ENGINEERING MECHANICS, BACHELOR OF SCIENCE

The BS in the **Engineering Mechanics** degree program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://nam02.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.abet.org%2F&data=05%7C01%7Cme-academic%40jhu.edu%7Ca42e4cf34fd34c670ef808db66b2b673%7C9fa4f438b1e6473b803f86f8aedf0dec%7C0%7C0%7C638216689974317674%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=r7t7aMe68f1%2Flo0U6FsGLJTJB2JPJbK%2B2mGrjn3E6tY%3D&reserved=0), under the General Criteria and the Program Criteria for Engineering Mechanics and Similarly Named Engineering programs.

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 solid systems, to promote a broad knowledge of the contemporary social and economic context, and to develop the communication skills necessary to excel.

The educational objectives for the B.S. in engineering mechanics degree are designed to educate a select group of science-oriented engineers who, after graduation, will be successful and on track to become leaders among their peers:

- ...in the best graduate programs in engineering, science, medical schools, or law schools, and
- ...in industry, government laboratories, and other organizations.

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

1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
4. An ability to communicate effectively with a range of audiences.
5. 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.
6. An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.
7. An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.

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 their 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 engineering science, engineering mechanics, and technical elective courses must be at the 300-level or higher. Exceptions can be considered in consultation with the faculty advisor, but will be uncommon.

Program Requirements

See also General Requirements (https://e-catalogue.jhu.edu/ksas-wse/undergraduate-policies/academic-policies/requirements-bachelors-degree/) for Departmental Majors and the department's undergraduate advising manuals (https://me.jhu.edu/education/undergraduate-studies/advising/).

The Engineering Mechanics curriculum is structured as follows:

Code	Title	Credits
MATHEMATICS [1]		
AS.110.108	Calculus I (Physical Sciences & Engineering)	4
AS.110.109	Calculus II (For Physical Sciences and Engineering)	4
AS.110.202	Calculus III	4
or AS.110.211	Honors Multivariable Calculus	
Linear Algebra and Differential Equations (select one of the options)		
Option 1		
EN.553.291	Linear Algebra and Differential Equations	4
Option 2		
AS.110.201 & AS.110.302	Linear Algebra and Differential Equations and Applications	8
Statistics Elective at 300-level or above		
EN.553.311	Intermediate Probability and Statistics	4
Other qualified statistics courses can be taken upon the faculty advisor's approval		
Mathematics Elective		4
BASIC SCIENCES [1]		
AS.030.101	Introductory Chemistry I	3
AS.171.102	General Physics: Physical Science Major II	4
or AS.171.108	General Physics for Physical Science Majors (AL)	
AS.173.112	General Physics Laboratory II	1
EN.530.123	Introduction to Mechanics I	3
EN.530.124	Intro to Mechanics II	2
Another basic science elective		4
HUMANITIES AND SOCIAL SCIENCES [2,3,7]		**18**
Select one humanities and/or social science elective that is also writing-intensive		3
Select five humanities and/or social science electives [2]		15
INTRODUCTORY ENGINEERING AND COMPUTING [4]		

