

# MATERIALS SCIENCE AND ENGINEERING, B.S.

Advances in technology are closely linked to the materials that people can design, manipulate, and produce. How we live is connected to our abilities to process materials and manufacture products; to develop and design nontraditional as well as traditional materials for an increasingly broad range of industries; and to research and develop high-performance materials for practical applications in coming decades. The materials that change the way we live may be the next generation of superalloys for applications in extreme conditions such as high-temperature or highly corrosive environments; new materials for application in energy generation, storage, and transmission; organic and inorganic materials for use and integration in applications ranging from electronics to medicine; or new materials systems yet to be developed for the ever-increasing needs of our society. Materials experts find employment in a broad range of industries and may practice experimental, computational, or theoretical materials science and engineering, or all of these in combination. The undergraduate curriculum leads to the Bachelor of Science Degree in Materials Science and Engineering. The curriculum is designed to prepare students with the foundation needed to thrive in broad and rapidly changing industries that are based on materials. It also provides substantial flexibility, through electives and with the assistance of a materials science and engineering faculty advisor, for tailoring to students' specific interests within the materials field. Science, engineering, teamwork, broad thinking, and communication skills all are integral parts of the curriculum. Graduates are well prepared for careers in industry or for graduate studies.

## MATERIALS SCIENCE AND ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES

**Objective 1:** Skills and Tools. Graduates will be applying the tools and skills acquired during their undergraduate experience either in post-graduate educational programs or as employees in materials-related industries.

**Objective 2:** Early Career Growth. Graduates will have experienced professional growth in their chosen post-baccalaureate pursuits, for example, through acquisition of advanced degrees or advancement in employment rank.

**Objective 3:** Professional Citizenship. Graduates will have demonstrated awareness of contemporary issues in technology and society and ethical responsibility.

**Objective 4:** Life-Long Learning. Graduates will have demonstrated a continuing commitment to learning.

## HOW TO GET IN

### ADMISSION TO THE COLLEGE AS A FRESHMAN

Students applying to UW-Madison (<https://www.admissions.wisc.edu/apply/>) need to indicate an engineering major (<https://engineering.wisc.edu/degrees-programs/undergraduate/>) as their first choice in order to be considered for direct admission to the College of Engineering. Direct admission to a major means students will start in the program of their choice in the College of Engineering and will need to meet progression requirements (<https://engineering.wisc.edu/student-services/undergraduate-student-advising/progression/>) at the end of the first year to guarantee advancement in that program.

### CROSS-CAMPUS TRANSFER TO ENGINEERING

UW-Madison students in other schools and colleges on campus must meet minimum admission requirements (<https://engineering.wisc.edu/admissions/undergraduate/cross-campus-students/>) for admission consideration to engineering degree granting classifications. Cross-campus admission is competitive and selective, and the grade point average expectations may increase as demand trends change. The student's overall academic record at UW-Madison is also considered. Students apply to their intended engineering program by submitting the online application by stated deadlines for spring and fall. The College of Engineering offers an online information tutorial and drop-in advising (<https://engineering.wisc.edu/admissions/undergraduate/cross-campus-students/>) for students to learn about the cross-campus transfer process.

### OFF-CAMPUS TRANSFER TO ENGINEERING

With careful planning, students at other accredited institutions can transfer coursework that will apply toward engineering degree requirements at UW-Madison. Off-campus transfer applicants are considered for direct admission to the College of Engineering by applying to the Office of Admissions with an engineering major listed as their first choice. Those who are admitted to their intended engineering program must meet progression requirements (<https://engineering.wisc.edu/admissions/undergraduate/transfer-from-off-campus/>) at the point of transfer or within their first two semesters at UW-Madison to guarantee advancement in that program. A minimum of 30 credits in residence in the College of Engineering is required after transferring, and all students must meet all requirements for their major in the college. Transfer admission to the College of Engineering is competitive and selective, and students who have exceeded the 80 credit limit at the time of application are not eligible to apply.

The College of Engineering has dual degree programs with select four-year UW System campuses. Eligible dual degree applicants are not subject to the 80 credit limit.

Off-campus transfer students are encouraged to discuss their interests, academic background, and admission options with the Transfer Coordinator in the College of Engineering: [ugtransfer@enr.wisc.edu](mailto:ugtransfer@enr.wisc.edu) or 608-262-2473.

