ensuring a specific level of expertise.

A student can take the exam beginning during the final semester of one's BS degree or any time after the degree completion.

The Department of Mechanical Engineering will cover the examination fees for five students who will take the exam! Please contact Academic Program Manager Mike Bernard at [me-academic@jhu.edu](mailto:me-academic@jhu.edu) for details.

## 14 The Combined Five-Year Bachelor's / Master's Program

The Mechanical Engineering department offers a combined five-year Bachelor's / Master's (BS/MSE) program for Mechanical Engineering and Engineering Mechanics majors.

This is an excellent program for individuals who would like to earn Master's Degrees quickly. The degree will generally increase a student's chances for higher quality employment than would a Bachelor's Degree.

### 14.1 Eligibility and Application Process

This program is available *only* to Mechanical Engineering or Engineering Mechanics majors at the Johns Hopkins University.



There are two application deadlines during the course of the year. Juniors can apply for the winter review period in January, and rising seniors can apply for the summer review period in June.

The application process is explained at <http://me.jhu.edu/undergraduate-studies/combined-bachelorsmasters-degree/>.

#### 14.2 *Whiting School 50% Tuition Fellowship*

The Whiting School of Engineering will provide a 50% tuition fellowship to all Johns Hopkins alumni who have completed eight semesters. Mechanical Engineering BS/MSE students will be eligible for this fellowship beginning their ninth semester.

#### 14.3 *Requirements*

The requirements for an M.S.E. in Mechanical Engineering are described in Sections “A” and “B,” where both sections must be met:

**SECTION A:** Satisfactory completion of eight one-semester advanced courses approved by your advisor, as follows:

- a) **At least four courses must be at the graduate level** (xxx.600 or higher, up to two Engineering for Professionals xx5.4xx or higher).
- b) **No more than four courses may be at the advanced undergraduate level** (full-time programs xxx.400 – xxx.499, Engineering for Professionals xx5.3xx).
- c) **At least two courses should be in applied mathematics, numerical analysis, or computational methods.** This requirement can be waived in writing by your advisor, if sufficient prior preparation in these areas can be demonstrated.
- d) **Ineligible Courses:** EN.530.800 Independent Study, EN.530.600/EN.530.820 MSE Graduate Research, and other departments’ Graduate Research, Independent Study, and Special Studies are not eligible courses to complete Section A’s requirement.
- e) At least 4 of 10 courses, or at least 3 of 8 courses if writing an essay – must be **Mechanical Engineering or related courses:**
  - o EN.530.xxx Mechanical Engineering
  - o Any of these courses:
    - EN.580.451/452 (Fall/Spring) – Cell and Tissue Engineering
    - Intro to Linear Systems – any one of EN.530.616, EN.520.601, or EN.580.616.

- EN.560.772 Nonlinear Finite Element Methods
- EN.560.773 Finite Element Methods
- EN.520.773 Advanced Topics in Fabrication and Microengineering
- EN.535.xxx – courses from the [Engineering for Professionals \(EP\) program](#). **New in Fall 2020:**
  - For all current and incoming students enrolled in the Fall 2020 semester – no more than three “EP” courses can count. This is to accommodate those impacted by the COVID-19 pandemic.
  - For students matriculating in Spring 2021 and later – no more than two “EP” courses can count.

**SECTION B:** In addition to the eight courses above, students must also complete either two more courses or an essay:

#### COURSE OPTION

- a) **Two additional one-semester graduate-level courses** (xx.xxx.6xx or higher, Engineering for Professionals EN.xx5.4xx or higher).
- b) **EN.530.600 / EN.530.820 (for those matriculating Fall 2020 and later) MSE Graduate Research** - one of these two courses can be EN.530.600/EN.530.820 MSE Graduate Research. Students must also have completed the appropriate Responsible Conduct of Research and Research Laboratory Safety courses.
- c) **Ineligible Courses:** EN.530.800 Independent Study, EN.530.602/EN.530.821 for those matriculating Fall 2020 and later) MSE Essay - Research and Writing, EN.530.609/EN.530.822 for those matriculating Fall 2020 and later) MSE Essay – Co-Op, and other departments’ Graduate Research, Independent Study, and Special Studies are not eligible courses to complete Section B’s requirement.

#### ESSAY OPTION

- An M.S.E. essay (the official title of master’s theses at Johns Hopkins) acceptable to your advisor and one other eligible reader.

If an essay is going to be written, students must register for EN.530.602/EN.530.821 for those matriculating Fall 2020 and later) MSE Essay - Research and Writing, EN.530.609/EN.530.822 for those matriculating Fall 2020 and later) MSE Essay – Co-Op every semester that he or she works on a master’s essay. This is separate from the Ph.D. dissertation.

This “Pass/Fail” course **does not** count as one of the eight courses required in addition to the thesis. The course is generally the equivalent of six credits and can be taken in one semester or split into three-credit courses taken over two semesters.

If a student needs subsequent semesters to continue thesis work, he or she can simply register for the same course each semester.

