# 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 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 Accreditation Board for Engineering and Technology (ABET). For further details, see www.abet.org.

1.2.2 Mechanical Engineering Program Educational Objectives

Our primary objective is to educate an exceptional group of engineers who, after graduation, will be (1) successful and on track to become leaders among their peers in industry, government laboratories and other organizations, and (2) advanced students in the best graduate programs.

1.2.3 Mechanical Engineering Student Outcomes

Students graduating from the B.S. in Mechanical Engineering will have demonstrated...
(a) ...an ability to apply knowledge of mathematics, science and engineering
(b) ...an ability to design and conduct experiments, as well as to analyze and interpret data
(c) ...an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability
(d) ...an ability to function on multidisciplinary teams
(e) ...an ability to identify, formulate, and solve engineering problems
(f) ...an understanding of professional and ethical responsibility
(g) ...an ability to communicate effectively
(h) ...the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context
(i) ...a recognition of the need for and an ability to engage in life-long learning
(j) ...a knowledge of contemporary issues
(k) ...an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

1.2.4 Engineering Mechanics Program Educational Objectives

Our primary objective is to educate an exceptional group of science-oriented engineers who, after graduation, will be successful and on track to become leaders among their peers (1) in the best graduate programs in engineering, science, medical schools, or law schools, and (2) in industry, government laboratories and other organizations.
1.2.5 Engineering Mechanics Student Outcomes

Students graduating with a B.S. in Mechanical Engineering will have demonstrated:
(a) …an ability to apply knowledge of mathematics, science and engineering
(b) …an ability to design and conduct experiments, as well as to analyze and interpret data
(c) …an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability
(d) …an ability to function on multidisciplinary teams
(e) …an ability to identify, formulate, and solve engineering problems
(f) …an understanding of professional and ethical responsibility
(g) …an ability to communicate effectively
(h) …the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context
(i) …a recognition of the need for and an ability to engage in life-long learning
(j) …a knowledge of contemporary issues
(k) …an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

1.2.6 Research Programs

The research programs in the Department of Mechanical Engineering are broad and varied:
- Energy and the Environment
- Fluid Mechanics and Heat Transfer
- Mechanics and Materials
- Micro/Nanoscale Science and Engineering
- Mechanical Engineering in Biology and Medicine
- Robotics

A comprehensive list of research topics and the faculty participating in them appear on the Mechanical Engineering website’s Research page.
1.2.7 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.

1.2.8 “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.

Please complete the course online:

- Go to the “myJHU” Portal at [http://my.jh.edu](http://my.jh.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 or 410-516-5525.
1.2.9 “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 (360.624) before conducting research and receiving payment or credit.
- Students receiving payment from NIH Training Grants must take the in-person training course (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 Sean Sun, whose office is in 105 Latrobe, telephone 410-516-4003, e-mail ssun@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://web.jhu.edu/registrar/catalog.

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 http://web.jhu.edu/parentsadvisinghandbook/. 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 taken after the first semester of the freshman year and counted toward the 126 credits required for Mechanical Engineering, or the 127 credits required for Engineering Mechanics, be taken for a letter grade (that is, they may not be taken with the Satisfactory/Unsatisfactory option).

2.1.1 S/U and Pass/Fail Grades Don’t Count after the Freshman Fall Semester

Whereas the University allows one S/U course each semester outside the student’s major, with the exception of grades in the first semester of the freshman year, the Department does not allow any S/U courses after the Freshman Fall Semester, including Intersession courses, to count toward the requirements for graduation.

2.1.2 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.

2.1.3 Grades Below C- (Humanities and Social Sciences)

Though grades of C- or higher are preferred, the department will accept up to ten D+, D, or D- graded credits toward graduation requirements for Humanities and Social Sciences courses.
2.2 **100-credit minimum at Johns Hopkins**

All students matriculating as freshmen in Fall 2014 or later must earn a minimum of 100 credits at Johns Hopkins University, even if they are not all used for a student’s major or minor. 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.

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 E-Catalog’s External Credit Policies page at [http://e-catalog.jhu.edu/undergrad-students/academic-policies/external-credit/#examcredittext](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 Administrator 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 530.103/104 Intro to Mechanics**

If a student takes the course which the AP credits normally would replace, the AP credits will be lost.

This is important to consider with the physics courses where taking either 530.103 or 530.104 or both will eliminate the “AP Physics C” credits.

**LABS MUST BE TAKEN, EVEN WITH AP PHYSICS CREDIT!**

While the University does not require the labs, departments can, and Mechanical Engineering does. All Mechanical Engineering or Engineering Mechanics students must take either the 530.105/.106 Mechanical Engineering Freshman Lab I and II or 173.111 General Physics Laboratory I as appropriate to the freshman introductory course track one is taking. Also, the 173.112 General Physics Laboratory II course or approved equivalent is required for all Mechanical Engineering and Engineering Mechanics students.