### SECOND BACHELOR'S DEGREE

The College of Engineering does not accept second undergraduate degree applications. Second degree student (<https://engineering.wisc.edu/admissions/undergraduate/adult-students-second-degree-students/>)s (<https://engineering.wisc.edu/student-services/undergraduate-student-advising/>) might explore the Biological Systems Engineering program at UW-Madison, an undergraduate engineering degree elsewhere, or a graduate program in the College of Engineering.

## REQUIREMENTS

### UNIVERSITY GENERAL EDUCATION REQUIREMENTS

All undergraduate students at the University of Wisconsin-Madison are required to fulfill a minimum set of common university general education requirements to ensure that every graduate acquires the essential core

of an undergraduate education. This core establishes a foundation for living a productive life, being a citizen of the world, appreciating aesthetic values, and engaging in lifelong learning in a continually changing world. Various schools and colleges will have requirements in addition to the requirements listed below. Consult your advisor for assistance, as needed. For additional information, see the university Undergraduate General Education Requirements (<http://guide.wisc.edu/undergraduate/#requirementsforundergraduatetext>) section of the *Guide*.

General Education	<ul style="list-style-type: none"> <li>• Breadth—Humanities/Literature/Arts: 6 credits</li> <li>• Breadth—Natural Science: 4 to 6 credits, consisting of one 4- or 5-credit course with a laboratory component; or two courses providing a total of 6 credits</li> <li>• Breadth—Social Studies: 3 credits</li> <li>• Communication Part A &amp; Part B *</li> <li>• Ethnic Studies *</li> <li>• Quantitative Reasoning Part A &amp; Part B *</li> </ul>
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\* The mortarboard symbol appears before the title of any course that fulfills one of the Communication Part A or Part B, Ethnic Studies, or Quantitative Reasoning Part A or Part B requirements.

## SUMMARY OF REQUIREMENTS

The following curriculum applies to students admitted to the materials science and engineering degree program (MS&E) in or after fall semester of 2019.

Code	Title	Credits
	Mathematics and Statistics	19
	General Science and Engineering Foundations	25-26
	MS&E Required Courses	45
	Materials Emphasis Elective Requirements	12
	Communication Skills	6
	Liberal Studies	16
	Free Electives	4-5
	<b>Total Credits</b>	<b>At least 128</b>

## MATHEMATICS AND STATISTICS

Code	Title	Credits
MATH 221	Calculus and Analytic Geometry I	5
or MATH 217	Calculus with Algebra and Trigonometry II	
or MATH 275	Topics in Calculus I	
MATH 222	Calculus and Analytic Geometry 2	4
or MATH 276	Topics in Calculus II	
MATH 234	Calculus--Functions of Several Variables	4
MATH 319	Techniques in Ordinary Differential Equations	3
or MATH 320	Linear Algebra and Differential Equations	
STAT 324	Introductory Applied Statistics for Engineers	3
	<b>Total Credits</b>	<b>19</b>

## GENERAL SCIENCE AND ENGINEERING FOUNDATIONS

Code	Title	Credits
<b>Science</b>		
<i>Physics</i>		
PHYSICS 201	General Physics	5
or PHYSICS 207	General Physics	
or PHYSICS 247	A Modern Introduction to Physics	
PHYSICS 202	General Physics	5
or PHYSICS 208	General Physics	
or PHYSICS 248	A Modern Introduction to Physics	
<i>Chemistry</i>		
CHEM 103 & CHEM 104	General Chemistry I and General Chemistry II	5
or CHEM 109	Advanced General Chemistry	
CHEM 343	Organic Chemistry I	3
or CHEM 341	Elementary Organic Chemistry	
<i>Science Elective</i>		
	Select one of the following:	3
CHEM 311	Chemistry Across the Periodic Table	
CHEM 327	Fundamentals of Analytical Science	
CHEM 329	Fundamentals of Analytical Science	
CHEM 345	Organic Chemistry II	
PHYSICS 205	Modern Physics for Engineers	
PHYSICS/ E C E 235	Introduction to Solid State Electronics	
PHYSICS 241	Introduction to Modern Physics	
ZOOLOGY/ BIOLOGY 101	Animal Biology	
ZOOLOGY/ BIOLOGY/ BOTANY 151	Introductory Biology	
ZOOLOGY 153	Introductory Biology	
<b>Engineering Foundation</b>		
<i>Introduction to Engineering</i>		
M S & E 260	Materials Experience (or another CoE Intro to Engineering course)	2
<i>Computer Sciences</i>		
	Select one of the following (COMP SCI 220 preferred):	3-4
COMP SCI 220	Data Science Programming I	
COMP SCI 200	Programming I	
COMP SCI 300	Programming II	
COMP SCI 320	Data Science Programming II	
COMP SCI 400	Programming III	
	<b>Total Credits</b>	<b>25-26</b>
<b>MATERIALS SCIENCE AND ENGINEERING REQUIRED COURSES</b>		
Code	Title	Credits
M S & E 330	Thermodynamics of Materials	4
M S & E 331	Transport Phenomena in Materials	3
M S & E 332	Macroprocessing of Materials	3
M S & E 333	Microprocessing of Materials	3

