

# MATERIALS SCIENCE & ENGINEERING, BS

for the degree of Bachelor of Science in Materials Science & Engineering

Materials science and engineering is the basis for all engineering. Improvements in the quality of life require knowledge of the processing and properties of current materials and the design, development and application of new materials. The Materials Science and Engineering (MatSE) curriculum provides an understanding of the underlying principles of synthesis and processing of materials and of the interrelationships between structure, properties, and processing. Students learn how to create advanced materials and systems required, e.g., for flexible electronic displays and photonics that will change communications technologies, for site specific drug delivery, for self-healing materials, for enabling the transition to a hydrogen-based economy, and for more efficient photovoltaics and nuclear systems for energy production. The curriculum uses concepts from both basic physics and chemistry and provides a detailed knowledge of what makes the materials we use every day behave as they do.

Students in the first two years take courses in general areas of science and engineering as well as courses introducing the concepts in MatSE. In the third year, students study the common, central issues related to MatSE. In the senior year, students focus on an area of MatSE of their greatest interest, providing them with the detailed knowledge to be immediately useful to corporations, become entrepreneurs, or to provide the underpinning knowledge for graduate study. Note: students interested in biomaterials take a specific set of courses to provide them with a background in biology and chemistry while maintaining a strong engineering focus.

## Current Program Educational Objectives

for the degree of Bachelor of Science in Materials Science & Engineering

## Graduation Requirements

Minimum hours required for graduation: 128 hours.

**Minimum Overall GPA: 2.0**

## University Requirements

Minimum of 40 hours of upper-division coursework at the 300- and 400-level. from all elements of the degree. These hours can be drawn from all elements of the degree. Students should consult their academic advisor for additional guidance in fulfilling this requirement.

The university and residency requirements can be found in the Student Code (<https://studentcode.illinois.edu/article3/part8/3-801/>) (§ 3-801) and in the Academic Catalog (<http://catalog.illinois.edu/general-information/degree-general-education-requirements/>).

## General Education Requirements

Follows the campus General Education (Gen Ed) requirements (<https://courses.illinois.edu/gened/DEFAULT/DEFAULT/>). Some Gen Ed

requirements may be met by courses required and/or electives in the program.

Code	Title	Hours
	Composition I	4-6
	Advanced Composition	3
	fulfilled by MSE 307 and MSE 308	
	Humanities & the Arts (6 hours)	6
	Natural Sciences & Technology (6 hours)	6
	fulfilled by CHEM 102, CHEM 104, PHYS 211, PHYS 212	
	Social & Behavioral Sciences (6 hours)	6
	Cultural Studies: Non-Western Cultures (1 course)	3
	Cultural Studies: US Minority Cultures (1 course)	3
	Cultural Studies: Western/Comparative Cultures (1 course)	3
	Quantitative Reasoning (2 courses, at least one course must be Quantitative Reasoning I)	6-10
	fulfilled by MATH 221 or MATH 220; MATH 231, MATH 241, MATH 285, PHYS 211, PHYS 212, CS 101	
	Language Requirement (Completion of the third semester or equivalent of a language other than English is required)	0-15

## Materials Science and Engineering Graduation Requirements

### Orientation and Professional Development

Code	Title	Hours
ENG 100	Grainger Engineering Orientation Seminar (External transfer students take ENG 300.)	1
	Recommended, optional 1 credit course, MSE 183 Introductory MatSE Laboratory. Credit hour counts toward free electives.	
<b>Total Hours</b>		<b>1</b>

### Foundational Mathematics and Science

Code	Title	Hours
CHEM 102	General Chemistry I	3
CHEM 103	General Chemistry Lab I	1
CHEM 104	General Chemistry II	3
CHEM 105	General Chemistry Lab II	1
MATH 221	Calculus I (MATH 220 may be substituted. MATH 220 is appropriate for students with no background in calculus. 4 of 5 credit hours count towards degree.)	4
MATH 231	Calculus II	3
MATH 241	Calculus III	4
MATH 257	Linear Algebra with Computational Applications	3
MATH 285	Intro Differential Equations	3
PHYS 211	University Physics: Mechanics	4
PHYS 212	University Physics: Elec & Mag	4
PHYS 214	Univ Physics: Quantum Physics	2
<b>Total Hours</b>		<b>35</b>