2.8 **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.

Independent Study is the result of creating a course of study that is focused on topics beyond coursework or expands on a topic in which further study is desired.
• Up to three credits can be earned in any one semester, summer, or intersession, though only up to a total of three credits of independent work can be counted toward the B.S. degree as an elective. This includes both Mechanical Engineering and Engineering Mechanics majors.

• Each credit should reflect 40 hours of work, which is unpaid.

• No distribution credits are attached to independent work, though your advisor can designate a distribution through a Course Exception Waiver form in the “Checkout Sheet, Course Dependency Maps, Waiver Forms” section of the Academic Advising page at http://me.jhu.edu/undergraduate-studies/academic-advising-undergraduate/.

• **NEW:** Effective Fall 2016, students taking three or more credits of undergraduate research are required to present a research poster at the Johns Hopkins University’s Undergraduate Research Day, which is presented at the annual School Open House and Overnight Program (SOHOP) for admitted freshmen. 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 advisor by presenting a completed “Undergraduate Research, Independent Study, Internship, and Departmental Thesis” form available at the Registrar or from the Academic Program Administrator. Research performed without this pre-approval will not be recognized and accredited.

**2.9 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.

First-semester grades for all students entering JHU will be “covered.” Grades of “Satisfactory” or “Unsatisfactory” will be displayed on transcripts for all first semester classes, even though letter grades are assigned by instructors.

**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. The flexibility of the Engineering Mechanics curriculum makes it possible to double major in a variety of engineering, science, and other fields.

**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://www.advising.jhu.edu/majorsminors.php](http://www.advising.jhu.edu/majorsminors.php)
- Engineering: [http://engineering.jhu.edu/fields-of-study/](http://engineering.jhu.edu/fields-of-study/)

**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 many areas including 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/](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.

<table>
<thead>
<tr>
<th>This course...</th>
<th>...counts toward both this E&amp;M minor requirement...</th>
<th>...and this Mechanical Engineering or Engineering Mechanics requirement.</th>
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<tbody>
<tr>
<td>550.310 or 560.348 Probability and Statistics</td>
<td>Statistics Option #2</td>
<td>Statistics</td>
</tr>
<tr>
<td>660.105 Introduction to Business</td>
<td>E&amp;M Fundamentals #1</td>
<td>One allowed “S” course from a Whiting School department</td>
</tr>
<tr>
<td>660.203 Financial Accounting</td>
<td>E&amp;M Fundamentals #2</td>
<td>Extra Course #1</td>
</tr>
<tr>
<td>660.250 Principles of Marketing</td>
<td>E&amp;M Fundamentals #3</td>
<td>Extra Course #2</td>
</tr>
<tr>
<td>660.361 or 660.461 Engineering Business and Management</td>
<td>Upper Level Elective #1</td>
<td>Core Engineering Course</td>
</tr>
<tr>
<td>CLE upper-level elective</td>
<td>Upper Level Elective #2</td>
<td>Extra Course #3</td>
</tr>
<tr>
<td>CLE upper-level elective</td>
<td>Upper Level Elective #3</td>
<td>Extra Course #4</td>
</tr>
</tbody>
</table>

Table 1 – Entrepreneurship and Management minor course comparison

View the Center for Leadership Education website at http://eng.jhu.edu/wse/cle/page/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.
<table>
<thead>
<tr>
<th>Semester</th>
<th>General</th>
<th>Robotics</th>
<th>Fluid Mechanics</th>
<th>Mechanics and Materials</th>
<th>Biomechanics</th>
</tr>
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<tbody>
<tr>
<td><strong>Spring 2017</strong></td>
<td>- 530.381 Engineering Design Process &lt;br&gt;- 530.464 Energy Systems Analysis</td>
<td>- 530.421 Mechatronics &lt;br&gt;- 530.470 Space Vehicle Dynamics and Control</td>
<td>- 530.3xx Guided Flight Systems (new) &lt;br&gt;(530.425 Mechanics of Flight is delayed to Spring 2018 and will not be offered in Spring 2017 or Fall 2017)</td>
<td>- 530.405 Mechanics of Solids and Structures</td>
<td>- 530.410 Biomechanics of the Cell &lt;br&gt;- 530.441 Intro to Biophotonics &lt;br&gt;- 530.452 Cell and Tissue Engineering Laboratory &lt;br&gt;- 530.672 Biosensing and BioMEMS (graduate)</td>
</tr>
</tbody>
</table>

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/](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, 18 credits) in the Humanities or Social Sciences (catalog code H or S) areas. Some Mechanical Engineering majors and all Engineering Mechanics majors will follow these minimum requirements, 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/](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 or both an “H” or “S” area designation. Not all courses offered in the Krieger School of Arts and Sciences carry the designation. A few Peabody School of Music courses carry the designations, but most do not.

