MATERIALS SCIENCE AND ENGINEERING, BSE

Degree: Bachelor of Science in Engineering (BSE)
Major: Materials Science and Engineering

Program Overview

The curriculum leading to the Bachelor of Science in Engineering degree with a major in Materials Science and Engineering includes the "Engineering Core" – basic courses in mathematics, physics, chemistry, and engineering along with breadth electives – and the CWRU General Education requirements. To these are added courses in engineering materials, which also allow students to choose one of several areas of concentration within the major. A total of 129 credit hours (units) is required.

Throughout the undergraduate curriculum in Materials Science and Engineering, scientific fundamentals are integrated with coverage of current manufacturing, design, and applications of engineering materials.

The goal of the Department of Materials Science and Engineering is to prepare students for rewarding careers that provide creative, effective solutions to societal needs, through coursework and associated activities that emphasize:

- The interrelationships among the processing, structure, properties, and performance of engineering materials
- The mutual reinforcement of education and professional development throughout one's career

The undergraduate experience in Materials Science and Engineering at Case Western Reserve is marked by a high degree of hands-on experience and many opportunities for professional development before graduation. Lab courses, senior projects, and plant tours ensure that every student sees the field first-hand in current research and industrial settings.

The Bachelor of Science in Engineering degree program with a major in Materials Science and Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org/.

Program Educational Objectives

a. Graduates will take an active part in professional organizations.
b. Graduates will assume leadership positions in materials science related industries.
c. Graduates will be effectively involved in solving technical problems.
d. Graduates may successfully enter and complete graduate and professional degree programs.

Learning Outcomes

As preparation for achieving the above educational objectives, the Bachelor of Science in Engineering degree program with a major in Materials Science and Engineering is designed so that students attain:

- an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- 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
- an ability to communicate effectively with a range of audiences
- 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
- 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
- an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Co-op and Internship Programs

Opportunities are available for students to alternate studies with work in industry or government as a co-op student, which involves paid full-time employment over seven months (one semester and one summer). Students may work in one or two co-ops, beginning in the third year of study. Co-ops provide students the opportunity to gain valuable hands-on experience in their field by completing a significant engineering project while receiving professional mentoring. During a co-op placement, students do not pay tuition but maintain their full-time student status while earning a salary. Learn more at engineering.case.edu/coop. Alternatively or additionally, students may obtain employment as summer interns.

Undergraduate Policies

For undergraduate policies and procedures, please review the Office of Undergraduate Studies section of the General Bulletin.

Accelerated Master's Programs

Undergraduate students may participate in accelerated programs toward graduate or professional degrees. For more information and details of the policies and procedures related to accelerated studies, please visit the Office of Undergraduate Studies section of the General Bulletin.

Program Requirements

Students seeking to complete this major and degree program must meet the general requirements for bachelor's degrees and the general requirements of the Case School of Engineering. Students completing this program as a secondary major while completing another undergraduate degree program do not need to satisfy the latter set of requirements.

Code	Title	Hours
EMSE 110	Transitioning Ideas to Reality I - Materials in Service of Industry and Society	1
EMSE 120	Transitioning Ideas to Reality II - Manufacturing Laboratory	2
EMSE 220	Materials Laboratory I	2
EMSE 228	Mathematical and Computational Methods for Materials Science and Engineering	3

EMSE 276	Materials Properties and Design	3
EMSE 319	Processing and Manufacturing of Materials	3
EMSE 320	Materials Laboratory II	1
EMSE 327	Thermodynamic Stability and Rate Processes	3
EMSE 328	Mesoscale Structural Control of Functional Materials	3
EMSE 330	Materials Laboratory III	2
EMSE 343	Processing of Electronic Materials	3
EMSE 345	Engineered Materials for Biomedical Applications	3
EMSE 349	Role of Materials in Energy and Sustainability	3
EMSE 372	Structural Materials by Design	4
EMSE 379	Design for Lifetime Performance	3
EMSE 398	Senior Project in Materials I	1
EMSE 399	Senior Project in Materials II	2
Related Required Courses		
EMAC 270	Introduction to Polymer Science and Engineering	3
EMAC 276	Polymer Properties and Design	3
Concentration Sequence (details: see below)		12
Total Hours		**60**

