

MATERIALS SCIENCE AND ENGINEERING, B.S.

Begin Campus: Any Penn State Campus

End Campus: University Park

Program Description

Materials, like ceramics, metals, polymers, and composites, are critical to the growth and success of many industries and key to most engineering disciplines. Graduates of Materials Science and Engineering are employed, or proceed to graduate studies, in many fields such as energy, medicine, sustainability, electronics, communications, transportation, aerospace, defense, and infrastructure industries.

The mission of the department is to provide students with a well-rounded engineering education, with specific emphasis on materials science and engineering in order to meet the needs of industry, academia, and government; to conduct research at the frontiers of the field; and to provide an integrating and leadership role to the broad multidisciplinary materials community.

What is Materials Science and Engineering?

Materials are ubiquitous. Materials play a role in every industry and facet of life. Materials science and engineering is an interdisciplinary study of the properties of matter and the exploration for new and creative uses of ceramics, metals, polymers, and composites. Materials scientists and engineers study the entire life cycle of materials (production, synthesis and processing, manufacturing, use, recycling, and reclamation) by employing science to solve engineering problems. This engineering discipline is unique in that our studies begin with understanding materials at the atomic scale, allowing for prediction and measurement of material properties, and creation of materials by design. What do you want to do with your career? Make alternative energy more economical? Improve human health, cure cancer? Provide clean drinking water to the world? Make transportation more efficient and environmentally friendly? Make everyday materials more sustainable? All these outcomes and more are possible by studying materials.

You Might Like This Program If...

- You like some combination of chemistry, physics, and math and want to be an engineer.
- You would like to understand why a material is chosen for a specific use or why materials behave the way they do.
- You like problem solving by utilizing existing materials in new creative ways or creating new materials to solve unique engineering challenges.
- You want an engineering degree that can take you to any industry, anywhere in the world.

Entrance to Major

In order to be eligible for entrance to the Materials Science and Engineering major, a student must have:

1. Attained at least a 2.00 cumulative grade-point average.
2. Completed CHEM 110, CHEM 111, CHEM 112, CHEM 113, MATH 140, MATH 141, MATH 220 and PHYS 211; earned a grade of C or better in

each of these courses; and earned a combined grade point average of at least 2.50 in these courses. (Note: If courses are repeated, only the higher grade will be used in this calculation.)

Degree Requirements

For the Bachelor of Science degree in Materials Science and Engineering, a minimum of 131 credits is required:

Requirement	Credits
General Education	45
Requirements for the Major	110

General Education

Connecting career and curiosity, the General Education curriculum provides the opportunity for students to acquire transferable skills necessary to be successful in the future and to thrive while living in interconnected contexts. General Education aids students in developing intellectual curiosity, a strengthened ability to think, and a deeper sense of aesthetic appreciation. These are requirements for all baccalaureate students and are often partially incorporated into the requirements of a program. For additional information, see the General Education Requirements (<http://bulletins.psu.edu/undergraduate/general-education/baccalaureate-degree-general-education-program>) section of the Bulletin and consult your academic adviser.

The keystone symbol appears next to the title of any course that is designated as a General Education course. Program requirements may also satisfy General Education requirements and vary for each program.

Foundations (grade of C or better is required.)

- **Quantification (GQ):** 6 credits
- **Writing and Speaking (GWS):** 9 credits

Knowledge Domains

- **Arts (GA):** 6 credits
- **Health and Wellness (GHW):** 3 credits
- **Humanities (GH):** 6 credits
- **Social and Behavioral Sciences (GS):** 6 credits
- **Natural Sciences (GN):** 9 credits

Integrative Studies (may also complete a Knowledge Domain requirement)

- **Inter-Domain or Approved Linked Courses:** 6 credits

24 of these 45 credits are included in the Requirements for the Major.

Note: The Accreditation Board for Engineering and Technology (ABET) does not permit the use of skills courses to satisfy the Arts category of General Education.

University Degree Requirements

First Year Engagement

All students enrolled in a college or the Division of Undergraduate Studies at University Park, and the World Campus are required to take 1 to 3 credits of the First-Year Seminar, as specified by their college First-Year Engagement Plan.

Other Penn State colleges and campuses may require the First-Year Seminar; colleges and campuses that do not require a First-Year Seminar provide students with a first-year engagement experience.

First-year baccalaureate students entering Penn State should consult their academic adviser for these requirements.

Cultures Requirement

6 credits are required and may satisfy other requirements

- United States Cultures: 3 credits
- International Cultures: 3 credits

Writing Across the Curriculum

3 credits required from the college of graduation and likely prescribed as part of major requirements.