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

### 5.1  Foreign Language Credit

Students taking elements of a foreign language (xxx.101) are granted an H area designator for both semesters only if the second semester course (xxx.102) is successfully completed. The second semester course (xxx.102) is always granted an H area designator, even if the student tests directly into this course (i.e. skipping the first semester course).

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

Whiting School of Engineering students must take two courses (6 credits) that carry the “writing intensive” (W) designation. Mechanical Engineering and Engineering Mechanics majors must take two courses that develop writing skills essential for success as an engineer.

530.403/.404 Engineering Design Project I/II is counted as one of the two courses.

The second “writing intensive” course must be either 060.100 Introduction to Expository Writing, 060.113 or 060.114 Expository Writing – (either one; both cannot be counted for H/S credit) or 220.105 Introduction to Fiction and Poetry Writing.

Other courses with the “W” course designation are not accepted for the Mechanical Engineering and Engineering Mechanics writing requirement, because they do not have the necessary required level of intensity in writing instruction. If there is an unusual circumstance that prevents a student from taking one of the approved courses, the student must discuss this with his or her advisor to request an exception. Any approved exceptions must be noted on a Course Exception Wavier Form.

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 Intro to Fiction and Poetry Writing**

Note that the instructors of 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 session.

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 H/S Course may be taken from the Whiting School of Engineering

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

Mechanical Engineering majors may count no more than one course that is taught in the Whiting School with an “H” or “S” course area towards this requirement.

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

- 510 - Materials Science and Engineering
- 520 - Electrical and Computer Engineering
- 530 - Mechanical Engineering
- 540 - Chemical and Biomolecular Engineering
• 550 - Applied Math and Statistics
• 560 - Civil Engineering
• 570 - Geography and Environmental Engineering
• 580 - Biomedical Engineering
• 600 - Computer Science
• 650 - Information Security Institute
• 660 - Entrepreneurship and Management / Center for Leadership Education
• 661 - Professional Communication
• 662 - Engineering Management
• 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

Our primary objective is to educate an exceptional group of engineers who, after graduation, will be (1) successful and on track to become leaders among their peers in industry, government laboratories and other organizations, and (2) advanced students in the best graduate programs.
6.4 Mechanical Engineering Curriculum

The Mechanical Engineering curriculum is structured as follows:

Mathematics (19 credits; grades of D+, D, or D- not accepted)

- 110.108 Calculus I
- 110.109 Calculus II
- 110.202 Calculus III (or 110.211 Honors Multivariable Calculus)
- 550.291 Linear Algebra/Differential Equations (or 110.201 Linear Algebra and 110.302 Differential Equations)
- Statistics Elective at the 300 level or above (e.g. 560.348 Probability and Statistics in Civil Engineering or 550.310 Probability and Statistics. AP Statistics will not be accepted as a substitute.)

Science (12 credits; grades of D+, D, or D- not accepted)

- 530.103/104 Introduction to Mechanics I/II
- 171.102 (or 171.108) Physics II
- 173.112 Physics Lab II (required for all students, even with AP credit)
- 510.101 Introduction to Materials Chemistry or 030.101 Chemistry I

Humanities and Social Sciences (18 or 21 credits)

- See Humanities and Social Sciences, Section 5

Required Engineering Courses (48 or 51 credits; grades of D+, D, or D- not accepted)

- 530.101/102 Freshman Experiences in Mechanical Engineering I/II
- 530.105/106 Mechanical Engineering Freshman Laboratory I/II
- 530.201 Statics and Mechanics of Materials
- 530.202 Dynamics (or either 530.202 or 560.202 before Spring 2015)
- 530.215 Mechanics Based Design
- 530.231 and 530.232 Mechanical Engineering Thermodynamics and Lab
- 530.241 Electronics and Instrumentation, or…
  - Before Fall 2017: 520.213 Circuits followed by 520.345 Electrical and Computer Engineering Laboratory
  - Fall 2017 and later: 520.230 Mastering Electronics
- 530.327 and 530.329 Introduction to Fluid Mechanics and Lab
- 530.334 and 530.335 Heat Transfer and Lab
- 530.343 Design and Analysis of Dynamic Systems [plus 530.344 Dynamic Systems Laboratory only for students taking a course substituting 530.343]
- 530.352 Materials Selection
- 530.354 Manufacturing Engineering
- 530.414 Computer Aided Design
- 660.361 (Spring 2015 and later) or 660.461 Engineering Business and Management
Capstone Design (8 credits)
- 530.403 and 530.404 Engineering Design Project I and II

Mechanical Engineering Electives (9 credits)
- Three courses (300-level or higher) in mechanical engineering (EN.530.xxx) or any of the courses listed below:
  - 580.451 Cell and Tissue Engineering
  - 580.452 Cell and Tissue Engineering II

Technical Electives (9 credits)
- Three (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. These courses are intended to complement the Mechanical Engineering Electives. One of the technical electives may be a computer language course of any level.

