MECHANICAL ENGINEERING, MASTER OF SCIENCE

Mechanical Engineering, Master of Science

A focus area must be chosen for this program.

Admission Requirements

Applicants must meet the general requirements for admission to graduate study, as outlined in the Admission Requirements (https://e-catalogue.jhu.edu/engineering/engineering-professionals/admission-requirements/) section.

The applicant's prior education must include a bachelor's degree in Mechanical Engineering or a closely related technical discipline. Applicant's prior education should include the following prerequisites:

1. Three semesters of college calculus (Calculus I, II and III)
2. Two semesters of college physics (Physics I and II)
3. A course or practical knowledge of a programing language (such as Python, Matlab, or C++)

Applicants whose prior education does not include the prerequisites listed above may still enroll under provisional status, followed by full admission status once they have completed the missing prerequisites with a letter grade B- or higher. Missing prerequisites may be completed with Johns Hopkins Engineering or at another regionally accredited institution.

Enrolled students typically have earned a grade point average of at least 3.3 on a 4.0 scale (B+ or above) in their undergraduate studies, though this is not a requirement for admission, nor is it a guarantee. Transcripts from all college studies must be submitted. When reviewing an application, the candidate's academic and professional background will be considered in its totality, and decisions are made on a case-by-case basis. It is strongly advised that applicants submit a maximum of two page curriculum vitae listing their relevant professional background.

Program Requirements

Students can choose one of two options to fulfill their Master's degree requirements: the "All-Course" option or the "Thesis" option. The requirements for both options are summarized below.

All-Course Option:

Students completing the "all-course" option must take a coordinated sequence of ten courses. All courses must be completed within five years from the start of the student's first class. Students are required to choose a focus area to follow. The focus area selected does not appear as an official designation on the student transcript. The curriculum consists of one core course in mathematics, two core courses from Group 1 and three other courses from Group 1 or 2 of the student's chosen focus area, and four technical electives. At least two of the four electives must be from a core engineering discipline, and at most two can be chosen from the Engineering Management, Systems Engineering, Space Systems Engineering, Information Systems Engineering, Healthcare Systems Engineering, Cybersecurity, Financial Mathematics, Occupational and Environmental Hygiene, or Environmental Planning and Management programs.

One of the four elective courses can be substituted for EN.535.820 Master's Graduate Research . This course is intended to give a research experience to those pursuing an "all-course" master's degree. The research must be approved by the student's research supervisor, which can be an academic advisor, a current full-time faculty member at the Department of Mechanical Engineering at Johns Hopkins University, a research staff member at the Johns Hopkins University Applied Physics Laboratory, or an active instructor affiliated with one of the Engineering for Professionals programs. Prior written approval of the advisor and the program chair must be received before enrolling in this course.

Courses from the full-time program (EN.530.XXX) may be substituted for a relevant requirement with advisor approval. One computationally-oriented course is strongly recommended and can serve as a technical elective or as a substitute to one of the three courses required from Group 2 of the student's chosen focus area. Only one C-range grade (C+, C, or C–) can count toward the master's degree. All course selections outside of the Mechanical Engineering program are subject to advisor approval.

Thesis Option:

Students completing the "thesis" option must take a coordinated sequence of eight courses and prepare and submit a Master's thesis. All requirements should be completed within five years. Students are required to choose a focus area to follow. The focus area selected does not appear as an official designation on the student transcript. The curriculum consists of one core course in mathematics, two core courses from those listed in Group 1 and three courses from those listed in Group 1 or 2 of the student's chosen focus area of the student's chosen focus area, two technical electives, and a thesis. The thesis should expand the body of theoretical or applied knowledge in the field of the student's chosen focus area. At least one of the two electives must be from a core engineering discipline, and at most one can be chosen from the Engineering Management, Systems Engineering, Space Systems Engineering, Information Systems Engineering, Healthcare Systems Engineering, Cybersecurity, Financial Mathematics, Occupational and Environmental Hygiene, or Environmental Planning and Management programs. Only one C-range grade (C+, C, or C–) can count toward the master's degree. All course selections outside of the Mechanical Engineering program are subject to advisor approval.

