

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

24 of the 45 credits for General Education are included in the Requirements for the Major. This includes: 9 credits of GN courses; 6 credits of GQ courses; 9 credits of GWS courses.

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.

Requirements for the Major

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 (<https://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
ENGL 202C	Effective Writing: Technical Writing	3
IE 424	Process Quality Engineering	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
MATSE 413	Solid-State Materials	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
PHYS 211	General Physics: Mechanics	4
PHYS 212	General Physics: Electricity and Magnetism	4
<i>Prescribed Courses: Require a grade of C or better</i>		
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 492W	Materials Engineering Methodology and Design	3

Additional Courses

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

Synthesis and Processing

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

Structure and Characterization

Select 3-6 credits of the following:	3-6
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MATSE 410	Phase Relations in Materials Systems
MATSE 415	Introduction to Glass Science
MATSE 421	Corrosion Engineering
MATSE 444	
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
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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
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MATSE 463	Characterization and Processing of Electronic and Photonic Materials Laboratory
MATSE 468	Ceramics Laboratory III
MATSE 472	
MATSE 474	

Senior Capstone Experience

MATSE 493W	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.

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 (<https://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 and Inter-Domain courses do not meet this requirement.)

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

Breadth in the Knowledge Domains (Inter-Domain courses do not meet this requirement.)

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

Integrative Studies

- **Inter-Domain Courses (Inter-Domain):** 6 credits

Exploration

- **GN**, may be completed with Inter-Domain courses: 3 credits
- **GA, GH, GN, GS, Inter-Domain courses.** This may include 3 credits of World Language course work beyond the 12th credit level or the requirements for the student's degree program, whichever is higher: 6 credits

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 (<https://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.

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

Student outcomes describe what students are expected to know and be able to do by the time of graduation. The Materials Science and Engineering program is designed to enable students to:

1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. 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. Communicate effectively with a range of audiences
4. 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. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. Acquire and apply new knowledge as needed, using appropriate learning strategies.

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 needed to plan the chosen program of study, and referrals to other specialized resources.

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

University Park

Office of Undergraduate Studies

Department of Materials Science and Engineering

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Suggested Academic Plan

The suggested academic plan(s) listed on this page are the plan(s) that are in effect during the 2023-24 academic year. To access previous years' suggested academic plans, please visit the archive (<https://bulletins.psu.edu/undergraduate/archive/>) to view the appropriate Undergraduate Bulletin edition (*Note: the archive only contains suggested academic plans beginning with the 2018-19 edition of the Undergraduate Bulletin*).

Materials Science and Engineering, B.S. at 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
EMSC 100S (or CAS 100 by substitution) (GWS) ^{††1}	3	PHYS 211 (GN) ^{*#†2}	4
General Education Knowledge Domain (IL)	3	ENGL 15, 30H, or ESL 15 (GWS) ^{††}	3
General Education Knowledge Domain (Integrative)	3		
	17		15

Second Year

Fall	Credits	Spring	Credits
PHYS 212 (GN) [†]	4	MATH 251	4
CHEM 202	3	IE 424 or STAT 401 ³	3
MATH 220 ^{*#2}	2	MATSE 202 [*]	3
MATH 231	2	MATSE 203 or ENGL 202C (GWS) ^{††}	3
MATSE 201 [*]	3	MATSE 413	3
MATSE 219 or CMPSC 200	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 492W (Writing Across the Curriculum) [*]	3
MATSE 436	3	MATSE 462	1
MATSE 460	1	MATSE Specialization Course 1 from Department List	3
General Education Knowledge Domain (US)	3	General Education Knowledge Domain (Integrative)	3
		General Education Health and Wellness (GHW)	1.5
	16		17.5

Fourth Year

Fall	Credits	Spring	Credits
MATSE 493W or 494W ⁴	3-0 or 2	MATSE 493W or 494W ⁴	0-3 or 1

MATSE Specialization Course 2 from Department List	3 MATSE Specialization Course 3 from Department List	3
Technical Elective 1	3 MATSE Specialization Course 4 from Department List	3
Technical Elective 2	3 Technical Elective 3	3
MATSE Senior Processing Laboratory (can be taken fall or spring)	0-1 Technical Elective 4	3
General Education Knowledge Domain	3 MATSE Senior Processing Laboratory (can be taken fall or spring)	1-0
General Education Health and Wellness (GHW)	1.5 General Education Knowledge Domain	3
	13.5-17.5	16-18

Total Credits 128-134

* 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

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 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.