M S & E 351	Materials Science-Structure and Property Relations in Solids	3
M S & E 352	Materials Science-Transformation of Solids	3
M S & E 360	Materials Laboratory I	2
M S & E 361	Materials Laboratory II	2
M S & E 362	Materials Laboratory III	3
M S & E/CHEM 421	Polymeric Materials	3
M S & E 441	Deformation of Solids	3
M S & E 451	Introduction to Ceramic Materials	3
M S & E 456	Electronic, Optical, and Magnetic Properties of Materials	3
M S & E 460	Introduction to Computational Materials Science and Engineering	3
M S & E 470	Capstone Project I	1
M S & E 471	Capstone Project II	3
<b>Total Credits</b>		<b>45</b>

## MATERIALS SCIENCE AND ENGINEERING EMPHASIS ELECTIVES

Code	Title	Credits
Select 6 credits from: M S & E courses numbered 400 or above, B M E/PHM SCI 430, M E 417, M E 418, or M E 419 <sup>1</sup>		6
Select 6 credits of select engineering, science and math/statistics coursework in consultation with an M S & E faculty advisor <sup>2</sup>		6
<b>Total Credits</b>		<b>12</b>

1

M S & E 699 Independent Study cannot be used to fulfill this requirement.

2

Select 6 credits of coursework from M S & E courses numbered 400 or above, other engineering, Biochemistry, Chemistry, Computer Sciences, Math, Physics, Statistics, or Zoology courses numbered 300 or above, or up to 3 credits of combined M S & E 1 Cooperative Education Program and/or M S & E 699 Independent Study research credit (or from another engineering department). M S & E advisor approval of the set of selections is required. Course sets may be broad-based or concentrated in a subfield of materials science and engineering.

## COMMUNICATION SKILLS

Code	Title	Credits
ENGL 100	Introduction to College Composition	3
or COM ARTS 100	Introduction to Speech Composition	
or LSC 100	Science and Storytelling	
or ESL 118	Academic Writing II	
INTEREGR 397	Engineering Communication	3
<b>Total Credits</b>		<b>6</b>

## LIBERAL STUDIES

Complete 16 credits of liberal studies requirements (<http://guide.wisc.edu/undergraduate/engineering/#requirements>).

- Students must take 16 credits that carry H, S, L, or Z breadth designators. These credits must fulfill the following subrequirements:

1. A minimum of two courses from the same subject area (<https://registrar.wisc.edu/subjectareas/>) (the description before the course number). At least one of these two courses must be designated as above the elementary level (I, A, or D).
2. A minimum of 6 credits designated as humanities (H, L, or Z in the course listing), and an additional minimum of 3 credits designated as social science (S or Z in the course listing). Foreign language courses count as H credits. Retroactive credits for language courses may not be used to meet the Liberal Studies credit requirement (they can be used for subrequirement 1 above).
3. At least 3 credits in courses designated as ethnic studies (lower case "e" in the course listing). These courses may help satisfy subrequirements 1 and 2 above, but they count only once toward the total required. Note: Some courses may have "e" designation but not have H, S, L, or Z designation; these courses do not count toward the Liberal Studies requirement.

## FREE ELECTIVES

Select 4-5 elective credits.

- The above subject requirements can be met with 123 credits of UW courses. Students must complete 128 credits of coursework to earn the B.S. in materials science and engineering. The 4-5 elective credits may be earned by choosing elective courses that carry more credits than the requirement's minimum credit load or by taking any additional coursework of the student's choice.