Students electing to choose the thesis option should get prior written approval from both their academic advisor and the program chair and must work with an approved research advisor. The research advisor can be any current full-time faculty member at the Department of Mechanical Engineering at Johns Hopkins University. Prior written approval should be secured from the program chair if the research advisor will be a research staff member at the Johns Hopkins University Applied Physics Laboratory or an active instructor affiliated with the Engineering for Professionals Mechanical Engineering program. An electronic version of the master thesis should be delivered to the Milton S. Eisenhower (MSE) library after its approval by the thesis committee. The thesis committee consists of the thesis research advisor and one other member who is an expert in the research area of the thesis and to be selected by the program chair. The research work should generally start after the student finishes all the course requirements for their chosen focus area and should not take more than 3 consecutive semesters. While working on the thesis, students must enroll in the two-course sequence EN.535.820 Master's Graduate Research and EN.535.821 Master's

Graduate Thesis, where the research advisor serves as the instructor for both. The prerequisite for these courses is the completion of all course requirements in the student's focus area and the approval of the program chair. The approval of the program chair follows the submission of a research proposal by the student that is approved by their research advisor. Hence, the student must contact a research advisor and discuss potential research topics of interest to both parties, conduct a literature survey, and present a maximum of three-page research proposal to be approved by the program chair. The latest a proposal can be submitted for consideration is during the third to last semester of the five-year limit.

Courses from the full-time program (EN.530.XXX) may substitute a relevant requirement with the advisor approval. One computationally-oriented course is strongly recommended and can serve as a technical elective or as a substitute to one of the three courses required from Group 2 of the student's chosen focus area. Only one C-range grade (C+, C, or C–) can count toward the master's degree. All course selections outside of the Mechanical Engineering program are subject to advisor approval.

Program Course Requirements

Code	Title	Credits
Core Course		**Credits**
EN.535.641	Mathematical Methods For Engineers [1]	3
Recommended (At least one of these computationally-oriented courses is strongly recommended in place of one of the three required courses from Group 2)		**Credits**
EN.535.609	Topics in Data Analysis	3
EN.535.610	Computational Methods of Analysis	3
EN.535.742	Applied Machine Learning for Mechanical Engineers	3
EN.535.743	Intermediate Applied Artificial Intelligence in Mechanical Engineering	3
EN.535.766	Numerical Methods	3
Focus Areas		
Select one of the following Focus Areas:		
Advanced Manufacturing (p. 2)		
Aerospace Engineering (p. 2)		
Biomechanics (p. 3)		
Fluid and Thermal Mechanics (p. 3)		
Hypersonic Technologies (p. 4)		
Ocean Engineering (p. 4)		
Robotics, Dynamics, and Controls (p. 4)		
Mechanics of Materials and Structures (p. 5)		

[1] This course must be taken in the first semester of the student's program, unless the advisor explicitly allows the student to do otherwise.

Focus Area Courses

Students are required to choose one of eight focus areas: Advanced Manufacturing; Aerospace Engineering; Biomechanical Engineering; Fluid Mechanics and Thermal Science; Hypersonic Technologies; Ocean Engineering; Robotics, Dynamics, and Controls; and Mechanics of Materials and Structures. The focus area selected does not appear as an official designation in the student transcript. Each focus area has five required courses. Of these courses, at least two must be completed from Group 1 and the additional 3 must be completed from Group 1 and/or 2. Post-master's certificate students are not limited to one focus area but can choose their courses among all the courses offered by the program.

ADVANCED MANUFACTURING

In this focus area students study the automation of design and manufacturing systems including computer-aided design (CAD), computer-aided engineering (CAE), computer-aided manufacturing (CAM), and robotics. They will gain understanding of the relationships between process machinery, process conditions, and material properties, as well as learn to design precision machines, instruments, and mechanisms through an understanding of gears, bearings, actuators, and sensors. They will develop a clear understanding of positional repeatability and accuracy as well as sources of machine and instrumentation errors. Students will also gain broad knowledge in smart automation, intelligent sensing, computer-integrated manufacturing, quality control, supply chain coordination, and explore the latest manufacturing processes in high-tech industries. This focus area prepares students for careers driving digital transformation in manufacturing. With exposure to both technical and analytical methods for advanced manufacturing, graduates will be ready to excel in cross-disciplinary engineering roles driving manufacturing innovation, efficiency, and competitiveness through digitalization and smart automation.