² 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.)

³ It is recommended to take STAT 401 only if the student has prior experience with statistics. Otherwise, students should take IE 424.

⁴ Students are required to choose either MATSE 493W (3) or MATSE 494W (3) as their capstone requirement. MATSE 493W involves a group project and all 3 credits are taken in a single semester in the final year of study. MATSE 494W, the individual research thesis, is typically split between fall and spring semesters.

University Requirements and General Education Notes:

US and IL are abbreviations used to designate courses that satisfy Cultural Diversity 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.

General Education includes Foundations (GWS and GQ), Knowledge Domains (GHW, GN, GA, GH, GS) and Integrative Studies (Inter-domain) requirements. N or Q (Honors) is the suffix at the end of a course number used to help identify an Inter-domain course, but the inter-domain

attribute is used to fill audit requirements. Foundations courses (GWS and GQ) require a grade of 'C' or better.

All incoming Schreyer Honors College first-year students at University Park will take ENGL 137H/CAS 137H in the fall semester and ENGL 138T/CAS 138T in the spring semester. These courses carry the GWS designation and satisfy a portion of that General Education requirement. If the student's program prescribes GWS these courses will replace both ENGL 15/ENGL 30H and CAS 100A/CAS 100B/CAS 100C. Each course is 3 credits.

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.

Materials Science and Engineering, B.S. at 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, CAS 100A, CAS 100B, or CAS 100C (GWS) ^{‡†1}	3	PHYS 211 (GN) ^{*#†2}	4
General Education Knowledge Domain	3	ENGL 15, 30H, 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 492W (Writing across the curriculum) [*]	3
MATSE 460	1	MATSE 462	1
MATSE 436	3	MATSE 413	3
CMPSC 200 or MATSE 219	3	MATSE Specialization Course 1 from Department List	3
	16		16

Fourth Year

Fall	Credits	Spring	Credits
MATSE 494W or 493W (Writing across the curriculum, can be taken fall or spring of fourth year)	0-3	MATSE 494W or 493W (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 3 from Department List	3

Technical Elective 1	3	MATSE Specialization Course 4 from Department List	3
Technical Elective 2	3	Technical Elective 3	3
Materials Senior Processing Laboratory (can be taken fall or spring)	1	Technical Elective 4	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

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Advising Notes:

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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.

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<https://www.matse.psu.edu/>

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 ABOUT POTENTIAL CAREER OPTIONS FOR GRADUATES OF THE MATERIALS SCIENCE AND ENGINEERING PROGRAM (<https://www.matse.psu.edu/undergraduate/internships-career-resources/>)

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 ABOUT OPPORTUNITIES FOR GRADUATE STUDIES (<https://www.matse.psu.edu/graduate/>)

Professional Resources

- Material Advantage Penn State Chapter (<https://sites.psu.edu/materialadvantage/>)
- Keramos National Professional Ceramic Engineering Fraternity (<https://ceramics.org/members/member-communities/classes/keramos/>)

Accreditation

The Bachelor of Science in Materials Science and Engineering at University Park is accredited by the Engineering Accreditation Commission of ABET, <https://www.abet.org>, under the General Criteria and the Materials Engineering Program Criteria.

Professional Licensure/Certification

Many U.S. states and territories require professional licensure/certification to be employed. If you plan to pursue employment in a licensed profession after completing this program, please visit the Professional Licensure/Certification Disclosures by State (<https://www.psu.edu/state-licensure-disclosures/>) interactive map.

Contact

University Park

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