EN.500.114	Gateway Computing: Matlab [5]	3
EN.530.107	MechE Undergraduate Seminar I	0.5
EN.530.108	MechE Undergraduate Seminar II	0.5
EN.530.111	Intro to MechE Design and CAD	2
EN.530.115	MechE Freshman Lab I	1
EN.530.116	MechE Freshman Lab II	1
REQUIRED ENGINEERING COURSES [4]		
EN.530.202	Mechanical Engineering Dynamics	3
EN.530.212	MechE Dynamics Laboratory	1
EN.530.215	Mechanics-Based Design	3
or EN.530.405	Mechanics of Advanced Engineering Structures	
EN.530.216	Mechanics Based Design Laboratory	1
EN.530.231	Mechanical Engineering Thermodynamics	3
EN.530.232	Mechanical Engineering Thermodynamics Laboratory	1
EN.530.327	Introduction to Fluid Mechanics	3
EN.530.329	Introduction to Fluid Mechanics Laboratory	1
EN.560.201	Statics & Mechanics of Materials	3
EN.560.211	Statics and Mechanics of Materials Laboratory	1
Capstone Design [1,6]		
EN.530.403 & EN.530.404	MechE Senior Design Project I and MechE Senior Design Project II	8
Engineering Science Electives [1]		
Select one course from each of the following: Fluid Mechanics, Dynamics, Mechanics of Materials, and Solid Mechanics (see below)		12
Engineering Mechanics Electives [1]		
Select one additional elective course in the same area of engineering mechanics (solid mechanics, fluid mechanics, or dynamics, see below).		3
Technical Electives [1]		
Engineering, Quantitative Studies, or Natural Science courses at or above the 300-level, chosen in consultation with the student's advisor from any combination of courses in engineering, basic sciences, or mathematics.		18
Total Credits 126		

1 Grades below C- are not accepted.

2 See the Distribution tab in the Requirements for a Bachelor's Degree section for two exceptions to the rule that each H/S distribution course be at least 3 credits. Visit Requirements for a Bachelor's Degree (https://e-catalogue.jhu.edu/ksas-wse/undergraduate-policies/academic-policies/requirements-bachelors-degree/) for information.

3 One course must be writing intensive. To obtain coherence and depth in these humanities and social science electives, at least six credits must be at the 300-level or higher. While a course grade of C- or higher is preferred, up to 10 credits with a D or D+ grade will be accepted. For examples of areas of concentration and more details, see the undergraduate academic advising manual (https://me.jhu.edu/undergraduate-studies/academic-advising-undergraduate/).

4 Required Engineering Courses (minimum of 26 credits; grades below C- not accepted).
Alternate introductory courses are available. If EN.530.107 MechE Undergraduate Seminar I/EN.530.108 MechE Undergraduate Seminar II, EN.530.111 Intro to MechE Design and CAD, EN.530.115 MechE Freshman Lab I, and EN.530.123 Introduction to Mechanics I/EN.530.124 Intro to Mechanics II are not taken, students must take one course from the engineering course: EN.500.101 What Is Engineering?, EN.520.137 Introduction To Electrical & Computer Engineering, or EN.570.108 Introduction to Environmental Engineering and Design.

5 Students who scored a 5 on the AP Computer Science exam have the option to take:
1. One of the Gateway Computing Courses (EN.500.113 Gateway Computing: Python or EN.500.114 Gateway Computing: Matlab) and forfeit the AP credits for EN.500.112 Gateway Computing: JAVA, OR
2. EN.601.220 Intermediate Programming, EN.601.226 Data Structures, or another programming course that is at least three credits approved by the student's faculty advisor, in which the AP Computer Science credits will count towards the student's core computing requirement, (replacing Gateway Computing). EN.601.220 or EN.661.226 could count as a Technical Elective.

6 EN.530.404 Senior Design is counted as the second writing-intensive course requirement. A grade of C- or higher must be earned for both EN.530.403 and EN.530.404 Senior Design to count toward the degree.

7 If you are bringing in exam or transfer credits that afford you space in the recommended schedule shown above, you may consider enrolling in an optional First-Year Seminar (FYS) during the fall semester. FYS courses carry course numbers EN.501.xxx.

Fluid mechanics courses may be chosen from courses such as:

Code	Title	Credits
EN.530.418	Aerospace Structures	3
EN.530.425	Mechanics of Flight	3
EN.530.426	Biofluid Mechanics	3
EN.530.427	Intermediate Fluid Mechanics	3
EN.530.430	Applied Finite Element Analysis	3
EN.530.432	Jet & Rocket Propulsion	3
EN.530.438	Aerospace Materials	3
EN.530.443	Fundamentals, Design Principles and Applications of Microfluidic Systems	3
EN.530.464	Energy Systems Analysis	3
EN.530.483	Applied Computational Modeling in Aerodynamics and Heat Transfer	3
EN.530.619	Aerospace Structures	3
EN.530.627	Intermediate Fluid Mechanics (graduate)	3
EN.530.643	Fundamentals, Design Principles and Applications of Microfluidic Systems	3
EN.530.664	Energy Systems Analysis (graduate)	3
EN.530.683	Applied Computational Modeling in Aerodynamics and Heat Transfer	3