Code	Title	Credits
Select five of the following of which two must be from Group 1:		
Group 1 (must select at least two)		**Credits**
EN.535.628	Computer-Integrated Design and Manufacturing	3
EN.535.659	Manufacturing Systems Analysis	3
EN.535.660	Precision Mechanical Design	3
EN.535.673	Mechanized Assembly: Hardware and Algorithms	3
Group 2		**Credits**
EN.515.601	Structure and Properties of Materials	3
EN.515.622	Micro and Nano Structured Materials & Devices	3
EN.515.655	Metal Additive Manufacturing	3
EN.515.658	Design for Additive Manufacturing	3
EN.515.661	Introduction to Polymer Science	3
EN.535.606	Advanced Strength Of Materials	3
EN.535.607	Mechanics of Solids and Structures: Theory and Applications I	3
EN.535.618	Fabricatology - Advanced Materials Processing	3
EN.535.623	Intermediate Vibrations	3
EN.535.627	Computer-Aided Design	3
EN.535.633	Intermediate Heat Transfer	3
EN.535.638	Mechanical Packaging for Electronics Systems	3
EN.535.642	Control Systems for Mechanical Engineering Applications	3
EN.535.671	Aerospace Materials, Structures and Design	3
EN.535.672	Advanced Manufacturing Systems	3
EN.535.684	Modern Polymeric Materials	3
EN.535.720	Mechanics of Composite Materials and Structures	3
EN.535.721	Advanced Composite Materials & Manufacturing Processes	3

AEROSPACE ENGINEERING

In this focus area students will study the analysis, design, and development of aircraft, spacecraft, satellites, and rockets. They will gain broad foundations in aerodynamics, aerospace materials, structures, propulsion, flight dynamics, orbital mechanics, systems

integration, and aerospace manufacturing. Students will explore topics such as aerodynamic analysis, computational fluid dynamics, aircraft structures, attitude determination and control, trajectory optimization, and propulsion. With exposure to core aeronautics and astronautics principles, graduates are prepared for rewarding careers advancing aerospace science and technologies through analysis, modeling, simulation, and development roles across the aerospace and defense industries.

Code	Title	Credits
Select five of the following of which two must be from Group 1:		
Group 1 (must select at least two)		**Credits**
EN.535.606	Advanced Strength Of Materials	3
EN.535.607	Mechanics of Solids and Structures: Theory and Applications I	3
EN.535.612	Intermediate Dynamics	3
EN.535.620	Fluid Dynamics I	3
EN.535.623	Intermediate Vibrations	3
EN.535.670	Advanced Aerodynamics	3
EN.535.752	Advanced Flight Dynamics and Control of Aerospace Vehicles	3
EN.535.761	Hypersonic Aerothermodynamics	3
Group 2		**Credits**
EN.515.655	Metal Additive Manufacturing	3
EN.515.658	Design for Additive Manufacturing	3
EN.515.661	Introduction to Polymer Science	3
EN.525.609	Continuous Control Systems	3
EN.525.645	Modern Navigation Systems	3
EN.525.661	UAV Systems and Control	3
EN.525.777	Control System Design Methods	3
EN.535.608	Hypersonic Technologies and Systems	3
EN.535.625	Turbulence	3
EN.535.627	Computer-Aided Design	3
EN.535.628	Computer-Integrated Design and Manufacturing	3
EN.535.632	Applied Finite Elements	3
EN.535.642	Control Systems for Mechanical Engineering Applications	3
EN.535.643	Plasticity	3
EN.535.652	Thermal Systems Design and Analysis	3
EN.535.660	Precision Mechanical Design	3
EN.535.671	Aerospace Materials, Structures and Design	3
EN.535.684	Modern Polymeric Materials	3
EN.535.706	Mechanics of Solids and Structures: Theory and Applications II	3
EN.535.720	Mechanics of Composite Materials and Structures	3
EN.535.721	Advanced Composite Materials & Manufacturing Processes	3
EN.535.724	Dynamics of Robots and Spacecraft	3
EN.535.731	Engineering Materials: Properties and Selection	3
EN.535.732	Fatigue and Fracture of Materials	3
EN.535.735	Computational Fluid Dynamics	3
EN.535.741	Optimal Control and Reinforcement Learning	3
EN.535.752	Advanced Flight Dynamics and Control of Aerospace Vehicles	3
EN.535.761	Hypersonic Aerothermodynamics	3
EN.535.762	Guidance, Navigation and Controls for Hypersonic Vehicles	3

BIOMECHANICS

In this focus area the students apply mechanical engineering principles to understand the mechanics of biological systems and the human body. They will study topics related to the musculoskeletal system, cardiovascular system, human motion, and flow within the body through a mechanics perspective. They will gain core knowledge in solid and fluid mechanics relating to tissues, organs, and overall body function. Students will learn about constitutive models for structures like bone, cartilage, ligaments, skin, and vessels, as well as analyze dynamics and motor control for movement and examine design requirements for medical implants and prosthetics. With a blend of mechanics fundamentals and bioengineering applications, graduates are prepared for biomedical and healthcare careers advancing patient treatment, diagnostics, and human recovery via technology innovations.

