***Twin Cities Campus***

# Materials Science and Engineering Ph.D.

*Chemical Engineering & Materials Science*

**College of Science and Engineering**

Link to a list of faculty for this program.

**Contact Information:**
Department of Chemical Engineering and Materials Science, University of Minnesota, 151 Amundson Hall, 421 Washington Avenue SE, Minneapolis, MN 55455 (612-625-0382; fax: 612-626-7246)
Email: cemsgrad@umn.edu
Website: http://www.cems.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2017
- Length of program in credits: 57
- This program requires summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Graduate courses offered by the Chemical Engineering and Materials Science (CEMS) Department cover core areas of materials science and engineering (structure and symmetry of materials; thermodynamics and kinetics; electronic, optical, and magnetic properties of materials; and mechanical properties of materials). In addition, several specialized topics are offered, including rheology, coating process fundamentals, process control, finite element methods of computer-aided analysis, ceramics, polymers, materials design and performance, materials processing, corrosion, contact and fracture properties of materials, electron microscopy, thin films and interfaces, composites, electrochemical engineering, solid state reaction kinetics, electronic structure of materials, organic semiconductors, electronic ceramics, dislocations and interfaces, epitaxial thin film growth, and the science of porous media.

## Program Delivery

This program is available:

- via classroom (the majority of instruction is face-to-face)

## Prerequisites for Admission

A bachelor's degree in materials science or other related field.

Other requirements to be completed before admission:
Applicants must submit scores from the general test of the GRE, three letters of recommendation from persons familiar with their scholarship and research potential, a complete set of official transcripts, and a clearly written statement of career interests, goals, and objectives. International students are required to provide TOEFL results.

**Special Application Requirements:**
Applications are accepted for fall semester only. Submission of all application materials by December 15 is strongly encouraged to ensure priority consideration for fellowships and assistantships; late applications are considered if space is available. More information is available at http://www.cems.umn.edu/graduate/admissions

Applicants must submit their test score(s) from the following:

- GRE

International applicants must submit score(s) from one of the following tests:

- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 560
- IELTS
  - Total Score: 6.5
- MELAB
  - Final score: 80

Key to test abbreviations(GRE, TOEFL, IELTS, MELAB).

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of March 28, 2024

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

## Program Requirements

21 credits are required in the major.
12 credits are required outside the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

The PhD requires 33 course credits and 24 thesis credits. The course credits must include 12 credits in four core MATS courses, and a minimum of 12 credits outside the major. The remaining 9 credits may be taken in the major or in any supporting field.

Students must attend, but not enroll in, the departmental seminar for six semesters. Informal attendance will be done within the department.

**Core Courses**

MATS 8001 - Structure and Symmetry of Materials (3.0 cr)
MATS 8002 - Thermodynamics and Kinetics (3.0 cr)
MATS 8003 - Electronic Properties (3.0 cr)
MATS 8004 - Mechanical Properties (3.0 cr)

**Thesis Credits**

Take 24 credits after passing preliminary oral exam
MATS 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

