MATERIALS SCIENCE AND ENGINEERING, BACHELOR OF SCIENCE

Program Requirements

The Department of Materials Science and Engineering offers a program leading to the Bachelor of Science Degree. The B.S. for the Materials Science and Engineering degree program is accredited by the Engineering Accreditation Commission of ABET, (https://www.abet.org/). The student must meet the general university requirements for the chosen degree as well as the departmental requirements, and must complete the program approved by the student's advisor.

An anticipated individual program of study designed to meet the university and department requirements for the B.S. degree, as well as to reflect the student's interest, should be filed as early as possible during the student's residence. The faculty advisor's signature is required on all course registration and course change forms. As changes are made in the program, it shall be the student's responsibility to see that a revised program is filed with the advisor. Each student must have an approved program on file no later than the semester before they expect to graduate.

See also General university requirements for Departmental majors: https://e-nextcatalogue.jhu.edu/engineering/full-time-residential-programs/undergraduate-policies/academic-policies/requirements-bachelors-degree/ (https://e-catalogue.jhu.edu/engineering/full-time-residential-programs/undergraduate-policies/academic-policies/requirements-bachelors-degree/)

- Complete program of study outlined by track or concentration (standard track, biomaterials concentration, or nanotechnology concentration).
- Fulfill the university writing requirement; two writing-intensive courses, at least 3 credits each.
- Fulfill the distribution requirement: 18 credits of courses coded (H) or (S), comprised of 6 courses at least 3 credits each. For more information, see the Distribution tab in the Requirements for a Bachelor's Degree (https://e-catalogue.jhu.edu/engineering/full-time-residential-programs/undergraduate-policies/academic-policies/requirements-bachelors-degree/).
- Take a minimum of 126 credits.

To meet the course requirements for the B.S. degree in Materials Science and Engineering, the student must complete a minimum of 126 credits, distributed as follows:

Code	Title	Credits
Materials Science Core Classes [1]		30
Upper-Level Materials Science Electives [1]		12
Basic Sciences & Engineering [2]		28
Mathematics [2]		20
Humanities (H) or (S) [2]		18
Science & Engineering Electives [3]		9
Unrestricted Electives [4]		9
Total Credits		**126**

1. The 42 credits of materials science courses must be passed with a letter grade of C or higher.
2. All courses must be passed with a letter grade of C- or higher
3. Three courses of 200- level or above in engineering, natural sciences or mathematics.
   A letter grade of C- or higher required if taken for a letter grade; S required if taken S/U
4. A letter grade of C- or higher require if taken for a letter grade; S required if taken S/U
   A student who has taken Foundations of MSE may count it toward one unrestricted elective.

In addition to the degree program in Materials Science and Engineering, students may elect to complete specialized concentrations in biomaterials or nanotechnology. Whether a student chooses to pursue studies following the standard track, the Biomaterials concentration or the Nanotechnology concentration, the course work specified for the degree will provide a firm grounding in the principles of materials science and engineering.

B.S. Degree Options Offered by the Department of Materials Science and Engineering

Standard Track

The Standard Track is intended for those students with general materials science interests. It permits the student to tailor the degree program to specific interests by allowing a broad range of choices for upper-level science and engineering electives.

Biomaterials Concentration

Biomaterials is an exciting and rapidly developing field. Engineered materials are increasingly used in medical applications (such as drug delivery, gene therapy, scaffolds for tissue engineering, replacement body parts, and biomedical and surgical devices) while an understanding of structure-property relationships in natural biomaterials may lead to improved interventions for a wide variety of diseases and injuries. Because it is highly interdisciplinary (involving elements of materials science, engineering, biology, chemistry and medicine), biomaterials as a discipline requires a deep understanding of the properties of materials in general, and the interactions of materials with the biological environment in particular.