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.

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 advisor and Academic Program Administrator 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 any courses whose course number prefixes are “530” and are at the .300-level or higher.
- **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 530.xxx at the .300-level or higher, as well.

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. All Mechanical Engineering electives begin with the course number prefix “530.” Note that many of the elective courses below are taught every other year. (Electives are in italics):

**Mechanics and Design**
- 530.215 Mechanics-Based Design
- 530.352 Materials Selection
- 530.405 Mechanics of Solids and Structures
- 530.414 Computer-Aided Design
- 530.418 Aerospace Structures and Materials
- 530.730 Finite Element Methods

**Thermo-fluids and Thermo-fluid Systems**
- 530.327/329 Introduction to Fluid Mechanics and Lab
- 530.328 Fluid Mechanics II
- 530.334/335 Heat Transfer and Lab
- 530.425 Mechanics of Flight
- 530.426 Biofluid Mechanics
- 530.432 Jet and Rocket Propulsion
- 530.435 Refrigeration and Heating, Ventilation and Air Conditioning
- 530.457 Introduction to Acoustics
- 530.467 Thermal Design Issues for Aerospace Systems

**Robotics**
- 530.202 Dynamics (or either 530.202 or 560.202 before Spring 2015)
- 530.343 Design and Analysis of Dynamic Systems
- 530.414 Computer-Aided Design (elective for those following old requirements)
- 530.420 Robot Actuators and Sensors
- 530.421 Mechatronics
- 530.424 Dynamics of Robots and Spacecraft

### 6.5 Aerospace Engineering Concentration
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 Concentration 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 Concentration are required to take at least five of the following courses.

**Note:** In the B.S. program, only courses numbered with the course prefix “530” can be counted toward Mechanical Engineering electives. All courses below – including 530.xxx courses - can be counted as Technical Elective requirements.
FALL 2015
530.418 Aerospace Structures and Materials
530.425 Mechanics of Flight
171.321 Introduction to Space Science and Technology

SPRING 2016 (anticipated)
530.328 Fluid Mechanics II
530.432 Jet and Rocket Propulsion

FALL 2016 (anticipated)
530.424 Dynamics of Robots and Spacecraft
530.467 Thermal Design Issues for Aerospace Systems
171.321 Introduction to Space Science and Technology
270.318 Remote Sensing of the Environment

SPRING 2017 (anticipated)
530.425 Mechanics of Flight
530.470 Space Vehicle Dynamics and Control

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 Concentration:

- 171.118 Stars and the Universe
- 520.214 Signals and Systems
- 520.401 Basic Communications
- 525.445 Modern Navigation Systems

For information on these courses and the frequency of course offerings, please consult the Registrar’s course listings at [http://web.jhu.edu/registrar/schedule/index.html](http://web.jhu.edu/registrar/schedule/index.html).
Courses for the Engineering Program for Professionals (525.xxx) can be found at [http://ep.jhu.edu/schedule](http://ep.jhu.edu/schedule).

**Internships in Aerospace Engineering**

Students in the Aerospace Engineering Concentration 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 Concentration

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 Concentration 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 2016 (confirmed)

- 530.410 Biomechanics of the Cell*
- 530.441 Introduction to Biophotonics
- 530.448 Biosolid Mechanics*
- 530.486/686 Mechanics of Locomotion*
- 530.672 Biosensing and BioMEMS
- 580.422 and 580.424 Systems Bioengineering II with lab (*6 credits total, counts as two courses, Prerequisite: 580.221 Molecules and Cells, 580.222 Biomedical Systems and Controls, and 110.302 Differential Equations*)
- 580.452 Cellular and Tissue Engineering Laboratory
- 580.456 Introduction to Rehabilitation Engineering

### FALL 2016 (anticipated)

- 530.437 Biosensor Materials and Mechanisms
- 540.440 MicroNanotechnology (Chemical and Biomolecular Engineering)*
- 540.452 Cellular and Tissue Engineering Laboratory
- 580.421 and 580.423 Systems Bioengineering I with lab (*6 credits total, counts as two courses, Prerequisite: 580.221 Molecules and Cells, 580.222 Biomedical Systems and Controls, and 110.302 Differential Equations*)

### SPRING 2017 (anticipated)

- 530.410 Biomechanics of the Cell*
- 530.441 Introduction to Biophotonics
- 530.672 Biosensing and BioMEMS* (graduate)
- 540.440 MicroNanotechnology (Chemical and Biomolecular Engineering)*
- 580.422 and 580.424 Systems Bioengineering II with lab (6 credits total, counts as two courses, Prerequisite: 580.221 Molecules and Cells, 580.222 Biomedical Systems and Controls, and 110.302 Differential Equations)
- 580.452 Cellular and Tissue Engineering Laboratory