## Materials Science and Engineering Technical Core

### For All Students

Code	Title	Hours
CS 101	Intro Computing: Engrg & Sci	3
ECE 205	Electrical and Electronic Circuits	3
MSE 182	Introduction to MatSE	2
MSE 201	Phases and Phase Relations	3
MSE 206	Mechanics for MatSE	4
MSE 307	Materials Laboratory I	3
MSE 308	Materials Laboratory II	3
MSE 494	Materials Design Thinking	1
MSE 495	Materials Design	2
MSE 401	Thermodynamics of Materials	3
MSE 402	Kinetic Processes in Materials	3
MSE 406	Thermal-Mech Behavior of Matls	3
Subtotal Hours of Technical Core for All Students		33

**For the Biomaterials Area**

Code	Title	Hours
CHEM 232	Elementary Organic Chemistry I	3 or 4
IE 300	Analysis of Data (Students in the Biomaterials Area may substitute STAT 400 for IE 300 with permission from the department.)	3
MCB 150	Molec & Cellular Basis of Life	4
MCB 450	Introductory Biochemistry	3
MCB 252	Cells, Tissues & Development	3
MSE 470	Design and Use of Biomaterials	3
<b>Total Hours for the Biomaterials Area</b>		<b>52</b>

**For All Other Areas**

Code	Title	Hours
IE 300	Analysis of Data (The extra hour of credit for STAT 400 may be used to help meet free elective requirements.)	3
or STAT 400	Statistics and Probability I	
MSE 304	Electronic Properties of Matls	3
MSE 405	Microstructure Determination	3
<b>Total Hours for All Other Areas</b>		<b>42</b>

**Technical Electives****For the Biomaterials Area**

Code	Title	Hours
MSE 404	Laboratory Studies in Materials Science and Engineering (Each section of MSE 404 is 1.5 hours. Students take 2 unique sections of MSE 404 for 3 hours.)	3
Topical lecture courses in the Biomaterials Area. See Topical Lecture list below.		5
Topical lecture courses outside of the Biomaterials Area. See Topical Lecture list below.		6
<b>Total Hours</b>		<b>14</b>

**For All Other Areas**

Code	Title	Hours
MSE 404	Laboratory Studies in Materials Science and Engineering (Each section of MSE 404 is 1.5 hours. Students take 4 unique sections of MSE 404 for 6 hours.)	6
Technical electives selected from the following rubrics: ABE, AE, BIOC, BIOE, BIOP, CHBE, CHEM, CEE, CS, CSE, ECE, IE, MATH, MCB, ME, MSE, NPRES, PHYS, SE, TAM, TE. Technical electives must be 200 level or higher courses—excluding independent study, research, or special topics—that do not currently satisfy another requirement. Other courses may be approved by the department.		6
Topical lecture courses. See Topical Lecture list below. No more than 6 hours may be from introductory topical lectures.		12
<b>Total Hours</b>		<b>24</b>

**Topical Lectures**

Code	Title	Hours
<b>Introductory - No more than 2 introductory courses can count for Topical Lecture</b>		
MSE 420	Ceramic Materials & Properties	3
MSE 441	Metals Processing	3
MSE 450	Polymer Science & Engineering	3 or 4
MSE 470	Design and Use of Biomaterials	3
ECE 340	Semiconductor Electronics	3
<b>Biomaterials</b>		
MSE 473	Biomolecular Materials Science	3
MSE 474	Biomaterials and Nanomedicine	3
ABE 446	Biological Nanoengineering	3 or 4
BIOE 416	Biosensors	3
BIOE 461	Cellular Biomechanics	4
BIOE 476	Tissue Engineering	3
BIOE 479	Cancer Nanotechnology	3
BIOE 487	Stem Cell Bioengineering	3 or 4
CHBE 472	Techniques in Biomolecular Eng	3 or 4
CHBE 473	Biomolecular Engineering	3 or 4
CHBE 475	Tissue Engineering	3
ECE 380	Biomedical Imaging	3
ECE 414	Biomedical Instrumentation	3
ECE 415	Biomedical Instrumentation Lab	2
ECE 472	Biomedical Ultrasound Imaging	3
ME 482	Musculoskel Tissue Mechanics	3 or 4
ME 483	Mechanobiology	4
<b>Biomaterials Science - Can only count one science course for Topical Lecture Biomaterials</b>		
BIOC 446	Physical Biochemistry	3
BIOC 455	Technqs Biochem & Biotech	4
BIOP 401	Introduction to Biophysics	3
<b>All Other Areas</b>		
MSE 403	Synthesis of Materials	3
MSE 421	Ceramic Processing	3 or 4
MSE 422	Electrical Ceramics	3
MSE 440	Mechanical Behavior of Metals	3
MSE 443	Design of Engineering Alloys	3
MSE 453	Plastics Engineering	3