The biomaterials concentration is designed to provide a broad basis in the fundamentals of materials science and engineering, as well as a particular emphasis on the principles and applications of biomaterials. While the fundamental principles of materials science still apply, a complete understanding of biomaterials and their interactions with biological environments requires a greater degree of specialization than the standard undergraduate curriculum provides. The biomaterials curriculum includes topics such as biomimetic materials, natural biomaterials, host responses to biomaterials, biocompatibility, and applications of biomaterials, particularly in tissue engineering, drug delivery, and medical devices and implants. Our goal is to train students who can apply these principles to the development of novel materials that benefit human health. In recognition of completion of the Biomaterials concentration, a student may elect to have their academic transcript annotated to indicate a concentration in Biomaterials.

To receive commendation for completion of the Biomaterials concentration, the student must complete three electives, whose subject matter is some aspect of Biomaterials, Molecules and Cells as a Science & Engineering elective, a biomaterials laboratory course, and complete a biomaterials-related senior design project. **Approval of electives must be made by a student's academic advisor prior to taking the courses, and the senior design project must be pre-approved by the senior design instructor.**

Nanotechnology Concentration

Nanotechnology advances the utilization of materials and devices with extremely small dimensions. Nanotechnology is a visionary field, as micro- and nano-structured devices impact all fields of engineering, including microelectronics (smaller, faster computer chips), mechanical engineering (micromotors and actuators), civil engineering ("smart", self-healing nanocomposite materials for buildings and bridges), and biomedical engineering (biosensors and tissue engineering).

Materials science is central to nanotechnology because the properties of materials can change dramatically when things are made extremely small. This observation is not simply that we need to measure such properties or develop new processing tools to fabricate nanodevices. Rather, our vision is that the wide (and sometimes unexpected) variety of phenomena associated with nanostructured materials allow us to envision radically new devices and applications that can only be made with nanostructured materials. The nanotechnology concentration encompasses a curriculum designed to train students in the fundamental interdisciplinary principles of materials science, including physics and chemistry, and also to expose students to the forefront of nanomaterials research through elective classes and research laboratories. In recognition of completion of the Nanotechnology concentration, a student may elect to have their academic transcript annotated to indicate a concentration in nanotechnology.

To receive commendation for completion of the Nanotechnology concentration, the student must complete three electives, whose subject matter is some aspect of nanotechnology, a Nanomaterials Laboratory course, and complete a nanotechnology-related senior design project. **Approval of electives must be made by a student's academic advisor prior to taking the courses, and the senior design project must be pre-approved by the senior design instructor.**

Detailed Description of the B.S. Program

Code	Title	Credits
Materials Science Core Classes [1]		
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.510.316	Biomaterials I	3
EN.510.428 & EN.510.429	Material Science Laboratory I and Materials Science Laboratory II	6
Select one of the following sequences:		6
EN.510.433 & EN.510.434	Senior Design Research and Senior Design/Research II	
EN.510.438 & EN.510.439	Biomaterials Senior Design I and Biomaterials Senior Design II	
EN.510.440 & EN.510.441	Nanomaterials Senior Design I and Nanomaterials Senior Design II	
EN.510.445 & EN.510.446	MSE Design Team II and MSE Design Team II	
EN.510.447 & EN.510.448	MSE Design Team Leader and MSE Design Team Leader	
Upper-Level Materials Science Electives		
Select 12 credits (each 300 level or higher)		12
Basic Sciences and Engineering [1]		
AS.171.101	General Physics: Physical Science Major I	4
or AS.171.107	General Physics for Physical Sciences Majors (AL)	
AS.171.102	General Physics: Physical Science Major II	4
or AS.171.108	General Physics for Physical Science Majors (AL)	
AS.173.111	General Physics Laboratory I	1
AS.173.112	General Physics Laboratory II	1
AS.030.101	Introductory Chemistry I	3
AS.030.102	Introductory Chemistry II	3
AS.030.105	Introductory Chemistry Laboratory I	1
AS.030.106	Introductory Chemistry Laboratory II	1
AS.030.205	Introductory Organic Chemistry I	4
EN.500.113	Gateway Computing: Python	3
EN.660.363	Leadership & Management in Materials Science and Engineering	3
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
EN.553.291	Linear Algebra and Differential Equations	4
EN.553.310	Probability & Statistics for the Physical Sciences & Engineering	4
or EN.553.311	Probability and Statistics for the Biological Sciences and Engineering	
Humanities (H or S) [1]		
Select 18 credits [3]		18
General Mathematics, Science and Engineering Electives		
Select 9 credits [4]		9
Unrestricted Electives		
Select 9 credits [5]		9
Total Credits		**126**