Total Minimum Credits

A minimum of 120 degree credits must be earned for a baccalaureate degree. The requirements for some programs may exceed 120 credits. Students should consult with their college or department adviser for information on specific credit requirements.

Quality of Work

Candidates must complete the degree requirements for their major and earn at least a 2.00 grade-point average for all courses completed within their degree program.

Limitations on Source and Time for Credit Acquisition

The college dean or campus chancellor and program faculty may require up to 24 credits of course work in the major to be taken at the location or in the college or program where the degree is earned. Credit used toward degree programs may need to be earned from a particular source or within time constraints (see Senate Policy 83-80 (<http://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#83-80>)). For more information, check the Suggested Academic Plan for your intended program.

Requirements for the Major

This includes 24 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 9 credits of GWS courses.

To graduate, a student enrolled in the major must earn a grade of C or better in each course designated by the major as a C-required course, as specified by Senate Policy 82-44 (<http://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#82-44>).

Code	Title	Credits
Prescribed Courses		
CHEM 110	Chemical Principles I	3
CHEM 111	Experimental Chemistry I	1
CHEM 113	Experimental Chemistry II	1
CHEM 202	Fundamentals of Organic Chemistry I	3
CMPSC 200	Programming for Engineers with MATLAB	3
EMSC 100S	Earth and Mineral Sciences First-Year Seminar ¹	3
MATH 140G	Calculus with Earth and Mineral Sciences Applications I	4
MATH 141G	Calculus with Earth and Mineral Sciences Applications II	4
MATH 220	Matrices	2
MATH 231	Calculus of Several Variables	2
MATH 251	Ordinary and Partial Differential Equations	4
MATSE 112	Applied Materials Chemistry for Engineers	3
PHYS 211	General Physics: Mechanics	4

PHYS 212	General Physics: Electricity and Magnetism	4
IE 424	Process Quality Engineering	3
MATSE 413	Solid-State Materials	3
ENGL 202C	Effective Writing: Technical Writing	3
MATSE 419	Computational Materials Science and Engineering	3
MATSE 436	Mechanical Properties of Materials	3
MATSE 460	Introductory Laboratory in Materials	1
MATSE 462	General Properties Laboratory in Materials	1

Prescribed Courses: Require a grade of C or better

MATSE 201	Introduction to Materials Science	3
MATSE 202	Introduction to Polymer Materials	3
MATSE 400	Crystal Chemistry	3
MATSE 401	Thermodynamics of Materials	3
MATSE 402	Materials Process Kinetics	3
MATSE 430	Materials Characterization	3
MATSE 492	Materials Engineering Methodology and Design	3

Additional Courses

ENGL 15	Rhetoric and Composition	3
or ENGL 30	Honors Freshman Composition	

Synthesis and Processing

Select 3-6 credits of the following:		3-6
MATSE 411	Processing of Ceramics	
MATSE 422	Thermochemical Processing	
MATSE 425	Processing of Metals	
MATSE 441	Polymeric Materials I	
MATSE 448	Polymer Processing Technology	
MATSE 450	Synthesis and Processing of Electronic and Photonic Materials	

Structure and Characterization

Select 3-6 credits of the following:		3-6
MATSE 410	Phase Relations in Materials Systems	
MATSE 415	Introduction to Glass Science	
MATSE 421	Corrosion Engineering	
MATSE 444	Solid State Properties of Polymeric Materials	
MATSE 445	Thermodynamics, Microstructure, and Characterization of Polymers	
MATSE 455	Properties and Characterization of Electronic and Photonic Materials	

Properties

Select 3-6 credits of the following:		3-6
MATSE 412	Thermal Properties of Materials	
MATSE 417	Electrical and Magnetic Properties	
MATSE 435	Optical Properties of Materials	
MATSE 446	Mechanical and Electrical Properties of Polymers and Composites	
MATSE 447	Rheology and Processing of Polymers	

Processing Laboratory

Select one of the following:		1
MATSE 463	Characterization and Processing of Electronic and Photonic Materials Laboratory	
MATSE 468	Ceramics Laboratory III	
MATSE 472	Metallurgy Laboratory II	
MATSE 474	Polymeric Materials Laboratory--Characterization	

Senior Capstone Experience

MATSE 493	Materials Science and Engineering Multidisciplinary Capstone Design Project	3
	or MATSE 494W Research and Design Senior Project	

Supporting Courses and Related Areas

Select 12 credits of approved Science or Engineering Elective courses in consultation with adviser	12
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¹ The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 or ENGL 202C can be substituted for EMSC 100S.

