MATERIALS SCIENCE & ENGINEERING + DATA SCIENCE, BS

for the degree of Bachelor of Science Major in Materials Science & Engineering + Data Science

Materials science and engineering is the basis for all engineering. Improvements in the quality of life require knowledge of the processing and properties of current materials and the design, development and application of new materials. At the same time, data science is revolutionizing all areas of science and engineering. The Materials Science and Engineering (MatSE+DS) curriculum provides an understanding of the underlying principles of synthesis and processing of materials and of the interrelationships between structure, properties, and processing, while also addressing the unique data science challenges in materials science and engineering. Students learn how to create advanced materials and systems required, e.g., for flexible electronic displays and photonics that will change communications technologies, for site specific drug delivery, for self-healing materials, for enabling the transition to a hydrogen-based economy, and for more efficient photovoltaics and nuclear systems for energy production. The curriculum uses concepts from both basic physics and chemistry combined with statistics and data science and provides a detailed knowledge of what makes the materials we use every day behave as they do.

Students in the first two years take courses in general areas of science and engineering and data science as well as courses introducing the concepts in MatSE. In the third year, students study the common, central issues related to MatSE while learning more advanced data science methods. In the senior year, students focus on an area of MatSE of their greatest interest, providing them with the detailed knowledge to be immediately useful to corporations, become entrepreneurs, or to provide the underpinning knowledge for graduate study, and complete a design project involving data science.

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Graduation Requirements

Minimum hours required for graduation: 128 hours.

Minimum Overall GPA: 2.0

University Requirements

Minimum of 40 hours of upper-division coursework, generally at the 300- or 400-level. These hours can be drawn from all elements of the degree. Students should consult their academic advisor for additional guidance in fulfilling this requirement.

The university and residency requirements can be found in the Student Code (https://studentcode.illinois.edu/article3/part8/3-801/) (§ 3-801) and in the Academic Catalog (http://catalog.illinois.edu/general-information/degree-general-education-requirements/).

General Education Requirements

Follows the campus General Education (Gen Ed) requirements (https://courses.illinois.edu/gened/DEFAULT/DEFAULT/). Some Gen Ed requirements may be met by courses required and/or electives in the program.

Code	Title	Hours
Composition I		4-6
Advanced Composition		3
fulfilled by MSE 307 and MSE 308		
Humanities & the Arts (6 hours)		6
Natural Sciences & Technology (6 hours)		6
fulfilled by CHEM 102, CHEM 104, PHYS 211, PHYS 212		
Social & Behavioral Sciences (6 hours)		6
Cultural Studies: Non-Western Cultures (1 course)		3
Cultural Studies: US Minority Cultures (1 course)		3
Cultural Studies: Western/Comparative Cultures (1 course)		3
Quantitative Reasoning (2 courses, at least one course must be Quantitative Reasoning I)		6-10
fulfilled by MATH 221 or MATH 220; MATH 231, MATH 241, MATH 285, CS 107, PHYS 211, PHYS 212, STAT 207		
Language Requirement (Completion of the third semester or equivalent of a language other than English is required)		0-15

Materials Science and Engineering plus Data Science Graduation Requirements

Orientation and Professional Development

Code	Title	Hours
ENG 100	Grainger Engineering Orientation Seminar (External transfer students take ENG 300.)	1
Recommended, optional 1 credit course, MSE 183 Introductory MatSE Laboratory. Credit hour counts toward free electives.		
Total Hours		**1**

Foundational Mathematics and Science

Code	Title	Hours
CHEM 102	General Chemistry I	3
Recommended, optional 1 credit course, CHEM 103 General Chemistry Lab I. Credit hour counts toward free electives.		
CHEM 104	General Chemistry II	3
Recommended, optional 1 credit course, CHEM 105 General Chemistry Lab II. Credit hour counts toward free electives.		
MATH 221	Calculus I (MATH 220 may be substituted. MATH 220 is appropriate for students with no background in calculus. 4 of 5 credit hours count towards degree.)	4
MATH 231	Calculus II	3
MATH 241	Calculus III	4
MATH 257	Linear Algebra with Computational Applications	3
MATH 285	Intro Differential Equations	3
PHYS 211	University Physics: Mechanics	4
PHYS 212	University Physics: Elec & Mag	4