1. Must be passed with a letter grade of C or higher.
2. Introductory language courses, even if not with H or S designator, can substitute for H designated courses.
3. Three courses of 200-level or above in engineering, natural sciences, or mathematics. At least one of the three electives must be from another department in the Whiting School of Engineering to ensure exposure to another engineering field. Must be passed with a letter grade of D or higher. For the Biomaterials concentration, one of the three electives must be EN.580.221 Biochemistry and Molecular Engineering (students can substitute Cell Biology and Biochemistry for Molecules and Cells). For other students, a possible choice is EN.560.201 Statics & Mechanics of Materials.
4. Must be passed with a letter grade of D or higher. A student who has taken both AS.030.101 and AS.030.102 may count one of them toward one unrestricted elective.

Total Credits Required for Graduation, Standard Track: 126
- with Biomaterials Concentration: 127 Credits
- with Nanotechnology Concentration: 127 Credits

Sample Program of Study

Sample Undergraduate Programs for Materials Science and Engineering

Standard Track

(For a student beginning with Calculus I)

First Year

First Semester	Credits	Second Semester	Credits
AS.110.108	4	AS.110.109	4
AS.030.101	3	AS.030.102	3
AS.030.105	1	AS.030.106	1
AS.171.101 or 107[1]	4	AS.171.102 or 108	4
AS.173.111	1	AS.173.112	1
EN.510.106 (or First-Year Seminar)[2, 3]	3	EN.500.113	3
	16		**16**

Second Year

First Semester	Credits	Second Semester	Credits
AS.110.202	4	EN.553.291	4
AS.030.205	4	EN.553.310	4
EN.510.311	3	EN.510.312	3
Math/Sci/Eng elective	3	EN.510.316	3
H/S Elective	3	H/S elective	3
	17		**17**

Third Year

First Semester	Credits	Second Semester	Credits
EN.510.315	3	EN.510.314	3
EN.510.313	3	EN.510.429	3
EN.510.428	3	Math/Sci/Eng elective	3
Math/Sci/Eng elective	3	H/S elective	3
H/S Elective	3	Unrestricted Elective	3
	15		**15**

Fourth Year

First Semester	Credits	Second Semester	Credits
EN.510.433	3	EN.510.434	3
510.4##: MSE elective	3	510.4##: MSE elective	3
510.4##: MSE elective	3	510.4##: MSE elective	3
EN.660.361	3	H/S elective	3
Unrestricted elective	3	H/S elective	3
	15		**15**

Total Credits 126

Biomaterials Concentration

(For a student beginning with Calculus I)

First Year

First Semester	Credits	Second Semester	Credits
AS.110.108	4	AS.110.109	4
AS.030.101	3	AS.030.102	3
AS.030.105	1	AS.030.106	1
AS.171.101 or 107[1]	4	AS.171.102 or 108	4
AS.173.111	1	AS.173.112	1
EN.510.106 (or First-Year Seminar)[2, 3]	3	EN.500.113	3
	16		**16**

Second Year

First Semester	Credits	Second Semester	Credits
AS.110.202	4	EN.553.291	4
AS.030.205	4	EN.553.310	4
EN.510.311	3	EN.510.312	3
EN.580.221 (This Math/Sci/Eng elective is required for Biomaterials Concentration)	4	EN.510.316	3
H/S Elective	3	H/S elective	3
	18		**17**

