MECHANICAL ENGINEERING

Mechanical engineering is a broad field of endeavor with opportunities in many areas of industry: production and manufacturing; aeronautics and aerospace; robotics and automation; conventional and renewable energy; automotive and transportation; and many others. Additional opportunities for mechanical engineers include careers in government, education, and private consulting. The mechanical engineering curriculum is designed to prepare students for this wide range of options by providing them with a strong foundation in the fundamental principles of science and engineering to tackle the complex technological problems of today and adapt for the challenges of tomorrow.

The required courses of the undergraduate mechanical engineering curriculum provide the basic mathematical and scientific fundamentals underlying the practice of mechanical engineering. Technical, free, and math/science elective courses allow the student flexibility in adapting the program to their interests in pursuit of their specific career goals. Electives in the humanities, social sciences, and the arts help to foster the links between society and engineering so that the mechanical engineering graduate is aware of the roles of engineering and science in solving complex technological and social problems as well as of the impacts of social and environmental factors on engineering activities such as design. For those undergraduates who choose to continue their education at Rose-Hulman, graduate work leading to a Master of Science in Mechanical Engineering or a Master of Engineering in Mechanical Engineering is offered by the department.

Mission

To provide the curriculum, the educational environment, and the individual support necessary to graduate mechanical engineers who are technically competent, effective in practice, creative, ethical, and mindful of their responsibility to society.

Vision

To graduate the best baccalaureate mechanical engineers.

Requirements

Summary of Degree Requirements

The freshman year of the mechanical engineering program includes courses in mathematics and foundational sciences, as well as introductory courses in engineering and design. Foundational sciences include physics, biology, and chemistry. The sophomore year features courses in mathematics, foundational sciences, and the engineering sciences. The final two years of the program stress the design and analysis of systems, machines and their components, and the transfer and transformation of energy. In addition to the required mathematics, science, and engineering courses, the program includes required writing and communication courses and an array of technical electives and free electives, a math/science elective, and elective courses in the humanities, social sciences, and the arts (HSSA). The requirements for an undergraduate degree in mechanical engineering are summarized in the following table:

Code	Title	Hours
Required engineering (ME, ES, EM) courses		86
Required math courses		27
Required foundational science courses		16
Required HSSA writing and communication courses		8
RHIT 100	Foundations for Rose-Hulman Success	1
Technical electives		16
Free electives		8
Math/science elective		4
HSSA electives		28
Total Hours		**194**

Areas of Concentration

Students who complete recommended courses in an area of concentration may receive, upon request, a letter from the Department Head attesting to the fact that the student has completed the requirements in the selected area of concentration in the Mechanical Engineering Department. With proper planning, students should be able to take these course offerings without overload. Students may add special topics courses or new courses not yet listed in the catalog to the list of acceptable courses for a concentration with written permission from the mechanical engineering department head.

Automotive Area of Concentration

Automotive Engineering is a very broad field covering many topics including system modeling, combustion, electrification, autonomous driving, materials, and virtual design. To help prepare for a career in this field, the Automotive Concentration is offered. One required and four elective courses are necessary, allowing students to gain either breadth or depth according to their interests.

Code	Title	Hours
Required Course		
ME 359	Vehicle System Modeling	4
Elective Courses		
Select four of the following:		12
CSSE 461	Computer Vision	
CSSE 463	Image Recognition	
EM 402	Three-Dimensional Dynamics	
EM 403	Advanced Mechanics of Materials	
MA 416	Deep Learning	
ME 401	Foundations of Fluid Mechanics	
ME 306	Control Systems	
ME 408	Renewable Energy	
ME 410	Internal Combustion Engines	
ME 422	Finite Elements for Engineering Applications	
ME 423	Fatigue	
ME 424	Mechanics of Composites	
ME 427	Introduction to Computational Fluid Dynamics	
ME 450	Combustion	
ME 506	Advanced Control Systems	
ME 522	Advanced Finite Element Analysis	
ME 559	xEV Analysis and Design	
OE 450	Laser Systems & Applications	
PH 470	Special Topics in Physics	

Aerospace Engineering Area of Concentration

The aerospace industry provides job opportunities each year for many mechanical engineering graduates. The aerospace engineering area of

concentration is intended to provide specialty courses which focus the application of basic mechanical engineering skills to aerospace systems.