MSE 455	Macromolecular Solids	3
MSE 456	Mechanics of Composites	3
MSE 457	Polymer Chemistry	3 or 4
MSE 458	Polymer Physics	3 or 4
MSE 460	Electronic Materials I	3
MSE 461	Electronic Materials II	3
MSE 464	Magnetic Materials and their Applications (Magnetic Materials and their Applications)	3 or 4
MSE 466	Electrochemical Energy Conversion	3
MSE 480	Surfaces and Colloids	3
MSE 481	Electron Microscopy	3
MSE 485	Atomic Scale Simulations	3
MSE 487	Materials for Nanotechnology	3
MSE 488	Optical Materials	3 or 4
MSE 489	Matl Select for Sustainability	3
MSE 498	Special Topics (Modern Methods in Materials Characterization, new course SP 2023)	3
ABE 482	Package Engineering	3
ABE 483	Engineering Properties of Food Materials	3
CEE 401	Concrete Materials	4
CEE 460	Steel Structures I	3
CHBE 458	Synthetic Nanomaterials	3
ECE 441	Physcs & Modeling Semicond Dev	3
ECE 443	LEDs and Solar Cells	4
ECE 444	IC Device Theory & Fabrication	4
ECE 481	Nanotechnology	4
ECE 487	Intro Quantum Electr for EEs	3
ECE 488	Compound Semicond & Devices	3
ECE 495	Photonic Device Laboratory	3
IE 431	Design for Six Sigma	3
ME 431	Mechanical Component Failure	3 or 4
ME 472	Introduction to Tribology	3 or 4
ME 487	MEMS-NEMS Theory & Fabrication	4
NPRE 470	Fuel Cells & Hydrogen Sources	3
SE 412	Nondestructive Evaluation	3 or 4
TAM 451	Intermediate Solid Mechanics	4
TAM 456	Experimental Stress Analysis	3
<b>Science - Can only count one science course for Topical Lecture</b>		
CHEM 436	Fundamental Organic Chem II	3
CHEM 483	Solid State Structural Anlys	4
PHYS 485	Atomic Phys & Quantum Theory	3
PHYS 486	Quantum Physics I	4
PHYS 487	Quantum Physics II	4

**Free Electives**

Code	Title	Hours
	Additional course work, subject to the Grainger College of Engineering restrictions to Free Electives, so that there are at least 128 credit hours earned toward the degree. ( <a href="https://go.grainger.illinois.edu/FreeElectives/">https://go.grainger.illinois.edu/FreeElectives/</a> )	10
<b>Total Hours of Curriculum to Graduate</b>		<b>128</b>

for the degree of Bachelor of Science in Materials Science & Engineering

## Sample Sequence

This sample sequence is intended to be used only as a guide for degree completion. All students should work individually with their academic advisors to decide the actual course selection and sequence that works best for them based on their academic preparation and goals. Enrichment programming such as study abroad, minors, internships, and so on may impact the structure of this four-year plan. Course availability is not guaranteed during the semester indicated in the sample sequence.

The curriculum sequence can also be viewed via dynamic and static curricular maps (Biomaterials (<https://grainger.illinois.edu/academics/undergraduate/majors-and-minors/matse-biomaterials-map/>) and All Other Areas (<https://grainger.illinois.edu/academics/undergraduate/majors-and-minors/matse-all-other-areas-map/>)), which include prerequisite sequencing.

