MATERIALS SCIENCE AND ENGINEERING, B.S.

The Department of Materials Science and Engineering offers B.S., M.S., and Ph.D. degrees in Materials Science and Engineering and an M.S. degree in Nanomaterials and Nanoengineering. The Nanomaterials and Nanoeengineering degree is offered as a one-year name option (within the Materials Science and Engineering M.S. degree program).

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 postgraduate 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://www engr wisc edu/academics/undergraduate-academics/choosing-a-major) 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://www engr wisc edu/academics/student-services/academic-advising/first-year-undergraduate-students/progression-requirements) 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 the course and credit requirements for admission to engineering degree granting classifications specified in the general college requirements (https://www engr wisc edu/academics/student-services/academic-advising/cross-campus-students). The requirements are the minimum for admission consideration. 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://www engr wisc edu/academics/student-services/academic-advising/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://www engr wisc edu/academics/student-services/academic-advising/transfer-students) 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 earned more than 80 transferable semester credits 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: ugrtransfer@engr.wisc.edu or 608-262-2473.

SECOND BACHELOR’S DEGREE

The College of Engineering does not accept second undergraduate degree applications. Second degree students (https://
www.engr.wisc.edu/admissions/undergraduate-admissions/returning-adults-second-degree-students) 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**
  - Breadth—Humanities/Literature/Arts: 6 credits
  - 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
  - Breadth—Social Studies: 3 credits
  - Communication Part A & Part B *
  - Ethnic Studies *
  - Quantitative Reasoning Part A & Part B *

* 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.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics and Statistics</td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>General Science and Engineering Foundations</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>MS&amp;E Required Courses</td>
<td></td>
<td>43</td>
</tr>
<tr>
<td>Materials Emphasis Elective Requirements</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Communication Skills</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Liberal Studies</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Free Electives</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td></td>
<td><strong>128</strong></td>
</tr>
</tbody>
</table>

### MATHEMATICS AND STATISTICS

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 221</td>
<td>Calculus and Analytic Geometry 1</td>
<td>5</td>
</tr>
<tr>
<td>or MATH 217</td>
<td>Calculus with Algebra and Trigonometry II</td>
<td></td>
</tr>
<tr>
<td>or MATH 275</td>
<td>Topics in Calculus I</td>
<td></td>
</tr>
<tr>
<td>MATH 222</td>
<td>Calculus and Analytic Geometry 2</td>
<td>4</td>
</tr>
<tr>
<td>MATH 234</td>
<td>Calculus—Functions of Several Variables</td>
<td></td>
</tr>
<tr>
<td>MATH 319</td>
<td>Techniques in Ordinary Differential Equations</td>
<td></td>
</tr>
<tr>
<td>or MATH 320</td>
<td>Linear Algebra and Differential Equations</td>
<td></td>
</tr>
<tr>
<td>STAT 324</td>
<td>Introductory Applied Statistics for Engineers</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 201</td>
<td>General Physics</td>
<td>5</td>
</tr>
<tr>
<td>or PHYSICS 207</td>
<td>General Physics</td>
<td></td>
</tr>
<tr>
<td>or PHYSICS 247</td>
<td>A Modern Introduction to Physics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 202</td>
<td>General Physics</td>
<td>5</td>
</tr>
<tr>
<td>or PHYSICS 208</td>
<td>General Physics</td>
<td></td>
</tr>
<tr>
<td>or PHYSICS 248</td>
<td>A Modern Introduction to Physics</td>
<td></td>
</tr>
<tr>
<td>CHEM 103 &amp; CHEM 104</td>
<td>General Chemistry I and General Chemistry II</td>
<td>5</td>
</tr>
<tr>
<td>or CHEM 109</td>
<td>Advanced General Chemistry</td>
<td></td>
</tr>
<tr>
<td>CHEM 343</td>
<td>Introductory Organic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>or CHEM 341</td>
<td>Elementary Organic Chemistry</td>
<td></td>
</tr>
</tbody>
</table>

### GENERAL SCIENCE AND ENGINEERING FOUNDATIONS

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 205</td>
<td>Modern Physics for Engineers</td>
<td></td>
</tr>
<tr>
<td>or PHYSICS/ECE 235</td>
<td>Introduction to Solid State Electronics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 241</td>
<td>Introduction to Modern Physics</td>
<td></td>
</tr>
<tr>
<td>ZOOLOGY/BIOLOGY 101</td>
<td>Animal Biology</td>
<td></td>
</tr>
<tr>
<td>ZOOLOGY/BIOLOGY/BOTANY 151</td>
<td>Introductory Biology</td>
<td></td>
</tr>
<tr>
<td>ZOOLOGY 153</td>
<td>Introductory Biology</td>
<td></td>
</tr>
</tbody>
</table>

### Engineering Foundation

- **Introduction to Engineering**
  - M S & E 260 | Materials Experience (or another CoE Intro to Engineering course) | 2       |

### Computer Sciences

- Select one of the following: 3
  - COMP SCI 200 | Programming I                                   |         |
  - COMP SCI 300 | Programming II                                  |         |
  - COMP SCI 301 | Introduction to Data Programming                 |         |
  - COMP SCI 310 | Problem Solving Using Computers                  |         |
MATERIALS SCIENCE AND ENGINEERING REQUIRED COURSES