Code	Title	Credits
Select five of the following of which two must be from Group 1:		
Group 1 (must select at least two)		**Credits**
EN.535.661	Biofluid Mechanics	3
EN.535.663	Biosolid Mechanics	3
EN.535.667	Biomechanics of Human Movement	3
EN.535.750	Biomechanics of the cell: From nano- and micro-mechanics to cell organization and function	3
EN.585.601	Physiology for Applied Biomedical Engineering I	3
EN.585.631	Introduction to Biomechanics	3
Group 2		**Credits**
EN.515.606	Chemical and Biological Properties of Materials	3
EN.525.786	Human Robotics Interaction	3
EN.535.607	Mechanics of Solids and Structures: Theory and Applications I	3
EN.535.720	Mechanics of Composite Materials and Structures	3
EN.585.631	Introduction to Biomechanics	3
EN.585.708	Biomaterials	3
EN.585.710	Biochemical Sensors	3
EN.585.720	Orthopedic Biomechanics	3
EN.585.726	Biomimetics in Biomedical Engineering	3
EN.585.729	Cell and Tissue Engineering	3
EN.585.747	Advances in Cardiovascular Medicine	3

FLUID AND THERMAL MECHANICS

In this focus area the students will develop advanced knowledge in fluid mechanics, thermodynamics, and heat transfer. They will study the fundamentals of fluid flow, multiphase flows, thermodynamics, and heat exchange processes. Additionally, they will explore topics such as computational fluid dynamics, heat exchanger design, combustion, mass transfer, and renewable power systems. They will examine a variety of single and multiphase fluid flow problems - including non-Newtonian flows, compressible flow, turbulence, boundary layers, and microfluidics. They will also understand solution methods for the transport of heat by conduction, convection, radiation, and phase change. Students will gain experience with analyzing and designing thermal-fluid systems and components such as turbines, pumps, valves, reactors, heat exchangers, and piping systems. They will also leverage computational methods and simulations tools for modeling complex thermofluids phenomena. Graduates are equipped for engineering careers related to processing

plants, energy systems, propulsion, microfluidics, HVAC, and emerging fields in renewable energies.

Code	Title	Credits
Select five of the following of which two must be from Group 1:		
Group 1 (must select at least two)		**Credits**
EN.515.602	Thermodynamics and Kinetics of Materials	3
EN.535.620	Fluid Dynamics I	3
EN.535.621	Intermediate Fluid Dynamics	3
EN.535.633	Intermediate Heat Transfer	3
EN.535.634	Applied Heat Transfer	3
EN.535.735	Computational Fluid Dynamics	3
EN.575.601	Fluid Mechanics	3
EN.615.761	Intro To Oceanography	3
Group 2		**Credits**
EN.515.622	Micro and Nano Structured Materials & Devices	3
EN.535.614	Fundamentals of Acoustics	3
EN.535.625	Turbulence	3
EN.535.652	Thermal Systems Design and Analysis	3
EN.535.661	Biofluid Mechanics	3
EN.535.662	Energy and Environment	3
EN.535.670	Advanced Aerodynamics	3
EN.535.737	Multiscale Modeling and Simulation of Mechanical Systems	3
EN.535.761	Hypersonic Aerothermodynamics	3
EN.535.771	Naval Architecture Design	3
EN.535.773	Acoustical Oceanography	3
EN.565.680	Marine Geotechnical Engineering	3

HYPERSONIC TECHNOLOGIES

In this focus area the students will study the complex multidisciplinary challenges associated with sustained hypersonic flight, spanning speeds from Mach 5 to orbital velocities. Students will learn the fundamentals of high-speed aerodynamics, propulsion, materials, controls, and thermal management unique to the hypersonic flight regime. They will explore topics such as scramjet/ramjet engines, high-temperature materials, plasma flow interactions, boundary layer transition, heat transfer, and guidance/navigation of hypervelocity vehicles. Students will examine the capabilities of existing and proposed hypersonic aircraft, re-entry vehicles, rocket systems, and space launchers. They will also understand the technology barriers and physical constraints that influence cruise and acceleration performance, range, maneuverability and survivability. With a balanced exposure to theoretical and practical problems, this focus area prepares students for developing cutting-edge aerospace crafts, defense systems, or fundamental research focused on expanding the horizons of high-speed flight. Graduates will be equipped to take on lingering challenges in aerodynamic design, propulsion integration, materials development and flight control for practical hypersonic vehicles.