Dynamics courses may be chosen from courses such as:

Code	Title	Credits
EN.530.343	Design and Analysis of Dynamical Systems (Students are also invited to take EN.530.344 Design and Analysis of Dynamical Systems Lab [1 credit])	3
EN.530.420	Robot Sensors/Actuators	4
EN.530.421	Mechatronics	3
EN.530.424	Dynamics of Robots and Spacecraft	3
EN.530.470	Space Vehicle Dynamics & Control	3
EN.553.391	Dynamical Systems	4

Mechanics of Materials courses may be chosen from courses such as:

Code	Title	Credits
EN.510.311	Structure Of Materials	3
EN.510.312	Thermodynamics/Materials	3
EN.510.313	Mechanical Properties of Materials	3
EN.510.314	Electronic Properties of Materials	3
EN.510.315	Physical Chemistry of Materials II	3
EN.530.352	Materials Selection	4
EN.530.405	Mechanics of Advanced Engineering Structures	3
EN.530.414	Computer-Aided Design	3
EN.530.417	Fabricatology - Advanced Materials Processing	3
EN.530.418	Aerospace Structures	3
EN.530.438	Aerospace Materials	3
EN.530.455	Additive Manufacturing	3
EN.530.605	Mechanics of Solids and Materials	3
EN.530.606	Mechanics of Solids and Materials II	3
EN.530.619	Aerospace Structures	3
EN.530.638	Aerospace Materials	3
EN.530.655	Additive Manufacturing (Graduate)	3
EN.560.330	Foundation Design	3
EN.560.730	Finite Element Methods	3

Solid Mechanics courses may be chosen from courses such as:

Code	Title	Credits
EN.530.405	Mechanics of Advanced Engineering Structures	3
EN.530.414	Computer-Aided Design	3
EN.530.417	Fabricatology - Advanced Materials Processing	3
EN.530.418	Aerospace Structures	3
EN.530.438	Aerospace Materials	3
EN.530.448	Biosolid Mechanics	3
EN.530.605	Mechanics of Solids and Materials	3
EN.530.606	Mechanics of Solids and Materials II	3
EN.530.619	Aerospace Structures	3
EN.530.638	Aerospace Materials	3
EN.530.655	Additive Manufacturing (Graduate)	3
EN.560.211	Statics and Mechanics of Materials Laboratory	1
EN.560.330	Foundation Design	3

Students may not use the satisfactory/unsatisfactory option for required courses, including Humanities and Social Sciences, unless approved by their faculty advisor. The department will accept D or D+ grades only up to a maximum of 10 Humanities and Social Science credits. All undergraduate students must follow a program approved by a faculty member in the department who is selected as the student's advisor.

Biomechanics Track

Engineering Mechanics (EM) is a highly flexible program offered by the Department of Mechanical Engineering, 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 will, in consultation with their EM advisor, choose the set of technical and EM electives that best matches the student's interests. Many electives from other departments are acceptable. The electives for the EM major are structured as follows:

Engineering Science Electives

Code	Title	Credits
One course in solid mechanics		3
One course in fluid mechanics		3
One course in mechanics of materials		3
One course in dynamics		3
Total Credits		**12**

Engineering Mechanics Electives

Code	Title	Credits
One engineering mechanics elective		3

Technical Electives

Code	Title	Credits
One of these two courses can count as a Technical Elective (optional)		3-4
EN.601.220	Intermediate Programming	
EN.601.226	Data Structures	
Select 14-15 credits from 300-level courses in engineering and the sciences in consultation with the student's faculty advisor		14-15
Total Credits		**17-19**