**FALL 2017 (anticipated)**
- 530.445 Introduction to Biomechanics*
- 580.451 Cellular and Tissue Engineering Laboratory
- 530.485 Physics and Feedback in Living Systems
- 530.495 Microfabrication Lab
- 580.221 Molecules and Cells (Prerequisite: 030.101 Introductory Chemistry) – NOTE: while this course would count for the Biomechanics concentration/track, it will not count for a Technical elective of either the B.S. Mechanical Engineering or B.S. Engineering Mechanics degrees, as it is a sophomore-level course.
- 580.421 and 580.423 Systems Bioengineering I with lab (6 credits total, counts as two courses. Prerequisite: 580.221 Molecules and Cells, 580.222 Biomedical Systems and Controls, and 110.302 Differential Equations)

---

**030.205 ORGANIC CHEMISTRY MIGHT COUNT AS A TECHNICAL ELECTIVE, BUT NOT ALWAYS**

Some biomechanics courses may require 030.205 Organic Chemistry (“Orgo”) as a prerequisite. Please check the courses for prerequisite requirements.

“Orgo” will count as a Technical Elective **ONLY** when taken to allow enrollment in a Biomechanics Concentration course that requires it as a pre-requisite. It will not count as a Technical Elective by itself.

Note that “Orgo” has several prerequisites: 030.101/.102 Intro to Chemistry and 030.105/.106 Chemistry labs. Please plan course work accordingly.

---

**6.7 Concentration – Grades and When they Count**

**6.7.1 Letter Grades only for Courses Counting Toward a Concentration**

Any course being counted toward a concentration, 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 concentration courses.

**6.7.2 Concentration 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 – whether all at Johns Hopkins or as a transfer student, 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 will count toward a concentration.

Students who need a ninth or tenth semester and are earning only B.S. degrees can use eligible courses taken in those semesters to count toward a concentration.

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 concentration.
### 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 110.302 Differential Equations (4) and 110.201 Linear Algebra (4) instead of the combined 550.291 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 110.302 Differential Equations can be counted as a Technical Elective.

** - Students must take either

A) 660.361 or 660.461 Engineering Business and Management or

▲ - 530.343 Design and Analysis of Dynamic Systems requires concurrent enrollment in or prior completion of 530.202 Dynamics (530.202 or 560.202 before Spring 2015) with a minimum C- grade.

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<td>110.108 Calculus I</td>
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<tr>
<td>530.103 Intro to Mechanics I</td>
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<tr>
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<tr>
<td>510.101 Intro to Materials Chemistry</td>
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<tr>
<td>171.102 or 171.108 General Physics II</td>
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<td>173.112 General Physics II Lab</td>
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<td>530.327/329 Intro. Fluid Mechanics</td>
<td>3+1</td>
</tr>
<tr>
<td>530.352 Materials Selection</td>
<td>3+1</td>
</tr>
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<td>530.414 CAD</td>
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<tr>
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</tr>
<tr>
<td>xxx.3xx or .4xx H/S (6) Elective</td>
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<tr>
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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 110.302 Differential Equations (4) and 110.201 Linear Algebra (4) instead of the combined 550.291 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 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) 660.361 or 660.461 Engineering Business and Management or


▲ - 530.343 Design and Analysis of Dynamic Systems requires concurrent enrollment in or prior completion of 530.202 Dynamics (530.202 or 560.202 before Spring 2015) with a minimum C- grade.

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<td>530.102 Freshman Exp in ME II</td>
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<td>530.104 Intro to Mechanics II</td>
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<td>530.106 MechE Freshman Lab II</td>
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<tr>
<td>530.201 Statics and Mechanics</td>
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<td>550.291 L.A./D.E. *</td>
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<td>530.231/232 Thermodynamics</td>
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<tr>
<td>530.327/329 Intro. Fluid Mechanics</td>
<td>3+1</td>
<td>530.334/335 Heat Transfer</td>
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<td>530.352 Materials Selection</td>
<td>3+1</td>
<td>530.343 D. &amp; A. Dynamic Systems ▲</td>
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<td>xxx.3xx or .4xx H/S (5) Elective</td>
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<td>530.354 or 530.454 Manufacturing Eng.</td>
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<td>530.414 CAD</td>
<td>3</td>
<td>Technical Elective (1)</td>
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<td>530.403 Eng. Design Project I</td>
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Mechanical Engineering major – Course Dependency Map
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 more specialized programs in a variety of areas, 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

Our primary objective is to educate an exceptional group of science-oriented engineers who, after graduation, will be successful and on track to become leaders among their peers (1) in the best graduate programs in engineering, science, medical schools, or law schools, and (2) in industry, government laboratories and other organizations.