Code	Title	Credits
Select five of the following of which two must be from Group 1:		
Group 1 (must select at least two)		**Credits**
EN.535.608	Hypersonic Technologies and Systems	3
EN.535.721	Advanced Composite Materials & Manufacturing Processes	3
EN.535.734	Ultra-high Temperature Materials	3
EN.535.752	Advanced Flight Dynamics and Control of Aerospace Vehicles	3
EN.535.761	Hypersonic Aerothermodynamics	3
Group 2		**Credits**
EN.535.620	Fluid Dynamics I	3
EN.535.627	Computer-Aided Design	3
EN.535.633	Intermediate Heat Transfer	3
EN.535.634	Applied Heat Transfer	3
EN.535.670	Advanced Aerodynamics	3
EN.535.671	Aerospace Materials, Structures and Design	3
EN.535.735	Computational Fluid Dynamics	3
EN.535.762	Guidance, Navigation and Controls for Hypersonic Vehicles	3
EN.575.601	Fluid Mechanics	3

OCEAN ENGINEERING

In this focus area students study the design, construction, and operation of equipment and systems for marine environments. Learn about naval architecture, ocean structures, underwater vehicles, ocean observing systems, coastal engineering, and marine renewable energy. Student will also explore topics such as ship hydrodynamics, offshore platforms, subsea pipelines, ocean instrumentation, wave/tidal energy, and environmental monitoring. This focus area prepares students for careers in shipbuilding, offshore oil/gas, ocean research, marine industries, and alternative ocean energy.

Code	Title	Credits
Select five of the following of which two must be from Group 1:		
Group 1 (must select at least two)		**Credits**
EN.535.606	Advanced Strength Of Materials	3
EN.535.607	Mechanics of Solids and Structures: Theory and Applications I	3
EN.535.620	Fluid Dynamics I	3
EN.535.621	Intermediate Fluid Dynamics	3
EN.615.761	Intro To Oceanography	3
Group 2		**Credits**
EN.525.645	Modern Navigation Systems	3
EN.535.614	Fundamentals of Acoustics	3
EN.535.625	Turbulence	3
EN.535.627	Computer-Aided Design	3
EN.535.632	Applied Finite Elements	3
EN.535.721	Advanced Composite Materials & Manufacturing Processes	3
EN.535.732	Fatigue and Fracture of Materials	3
EN.535.735	Computational Fluid Dynamics	3
EN.535.771	Naval Architecture Design	3
EN.535.773	Acoustical Oceanography	3
EN.565.680	Marine Geotechnical Engineering	3
EN.565.682	Design of Ocean Structures	3
EN.615.775	Physics of Climate	3

ROBOTICS, DYNAMICS, AND CONTROLS

In this focus area students study different aspects of robot motion planning including rigid and compliant body kinematics, trajectory optimization, robust and adaptive control, machine vision, and mapping. Students will also learn how to analyze dynamics and control for robotic

manipulators and mobile systems. Additionally, students will gain hands-on experience programming autonomous ground vehicles, aerial robots, robotic arms and/or self-driving miniature cars. Students Learn classical feedback control techniques as well as modern optimal, adaptive, intelligent and learning control methodologies. Students will ultimately gain cross-disciplinary knowledge to tackle advanced automation and robotics problems across domains such as manufacturing, surgery, transportation, defense and more. The focus area provides strong foundations for robotics specialized research or industry careers.