Concentration Requirements

The undergraduate program includes courses that expose students to greater depth in areas related to materials science and engineering. These concentration sequences are of two types:

- Students may select an area of concentration that is based on an application or subfield of engineering materials. Each concentration will be a coherent set of courses that, in conjunction with one or more of the courses already required for all EMSE majors plus a specified mathematics/natural science/statistics course, will provide significant depth in an area of materials specialization.
- Students also have the option of designing a concentration — Advanced Materials Science and Engineering — in consultation with their advisors and subject to approval by the department's Undergraduate Studies Committee.

The concentrations are below. All concentrations equal 12 units (four courses).

Biomaterials

Code	Title	Hours
EBME 201	Physiology-Biophysics I *	3
EBME 202	Physiology-Biophysics II *	3
Plus two of the following:		
EBME/EMAC 303	Structure of Biological Materials	3
EBME 305	Materials for Prosthetics and Orthotics	3
EBME 306	Introduction to Biomedical Materials	3
EBME 316	Biomaterials for Drug Delivery	3
EBME 325	Introduction to Tissue Engineering	3
EBME 406/ EMAC 471	Polymers in Medicine	3
EBME/ECSE 480B	The Human Body	3

Electronic Materials

Code	Title	Hours
PHYS 221	Introduction to Modern Physics *	3
Plus 3 (from either or both) of the following 2 categories:		
1. Emphasis on Solid-State Physics		
PHYS 315	Introduction to Solid State Physics	3
PHYS 326	Physical Optics	3
PHYS 327	Laser Physics	3
PHYS 331	Introduction to Quantum Mechanics I	3
2. Emphasis on Electronic Device Technology		
CHEM 340	Solar Energy Conversion	3
ECHE 383	Chemical Engineering Applied to Microfabrication and Devices	3
ECSE 309	Electromagnetic Fields I	3
ECSE 321	Semiconductor Electronic Devices	4
ECSE 322	Integrated Circuits and Electronic Devices	3
EMSE 427	Defects in Solids	3
EMSE 463		3

Materials Data Science

Code	Title	Hours
STAT 312R	Basic Statistics for Engineering and Science Using R Programming	3
DSCI 351M	Exploratory Data Science	3
Plus 2 of the following, of which of 1 should be a DSCI course:		
DSCI 352M	Applied Data Science Research	3
DSCI 353M	Data Science: Statistical Learning, Modeling and Prediction	3
MATH 307	Linear Algebra	3
MATH 304	Discrete Mathematics	3
ECSE 321	Semiconductor Electronic Devices	4
ECSE 322	Integrated Circuits and Electronic Devices	3

Polymers

Code	Title	Hours
CHEM 223	Introductory Organic Chemistry I *	3
or CHEM 323	Organic Chemistry I	
Plus 3 of the following:		
EMAC 351	Physical Chemistry for Engineering	3
EMAC 355	Polymer Analysis Laboratory	3
EMAC 372	Polymer Processing and Testing Laboratory	3
EMAC 375	Fundamentals of Non-Newtonian Fluid Mechanics and Polymer Rheology	3
EMAC 376	Polymer Engineering	3
EMAC 377	Polymer Processing	3
Completion of this concentration (including EMAC 270 and EMAC 276, as required for the major in Materials Science and Engineering) satisfies the requirements for a minor in Polymer Science and Engineering.		
EMAC 270	Introduction to Polymer Science and Engineering	3

Structural Materials and Mechanical Behavior

Code	Title	Hours
STAT 312	Basic Statistics for Engineering and Science *	3
Plus three of the following:		
ECHE 481	Corrosion Fundamentals	3
ECIV 310	Strength of Materials	3
EMAE 370	Design of Mechanical Elements	3
EMSE 417	Properties of Materials in Extreme Environments	3
EMSE 421	Fracture of Materials	3
EMSE 422	Failure Analysis	3
EMSE 427	Defects in Solids	3
EMAE 480	Fatigue of Materials	3

* Satisfies the Mathematics/Science/Statistics requirement of the Case School of Engineering.