Program Educational Objectives

The educational objectives of the undergraduate program are embedded into our mission statement. We will provide and maintain a curriculum that will prepare our recent graduates to accomplish the following Program Educational Objectives:

1. Our graduates provide science and engineering leadership in international industrial, governmental, and academic settings, while serving both their profession and the public.
2. Our graduates are innovators in a wide variety of technical fields including, but not limited to, materials, energy, electronics, medicine communications, transportation, and recreation.
3. Our graduates excel in careers relating to the entire life cycle of materials, from synthesis and processing, through design and development, to manufacturing, performance, reclamation, and recycling.
4. Our graduates engage in lifelong learning activities which enhance their careers and provide flexibility to respond to changing professional and societal needs.

We achieve these objectives by providing a rigorous but flexible curriculum that allows the student to design their degree in materials science and engineering to achieve their specific academic and professional career interests.

In addition to the cutting edge curriculum, we provide many opportunities to strengthen the student's undergraduate studies through research experiences. For example, over 60% of the undergraduates are members of a research group and participate in the extensive materials research programs at Penn State. Further, we provide opportunities for International Internships in Materials, where our students go abroad to perform research at one of the many internationally recognized partner universities in Europe and Asia.

Student Outcomes

The integration of knowledge and skills acquired during the course of study in the Materials Science and Engineering program provides graduates with the following student outcomes:

- a. Graduates will be able to apply knowledge of mathematics and advanced science and engineering principles to materials systems.
- b. Graduates will be able to design and conduct experiments and to analyze and interpret data.
- c. Graduates will be able to design a process, a microstructure, or a component to satisfy system needs.
- d. Graduates will be able to function on multi-disciplinary teams.
- e. Graduates will be able to identify, formulate, and solve engineering problems.

- f. Graduates will understand professional and ethical responsibility.
- g. Graduates will be able to communicate effectively, both in writing and in speech.
- h. Graduates will possess the broad education necessary to understand the impact of engineering solutions in a global and societal context.
- i. Graduates will recognize the need for, and be able to engage in, lifelong learning.
- j. Graduates will have a knowledge of contemporary issues.
- k. Graduates will be able to use the experimental, analytical, statistical, and computational tools for engineering practice in the materials discipline.
- l. Graduates will be able to apply the fundamental principles underlying and connecting the structure, processing, properties, and performance of materials systems.

Academic Advising

The objectives of the university's academic advising program are to help advisees identify and achieve their academic goals, to promote their intellectual discovery, and to encourage students to take advantage of both in-and out-of class educational opportunities in order that they become self-directed learners and decision makers.

Both advisers and advisees share responsibility for making the advising relationship succeed. By encouraging their advisees to become engaged in their education, to meet their educational goals, and to develop the habit of learning, advisers assume a significant educational role. The advisee's unit of enrollment will provide each advisee with a primary academic adviser, the information need to plan the chosen program of study, and referrals to other specialized resources.

READ SENATE POLICY 32-00: ADVISING POLICY (<http://senate.psu.edu/policies-and-rules-for-undergraduate-students/32-00-advising-policy>)

University Park

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Suggested Academic Plan

University Park Campus

The course series listed below provides **only one** of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an **Academic Requirements** or **What If** report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

First Year

Fall	Credits Spring	Credits
MATH 140 or 140G (GQ) ^{*†#†2}	4 MATH 141 or 141G (GQ) ^{*†#†2}	4
CHEM 110 (GN) ^{*#†2}	3 MATSE 112 or CHEM 112 (GN) ^{*#2}	3
CHEM 111 (GN) ^{*#†2}	1 CHEM 113 ^{*#2}	1

General Education Knowledge Domain	3 PHYS 211 (GN) ^{*#†2}	4
General Education Knowledge Domain	3 ENGL 15, 30, or ESL 15 (GWS) ^{††}	3
EMSC 100S (or CAS 100 by substitution) (GWS) ^{††1}	3	
	17	15

Second Year

Fall	Credits Spring	Credits
PHYS 212 (GN) [†]	4 IE 424	3
CHEM 202	3 MATH 251	4
MATH 220 ^{*#2}	2 CMPSC 200	3
MATH 231	2 MATSE 202 [*]	3
General Education Knowledge Domain	3 MATSE 413	3
MATSE 201 [*]	3	
	17	16

Third Year

Fall	Credits Spring	Credits
MATSE 400 [*]	3 MATSE 402 [*]	3
MATSE 401 [*]	3 MATSE 419	3
MATSE 430 [*]	3 MATSE 492 (Writing across the curriculum) [*]	3
MATSE 460	1 MATSE 462	1
MATSE 436	3 MATSE Specialization Course 1 from Department List	3
ENGL 202C (GWS) ^{††}	3 General Education Knowledge Domain	3
	General Education Health and Wellness (GHW)	1.5
	16	17.5

