The field of materials science and engineering is the study of “condensed matter” (that is, solids and liquids), and how an understanding of materials can be applied to fabricating devices and structures of utility. A relatively young discipline, materials science is an outgrowth of two traditional areas: the study of matter (and its structure-property relationship) that originated in chemistry and physics, and developments in various “materials” engineering fields (notably, microelectronics, metallurgy, ceramics, and plastics).

Two comprehensive majors are offered: Materials Science and Engineering, and Materials Science. Both majors are designed to give students a strong foundation in fundamental sciences and mathematics.

Faculty
Marcus McEllistrem, Academic Program Director
Douglas Dunham, Materials Science and Engineering Center Director
Liz Glogowski
Matt Jewell
Ying Ma
Professional Staff, MSEC
Laurel McEllistrem
Anthony Wagner

Majors
- Comprehensive Major: Materials Science and Engineering - B.S.
- Comprehensive Major: Materials Science, Physics of Materials Emphasis, Liberal Arts - B.A./B.S.
- Comprehensive Major: Materials Science, Chemistry of Materials Emphasis, Liberal Arts - B.A./B.S.
- Comprehensive Major: Materials Science, Geomaterials Emphasis, Liberal Arts - B.A./B.S.
- Comprehensive Major: Materials Science, Liberal Arts Emphasis - B.A./B.S.
- Comprehensive Major: Materials Science, Nanoscience Emphasis, Liberal Arts - B.A./B.S.
- Comprehensive Major: Materials Science, Applied Materials Emphasis, Liberal Arts - B.A./B.S.
- Comprehensive Major: Materials Science, Entrepreneurship Emphasis, Liberal Arts - B.A./B.S.
- Comprehensive Major: Materials Science, Mathematics of Materials Emphasis, Liberal Arts - B.A./B.S.

Materials Science (MSCI)

MSCI 100 Introduction to Materials Science and Nanoscience (4 crs)
Prerequisite: High school chemistry and high school physics.
Students explore how atomic bonds and molecular structure explain the properties of materials, and why nanomaterials have different properties.
Attributes: GE IIF Natural Science-Interdisciplinary Studies, Lab Science
Lecture/Discussion Hours: 3
Lab/Studio Hours: 3

MSCI 291 Special Topics in Materials Science (1-3 crs)
Prerequisite: CHEM 104 or CHEM 115; PHYS 232; MSE 221
Consent: Instructor Consent Required
- Field trips optional. A total of no more than nine credits from MSCI 291 and MSCI 491 may be applied toward major or graduation.
Lecture and possibly laboratory or field work in the study of current topics in Materials Science of special interest to students and faculty.
Repeat: Course may be repeated for a maximum of 9 credits

MSCI 310 Nanotechnology in Today's World (3 crs)
- No credit toward the Materials Science or Materials Science & Engineering comprehensive majors.
Provides the fundamentals of nanoscience at an elementary level, i.e., how material behavior, properties, and function change due to small size. Addresses applications in science and industry and nanotechnology products, along with environmental, social, and ethical implications.
Attributes: GE IIF Natural Science-Interdisciplinary Studies
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MSCI 382 Advanced Materials Science and Nanoscience (3 crs)
Prerequisite: MSCI 234 or MSE 334; MSCI 300 or CHEM 433 or PHYS 445 (or equivalent).
A survey of materials science, including in-depth discussions of metals, ceramics, polymers, and semiconductors. Contrasting views of the "molecular" nature of matter and the "band" nature will be discussed. Includes in-depth discussion of Nanoscience and Materials Science.
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MSCI 384 Materials Science Junior Seminar I (0.5 crs)
Prerequisite: Minimum junior standing
Career preparation for Materials Science majors. Will include seminars with external speakers and class discussions of relevant issues.
Lab/Studio Hours: 0
Seminar Hours: .5

MSCI 385 Materials Science Junior Seminar II (0.5 crs)
Prerequisite: MSCI 384
The second course in the junior seminar course sequence. Will include seminars with external speakers and class discussions of relevant issues.
Lab/Studio Hours: 0
Seminar Hours: .5
MSCI 391 Materials Science Seminar (1 cr)
Prerequisite: MSCI 234 and MSCI 355.

Students will explore career pathways in Materials Science. The course will offer a mix of seminars by various speakers and discussions about issues relevant to Materials Science.