For the essay, the Responsible Conduct of Research and Research Laboratory Safety courses described elsewhere in this manual must be completed.

#### **14.4 Master's Degree Timeline**

Combined 5th Year Master's students can generally expect to complete degrees in this timeframe:

##### **Junior/Senior Undergraduate Years**

- Double-count two .400-level academic courses from the Bachelor's Degree.
- Take two courses that count for the master's degree but do not count for the Bachelor's Degree.

##### **Fifth Year, Semester 1**

- Complete required introductory courses: Academic Ethics, Title IX, and Opioid Awareness
- Take 3 academic courses
- If taking or planning to take a research course, complete required Lab Safety and Responsible Conduct of Research courses

##### **Fifth Year, Semester 2**

- All-Course: Take 3 academic courses and graduate.
- Essay / Thesis:
  - Complete required Lab Safety and Responsible Conduct of Research courses
  - Take 2 academic courses, begin research, begin writing the essay
  - Semester 3 – complete the essay, have readers approve, submit essay to the library, and then graduate.

If students do not take two courses outside the bachelor's degree in their Undergraduate Years, they may have to return for a third semester. It is not recommended to take more than three courses in a semester. Please talk to your advisor first if you want to take more than three courses in one semester.

#### **14.5 Bachelor's/Master's Course Double Counting**

Students either in a bachelor's/master's program or seeking a master's degree in the Whiting School, after having earned a Whiting School or Krieger School of Arts and Sciences bachelor's degree may double-count two courses (.400-level or higher) to both programs with the permission of the master's faculty advisor.

Information is available at <http://engineering.jhu.edu/graduate-studies/academic-policies-procedures-graduate/>, then select “Policy on Double-Counting Courses.”

## 15 Master of Science in Engineering Management

The Whiting School of Engineering offers a Master of Science degree in Engineering Management (MSEM). This program bridges the gap between technology and business by equipping students with the technical expertise and leadership skills they need to advance their career in the fast-paced world of technology.

Just ten courses are required to complete this advanced degree:

- Five advanced courses to fulfill the management concentration, including one capstone course that integrates and applies knowledge gained throughout the program.
- Five advanced courses in a declared technical area of engineering or applied science.

Visit <http://msem.engineering.jhu.edu/program-structure-require/> for additional course and application information.

## 16 Internships, Scholarships, Jobs, and Careers



The Johns Hopkins University and the Whiting School of Engineering offer resources to help you find internships during the summer months, assistance in the process of searching for jobs before and after graduation, and help in determining your career path and identifying opportunities. The department will forward opportunities it receives to students.

You are strongly encouraged to take advantage of these resources, as successful career and opportunity planning begins with you.

### 16.1 Internships, Research Positions, and Jobs

Information regarding research positions, internships, study abroad, career planning, scholarships, grants, and fellowships are linked to the “After You Graduate” site at <http://engineering.jhu.edu/undergraduate-studies/after-you-graduate/>.

## 16.2 Scholarships

Information on scholarships is available on the “Scholarships and Fellowships” bar of the Mechanical Engineering “Academic Advising – Undergraduate” page at <http://me.jhu.edu/undergraduate-studies/academic-advising-undergraduate/>.

## 16.3 Careers and Career Planning

The Life Design Lab at Homewood, located on the third floor of Garland Hall and at <http://studentaffairs.jhu.edu/careers/>, offers practical advice on determining a career path, resume preparation, interviewing, appropriate dress, and on-campus recruiting by companies.

You can set up a Handshake account to receive information on the latest career recruiting events and surf their site for the other services offered. The Life Design Lab at Homewood also welcomes you to visit at available drop-in hours to discuss your questions and get help with your career planning decisions.

## 17 Mechanical Engineering Undergraduate Student Council (MUSC)

MUSC is a student-run organization that focuses on improvements to the department as it applies to the undergraduate students. It is comprised of nine members: two students from each of the four class levels.

### **MUSC Services and Activities**

Projects include planning recreational activities for the department, suggesting improvements and additions to the curriculum, requesting updates in department resources, and so on. Every year, the student representatives generally choose one major issue that they believe requires immediate attention. For example, recent years’ issues led to the creation of a new intersession CAD course, requiring a CAD course for the degree, and annual updates to this manual.

Any student who has ideas for changes, updates, and improvements is strongly encouraged to speak to the class representatives. Freshman appointments for class representatives are made in the Fall.

## 18 Student Groups

There are many opportunities to participate in student professional engineering clubs, team projects, and competitions. Among these organizations are events, along with their websites are:

- ASME, the American Society of Mechanical Engineers: and <http://www.asme.org>
- AIAA, the American Institute of Aeronautics and Astronautics: <http://www.aiaa.org>
- Baja SAE: <http://pages.jh.edu/baja/>
- Design, Build, Fly: <https://designbuildfly.web.jhu.edu/>
- Hopkins Organization of Multicultural Engineers and Scientists: <https://www.facebook.com/groups/188206367913027/>
- SWE, the Society of Women Engineers: <http://pages.jh.edu/~swe/>



Campus-wide student groups, clubs, athletics, and activities are posted at <https://johnshopkins.campuslabs.com/engage/organizations>.