7.3.1  Engineering Mechanics Biomechanics Concentration

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

7.3.2  Engineering Mechanics Electives

The electives for the EM major are structured as follows:

Engineering Science Electives (12 credits)

- One course in solid mechanics
- One course in fluid mechanics
- One course in mechanics of either solids or fluids
• One course in either materials or dynamics

**Engineering Mechanics Electives (6 credits)**

• Two additional courses in the same area of mechanics (i.e., fluids, solids, or dynamics)

**Technical Electives (18 credits)**

• 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 above three categories include (but are not limited to):**

- 020.346 Immunobiology
- 020.363 Developmental Biology
- 020.380 Eukaryotic Molecular Biology
- 250.353 Computational Biology
- 530.426 Biofluid Mechanics
- 530.440 Computational Mechanics of Biological Macromolecules
- 530.441 Introduction to Biophotonics
- 530.445 Introductory Biomechanics
- 530.448 Biosolid Mechanics
- 580.456 Introduction to Rehabilitation Engineering
- 530.495 Microfabrication Laboratory
- 540.409 Modeling Dynamics and Control for Chemical and Biological Systems
- 530.671 Statistical Mechanics in Biological Systems

This is not a complete list of possible courses that can be taken, and not all of these courses must be taken. Rather, students who wish to pursue the Biomechanics concentration 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 concentrations simultaneously if they apply all 12 of their elective courses towards this end.

### 7.4 Engineering Mechanics Course Requirements

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 of D+, D, or D- not accepted)
- 110.108 Calculus I
- 110.109 Calculus II
- 110.202 Calculus III (or 110.211 Honors Multivariable Calculus)
- 550.291 Linear Algebra/Differential Equations (or 110.212 Honors Multivariable Calculus, or 110.201 Linear Algebra and 110.302 Differential Equations, the latter which can count as a technical elective)
- Another Mathematics Elective
- Statistics Elective at the .300-level or above (e.g. 560.348 Probability and Statistics in Civil Engineering or 550.310 Probability and Statistics. AP Statistics is not accepted)

(or…) Mathematics with a focus on fundamentals:
(23 credits; grades of D+, D, or D- not accepted)
- 110.108 Calculus I
- 110.109 Calculus II
- 110.211-212 Honors Multivariable Calculus and Linear Algebra
- 110.302 Differential Equations with Applications
- Statistics Elective at the 300 level or above (e.g. 560.348 Probability and Statistics in Civil Engineering or 550.310 Probability and Statistics. AP Statistics is not accepted)

Basic Science (16 credits; grades of D+, D, or D- not accepted)
- A Physics course suite that covers mechanics: either 171.101 or 171.107 Physics I and 173.111 Physics Lab I or 530.103/104 Introduction to Mechanics I/II
- 171.102 or 171.108 Physics II and 173.112 Physics Lab II
- 510.101 Introduction to Materials Chemistry (or 030.101 Chemistry I)
- Another basic science elective

Humanities: (18 credits)
- See Humanities, Section 5

Required Engineering Courses (minimum of 26 credits; grades of D+, D, or D- not accepted)
I) INTRODUCTORY COURSE: The Freshman Experiences course suite: 530.101/102 Freshman Experiences in Mechanical Engineering and 530. 105/106 Mechanical Engineering Freshman Laboratory I/II, is a strongly recommended choice for introductory engineering but other options are accepted.
If choosing alternate options, students must take:

- An **introductory computing** course, such as:
  - 500.200 Computing for Engineers and Scientists
  - 510.202 Computation and Programming for Materials Scientists and Engineers
  - 560.220 Civil Engineering Analysis
  - 580.200 Intro to Scientific Computing
  - 600.112 Intro to Programming for Scientists and Engineers
  - 250.205 Intro to Scientific Computing
  - 600.107 Intro to Java (other courses are preferred, but this will be accepted with the advisor’s approval such as when scheduling conflicts prevent a student from taking preferred programming courses.)

- One of these **introductory freshman engineering** courses (**=strongly recommended, *=recommended):**
  - 500.101 What is Engineering?
  - 510.101 Introduction to Materials Chemistry (if not taken to complete the Basic Science requirement)
  - 520.137 Introduction to Electrical and Computer Engineering
  - 570.108 Introduction to Environmental Engineering
  - 580.202 Biomedical Engineering in the Real World (Biomedical Engineering double majors only)

II) OTHER REQUIRED ENGINEERING COURSES:

- 530.201 Statics and Mechanics of Materials
- 530.215 Mechanics Based Design or 530.405 Mechanics of Solids and Structures
- 530.231/.232 Mechanical Engineering Thermodynamics Lecture and Lab
- 530.327/.329 Introduction to Fluid Mechanics Lecture and Lab

*Engineering Science Electives (12 credits; grades of D+, D, or D- not accepted)*

- One course in each of these disciplines:
  - mechanics of solids
  - mechanics of fluids
- An additional course in either mechanics of solids or mechanics of fluids
- One course in either materials or dynamics

*Engineering Mechanics Electives (6 credits; grades of D+, D, or D- not accepted)*

- Two additional elective courses in the same area of engineering mechanics (solid mechanics, fluid mechanics, or dynamics)
Technical Electives (minimum of 18 credits; grades of D+, D, or D- not accepted)

A minimum of five (E), (Q), or (N) courses at or above the 300 level totaling at least 18 credits, chosen from any combination of courses in engineering, basic sciences, or mathematics chosen in consultation with the student’s advisor are required. Students may also take one of any computer language course at any level.