Advanced Materials Science and Engineering

Students may satisfy the concentration requirement by taking 9 credit hours (units) of courses from engineering, math, statistics, or natural sciences departments (beyond those specifically required in the curriculum) at the 300 level or above, plus a course to satisfy the Mathematics/Natural Sciences/Statistics requirement in the Engineering Core. The courses are to be selected in consultation with the student's advisor and will be subject to approval by the department's Undergraduate Studies Committee. This option is appropriate for students who desire further study in topics relevant to materials science and engineering that are not represented in the specializations listed above.

Sample Plan of Study

The following is a suggested program of study. Current students should always consult their advisers and their individual graduation requirement plans as tracked in SIS.

First Year		
Fall		**Hours**
SAGES First year Seminar *		4
PHED 1xx Physical Education Activities *		
EMSE 110	Transitioning Ideas to Reality I - Materials in Service of Industry and Society	1
MATH 121	Calculus for Science and Engineering I **	4
CHEM 111	Principles of Chemistry for Engineers **	4
ENGR 131 or ECSE 132	Elementary Computer Programming or Programming in Java	3
	Hours	**16**
Spring		
SAGES University Seminar I *		3
PHED 1xx Physical Education Activities *		
MATH 122	Calculus for Science and Engineering II **	4
ENGR 145	Chemistry of Materials **	4
PHYS 121 or PHYS 123	General Physics I - Mechanics ** or Physics and Frontiers I - Mechanics	4
EMSE 120	Transitioning Ideas to Reality II - Manufacturing Laboratory [b]	2
	Hours	**17**
Second Year		
Fall		
SAGES University Seminar 2 *		3
MATH 223 or MATH 227	Calculus for Science and Engineering III ** or Calculus III	3
PHYS 122 or PHYS 124	General Physics II - Electricity and Magnetism ** or Physics and Frontiers II - Electricity and Magnetism	4
EMSE 276	Materials Properties and Design	3
EMAC 270	Introduction to Polymer Science and Engineering	3
	Hours	**16**
Spring		
ENGL 398	Professional Communication for Engineers **	2
ENGR 398	Professional Communication for Engineers **	1
Breadth elective I **		3
MATH 224 or MATH 228	Elementary Differential Equations ** or Differential Equations	3
ENGR 200	Statics and Strength of Materials **	3
EMSE 220	Materials Laboratory I	2
EMSE 228	Mathematical and Computational Methods for Materials Science and Engineering	3
	Hours	**17**
Third Year		
Fall		
ENGR 225	Thermodynamics, Fluid Dynamics, Heat and Mass Transfer **	4
EMSE 320	Materials Laboratory II	1
EMSE 328	Mesoscale Structural Control of Functional Materials	3
EMSE 372	Structural Materials by Design	4
Concentration I [a]		3
	Hours	**15**
Spring		
Breadth elective II **		3
ENGR 210	Introduction to Circuits and Instrumentation **	4
EMAC 276	Polymer Properties and Design	3
EMSE 327	Thermodynamic Stability and Rate Processes	3
EMSE 330	Materials Laboratory III	2
Concentration II [a]		3
	Hours	**18**
Fourth Year		
Fall		
EMSE 398	Senior Project in Materials I [c]	1

Breadth elective III [**]		3
EMSE 343	Processing of Electronic Materials	3
EMSE 345	Engineered Materials for Biomedical Applications	3
EMSE 349	Role of Materials in Energy and Sustainability	3
Concentration III [a]		3
	Hours	**16**
Spring		
EMSE 399	Senior Project in Materials II [c]	2
Breadth elective IV [**]		3
EMSE 319	Processing and Manufacturing of Materials	3
EMSE 379	Design for Lifetime Performance	3
Concentration IV [a]		3
	Hours	**14**
	Total Hours	**129**

* University general education requirement.

** Engineering general education requirement.

a Actual courses and sequence will vary depending on the concentration chosen; see "Concentrations."

b This requirement may also be met by a minimum of two credit hours (units) selected from EMAE 160, EMSE 125 or EMSE 325.

c SAGES Capstone course.