

# MATERIALS SCIENCE AND ENGINEERING

The Materials Science and Engineering (MSE) program at CU Boulder is an interdisciplinary, graduate-level program that allows students to explore science at the intersection of advanced chemistry, biology, engineering and physics. Our faculty members work across a broad range of scientific and engineering disciplines (<https://www.colorado.edu/mse/news-events-0/>), but all share expertise and passion for materials development and application. Students will achieve their educational goals through a combination of cross-disciplinary coursework and research under the supervision of one or more of the program's science and engineering faculty members.

The program offers two degrees to provide students with the necessary skills to be successful in industry. At CU Boulder, students have the opportunity to choose from seven unique program tracks for specialization including:

- Electronic, magnetic and photonics materials
- Soft materials
- Structural materials
- Materials characterization and processing
- Materials for energy
- Biomaterials
- Computational materials science

The MSE program is directed by Professor Stephanie Bryant of the Department of Chemical and Biological Engineering. For more information, see the Materials Science & Engineering Program (<https://www.colorado.edu/mse/>) website.

## Master's Degree

- Materials Science and Engineering - Master of Science (MS) (<https://catalog.colorado.edu/graduate/colleges-schools/engineering-applied-science/programs-study/materials-science-engineering/materials-science-engineering-master-science-ms/>)

## Doctoral Degree

- Materials Science and Engineering - Doctor of Philosophy (PhD) (<https://catalog.colorado.edu/graduate/colleges-schools/engineering-applied-science/programs-study/materials-science-engineering/materials-science-engineering-doctor-philosophy-phd/>)

## Faculty

While many faculty teach both undergraduate and graduate students, some instruct students at the undergraduate level only. For more information, contact the faculty member's home department.

Betterton, Meredith D. ([https://experts.colorado.edu/display/fisid\\_125396/](https://experts.colorado.edu/display/fisid_125396/))  
Associate Professor; PhD, Harvard University

Borden, Mark A. ([https://experts.colorado.edu/display/fisid\\_148514/](https://experts.colorado.edu/display/fisid_148514/))  
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Bowman, Christopher N. ([https://experts.colorado.edu/display/fisid\\_102043/](https://experts.colorado.edu/display/fisid_102043/))  
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## Courses

### **MSEN 5000 (1-3) Fundamentals of Materials Science and Engineering**

Discusses fundamental topics in materials science and engineering.

**Requisites:** Restricted to graduate students only.

**Grading Basis:** Letter Grade

**MSEN 5064 (3) Soft Machines**

Introduces soft machines as a new paradigm of engineering that starts to impact healthcare, consumer electronics, renewable energy and collaborative robotics. Prepares students to participate in research on soft machines by starting with fundamentals of soft materials and by covering soft robotics, stretchable electronics, energy harvesting and functional polymers. Includes guest lectures, a literature review and a hands-on lab project.

**Equivalent - Duplicate Degree Credit Not Granted:** MCEN 4046 and MCEN 5046

**Requisites:** Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Mechanical (MCEN) majors or College of Engineering graduate students only.

**Grading Basis:** Letter Grade

**MSEN 5270 (3) Materials Characterization for Engineering**

Rigorous materials characterization is at the heart of understanding property-structure-processing relationships of materials, including soft matter. The goal of the course is to prepare graduate students to understand the basic principles behind material characterization tools and techniques. This class will offer students (1) an introduction to the principles and practice of diffraction, (2) introductory exposure to common characterization methods for the determination of structure, composition, and defects in inorganic and organic solids.

**Requisites:** Restricted to graduate students only.

**Grading Basis:** Letter Grade

**MSEN 5370 (3) Materials Thermodynamics and Kinetics**

Reviews fundamentals of thermodynamics and kinetics and applies them to understand the chemical, thermal, and mechanical behavior of materials. Examines equations of state, solution theory, equilibrium diagrams, and phase changes. Examines kinetics of phase transformations including theories of diffusion, nucleation and growth, and solidification.

**Requisites:** Restricted to graduate students only.

**Grading Basis:** Letter Grade

**MSEN 5430 (3) Transmission Electron Microscopy in Materials Science & Engineering**

This course provides a comprehensive introduction to transmission electron microscopy (TEM) as a powerful characterization tool in materials science. It is aimed at beginners and intermediate users of TEM and covers both the theoretical and practical aspects of advanced electron microscopy techniques. By taking this course, students will be able to interpret and analyze TEM data and understand electron microscopy publications. Students will learn the necessary theoretical basis for taking practical training on modern aberration-corrected TEMs. Previously offered as a special topics course.

**Requisites:** Restricted to students with 87-180 credits (Senior, 5th Yr Senior) or graduate students only.

**Recommended:** Prerequisite Experience on electron microscopy is recommended but not necessary.

**Grading Basis:** Letter Grade

**MSEN 5470 (3) Materials Composition and Structure**

The synthesis, organization, and processing of materials can enable functional performance. Curriculum will overview the synthesis and design of functional organic and inorganic materials. A particular emphasis will be placed on structure-performance correlations between chemistry and materials organization. Topical foci will include polymers, biomaterials, and materials for energy.

**MSEN 5840 (1-6) Independent Study**

Offers an opportunity for students to do independent work. Subject arranged to fit the needs of the student.

**Repeatable:** Repeatable for up to 6.00 total credit hours.

**Requisites:** Restricted to MS and PhD students in the Materials Science and Engineering program (MTEN) only.

**MSEN 5919 (1-5) Special Topics in MSE: Mass Transport**

Mass Transport Phenomena for Materials & Membranes: Fundamentals of mass transport with particular attention to design problems associated with materials science (reactive 3d printing), electrochemistry and energy systems (fuel cells & batteries), environmental concerns (CO<sub>2</sub> capture), and general separations (water desalination). The principles of transport phenomena in material systems, involving multiple components, phases, chemical reaction, and simultaneous momentum, heat and mass transport will be discussed

**Repeatable:** Repeatable for up to 10.00 total credit hours. Allows multiple enrollment in term.

**Requisites:** Restricted to graduate students only.

**Grading Basis:** Letter Grade

**MSEN 6101 (1) Seminar in Materials Science and Engineering**

Required of all materials science and engineering PhD students. Student, faculty, and guest presentations and discussions of current research in materials science and engineering.

**Recommended:** first- and second-year materials science and engineering PhD MSE students.

**Grading Basis:** Letter Grade

**MSEN 6930 (3) Materials Science and Engineering Professional Internship**

This class provides a mechanism for MSE graduate students to receive academic credit for internships with industry partners that include an academic component suitable for graduate-level work. Participation in the course will consist of an internship agreement between the student and an industry partner who will employ the student in a role that supports the academic goals of the MSE program and the internship. Instructor participation will include facilitation of the mid-term and final assessments of student performance as well as support for any academic-related issues that may arise during the internship period. May be taken during any term after one semester of coursework in MSE graduate program.

**Grading Basis:** Letter Grade

**MSEN 6950 (1-6) Master's Thesis**

**Repeatable:** Repeatable for up to 6.00 total credit hours.

**Requisites:** Restricted to MS students in the Materials Science and Engineering program (MTEN) only.

**MSEN 8990 (1-10) Doctoral Dissertation**

Doctoral Dissertation hours

**Repeatable:** Repeatable for up to 30.00 total credit hours.

**Requisites:** Restricted to PhD students in the Materials Science and Engineering program (MTEN) only.