The courses required to complete the concentration are as follows:

Code	Title	Hours
Required Course:		
ME 305	Introduction to Aerospace Engineering	4
Select four of the following elective courses:		16
ME 401	Foundations of Fluid Mechanics	
ME 405	Theoretical Aerodynamics	
ME 410	Internal Combustion Engines	
ME 411	Propulsion Systems	
ME 422	Finite Elements for Engineering Applications	
ME 426	Turbomachinery	
ME 427	Introduction to Computational Fluid Dynamics	
ME 461	Aircraft Design	
ME 506	Advanced Control Systems	
ME 510	Gas Dynamics	
ME 522	Advanced Finite Element Analysis	
EM 402	Three-Dimensional Dynamics	
EM 403	Advanced Mechanics of Materials	
MA 336	Boundary Value Problems	
MA 438	Advanced Engineering Mathematics	
PH 322	Celestial Mechanics	

CAD Area of Concentration

The CAD Concentration is intended to prepare students for careers with a focus in computer-aided design and analysis. The Concentration is divided into two sets of courses: Design and Analysis. The Design courses provide students with expertise in the use of modern Computer-Aided Design tools to model three-dimensional shapes and to communicate these designs graphically. The Analysis courses explore the mathematics behind modern CAD tools, giving students a solid background in computer-aided kinematics and finite element analysis.

To earn the CAD Concentration, students must complete the following three Design classes:

Code	Title	Hours
Select one of the following:		2-8
EM 104	Graphical Communications	
ENGD 100	Design & Communication Studio	
BE 118	Design Thinking and Communication	
EM 304	Advanced CAD | Professional Certification	4
EM 305	Advanced CAD | Design Applications	4
Select three Analysis courses from the following:		12
ME 422	Finite Elements for Engineering Applications	
ME 522	Advanced Finite Element Analysis	
ME 304	Introduction to the Design of Mechanisms	
ME 404	Advanced Design of Mechanisms	
ME 380	Machine Component Design	

Dynamic Systems & Control Area of Concentration

Mechanical engineering graduates may work in industries, such as the automotive and aerospace industries, in which the understanding and control of a system's dynamic response is critical. The dynamic systems & control concentration provides students with experiences in modeling, analysis, and simulation of the dynamic behavior of systems with and without feedback control, as well as opportunities to explore data collection for vibratory systems and control algorithm implementation in a laboratory setting.

To complete the requirements of the area of concentration in Dynamics Systems & Control, students must complete five courses from this list:

Code	Title	Hours
EM 402	Three-Dimensional Dynamics	4
EM 306	Vibration Analysis	4
EM 502	Advanced Dynamics	4
EM 503	Advanced Vibration Analysis	4
ME 304	Introduction to the Design of Mechanisms	4
ME 404	Advanced Design of Mechanisms	4
ME 306	Control Systems	4
ME 441	Advanced Modeling and Simulation Techniques	4
ME 445	Robot Dynamics and Control	4
ME 506	Advanced Control Systems	4
PH 322	Celestial Mechanics	4

Thermal Fluid Area of Concentration

The Thermal Fluid concentration is designed to prepare students for careers with a focus on thermodynamics, fluid dynamics, and heat transfer. The concentration comprises two balanced areas of study: thermal fluid systems (with an emphasis on applications) and thermal fluid sciences (with an emphasis on fundamentals). They equip students with astrong foundation to analyze and design thermal fluid systems. Emerging global challenges such as climate change, sustainable energy, and water resources call for creative solutions within the constraints of fundamental physical principles. The Thermal Fluid concentration plays an active and crucial role in the broad discipline of mechanical engineering.

To complete the requirements of the area of concentration in Thermal Fluid, students must complete:

Code	Title	Hours
ME 401	Foundations of Fluid Mechanics	4
Select 4 more courses from the following two areas (with at least one course from each area):		16
Area 1: Thermal Fluid Systems		
ME 408	Renewable Energy	
ME 410	Internal Combustion Engines	
ME 411	Propulsion Systems	
ME 426	Turbomachinery	
Area 2: Thermal Fluid Sciences		
ME 405	Theoretical Aerodynamics	
ME 427	Introduction to Computational Fluid Dynamics	
ME 450	Combustion	
ME 510	Gas Dynamics	

The mechanical engineering program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org

Automotive Area of Concentration (p. 1)
Aerospace Engineering Area of Concentration (p. 1)
CAD Area of Concentration (p. 2)
Dynamic systems & control Area of Concentration (p. 2)
Thermal Fluid Area of Concentration (p. 2)

Plan of Study

Below is a sample plan of study that illustrates one way to achieve the program requirements. Any given student's plan of study may differ based on a variety of factors (e.g., advanced credit, placement exams, adding a minor). Enrolled students will work with their academic advisor; utilize the degree audit/planner to create a specific plan of study.