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>M S &amp; E 330</td>
<td>Thermodynamics of Materials</td>
<td>4</td>
</tr>
<tr>
<td>M S &amp; E 331</td>
<td>Transport Phenomena in Materials</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 332</td>
<td>Macroprocessing of Materials</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 333</td>
<td>Microprocessing of Materials</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 351</td>
<td>Materials Science-Structure and Property Relations in Solids</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 352</td>
<td>Materials Science-Transformation of Solids</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 360</td>
<td>Materials Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>M S &amp; E 361</td>
<td>Materials Laboratory II</td>
<td>2</td>
</tr>
<tr>
<td>M S &amp; E 362</td>
<td>Materials Laboratory III</td>
<td>2</td>
</tr>
<tr>
<td>M S &amp; E/ CHEM 421</td>
<td>Polymeric Materials</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 441</td>
<td>Deformation of Solids</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 451</td>
<td>Introduction to Ceramic Materials</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 456</td>
<td>Electronic, Optical, and Magnetic Properties of Materials</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 460</td>
<td>Introduction to Computational Materials Science and Engineering</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 470</td>
<td>Capstone Project I</td>
<td>1</td>
</tr>
<tr>
<td>M S &amp; E 471</td>
<td>Capstone Project II</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credits: 43

MATERIALS SCIENCE AND ENGINEERING EMPHASIS ELECTIVES

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

Select 6 credits of select engineering, science and math/statistics coursework in consultation with an M S & E faculty advisor

Total Credits: 12

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 100</td>
<td>Introduction to College Composition</td>
<td>3</td>
</tr>
<tr>
<td>or COM ARTS 100</td>
<td>Introduction to Speech Composition</td>
<td></td>
</tr>
<tr>
<td>or LSC 100</td>
<td>Science and Storytelling</td>
<td></td>
</tr>
<tr>
<td>or ESL 118</td>
<td>Academic Writing II</td>
<td></td>
</tr>
</tbody>
</table>

or E P D 397 | Technical Communication | 3 |

Total Credits: 6

LIBERAL STUDIES

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

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 department or program. 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 7 elective credits.

The above subject requirements can be met with 121 credits of UW courses. Students must complete 128 credits of coursework to earn the B.S. in materials science and engineering. The 7 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
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.

FOUR-YEAR PLAN

SAMPLE FOUR-YEAR PLAN

**First Year**

<table>
<thead>
<tr>
<th>Credits</th>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 221</td>
<td>5</td>
<td>MATH 222</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 109</td>
<td>5</td>
<td>PHYSICS 201, 207, or 247</td>
<td>5</td>
</tr>
<tr>
<td>M S &amp; E 260</td>
<td>2</td>
<td>Science Elective</td>
<td>3</td>
</tr>
<tr>
<td>Communications A</td>
<td>3</td>
<td>Liberal Studies Elective</td>
<td>3</td>
</tr>
<tr>
<td>Liberal Studies Elective</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td><strong>18</strong></td>
<td><strong>15</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Second Year**

<table>
<thead>
<tr>
<th>Credits</th>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 234</td>
<td>4</td>
<td>MATH 319 or 320</td>
<td>3</td>
</tr>
<tr>
<td>Computer Science Elective</td>
<td>3</td>
<td>PHYSICS 202, 208, or 248</td>
<td>5</td>
</tr>
<tr>
<td>M S &amp; E 330</td>
<td>4</td>
<td>M S &amp; E 352</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 351</td>
<td>3</td>
<td>M S &amp; E 361</td>
<td>2</td>
</tr>
<tr>
<td>M S &amp; E 360</td>
<td>1</td>
<td>Liberal Studies Elective</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td><strong>15</strong></td>
<td><strong>16</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Third Year**

<table>
<thead>
<tr>
<th>Credits</th>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 341 or 343</td>
<td>3</td>
<td>M S &amp; E 331</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 332</td>
<td>3</td>
<td>M S &amp; E 333</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 362</td>
<td>2</td>
<td>M S &amp; E/CHEM 421</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 451</td>
<td>3</td>
<td>STAT 324</td>
<td>3</td>
</tr>
<tr>
<td>Liberal Studies Elective</td>
<td>3</td>
<td>Liberal Studies Elective</td>
<td>4</td>
</tr>
<tr>
<td>Free Elective</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td><strong>17</strong></td>
<td><strong>16</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Fourth Year**

<table>
<thead>
<tr>
<th>Credits</th>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>M S &amp; E 456</td>
<td>3</td>
<td>M S &amp; E 471</td>
<td>3</td>
</tr>
<tr>
<td>M S &amp; E 470</td>
<td>1</td>
<td>M S &amp; E 441</td>
<td>3</td>
</tr>
<tr>
<td>Tech Emphasis Elective</td>
<td>3</td>
<td>M S &amp; E 460</td>
<td>3</td>
</tr>
<tr>
<td>Tech Emphasis Elective</td>
<td>3</td>
<td>Materials Emphasis Elective</td>
<td>3</td>
</tr>
<tr>
<td>Materials Emphasis Elective</td>
<td>3</td>
<td>E P D 397</td>
<td>3</td>
</tr>
<tr>
<td>Free Elective</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td><strong>16</strong></td>
<td><strong>15</strong></td>
<td></td>
</tr>
</tbody>
</table>

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

Arnold Babcock (chair)
Eom Evans
Gopalan Kou
Lakes Morgan
Perepezko Robertson
Stone Szlufarska
Thoma Voyles
Wang
ASSISTANT PROFESSORS
Feng Hu Kawasaki

ACCREDITATION

Accreditation.


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.")