Grading Basis: A-F Grades Only
Lab/Studio Hours: 0
Seminar Hours: 1

MSCI 395 Directed Studies (1-3 crs)
Prerequisite: Minimum 2.0 GPA in Materials Science or Materials Science & Engineering comprehensive majors
Consent: Department Consent Required

This course is designed to allow a single student or a group of students to pursue their educational goals and interests under the direction of a faculty member.

Repeat: Course may be repeated
Grading Basis: A-F Grades Only

MSCI 399 Independent Study - Juniors (1-3 crs)
Prerequisite: Minimum junior standing.
Consent: Department Consent Required

This course provides junior-level students with research opportunities in Materials Science or Materials Science & Engineering.

Repeat: Course may be repeated
Grading Basis: A-F Grades Only

MSCI 480 Advanced Materials Science Lab I (1 cr)
Prerequisite: MSCI 362, MSCI 363, MSCI 382, PHYS 338.

First of a two-course capstone sequence. Focuses on hands-on, project-based, research-inspired labs that emphasize diverse areas of Materials Science.

Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 0
Lab/Studio Hours: 3

MSCI 481 Advanced Materials Science Lab II - Scientific Writing (1 cr)
Prerequisite: MSCI 480, or consent of instructor.
Consent: Instructor Consent Required

Second of a two-course capstone sequence. Focuses on preparation of a scientific paper, including a Materials Science literature review and developing a manuscript for publication. Students will use experimental processes and results obtained from MSCI 480 in developing the manuscript.

Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 0
Lab/Studio Hours: 3

MSCI 484 Materials Science Capstone I (1 cr)
Prerequisite: MSE 350; Credit may not be earned in both MSCI 480 and MSCI 484

First of a two-course capstone sequence. This course emphasizes hands-on, project-based experiences that are formulated and executed by the student.

Lab/Studio Hours: 0
Seminar Hours: 2

MSCI 485 Materials Science Capstone II (2 crs)
Prerequisite: MSCI 484; Credit may not be earned in both MSCI 485 and MSCI 481

Second of a two-semester capstone sequence. This course emphasizes writing projects based on student designed experiments.

Attributes: LE-I1 Integration
Lab/Studio Hours: 0
Seminar Hours: 4

MSCI 491 Special Topics in Advanced Materials Science (1-3 crs)
Prerequisite: MSCI 300. Limited to Materials Science or Materials Science & Engineering majors.
Consent: Instructor Consent Required

• Field trips optional. A total of no more than nine credits from MSCI 291 and MSCI 491 may be applied toward major or graduation.

Lecture and possibly laboratory or field work in the study of current topics of Materials Science of special interest to advanced students and faculty.

Repeat: Course may be repeated for a maximum of 9 credits

MSCI 499 Independent Study - Seniors (1-3 crs)
Prerequisite: Minimum senior standing.
Consent: Department Consent Required

This course provides senior-level students with research opportunities in Materials Science or Materials Science & Engineering.

Repeat: Course may be repeated
Grading Basis: A-F Grades Only

Materials Science and Engineering (MSE)

MSE 120 Introduction to Engineering (2 crs)
Prerequisite: MATH 109 or concurrent enrollment.

• Credit may not be earned in both MSE 120 and PHYS 120.

A comprehensive study of the engineering design process. Discussion of engineering disciplines with comparisons. The laboratory portion of the course includes design projects from various engineering disciplines.

Attributes: LE-S3 Creativity
Lecture/Discussion Hours: 1
Lab/Studio Hours: 3
MSE 221 Living in a Materials World (3 crs)
Prerequisite: MATH 114 or concurrent enrollment. No credit if taken after MSCI 100.
Processing and structure’s impact on materials properties and performance. Societal benefits of sustainable, biomimetic, or responsible materials selection.
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MSE 256 Introduction to Computer Aided Design (1 cr)
Prerequisite: MATH 109 or concurrent enrollment.
The course provides an introduction to 3-dimensional computer aided design and modeling.
Lecture/Discussion Hours: 0
Lab/Studio Hours: 3

MSE 315 Materials Characterization (4 crs)
Prerequisite: CHEM 103 or CHEM 115 and PHYS 211 or PHYS 231.
A survey of commonly used materials characterization methods (XPS, SEM, AFM, XRD, XRF), including their theory of operation and hands-on experience. Includes a discussion of the measurement process and instrumental analysis of samples.
Attributes: LE-S3 Creativity
Lecture/Discussion Hours: 2
Lab/Studio Hours: 4