Code	Title	Credits
Select five of the following of which two must be from Group 1:		
Group 1 (must select at least two)		**Credits**
EN.525.609	Continuous Control Systems	3
EN.525.610	Microprocessors for Robotic Systems	3
EN.525.626	Feedback Control in Biological Signaling Pathways	3
EN.525.645	Modern Navigation Systems	3
EN.525.661	UAV Systems and Control	3
EN.525.777	Control System Design Methods	3
EN.525.786	Human Robotics Interaction	3
EN.535.622	Robot Motion Planning	3
EN.535.630	Kinematics & Dynamics of Robots	3
EN.535.642	Control Systems for Mechanical Engineering Applications	3
EN.535.724	Dynamics of Robots and Spacecraft	3
EN.535.752	Advanced Flight Dynamics and Control of Aerospace Vehicles	3
EN.605.613	Introduction to Robotics	3
EN.605.716	Modeling and Simulation of Complex Systems	3
Group 2		**Credits**
EN.535.603	Applied Optimal Control	3
EN.535.612	Intermediate Dynamics	3
EN.535.623	Intermediate Vibrations	3
EN.535.627	Computer-Aided Design	3
EN.535.628	Computer-Integrated Design and Manufacturing	3
EN.535.635	Introduction to Mechatronics	3
EN.535.638	Mechanical Packaging for Electronics Systems	3
EN.535.645	Digital Control and Systems Applications	3
EN.535.659	Manufacturing Systems Analysis	3
EN.535.660	Precision Mechanical Design	3
EN.535.673	Mechanized Assembly: Hardware and Algorithms	3
EN.535.741	Optimal Control and Reinforcement Learning	3
EN.535.782	Haptic Applications	3
EN.665.681	Application of Sensing Systems	3

MECHANICS OF MATERIALS AND STRUCTURES

In this focus area the students develop an in-depth understanding of solid mechanics and its application to analyzing structural systems across scale (from microelectromechanical systems to infrastructures). The curriculum provides core knowledge on stress and strain analysis of structural components, elasticity, plasticity, and failure/fracture mechanics, fatigue, creep, and advanced material models, vibration analysis with analytical and computational methods. Additionally, the focus area covers multi-scale modeling of material systems, characterization of material properties, design and analysis of mechanical components, dynamic simulation and testing of structures, and utilizing tools such as finite element analysis in the design and prediction process. This focus area will prepare you to apply advanced mechanics principles to tackle real-world structural analysis and design problems across applications in aerospace, automotive, civil, marine, biomechanical, and other engineering systems. Our cross-cutting mechanics education prepares students for engineering careers or research related to modeling, testing, design, and development of advanced materials and structural systems by providing both theoretical grounding and practical experience applying concepts to analyze complex structural systems across length scales.

Code	Title	Credits
Select five of the following of which two must be from Group 1:		
Group 1 (must select at least two)		**Credits**
EN.535.606	Advanced Strength Of Materials	3
EN.535.607	Mechanics of Solids and Structures: Theory and Applications I	3
EN.535.623	Intermediate Vibrations	3
EN.535.632	Applied Finite Elements	3
EN.535.731	Engineering Materials: Properties and Selection	3
Group 2		**Credits**
EN.515.601	Structure and Properties of Materials	3
EN.515.602	Thermodynamics and Kinetics of Materials	3
EN.515.606	Chemical and Biological Properties of Materials	3
EN.515.611	Computational Molecular Dynamics	3
EN.515.617	Nanomaterials	3
EN.515.622	Micro and Nano Structured Materials & Devices	3
EN.515.627	Chemistry of Nanomaterials	3
EN.515.655	Metal Additive Manufacturing	3
EN.515.658	Design for Additive Manufacturing	3
EN.515.661	Introduction to Polymer Science	3
EN.525.606	Electronic Materials	3
EN.535.612	Intermediate Dynamics	3
EN.535.618	Fabricatology - Advanced Materials Processing	3
EN.535.627	Computer-Aided Design	3
EN.535.643	Plasticity	3
EN.535.660	Precision Mechanical Design	3
EN.535.663	Biosolid Mechanics	3
EN.535.671	Aerospace Materials, Structures and Design	3
EN.535.684	Modern Polymeric Materials	3
EN.535.706	Mechanics of Solids and Structures: Theory and Applications II	3
EN.535.720	Mechanics of Composite Materials and Structures	3
EN.535.721	Advanced Composite Materials & Manufacturing Processes	3
EN.535.732	Fatigue and Fracture of Materials	3
EN.535.748	Stress Waves, Impacts and Shockwaves	3
EN.565.604	Structural Mechanics	3
EN.565.680	Marine Geotechnical Engineering	3
EN.565.682	Design of Ocean Structures	3
EN.565.731	Structural Dynamics	3

INDEPENDENT STUDY/THESIS COURSES

Code	Title	Credits
Courses		**Credits**
EN.535.800	Independent Study	3
EN.535.820	Master's Graduate Research	3
EN.535.821	Master's Graduate Thesis	3

Please refer to the course schedule (https://ep.jhu.edu/courses/) published each term for exact dates, times, locations, fees, and instructors.