PHYS 214	Univ Physics: Quantum Physics	2
Total Hours		**33**

Materials Science and Engineering with Data Science Technical Core

Code	Title	Hours
CS 107	Data Science Discovery	4
MSE 182	Introduction to MatSE	2
ECE 205	Electrical and Electronic Circuits	3
MSE 201	Phases and Phase Relations	3
MSE 206	Mechanics for MatSE	4
STAT 207	Data Science Exploration	4
CS 277	Algorithms and Data Structures for Data Science	4
CS 307	Modeling and Learning in Data Science	4
MSE 307	Materials Laboratory I	3
MSE 308	Materials Laboratory II	3
MSE 304	Electronic Properties of Matls	3
or MSE 405	Microstructure Determination	
MSE 401	Thermodynamics of Materials	3
MSE 402	Kinetic Processes in Materials	3
MSE 406	Thermal-Mech Behavior of Matls	3
IS 467	Ethics and Policy for Data Science	3
IS 477	Data Management, Curation & Reproducibility	3
MSE 494	Materials Design Thinking	1
MSE 495	Materials Design	2
Total Hours		**55**

Technical Electives

Code	Title	Hours
MSE 404	Laboratory Studies in Materials Science and Engineering (Each section of MSE 404 is 1.5 hours. Students take 4 unique sections of MSE 404 for 6 hours.)	6
Topical lecture courses. See Topical Lecture list below.		6
Total Hours		**12**

Topical Lectures

Code	Title	Hours
Introductory		
MSE 420	Ceramic Materials & Properties	3
MSE 441	Metals Processing	3
MSE 450	Polymer Science & Engineering	3 or 4
MSE 470	Design and Use of Biomaterials	3
ECE 340	Semiconductor Electronics	3
All Areas		
MSE 403	Synthesis of Materials	3
MSE 421	Ceramic Processing	3 or 4
MSE 422	Electrical Ceramics	3
MSE 440	Mechanical Behavior of Metals	3
MSE 443	Design of Engineering Alloys	3
MSE 453	Plastics Engineering	3
MSE 455	Macromolecular Solids	3
MSE 456	Mechanics of Composites	3
MSE 457	Polymer Chemistry	3 or 4
MSE 458	Polymer Physics	3 or 4
MSE 460	Electronic Materials I	3
MSE 461	Electronic Materials II	3
MSE 464	Magnetic Materials and their Applications	3 or 4
MSE 466	Electrochemical Energy Conversion	3
MSE 473	Biomolecular Materials Science	3
MSE 474	Biomaterials and Nanomedicine	3
MSE 480	Surfaces and Colloids	3 or 4
MSE 481	Electron Microscopy	3 or 4
MSE 485	Atomic Scale Simulations	3 or 4
MSE 487	Materials for Nanotechnology	3 or 4
MSE 488	Optical Materials	3 or 4
MSE 489	Matl Select for Sustainability	3 or 4
MSE 498	Special Topics (Modern Methods in Materials Characterization)	1 to 4
ABE 446	Biological Nanoengineering	3 or 4
ABE 482	Package Engineering	3
ABE 483	Engineering Properties of Food Materials	3
BIOE 476	Tissue Engineering	3
BIOE 479	Cancer Nanotechnology	3
CEE 401	Concrete Properties & 3D Print	4
CEE 460	Steel Structures I	3
CHBE 458	Synthetic Nanomaterials	3
CHBE 472	Techniques in Biomolecular Eng	3 or 4
CHBE 473	Biomolecular Engineering	3 or 4
CHBE 475	Tissue Engineering	3
ECE 380	Biomedical Imaging	3
ECE 441	Physcs & Modeling Semicond Dev	3
ECE 443	LEDs and Solar Cells	4
ECE 444	IC Device Theory & Fabrication	4
ECE 472	Biomedical Ultrasound Imaging	3
ECE 481	Nanotechnology	4
ECE 487	Intro Quantum Electr for EEs	3
ECE 488	Compound Semicond & Devices	3
ECE 495	Photonic Device Laboratory	3
ES 470	Fuel Cells & Hydrogen Sources	3
IE 431	Design for Six Sigma	3
ME 432	Fundamentals of Photovoltaics	3 or 4
ME 431	Mechanical Component Failure	3 or 4
ME 472	Introduction to Tribology	3 or 4
ME 482	Musculoskel Tissue Mechanics	3 or 4
ME 483	Mechanobiology	4
ME 487	MEMS-NEMS Theory & Fabrication	4
SE 412	Nondestructive Evaluation	3 or 4
TAM 451	Intermediate Solid Mechanics	4
TAM 456	Experimental Stress Analysis	3
Science - Can only count one science course for Topical Lecture		
BIOC 446	Physical Biochemistry	3
BIOP 401	Introduction to Biophysics	3

