

MATERIALS SCIENCE AND ENGINEERING, MSE

The master's program in Materials Science and Engineering prepares students to be leaders, innovators, and visionaries in the materials revolution that is being driven by discoveries that cross the boundaries of physics, chemistry, engineering and biology, such as in the growing fields of nanobioscience, nanophotonics and optoelectronics.

Penn is one of the first universities to establish a center for materials research. By remaining at the forefront of technology innovations, this center, the Laboratory for Research on the Structure of Matter (LRSM), has grown to be one of the largest in the nation. We are opening up new fields in materials science, preparing tomorrow's leaders, and putting our knowledge to practical use in today's high-tech society. Our multidisciplinary program allows you to tailor your education to your own professional and career goals, from ceramics, polymers, and metals to non-structured and soft materials. Our graduates can be found in positions in industries that range from electronics, manufacturing, and communications to transportation and energy, or pursuing doctoral degrees at Penn and other top-ranked research universities.

For more information: <https://mse.seas.upenn.edu/>

Curriculum

10 course units are required for the MSE in Materials Science and Engineering.¹⁻⁵

Code	Title	Course Units
MSE Courses		
Select 6 from the approved list: ¹		6
MSE 5000	Experimental Methods in Materials Science	
MSE 5020	Sustainability of Materials	
MSE 5050	Mechanical Properties of Macro/Nanoscale Materials	
MSE 5060	Failure Analysis of Engineering Materials	
MSE 5070	Fundamentals of Materials	
MSE 5150	Mathematical Methods for Engineering Applications	
MSE 5180	Structure and Function of Biological Materials	
MSE 5200	Structure of Materials	
MSE 5250	Nanoscale Science and Engineering	
MSE 5280	Optical Information Processing for Materials Characterization	
MSE 5300	Thermodynamics and Phase Equilibria	
MSE 5360	Electronic Properties of Materials	
MSE 5380	Phase Transformations	
MSE 5400	Kinetics of Materials	
MSE 5440	Computational Science of Energy and Chemical Transformations	
MSE 5450	Materials for Energy and Environmental Sustainability	
MSE 5500	Elasticity and Micromechanics of Materials	
MSE 5550	Electrochemical Engineering of Materials	

MSE 5610	Atomic Modeling in Materials Science
MSE 5650	Fabrication and Characterization of Micro and Nanostructured Materials
MSE 5700	Physics of Materials I
MSE 5750	Statistical Mechanics
MSE 5760	Machine Learning and Its Applications in Materials Science
MSE 5800	Introduction to Polymers
MSE 5850	Materials for Bioelectronics
MSE 6100	Transmission Electron Microscopy
MSE 6110	Advanced Synchrotron and Electron Characterization of Materials
MSE 6400	Optical Materials
MSE 6500	Mechanics of Soft and Biomaterials
MSE 7900	Selected Topics in Materials Science and Engineering

Electives

Select up to 2 Electives and choose 2 or more SEAS courses relevant to materials science; a sample list is provided below: ⁴

CBE 5350	Interfacial Phenomena
CIT 5900	Programming Languages and Techniques
EAS 5100	Technical Communication and Academic Writing for Non-native Speakers of English
EAS 5450	Engineering Entrepreneurship I
ENM 5110	Foundations of Engineering Mathematics - II
ESE 5210	The Physics of Solid State Energy Devices
ESE 5360	Nanofabrication and Nanocharacterization
PHYS 5518	Introduction to Condensed Matter Physics

Total Course Units **10**

Non-thesis or Thesis option:

- **Non-thesis course-based option:** Students successfully complete 10 course units at the 5000 or higher level. All courses must carry a letter grade (A, B, C or D).
 - Students must secure written approval for all course selections from the Masters Program Advisor. Furthermore, all changes to these course selections must be approved in writing by the Masters Program Advisor. Students wishing to take courses not listed on the provided list are required to receive written approval from the Masters Program Advisor. All non-elective courses should have technical/scientific content relevant to the student's M.S.E. degree program.
 - 6 MSE courses (5000 level or higher) requiring a letter grade are compulsory. Up to 7 MSE courses are highly recommended for obtaining a solid background in materials science. 3 MSE courses are compulsory in the first semester of study.
- **Non-thesis option with independent study:** Students take 8 courses credits at the 5000 or higher level earning letter grades and complete 2 Masters Independent Study (MSE 5990) credits. Students receive a letter grade (A, B, C, D or F) in MSE 5990. Independent Study requires a faculty advisor; see below for selecting an advisor.
- **Thesis option:** Students take 7 course units at the 5000 or higher level earning letter grades and complete 3 course units of research with a faculty member by registering for two research credits (MSE 9990 Masters Thesis) and 1 Independent Study (MSE 5990). Students

receive a letter grade (A, B, C, D or F) in both MSE 9990 and MSE 5990. Students must have their thesis approved by their thesis advisor and the Graduate Group Chair, as well as submit their thesis to the Graduate Group Coordinator. The thesis option requires a faculty advisor; see details below.

- Students interested in pursuing the non-thesis option with independent study or the thesis option are encouraged to meet with individual faculty and the Master's Program Advisor to discuss their research interests.

¹ A maximum of two free electives (5000 level or higher) are permitted. Free electives can be selected from across the university, including SEAS, SAS and Wharton courses. Free electives are not permitted for students pursuing a dual degree at Penn.

² During the first semester, Masters degree students are not permitted to take Independent Study or Master's Thesis and are required to enroll in only MSE courses.

³ All Masters degree students must maintain a GPA of 2.7 or higher to be in good standing and for graduation. Students are required to attend weekly MSE seminars organized by the department as part of their education and exposure to latest scientific advances

⁴ Note that only one Engineering Entrepreneurship course will count as a MSE related SEAS-course. A second entrepreneurship course will be counted as a free elective. A student who takes two free electives and EAS 5100 will be permitted to take CIT 5900 only if the student has also taken six MSE courses. This is done to ensure that at least 60% of the courses that count towards the Master's degree have physical science content and preferably MSE content.

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2025 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.