Capstone Design (8 credits)
- 530.403 and 530.404 Senior Design Project I and II

7.5 Engineering Mechanics Elective Courses

Solid mechanics courses may be chosen from courses such as:
- 530.215 Mechanics Based Design*
- 530.405 Mechanics of Solids and Structures*
- 530.414 Computer-Aided Design
- 530.448 Biosolid Mechanics
- 530.730 Finite Element Methods
- 560.320 Steel Structures
- 560.330 Foundation Design

Fluid mechanics courses may be chosen from courses such as:
- 530.328 Fluid Mechanics II
- 530.425 Mechanics of Flight
- 530.426 Biofluid Mechanics
- 530.444 Computer-Aided Fluid Mechanics and Heat Transfer
- 570.301 Environmental Engineering I: Fundamentals

Dynamics courses may be chosen from courses such as:
- 530.343 Design and Analysis of Dynamic Systems
- 530.424 Dynamics of Robots and Spacecraft
- 530.420 Robot Sensors and Actuators
- 550.391 Dynamical Systems

Materials courses may be chosen from courses such as:
- 580.440 Cellular and Tissue Engineering
- 510.311 Structure of Materials
- 510.312 Thermodynamics of Materials
- 510.313 Mechanical Properties of Materials
- 510.314 Electronic Properties of Materials

* If not used to satisfy the Required Engineering Courses.
• 510.315 Physical Chemistry of Materials
• 510.426 Biomolecular Materials
• 510.431 Biocompatibility of Materials

A program of no fewer than 127 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.
7.6 Sample Engineering Mechanics Programs

Sample Engineering Mechanics Program for students beginning with Calculus I taking the Mechanical Engineering Freshman Experiences course suite.

This is but one version of ways to complete the program. Total Credits - B.S. Degree in Engineering Mechanics – 127

* - Students are encouraged to take 110.302 Differential Equations (4) and 110.201 Linear Algebra (4) instead of the combined 550.291 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 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 171.101 or 171.107 Physics I (4), and 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.

<table>
<thead>
<tr>
<th>FRESHMAN YEAR</th>
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<tbody>
<tr>
<td>110.108 Calculus I</td>
<td>4</td>
<td>110.109 Calculus II</td>
</tr>
<tr>
<td>530.101 Freshman Experiences★</td>
<td>2</td>
<td>530.102 Freshman Experiences★</td>
</tr>
<tr>
<td>530.103 Intro to Mechanics I ★</td>
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<td>530.104 Intro to Mechanics II ★</td>
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<td>530.106 Freshman Lab ★</td>
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<td>H/S Elective (2)</td>
</tr>
<tr>
<td>510.101 Intro to Materials Chemistry</td>
<td>3</td>
<td>Basic Science Elective</td>
</tr>
<tr>
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<tr>
<td>110.202 or .211 Calculus options</td>
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<td>550.291 LA/DE *</td>
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<tr>
<td>530.201 Statics and Mechanics</td>
<td>3+1</td>
<td>530.202 Dynamics (560.202 before S15)</td>
</tr>
<tr>
<td>530.231/232 Mech. Eng. Thermodynamics</td>
<td>3+1</td>
<td>530.215 or .405 Mechanics course</td>
</tr>
<tr>
<td>171.102 or 171.108 General Physics II</td>
<td>4</td>
<td>Technical Elective (1)</td>
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<td>173.112 General Physics II Lab.</td>
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<td>3+1</td>
<td>E. S. Elective (fluids)</td>
</tr>
<tr>
<td>E. S. Elective (solids)</td>
<td>3</td>
<td>E. S. Elective (solids or fluids)</td>
</tr>
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<td>Technical Elective (3)</td>
</tr>
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<td>Statistics Elective</td>
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<td>Mathematics Elective</td>
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<td>H/S Elective (3)</td>
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<td>530.404 Senior Design Project II</td>
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<td>E. M. Elective (solids, fluids, dynamics)</td>
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<td>E. S. Elective (materials/dynamics)</td>
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<td>Technical Elective (5)</td>
</tr>
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<td>E. M. Elective (solids, fluids, dynamics)</td>
<td>3</td>
<td>xxx.3xx or .4xx H/S Elective (6)</td>
</tr>
<tr>
<td>xxx.3xx or .4xx H/S Elective (5)</td>
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<tr>
<td><strong>Total credits</strong></td>
<td><strong>16</strong></td>
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Sample *Engineering Mechanics* Program for students beginning with Calculus II taking the Mechanical Engineering Freshman course suite.