## 19 Office of Student Disability Services

The Office of Student Disability Services (SDS) assists full-time undergraduate and graduate students in the Krieger School of Arts and Sciences and the Whiting School of Engineering with disability concerns, in compliance with the provisions of the Americans with Disabilities Act of 1990 (ADA) and Section 504 of the Rehabilitation Act of 1973.

SDS assists the University community in understanding the effects of disabilities and in eliminating the physical, technical, attitudinal and programmatic barriers that limit the range of opportunities for students with disabilities, as well as provides individuals with reasonable accommodations. The SDS maintains and protects the confidentiality of individual records as required by law.

For additional information and to access the services of the SDS office, please see their website at <https://studentaffairs.jhu.edu/disabilities/>, or contact them at 410-516-4720 or [studentdisabilityservices@jh.edu](mailto:studentdisabilityservices@jh.edu). You may also visit their office in 385 Garland Hall.

## 20 Laboratory Safety

Lab Safety is the responsibility of all who use, maintain, or visit the labs within Mechanical Engineering. Laboratory researchers are responsible for working with the principal investigator to become familiar with the appropriate hazard information and safety policies before performing any work.

Visit the Homewood Campus Laboratory Safety page at <http://labsafety.jhu.edu/> for important information.

For each lab, a Principal Investigator (PI) is assigned. That person is responsible for the safe operation of the lab, training on all chemicals in the work area, the training of the persons on the equipment within the lab, and is a ready source to answer any questions on a specific lab about its operation and all safety aspects. The PI's for each lab are listed on the entrance door to each lab.

## 21 WSE Manufacturing

The WSE Manufacturing student machine shop is located in the basement of the Wyman Park Building, and is open to students, faculty, and staff across the Johns Hopkins University. To be allowed to work in the student machine shop, an orientation regarding shop safety, shop rules, and equipment operations is required.

To learn more about the WSE Manufacturing equipment and services available to students, visit <http://engineering.jhu.edu/wse-research/wse-manufacturing/>.

## 22 Computing

There are a cornucopia of computing facilities and services available to the Johns Hopkins community. The Information Technology website at <http://it.jhu.edu> offers an overview of the IT Organization, its projects and services, support for applications and general questions, and news about emerging technologies and strategic imperatives, as well as e-mail, web, and file sharing services.

### 22.1 JHU Information Technology

Information Technology at Johns Hopkins is the online resource for IT-related information. Their primary focus is to support the missions of the Johns Hopkins Institutions and provide technology solutions for faculty, staff, patients, and students in support of teaching, research, and patient care.

This Web site serves as a repository for all IT-related information at Johns Hopkins. You will find a lot of useful information within this site, including an overview of the IT Organization, its projects and services, support for applications and general questions, and news about emerging technologies and strategic imperatives.



### **22.2 WSE Information Technology**

WSE IT is tasked with supporting the IT needs of the Whiting community. They are a component of the WSE Dean's office, and not a branch of IT@JH. Please visit their website at <http://wseit.engineering.jhu.edu/> to learn how WSE IT can serve you.

### **22.3 Software Downloads**

The university owns licenses to many software packages, many of which may be downloaded from the WSE IT website. Please visit <http://wseit.engineering.jhu.edu/software-downloads/> to learn more.

### **22.4 Academic Computer Lab – Krieger Hall**

The Academic Computer lab, which offers a wide variety of Mac and Windows operating systems loaded with all kinds of software: Matlab, Mathematica, Microsoft Office, Adobe products and more are available in 160 Krieger Hall. Information is available at <https://studentaffairs.jhu.edu/computing/campus-resources/>.

## **23 Notice of Non-Discriminatory Policy**

The Johns Hopkins University admits students of any race, color, sex, religion, national or ethnic origin, handicap or veteran status to all of the rights, privileges, programs, benefits and activities generally accorded or made available to students at the University. It does not discriminate on the basis of race, color, sex, religion, sexual orientation, national or ethnic origin, handicap or veteran status in any program or activity, including the administration of its educational policies, admission policies, scholarship and loan programs, and athletic and other University-administered programs. Accordingly, the University does not take into consideration personal factors that are irrelevant to the program involved.

Questions regarding access to programs following Title VI, Title IX, and Section 504 should be referred to the Affirmative Action Officer, 205 Garland Hall, 410-516-8075.

## **24 For More Information...**

Visit the Mechanical Engineering webpage at <http://me.jhu.edu>, or any of these pages:

- Faculty, Staff, and Students - <http://me.jhu.edu/people/>
- Academic Advising - <http://me.jhu.edu/undergraduate-studies/academic-advising-undergraduate/>
- Top 12 – Undergraduate – for most information that undergrad students seek - <http://me.jhu.edu/t12/top-12-undergraduate-students/>