**Electives**

The remaining credits may be chosen from the following list or consult with advisor for further options.
AEM 4201 - Fluid Mechanics (4.0 cr)
AEM 4511 - Mechanics of Composite Materials (3.0 cr)
AEM 4581 - Mechanics of Solids (3.0 cr)
AEM 5501 - Continuum Mechanics (3.0 cr)
AEM 5503 - Theory of Elasticity (3.0 cr)
AEM 8251 - Finite-Volume Methods in Computational Fluid Dynamics (3.0 cr)
AEM 8531 - Fracture Mechanics (3.0 cr)
AEM 8541 - Mechanics of Crystalline Solids (3.0 cr)
BMEN 5001 - Advanced Biomaterials (3.0 cr)
BMEN 5041 - Tissue Engineering (3.0 cr)
BMEN 5151 - Introduction to BioMEMS and Medical Microdevices (2.0 cr)
BMEN 5201 - Advanced Biomechanics (3.0 cr)
BMEN 5501 - Biology for Biomedical Engineers (3.0 cr)
BMEN 8511 - Systems and Synthetic Biology (3.0 cr)
CEGE 8022 - Numerical Methods for Free and Moving Boundary Problems (3.0 cr)
CEGE 8401 - Fundamentals of Finite Element Method (3.0 cr)
CEGE 8402 - Nonlinear Finite Element Analysis (3.0 cr)
CEGE 8501 - Environmental Fluid Mechanics I (4.0 cr)
CEGE 8502 - Environmental Fluid Mechanics II (4.0 cr)
CEGE 8504 - Theory of Unit Operations (4.0 cr)
CEGE 8505 - Biological Processes (3.0 cr)
CHEM 5210 - Materials Characterization (4.0 cr)
CHEM 5755 - X-Ray Crystallography (4.0 cr)
CHEM 8011 - Mechanisms of Chemical Reactions (4.0 cr)
CHEM 8152 - Analytical Spectroscopy (4.0 cr)
CHEM 8201 - Materials Chemistry (4.0 cr)
CHEM 8221 - Synthetic Polymer Chemistry (4.0 cr)
CHEM 8321 - Organic Synthesis (4.0 cr)
CHEM 8322 - Advanced Organic Chemistry (4.0 cr)
CHEM 8361 - Interpretation of Organic Spectra (4.0 cr)
CHEM 8551 - Quantum Mechanics I (4.0 cr)

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.