## UNIVERSITY DEGREE REQUIREMENTS

**Total Degree** To receive a bachelor's degree from UW-Madison, students must earn a minimum of 120 degree credits. The requirements for some programs may exceed 120 degree credits. Students should consult with their college or department advisor for information on specific credit requirements.

**Residency** Degree candidates are required to earn a minimum of 30 credits in residence at UW-Madison. "In residence" means on the UW-Madison campus with an undergraduate degree classification. "In residence" credit also includes UW-Madison courses offered in distance or online formats and credits earned in UW-Madison Study Abroad/Study Away programs.

**Quality of Work** Undergraduate students must maintain the minimum grade point average specified by the school, college, or academic program to remain in good academic standing. Students whose academic performance drops below these minimum thresholds will be placed on academic probation.

## LEARNING OUTCOMES

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

- 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.

## FOUR-YEAR PLAN

### SAMPLE FOUR-YEAR PLAN

#### First Year

Fall	Credits	Spring	Credits
MATH 221		5 MATH 222	4
CHEM 109		5 PHYSICS 201, 207, or 247	5
MS & E 260		2 Science Elective	3
Communications A		3 Liberal Studies Elective	3
Liberal Studies Elective		3	
	<b>18</b>		<b>15</b>

#### Second Year

Fall	Credits	Spring	Credits
MATH 234		4 MATH 319 or 320	3
Computer Science Elective		3 PHYSICS 202, 208, or 248	5
MS & E 330		4 MS & E 352	3
MS & E 351		3 MS & E 361	2
MS & E 360		2 Liberal Studies Elective	3
	<b>16</b>		<b>16</b>

#### Third Year

Fall	Credits	Spring	Credits
CHEM 341 or 343		3 MS & E 331	3
MS & E 332		3 MS & E 333	3
MS & E 362		3 STAT 324	3
MS & E 451		3 Materials Emphasis Elective	3
Liberal Studies Elective		3 Liberal Studies Elective	4
Free Elective		1	
	<b>16</b>		<b>16</b>

#### Fourth Year

Fall	Credits	Spring	Credits
MS & E 456		3 MS & E 471	3
MS & E 470		1 MS & E 441	3
MS & E/CHEM 421		3 MS & E 460	3
Tech Emphasis Elective		3 Materials Emphasis Elective	3
Tech Emphasis Elective		3 INTEREGR 397	3

Free Elective	3	
	<b>16</b>	<b>15</b>

**Total Credits 128**

## ADVISING AND CAREERS

### ADVISING

Each College of Engineering program has academic advisors dedicated to serving its students. Program advisors can help current College of Engineering students with questions about accessing courses, navigating degree requirements, resolving academic issues and more. Students can find their assigned advisor on the homepage of their student center.

### ENGINEERING CAREER SERVICES

Engineering Career Services (ECS) assists students in identifying pre-professional work-based learning experiences such as co-ops and summer internships, considering and applying to graduate or professional school, and finding full-time professional employment during their graduation year.

ECS offers two major career fairs per year, assists with resume writing and interviewing skills, hosts workshops on the job search, and meets one-on-one with students to discuss offer negotiations.

Students are encouraged to utilize the ECS office early in their academic careers. For comprehensive information on ECS programs and workshops, see the ECS website or call 608-262-3471.

## PEOPLE

### PROFESSORS

Izabela Szulfarska (Chair)  
 Michael S. Arnold  
 Susan Babcock  
 Chang-beom Eom  
 Paul Evans  
 Padma Gopalan  
 Sindo Kou  
 Roderic Lakes  
 Dane Morgan  
 John Perepezko  
 Ian Robertson  
 Kumar Sridharan  
 Donald Stone  
 Dan J. Thoma  
 Paul Voyles  
 Xudong Wang

### ASSOCIATE PROFESSORS

Jason Kawasaki

### ASSISTANT PROFESSORS

Dawei Feng  
 Jiamian Hu  
 Fang Liu  
 Hyunseok Oh  
 Daniel Rhodes  
 Jun Xiao

## ASSISTANT TEACHING PROFESSORS

Franklin Hobbs

See also Materials Science and Engineering Faculty Directory (<https://directory.engr.wisc.edu/mse/faculty/>).

## ACCREDITATION

Accreditation.

Accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org> (<http://www.abet.org/>).

Note: Undergraduate Program Educational Objectives and Student Outcomes are made publicly available at the Departmental website. (In this Guide, the program's Student Outcomes are designated by our campus as "Learning Outcomes.")