Students must fulfill their Language Other Than English requirement by successfully completing a third level of a language other than English. See the corresponding section on the Degree and General Education Requirements (<http://catalog.illinois.edu/general-information/degree-general-education-requirements/>). MSE 307 and MSE 308 will satisfy technical core requirements and the Campus General Education Advanced Composition requirement.

Free Electives: Additional course work, subject to the Grainger College of Engineering restrictions to Free Electives (<https://go.grainger.illinois.edu/FreeElectives/>), so that there are at least 128 credit hours earned toward the degree.

**First Year**

First Semester	Hours	Second Semester	Hours
MSE 182		2 MSE 183 (Optional, recommended)	1
MATH 221 (MATH 220 may be substituted)		4 MATH 231	3
CHEM 102		3 CHEM 104	3
CHEM 103		1 CHEM 105	1
ENG 100		1 PHYS 211	4
Composition I or General Education (Choose a Humanities or Social/Behavioral Science course)		4-3 General Education (Choose a Humanities or Social/Behavioral Science course) or Composition I course	3-4
		CS 101	3
		<b>15</b>	<b>18</b>

**Second Year**

First Semester	Hours	Second Semester	Hours
MSE 201		3 MSE 206	4
MATH 241		4 MATH 285	3
MATH 257		3 ECE 205	3
PHYS 212		4 PHYS 214	2

General Education course (choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)	3 General Education course (choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)	3
<b>17</b>		<b>15</b>

**Total Hours 65****Biomaterials Area****Third Year**

First Semester	Hours	Second Semester	Hours
MSE 307	3	MSE 308	3
MSE 401	3	MSE 402	3
MSE 406	3	IE 300 (Students in the Biomaterials Area may substitute STAT 400 for IE 300 with permission from the department.)	3
MCB 150	4	MCB 252	3
CHEM 232	3-4	General Education course (choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)	3
<b>16</b>		<b>15</b>	

**Fourth Year**

First Semester	Hours	Second Semester	Hours
MSE 494	1	MSE 495	2
MSE 470	3	Topical Lecture in Biomaterials Area	3
Topical Lecture in Biomaterials Area	2	Topical Lecture outside of Biomaterials Area	3
Topical Lecture outside of Biomaterials Area	3	MSE 404 (Each section of MSE 404 is 1.5 hours. Students take 2 unique sections of MSE 404 for 3 hours.)	3
MCB 450	3	Free elective course	2

Language Other Than English (3rd level) course	4 Free elective course	3
<b>16</b>		<b>16</b>

**Total Hours 63****All Other Areas****Third Year**

First Semester	Hours	Second Semester	Hours
MSE 307	3	MSE 308	3
MSE 401	3	MSE 304	3
MSE 406	3	MSE 402	3
IE 300 (or STAT 400. The extra hour from STAT 400 counts toward free elective.)	3	MSE 405	3
General Education course (choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)	3	Topical Lecture (intro level suggested)	3
<b>15</b>		<b>15</b>	

**Fourth Year**

First Semester	Hours	Second Semester	Hours
MSE 404 (Each section of MSE 404 is 1.5 hours. Students take 2 unique sections of MSE 404 for 3 hours.)	3	MSE 404 (Each section of MSE 404 is 1.5 hours. Students take 2 unique sections of MSE 404 for 3 hours.)	3
MSE 494	1	MSE 495	2
Topical Lecture	3	Topical Lecture	3
Topical Lecture	3	Technical Elective	3
Technical Elective	3	Free elective course	2
Language Other Than English (3rd level) course	4	Free elective course	3
<b>17</b>		<b>16</b>	

**Total Hours 63**

Code	Title	Hours
<b>Total Hours all semesters</b>		<b>128</b>

*for the degree of Bachelor of Science Major in Materials Science & Engineering*

Student learning outcomes are based on learning outcomes in line with the ABET accreditation process.

Materials Science & Engineering graduates will have:

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.

*for the degree of Bachelor of Science in Materials Science & Engineering*

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Materials Science & Engineering Website (<https://matse.illinois.edu/people/faculty/>)

Materials Science & Engineering Faculty

The Grainger College of Engineering Admissions (<https://grainger.illinois.edu/admissions/>)

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