Course	Title	Hours
Freshman		
Fall		
MA 111	Calculus I	5
PH 111	Physics I (Foundational Science) [1]	4
RHIT 100	Foundations for Rose-Hulman Success	1
EM 104	Graphical Communications	2
Select one of the following:		4
HUM H190	First-Year Writing Seminar	
HSSA Elective		
	Hours	**16**
Winter		
MA 112	Calculus II	5
PH 112	Physics II (Foundational Science) [1]	4
EM 121	Statics & Mechanics of Materials I	4
Select one of the following:		4
HSSA Elective		
HUM H190	First-Year Writing Seminar	
	Hours	**17**
Spring		
MA 113	Calculus III	5
EM 103	Introduction to Design	2
ME 123	Computer Programming	4
Select one of the following	Foundational Science courses: [1]	4
CHEM 111	General Chemistry I	
BIO 101	Essential Biology	
	Hours	**15**
Sophomore		
Fall		
MA 221	Matrix Algebra & Differential Equations I	4
ES 201	Conservation & Accounting Principles	4
ES 213	Electrical Systems	3
ES 213L	Electrical Systems Lab	1
Select one of the following	Foundational Science courses: [1]	4
BIO 101	Essential Biology	
CHEM 111	General Chemistry I	
	Hours	**16**
Winter		
MA 222	Matrix Algebra & Differential Equations II	4
ME 201	Applications of Thermodynamics	4
ES 214	Mechanical Systems	4
HSSA Elective		4
	Hours	**16**
Spring		
MA 223	Engineering Statistics	4
HSSA Elective		4
ME 227	Numerical Methods	4
ME 230	Mechatronic Systems	4
	Hours	**16**
Junior		
Fall		
EM 204	Statics & Mechanics of Materials II	4
ES 305	System Dynamics	4
ES 312	Fluid Systems	4
Free Elective [2]		4
	Hours	**16**
Winter		
ME 317	Design for Manufacturing	4
ME 328 or ME 321	Materials Engineering or Measurement Systems	4
Select one of the following:		4
ENGL H290	Technical & Professional Communication	
HSSA Elective		
ME 306 or EM 306	Control Systems or Vibration Analysis	4
	Hours	**16**
Spring		
ME 302	Heat Transfer	4
ME 321 or ME 328	Measurement Systems or Materials Engineering	4
ME 380	Machine Component Design	4
Select one of the following:		4
HSSA Elective split winter		
ENGL H290	Technical & Professional Communication (split spring)	
	Hours	**16**
Senior		
Fall		
ME 470	Capstone Design I	4
ME 421	Mechanical Engineering Laboratory	2
or		
Tech Elective [2]		
HSSA Elective		4
Math/Science Elective [2]		4
Tech Elective		4
	Hours	**18**
Winter		
ME 471	Capstone Design II	4
Tech Elective [2]		4
or ME 421		
HSSA Elective		4
Free Elective [2]		4
	Hours	**16**
Spring		
ME 472	Capstone Design III	4
Tech Elective [2]		4
Tech Elective [2]		4
HSSA Elective		4
	Hours	**16**
	Total Hours	**194**

1. Students must complete four foundational science classes, one in Biology (BIO 101 Essential Biology or BIO 110 Cell Structure and Function or BIO 120 Comparative Anatomy & Physiology or BIO 130 Evolution & Diversity), two in Physics (PH 111 Physics I and PH 112 Physics II), and one in Chemistry (CHEM 111 General Chemistry I). All foundational science classes have a laboratory component.
2. 28 credit hours in electives composed of 16 credit hours in technical electives, 8 credit hours in free electives, and 4 credit hours of a math elective or a science elective. A technical elective is any course (at the 200 level or above) in biomathematics, chemistry, computer science, engineering, engineering management, geology, mathematics, or

physics that is not cross-listed with HSSA or similar in content to a required course. A math elective is at the 200-level or higher and has an MA or BMTH prefix. A science elective is any course in biology, chemistry, geology, or physics except those courses that are cross-listed with an engineering course.

Program Objectives

Mechanical Engineering Program Educational Objectives

Program Educational Objectives

The mechanical engineering curriculum aims to prepare students for productive careers in industry, government, education, and private consulting, as well as for graduate study. By providing a strong foundation in the fundamental principles of science and engineering and by illuminating the links between society and engineering, the curriculum enables students to apply what they have learned and to teach themselves new skills to address complex technological problems within the social and environmental context of our world. Thus, within a few years of graduation, we expect our graduates to attain the following educational objectives, which are based on the needs of our constituencies:

The Rose-Hulman Mechanical Engineering Department seeks to develop engineers that:

1. can apply their technical knowledge to address complex problems,
2. continuously pursue intellectual and personal growth, adapting to the ever-changing needs of their professions and communities,
3. actively engage with the teams and communities to which they belong through communication, collaboration, and leadership,
4. demonstrate an ethical commitment to serving humanity as professionals and global citizens, and
5. set and meet their own goals for career fulfillment.

Learning Outcomes

Mechanical Engineering Program Student Outcomes

Student Outcomes

Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program. We expect our graduates to have the ability to:

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

The mechanical engineering program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org, under the commission's General Criteria and Program Criteria for Mechanical and Similarly Named Engineering Programs.