This is but one version of ways to complete the program. Total Credits - B.S. Degree in Engineering Mechanics – 127

* - Students are encouraged to take 110.302 Differential Equations (4) and 110.201 Linear Algebra (4) instead of the combined 550.291 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 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 171.101 or 171.107 Physics I (4), and 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. As of Fall 2010, economics is no longer required.

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<td><strong>Total credits</strong></td>
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<td><strong>Total credits</strong></td>
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<tr>
<td>H/S Elective (3)</td>
<td>3</td>
<td>E. M. Elective (solids, fluids, dynamics)</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total credits</strong></td>
<td>18</td>
<td><strong>Total credits</strong></td>
<td>15</td>
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<td><strong>SENIOR YEAR</strong></td>
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<td>530.403 Eng. Design Project I</td>
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<td>xxx.3xx or .4xx H/S Elective (6)</td>
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<td><strong>Total credits</strong></td>
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<td><strong>Total credits</strong></td>
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</table>
8 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.

8.1 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.

9 Graduation and Commencement

We celebrate the accomplishment of your graduation in a number of ways, including the University’s Commencement Ceremonies, recognition of honors with the induction into Pi Tau Sigma, and the presentation of Convocation Awards.

9.1 Honors

There are three methods to recognize our outstanding students:

- Membership in Pi Tau Sigma
- Honors upon graduation
- Convocation awards
9.2  **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.

9.3  **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.

9.4  **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.

10  **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 Chair.
11 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.

11.1 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/.

11.2 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.

11.3 Requirements

The requirements for an M.S.E. in Mechanical Engineering are as follows:

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

- No more than two courses may be chosen from the part-time EP program.
- No more than four courses may be at the intermediate/advanced undergraduate (xxx.300 – xxx.499) level. [NOTE: Computer Science (CS) uses the 400-level designation (600.4xx) for courses at the beginning graduate level. A maximum of two 400-level CS courses may be used to fulfill the graduate-level course requirements for Ph.D. and M.S.E students. Those two courses will not count against the four-course limit for intermediate/advanced-undergraduate courses. This may result in listing up to six courses at the 400 level, though the 400-level CS courses are actually graduate-level courses.]
- At least two courses should be in applied mathematics, numerical analysis, or computational methods.
• These courses cannot include Independent Study, Graduate Research, MSE Graduate Student Research, or Special Studies.

Plus either:

• Two additional one-semester graduate courses (xxx.600–xxx.799) approved by your advisor, only one of which can be 530.600 MSE Graduate Student Research, or

• An M.S.E. Thesis acceptable to your advisor and one other reader.

11.4 Bachelor's/Master's Double Counting of Courses

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.”

12 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://mse.msem.jhu.edu/program-structure-require/ for additional course and application information.
13 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 often receives information on opportunities and will forward them to you as they are received. You are strongly encouraged to take advantage of these resources, as successful career and opportunity planning begins with you.

13.1 Internships, Research Positions, and Jobs

Information regarding research positions and how to find them, 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/.

13.2 Scholarships

Information on scholarships is available from the Office of Academic Advising at the website http://www.jhu.edu/~advising/scholarships/index.html.

13.3 Careers and Career Planning

The Career Center, located on the third floor of Garland Hall and at http://pages.jh.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 Career Center account to receive information on the latest career recruiting events and surf their site for the other services offered. The Career Center also welcomes you to make an appointment to visit or drop by at available drop-in hours to discuss your questions and get help with your career planning decisions.

14 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 believes that any aspect of the department needs to be updated, changed, or improved is strongly encouraged to speak to the class representatives. Freshman appointments for class representatives are made in the Fall.

15 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://sites.google.com/site/jhudbf/
- 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.collegiatelink.net/organizations

16 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 http://web.jhu.edu/disabilities/index.html, or contact them at 410-516-4720 or studentdisabilityservices@jhu.edu. You may also visit their office in 385 Garland Hall.

17 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 with regards to its operation and all safety aspects. The PI’s for each lab are listed on the entrance door to each lab.

18 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. An orientation regarding shop safety, shop rules, and equipment operations is required to be allowed to work in the student machine shop.

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

19 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.

19.1 **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.

19.2 **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/](http://wseit.engineering.jhu.edu/) to learn how WSE IT can serve you.

19.3 **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/](http://wseit.engineering.jhu.edu/software-downloads/) to learn more.

19.4 **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 [http://classrooms.johnshopkins.edu/kriegerlab/](http://classrooms.johnshopkins.edu/kriegerlab/).

20 **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.
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