Examples of bio-oriented courses which can be applied to the above three categories include (but are not limited to):

Code	Title	Credits
EN.520.495	Microfabrication Laboratory	4
EN.530.410	Biomechanics of the Cell	3
EN.530.426	Biofluid Mechanics	3
EN.530.436	Bioinspired Science and Technology	3
EN.530.441	Introduction to Biophotonics	3
EN.530.443	Fundamentals, Design Principles and Applications of Microfluidic Systems	3
EN.530.445	Introduction to Biomechanics	3
EN.530.448	Biosolid Mechanics	3
EN.530.468	Locomotion Mechanics: Fundamentals	3
EN.530.469	Locomotion Mechanics: Recent Advances	3
EN.530.473	Molecular Spectroscopy and Imaging	3
EN.530.474	Effective and Economic Design for Biomedical Instrumentation	4
EN.530.480	Image Processing and Data Visualization	3
EN.530.668	Locomotion Mechanics: Fundamentals	3
EN.530.669	Locomotion Mechanics: Recent Advances	3

EN.530.672	Biosensing & BioMEMS	3
EN.530.674	Effective and Economic Design for Biomedical Instrumentation	4
EN.540.440	Micro/Nanotechnology: The Science and Engineering of Small Structures	3
EN.580.221	Biochemistry and Molecular Engineering	4
EN.580.452	Cell and Tissue Engineering Lab	3
EN.580.456	Introduction to Rehabilitation Engineering	3
EN.580.457	Introduction to Rehabilitation Engineering: Design Lab	3

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 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 EM program, it would be possible for students to satisfy both of these kinds of tracks simultaneously if they apply all 12 of their elective courses toward this end.

Sample Program of Study

First Year

First Semester	Credits	Second Semester	Credits
AS.110.108	4	AS.110.109	4
AS.030.101	3	EN.500.114	3
EN.530.107[1]	.5	EN.530.108	.5
EN.530.111[1]	2	EN.530.116	1
EN.530.115[1]	1	EN.530.124	2
EN.530.123[2]	3	Humanities/Social Sciences Elective	3
Humanities/Social Sciences Elective[3]	3	Basic Science Elective	3
	16.5		**16.5**

Second Year

First Semester	Credits	Second Semester	Credits
AS.110.202	4	EN.530.202	3
AS.171.102	4	EN.530.212	1
AS.173.112	1	EN.530.215	3
EN.530.231	3	EN.530.216	1
EN.530.232	1	EN.553.291	4
EN.560.201	3	Humanities/Social Science Elective	3
EN.560.211	1		
	17		**15**

Third Year

First Semester	Credits	Second Semester	Credits
EN.530.327	3	Engineering Science elective	3
EN.530.329	1	Engineering Science elective	3
Engineering Science elective	3	Technical Elective	3
Technical Elective	3	Mathematics Elective	4
Statistics Elective	4	Humanities/Social Sciences Elective	3
Humanities/Social Sciences Elective	3		
	17		**16**

Fourth Year

First Semester	Credits	Second Semester	Credits
EN.530.403	4	EN.530.404	4
Engineering Mechanics elective	3	Technical Elective	3
Engineering Science elective	3	Technical Elective	3
Technical Elective	3	Technical Elective	3
Humanities/Social Sciences Elective	3		
	16		**13**

Total Credits 127

1. If EN.530.107 MechE Undergraduate Seminar I, EN.530.111 Intro to MechE Design and CAD, and EN.530.115 MechE Freshman Lab I are not taken, then take Intro to Engineering and Lab I options
2. If EN.530.123 Introduction to Mechanics I is not taken, then take another intro to mechanics or physics course, per advisor approval
3. If you are bringing in exam or transfer credit that affords you space in the recommended schedule shown above, you may consider enrolling in an optional First-Year Seminar (FYS) during the fall semester. FYS courses carry course numbers EN.501.xxx.