MSE 334 Soft Materials (4 crs)
Prerequisite: CHEM 325
Includes in-depth soft materials topics such as synthesis and processing, structure-property relationships, and applications of soft materials.
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MSE 350 Thermodynamics of Materials (4 crs)
Prerequisite: MSCI 100 or MSE 221 or GEOL 312; CHEM 104 or CHEM 115; MATH 215; PHYS 232 or concurrent enrollment.
Survey of the laws of thermodynamics and their application in Materials Science including phase equilibria. Aspects of quantum mechanics as they relate to Materials Science will be discussed.
Grading Basis: No S/U Grade Option
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MSE 357 Phase Transformation & Kinetics (3 crs)
Prerequisite: MSE 221; MATH 215; CHEM 104 or CHEM 115
Phase transformations are explored with emphasis on microstructure development, the impact of diffusion, and nucleation/growth mechanisms.
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MSE 362 Microelectronic Materials Processing (2 crs)
Prerequisite: MSE 350; MSE 357 or concurrent enrollment. No credit if taken after MSCI 362
• Formerly MSCI 362.
The fabrication of microelectronic devices is discussed, and the thermodynamics and kinetics that impact process design. Methods and practices are reviewed.
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 2
Lab/Studio Hours: 0

MSE 363 Microelectronic Materials Processing Lab (2 crs)
Prerequisite: MSE 350 or CHEM 433 or PHYS 332. No credit if taken after MSCI 363
• Formerly MSCI 363.
The fabrication of microelectronic devices is explored. Methods and practices for photolithography, etching, and deposition are studied in a lab setting.
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 0
Lab/Studio Hours: 4

MSE 367 Macroprocessing of Materials (3 crs)
Prerequisite: MSE 357
Processing approaches for major categories of bulk materials. Topics range from raw materials to forming and finishing of final products.
Lecture/Discussion Hours: 2
Lab/Studio Hours: 0

MSE 368 Macroprocessing Materials Lab (2 crs)
Prerequisite: MSE 367 or concurrent enrollment.
Practical and analytical aspects of processing techniques and investigation of structure-property-processing relationships using hands-on experiences.
Lecture/Discussion Hours: 0
Lab/Studio Hours: 6

MSE 372 Transport Phenomena (3 crs)
Prerequisite: MATH 312
Principles of momentum, heat, and mass transport. Applications of appropriate differential equations and boundary conditions to solve problems in materials processing.
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0
MSE 374 Physics of Solids (4 crs)
Prerequisite: PHYS 332 or MSE350
- Credit may not be earned in both MSE 374 and PHYS 374.

A description of the behaviors of crystalline solids. Topics include crystallography, diffraction, and the electrical, optical and magnetic properties of materials. Semiconducting materials and devices will also be discussed.

Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MSE 386 MS&E Junior Seminar I (0.5 crs)
Prerequisite: Limited to Pre-Materials Science and Engineering or Materials Science and Engineering majors
- Must be admitted to MSE by first day of class.

Career preparation for Materials Science & Engineering majors. Will include seminars with external speakers and class discussions of relevant issues.

Lab/Studio Hours: 0
Seminar Hours: .5

MSE 387 MS&E Junior Seminar II (0.5 crs)
Prerequisite: MSE 386; Limited to Materials Science and Engineering majors

The second course in the junior seminar course sequence. Will include seminars with external speakers and class discussions of relevant issues.

Lab/Studio Hours: 0
Seminar Hours: .5

MSE 451 Computational Materials Science (4 crs)
Prerequisite: MSE 350 or PHYS 333 or CHEM 434.

Theory and application of computational methods to model, understand and predict the behavior of materials. Labs provide hands-on experience in solving real materials problems using computational approaches.

Lecture/Discussion Hours: 2
Lab/Studio Hours: 4

MSE 475 Nanomaterials (3 crs)
Prerequisite: CHEM 104 or 115, and one of the following: MSE 350, or PHYS 333, or CHEM 434.

Quantum behavior and statistical mechanics of nanomaterials, plus modern synthesis methods, electronic and optical applications, biomaterials.

Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MSE 486 MS&E Capstone I (2 crs)
Prerequisite: MSE 256; MSE 350; MSE 387 or departmental consent

First of a two-course capstone sequence. Hands-on, project-based experiences including engineering design, problem solving and Computer Aided Design (CAD).

Lab/Studio Hours: 0
Seminar Hours: 4

MSE 487 MS&E Capstone II (2 crs)
Prerequisite: MSE 487

Second of a two-course capstone sequence. Conclusion of student-designed projects accompanied by preparation of multiple technical documents.

Attributes: LE-I1 Integration
Lab/Studio Hours: 0
Seminar Hours: 4