Fourth Year

Fall	Credits Spring	Credits
MATSE 494W or 493 (Writing across the curriculum, can be taken fall or spring of fourth year)	0-3 MATSE 494W or 493 (Writing across the curriculum, can be taken fall or spring of fourth year)	3-0
MATSE Specialization Course 2 from Department List	3 MATSE Specialization Course 5 from Department List	3
MATSE Specialization Course 3 from Department List	3 MATSE Specialization Course 6 from Department List	3
MATSE Specialization Course 4 from Department List	3 MATSE Specialization Course 7 from Department List	3
Materials Senior Processing Laboratory (can be taken fall or spring of fourth year)	0-1 MATSE Specialization Course 8 from Department List	3
General Education Knowledge Domain	3 Materials Senior Processing Laboratory (can be taken fall or spring of fourth year)	1-0

General Education Health and Wellness (GHW)	1.5 General Education Knowledge Domain	3
	13.5-17.5	19-15
Total Credits 131		

* Course requires a grade of C or better for the major

‡ Course requires a grade of C or better for General Education

Course is an Entrance to Major requirement

† Course satisfies General Education and degree requirement

University Requirements and General Education Notes:

US and IL are abbreviations used to designate courses that satisfy University Requirements (United States and International Cultures).

W, M, X, and Y are the suffixes at the end of a course number used to designate courses that satisfy University Writing Across the Curriculum requirement.

GWS, GQ, GHW, GN, GA, GH, and GS are abbreviations used to identify General Education program courses. General Education includes Foundations (GWS and GQ) and Knowledge Domains (GHW, GN, GA, GH, GS, and Integrative Studies). Foundations courses (GWS and GQ) require a grade of 'C' or better.

Integrative Studies courses are required for the General Education program. N is the suffix at the end of a course number used to designate an Inter-Domain course and Z is the suffix at the end of a course number used to designate a Linked course.

All incoming Schreyer Honors College first-year students at University Park will take ENGL/CAS 137 in the fall semester and ENGL/CAS 138 in the spring semester. These courses carry the GWS designation and replace both ENGL 30 and CAS 100. Each course is 3 credits.

- Students who begin their studies at non-UP locations and/or join the college after their first year should substitute CAS 100, CAS 100A, CAS 100B, or CAS 100C (GWS) for EMSC 100S (GWS). EMSC 100S Earth and Mineral Sciences First year Seminar (3) is a required course only for students who begin their studies at UP in the College of Earth and Mineral Sciences.
- In order to be eligible for entrance to the Materials Science and Engineering major, a student must have: 1) Attained at least a 2.00 cumulative grade-point average. 2) Completed CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), MATH 140 GQ(4), MATH 141 GQ(4), MATH 220(2) and PHYS 211(4); earned a grade of C or better in each of these courses; and earned a combined grade point average of at least 2.50 in these courses. (Note: If courses are repeated, only the higher grade will be used in this calculation.)

Advising Notes:

In order to be eligible for entrance to the Materials Science and Engineering major, a student must have: 1) Attained at least a 2.00 cumulative grade-point average. 2) Completed CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), MATH 140 GQ(4), MATH 141 GQ(4), MATH 220(2) and PHYS 211(4); earned a grade of C or better in each of these courses; and earned a combined grade point average

of at least 2.50 in these courses. (Note: If courses are repeated, only the higher grade will be used in this calculation.)

Courses required for the major may be offered fall semester only, spring semester only, or both fall and spring semesters. Consult with your adviser and department to discuss your academic progress and course sequencing.

Commonwealth Campuses

The course series listed below provides **only one** of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an **Academic Requirements** or **What If** report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

First Year

Fall	Credits	Spring	Credits
MATH 140 (GQ) ^{†##2}	4	MATH 141 (GQ) ^{†##2}	4
CHEM 110 (GN) ^{**#2}	3	MATSE 112 or CHEM 112 (GN) ^{**#2}	3
CHEM 111 (GN) ^{**#2}	1	CHEM 113 ^{**#2}	1
CAS 100, 100A, 100B, or 100C (GWS) ^{††1}	3	PHYS 211 (GN) ^{**#2}	4
General Education Knowledge Domain	3	ENGL 15, 30, or ESL 15 (GWS) ^{††}	3
General Education Knowledge Domain	3	General Education Health and Wellness (GHW)	1.5
	17		16.5