Third Year

First Semester	Credits	Second Semester	Credits
EN.510.313	3	EN.510.314	3
EN.510.315	3	EN.510.429	3
EN.510.428	3	Math/Sci/Eng elective	3
Math/Sci/Eng elective	3	H/S elective	3
H/S Elective	3	Unrestricted Elective	3
	15		**15**

Fourth Year

First Semester	Credits	Second Semester	Credits
EN.510.438	3	EN.510.439	3
510.4##: MSE elective (e.g. Biomolecular Materials)	3	510.4##: MSE elective (e.g. Biomaterials Lab)	3
510.4##: MSE elective (e.g. Chemistry & Physics of Polymers)	3	H/S elective	3
510.4##: MSE Elective (e.g. Biomaterials II)	3	H/S elective	3
EN.660.361	3	Unrestricted Elective	3
	15		**15**

Total Credits 127

Nanotechnology Concentration

(For a student beginning with Calculus I)

First Year

First Semester	Credits	Second Semester	Credits
AS.110.108	4	AS.110.109	4
AS.030.101	3	AS.030.102	3
AS.030.105	1	AS.030.106	1
AS.171.101 or 107[1]	4	AS.171.102 or 108	4
AS.173.111	1	AS.173.112	1
EN.510.106 (or First-Year Seminar)[2, 3]	3	EN.500.113	3
	16		**16**

Second Year

First Semester	Credits	Second Semester	Credits
AS.110.202	4	EN.553.291	4
AS.030.205	4	EN.553.310	4

EN.510.311	3	EN.510.312	3
EN.560.201	3	EN.510.316	3
EN.560.211	1	H/S elective	3
H/S Elective	3		
	18		**17**

Third Year

First Semester	Credits	Second Semester	Credits
EN.510.313	3	EN.510.314	3
EN.510.315	3	EN.510.429	3
EN.510.428	3	Math/Sci/Eng elective	3
Math/Sci/Eng elective	3	H/S elective	3
H/S Elective	3	Unrestricted Elective	3
	15		**15**

Fourth Year

First Semester	Credits	Second Semester	Credits
EN.510.440	3	EN.510.441	3
510.4##: MSE elective (e.g. Nanomaterials Lab)	3	510.4##: MSE elective (e.g. Micro Nano Materials & Devices)	3
510.4##: MSE elective (e.g. Materials Characterization)	3	510.4##: MSE elective (e.g. Nanoparticles)	3
EN.660.361	3	H/S elective	3
Unrestricted elective	3	H/S elective	3
	15		**15**

Total Credits 127

[1] Students beginning at the Calculus I level should discuss when to take Physics I and lab with an academic advisor.

[2] Students are encouraged to take EN.510.106 Foundations of Materials Science & Engineering and count it as an unrestricted elective.

[3] If you are bringing in exam or transfer credit that affords you space in the recommended schedule shown below, you may consider enrolling in an optional First-Year Seminar during the fall semester. FYS courses carry course numbers EN.501.XXX.

ABET Objectives and Outcomes

Accreditation

Our BS program in Materials Science and Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org (http://www.abet.org/).

Program Objectives

The program has as its objectives that within 3 to 5 years, our graduates will:

- be engaged in advanced education, research, and development in materials science and engineering, including materials discovery and/or processing, and in any professional disciplines that benefit from an understanding of MSE.
- employ elements of the materials research process in their careers including the use of:
  - critical reasoning to identify fundamental issues and establish directions for investigation
  - creative processes to define specific plans for problem solution
  - analytical thought to interpret results and place them within a broader context.
  - application of materials solutions to enhance or radically improve existing and future technology
- demonstrate ethical responsibility and an appreciation for the societal and global impact of their endeavors and maintaining their intellectual curiosity through lifelong learning.

Student Outcomes

Students graduating with a B.S. in Materials Science and Engineering will have demonstrated:

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

Enrollments and Graduates

Academic Year	Total Enrollment	BS Degrees Awarded
2014-2015	75	13
2015-2016	72	21
2016-2017	60	12
2017-2018	73	21
2018-2019	73	20
2019-2020	61	10
2020-2021	69	13