CHEM 8552 - Quantum Mechanics II (2.0 cr)
CHEM 8561 - Thermodynamics, Statistical Mechanics, and Reaction Dynamics I (4.0 cr)
CHEM 8562 - Thermodynamics, Statistical Mechanics, and Reaction Dynamics II (4.0 cr)
CHEN 5551 *{Inactive}*(3.0 cr)
CHEN 5753 - Advanced Biomedical Transport Processes (3.0 cr)
CHEN 5771 - Colloids and Dispersions (3.0 cr)
CHEN 8101 - Fluid Mechanics (3.0 cr)
CHEN 8102 - Introduction to Rheology (3.0 cr)
CHEN 8104 - Coating Process Fundamentals (2.0 cr)
CHEN 8201 - Applied Math (3.0 cr)
CHEN 8301 - Physical Rate Processes I: Transport (3.0 cr)
CHEN 8402 - Statistical Thermodynamics and Kinetics (3.0 cr)
CHEN 8501 - Chemical Rate Processes: Analysis of Chemical Reactors (3.0 cr)
CHEN 8754 - Systems Analysis of Biological Processes (3.0 cr)
EE 5163 - Semiconductor Properties and Devices I (3.0 cr)
EE 5164 - Semiconductor Properties and Devices II (3.0 cr)
EE 5171 - Microelectronic Fabrication (3.0 cr)
EE 5173 - Basic Microelectronics Laboratory (1.0 cr)
EE 5181 - Micro and Nanotechnology by Self Assembly (3.0 cr)
EE 5621 - Physical Optics (3.0 cr)
EE 5622 - Physical Optics Laboratory (1.0 cr)
EE 5624 - Optical Electronics (4.0 cr)
EE 5653 - Physical Principles of Magnetic Materials (3.0 cr)
EE 5655 - Magnetic Recording (3.0 cr)
EE 5657 - Physical Principles of Thin Film Technology (4.0 cr)
ESCI 5353 - Electron Microprobe Theory and Practice (3.0 cr)
GCD 5036 - Molecular Cell Biology (3.0 cr)
MATH 4428 - Mathematical Modeling (4.0 cr)
MATH 4512 - Differential Equations with Applications (3.0 cr)
MATH 5485 - Introduction to Numerical Methods I (4.0 cr)
MATH 5486 - Introduction To Numerical Methods II (4.0 cr)
MATH 5525 - Introduction to Ordinary Differential Equations (4.0 cr)
MATH 5535 - Dynamical Systems and Chaos (4.0 cr)
MATH 5587 - Elementary Partial Differential Equations I (4.0 cr)
MATH 5588 - Elementary Partial Differential Equations II (4.0 cr)
MATH 5651 - Basic Theory of Probability and Statistics (4.0 cr)
MATH 5652 - Introduction to Stochastic Processes (4.0 cr)
MATH 8441 - Numerical Analysis and Scientific Computing (3.0 cr)
MATH 8442 - Numerical Analysis and Scientific Computing (3.0 cr)
MATS 4212 - Ceramics (3.0 cr)
MATS 4214 - Polymers (3.0 cr)
MATS 4221 - Materials Performance (4.0 cr)
MATS 4223W - Polymer Laboratory [WI] (2.0 cr)
MATS 4301W - Materials Processing [WI] (4.0 cr)
MATS 4511W *{Inactive}*[WI] (4.0 cr)
MATS 5353 *{Inactive}*(3.0 cr)
MATS 5517 - Microscopy of Materials (3.0 cr)
MATS 5531 *{Inactive}*(3.0 cr)
MATS 8001 - Structure and Symmetry of Materials (3.0 cr)
MATS 8002 - Thermodynamics and Kinetics (3.0 cr)
MATS 8003 - Electronic Properties (3.0 cr)
MATS 8004 - Mechanical Properties (3.0 cr)
MATS 8201 - Applied Math (3.0 cr)
MATS 8211 - Physical Chemistry of Polymers (4.0 cr)
MATS 8221 - Synthetic Polymer Chemistry (4.0 cr)
ME 5228 - Introduction to Finite Element Modeling, Analysis, and Design (4.0 cr)
ME 5247 - Applied Stress Analysis (4.0 cr)
ME 5446 - Introduction to Combustion (4.0 cr)
ME 8390 - Advanced Topics in the Thermal Sciences : Biostabilization in Biomedicine, and Biotechnology (1.0 - 3.0 cr)
PA 5011 - Dynamics of Public Affairs Organizations (3.0 cr)
PA 5012 - The Politics of Public Affairs (3.0 cr)
PA 5021 - Microeconomics for Policy Analysis (3.0 cr)
PA 5701 *{Inactive}*(3.0 cr)
PA 5711 - Science, Technology & Environmental Policy (3.0 cr)
PA 5721 - Energy Systems and Policy (3.0 cr)
PA 5722 - Economics of Environmental Policy (3.0 cr)

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of March 28, 2024

PA 5801 - Global Public Policy (3.0 cr)
PHYS 5001 - Quantum Mechanics I (4.0 cr)
PHYS 5002 - Quantum Mechanics II (4.0 cr)
PHYS 5081 - Introduction to Biopolymer Physics (3.0 cr)
PHYS 5201 - Thermal and Statistical Physics (3.0 cr)
PHYS 5701 - Solid-State Physics for Engineers and Scientists (4.0 cr)
PHYS 8001 - Advanced Quantum Mechanics (3.0 cr)
PHYS 8702 - Statistical Mechanics and Transport Theory (3.0 cr)
PHYS 8711 - Solid-State Physics I (3.0 cr)
PHYS 8712 - Solid-State Physics II (3.0 cr)
STAT 5021 - Statistical Analysis (4.0 cr)

**Special Topics Electives**

The following electives are topics courses. Only the approved topic titles below may be used.
AEM 8511 Advanced Topics in Continuum Mechanics - Problems in Materials Science
CEGE 5180 Special Topics - Membrane Science and Technology
EE 5940 Special Topics - Thin Films and Nanostructures: Materials and Devices
EE 8950 Advanced Topics - Materials & Design for Future Nonvolatile Memory
Math 8450 Topics in Numerical Analysis - Applications of Continuum Mechanics in Biology

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.