Second Year

Fall	Credits	Spring	Credits
PHYS 212 (GN) [†]	4	ENGL 202C (GWS) ^{††}	3
CHEM 202	3	MATH 251	4
MATH 220 ^{**#2}	2	MATSE 202 (online) [*]	3
MATH 231	2	General Education Knowledge Domain	3
MATSE 201 (online) [*]	3	General Education Knowledge Domain	3
General Education Knowledge Domain	3	General Education Health and Wellness (GHW)	1.5
	17		17.5

Third Year

Fall	Credits	Spring	Credits
MATSE 400 [*]	3	MATSE 402 [*]	3
MATSE 401 [*]	3	MATSE 419	3
MATSE 430 [*]	3	MATSE 492 (Writing across the curriculum) [*]	3
MATSE 460	1	MATSE 462	1
MATSE 436	3	MATSE 413	3
CMPSC 200	3	MATSE Specialization Course 1 from Department List	3
	16		16

Fourth Year

Fall	Credits	Spring	Credits
MATSE 494W or 493 (Writing across the curriculum, can be taken fall or spring of fourth year)	0-3	MATSE 494W or 493 (Writing across the curriculum, can be taken fall or spring of fourth year)	3-0
MATSE Specialization Course 2 from Department List	3	MATSE Specialization Course 5 from Department List	3
MATSE Specialization Course 3 from Department List	3	MATSE Specialization Course 6 from Department List	3
MATSE Specialization Course 4 from Department List	3	MATSE Specialization Course 7 from Department List	3
Materials Senior Processing Laboratory	1	MATSE Specialization Course 8 from Department List	3
IE 424	3	General Education Knowledge Domain	3
	13-16		18-15

Total Credits 131

* Course requires a grade of C or better for the major

‡ Course requires a grade of C or better for General Education

Course is an Entrance to Major requirement

† Course satisfies General Education and degree requirement

University Requirements and General Education Notes:

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GWS, GQ, GHW, GN, GA, GH, and GS are abbreviations used to identify General Education program courses. General Education includes Foundations (GWS and GQ) and Knowledge Domains (GHW, GN, GA, GH, GS, and Integrative Studies). Foundations courses (GWS and GQ) require a grade of 'C' or better.

Integrative Studies courses are required for the General Education program. N is the suffix at the end of a course number used to designate an Inter-Domain course and Z is the suffix at the end of a course number used to designate a Linked course.

¹ Students who begin their studies at non-UP locations and/or join the college after their first year should substitute CAS 100, CAS 100A, CAS 100B, or CAS 100C (GWS) for EM SC 100S (GWS). EMSC 100S Earth and Mineral Sciences First year Seminar (3) is a required course only for students who begin their studies at UP in the College of Earth and Mineral Sciences.

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Advising Notes:

In order to be eligible for entrance to the Materials Science and Engineering major, a student must have: 1) Attained at least a 2.00 cumulative grade-point average. 2) Completed CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), MATH 140 GQ(4), MATH 141 GQ(4), MATH 220(2) and PHYS 211(4); earned a grade of C or better in each of these courses; and earned a combined grade point average of at least 2.50 in these courses. (Note: If courses are repeated, only the higher grade will be used in this calculation.)

Courses required for the major may be offered fall semester only, spring semester only, or both fall and spring semesters. Consult with your adviser and department to discuss your academic progress and course sequencing.

Career Paths

Because all industries rely on materials, materials science and engineering graduates find employment in numerous fields, both within traditional engineering domains and in arenas outside of those traditional engineering disciplines.

Careers

Graduates may find work in industries such as manufacturing, materials production, transportation, consulting, energy, environmental solutions, medical, and more. Careers within these industries encompass such areas as research and development, product design and production, quality control, and sales.

MORE INFORMATION (<http://www.matse.psu.edu/undergraduate/internships-and-careers>)

Opportunities for Graduate Studies

Graduates seeking higher-level degrees typically stay in materials science and engineering. However, many students have gone to pursue graduate degrees in many different engineering and basic science areas, as well as medicine and law. On average, 50 percent of our graduates will go on to graduate studies.

MORE INFORMATION (<http://www.matse.psu.edu/graduate>)

Professional Resources

- Material Advantage Penn State Chapter (<https://sites.psu.edu/materialadvantage>)
- MatSE Lion Scouts (<http://www.matse.psu.edu/undergraduate/student-organizations>)
- Keramos National Professional Ceramic Engineering Fraternity (<http://ceramics.org/classes/keramos>)

Accreditation

This baccalaureate program in Materials Science and Engineering is accredited by the Engineering Accreditation Commission of ABET, Inc., www.abet.org. (<http://www.abet.org>)

Contact

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