CHEM 436	Fundamental Organic Chem II	3
CHEM 483	Solid State Structural Anlys	4
PHYS 485	Atomic Phys & Quantum Theory	3
PHYS 486	Quantum Physics I	4
PHYS 487	Quantum Physics II	4

Free Electives

Code	Title	Hours
Additional course work, subject to the Grainger College of Engineering restrictions to Free Electives, so that there are at least 128 credit hours earned toward the degree.		11
Total Hours of Curriculum to Graduate		128

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This sample sequence is intended to be used only as a guide for degree completion. All students should work individually with their academic advisors to decide the actual course selection and sequence that works best for them based on their academic preparation and goals. Enrichment programming such as study abroad, minors, internships, and so on may impact the structure of this four-year plan. Course availability is not guaranteed during the semester indicated in the sample sequence.

Students must fulfill their Language Other Than English requirement by successfully completing a third level of a language other than English. For more information, see the corresponding section on the Degree and General Education Requirements page *(*http://catalog.illinois.edu/general-information/degree-general-education-requirements/*).*

First Year

First Semester	Hours	Second Semester	Hours
MSE 182	2	MSE 183	1
MATH 221	4	MATH 231	3
CHEM 102	3	CHEM 104	3
CHEM 103	1	CHEM 105	1
ENG 100	1	PHYS 211	4
Composition I or CS 107	4	CS 107 (or Composition I)	4
	15		**16**

Second Year

First Semester	Hours	Second Semester	Hours
MSE 201	3	MSE 206	4
MATH 241	4	MATH 285	3
MATH 257	3	ECE 205	3
PHYS 212	4	PHYS 214	2
General Education course (choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)	3	STAT 207	4
	17		**16**

Third Year

First Semester	Hours	Second Semester	Hours
MSE 307	3	MSE 308	3
MSE 401	3	MSE 304 or 405	3
MSE 406	3	MSE 402	3
CS 277	4	CS 307	4
General Education course (choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)	3	Free Elective	2
	16		**15**

Fourth Year

First Semester	Hours	Second Semester	Hours
MSE 404	3	MSE 404	3
IS 467	3	IS 477	3
MSE 494	1	MSE 495	2
Topical Lecture	3	Topical Lecture	3
General Education course (choose a Humanities or Social/Behavioral Science course with Cultural Studies designation)	3	General Education course (choose a Humanities or Social/Behavioral Science course)	3
Language Other Than English (3rd level) course	4	Free elective	2
	17		**16**

Total Hours 128

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The program educational objectives of the MatSE Department and its faculty at the undergraduate level are:

1. Our graduates will attain the foundational knowledge to be successful in their chosen career.
2. Our graduates will be skilled at teamwork, communication and individual professionalism, including ethics and environmental awareness.
3. Our graduates will provide valuable service to their chosen profession and to society.
4. Our graduates will have the ability to achieve their personal goals and advance in their chosen profession through life-long learning.

The curriculum is designed to guarantee a certain breadth of knowledge in materials science and engineering through a set of core courses, ensure depth and focus in specialties with materials science, and provide a breadth of knowledge in data science. In accordance with the

ABET educational criteria and the Data Science learning objectives, the program has been developed so that graduates will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, mathematics, and computational analysis of data.
2. An ability to apply engineering design with data science skills 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, including accurate and informative visualizations of data.
4. An ability to recognize ethical and professional responsibilities in engineering situations and data science 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, build and evaluate data-based models and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
8. An ability to describe, curate, and manage data.

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Materials Science & Engineering Website (https://matse.illinois.edu/)
Materials Science & Engineering Faculty (https://matse.illinois.edu/people/faculty/)

The Grainger College of Engineering Admissions (https://grainger.illinois.edu/admissions/)
The Grainger College of Engineering (https://grainger.illinois.edu/)