UNIVERSITY OF MINNESOTA
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Twin Cities Campus

Chemical 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)
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Website: http://www.cems.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2020
- 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.

Research activities in the Chemical Engineering and Materials Science (CEMS) Department focus on the development of renewable energy technologies, the solution of important medical and biological engineering challenges, the development of advanced materials, and the application of sophisticated mathematical and theoretical models.

Graduate courses offered cover core areas of chemical engineering (fluid mechanics, applied mathematics: linear and nonlinear analysis, transport, chemical thermodynamics, statistical thermodynamics and kinetics, and analysis of chemical reactors) and core areas of materials science (structure and symmetry of materials, thermodynamics and kinetics, electronic properties of materials, and mechanical properties of materials). In addition, several specialized topics are offered, including biochemical engineering, biological transport processes, food processing technology, colloids, principles of mass transfer in engineering and biological engineering, rheology, coating process fundamentals, process control, finite elements methods of computer-aided analysis, ceramics, polymers, materials design and performance, materials processing, corrosion, introduction to polymer chemistry, polymer laboratory, contact and fracture properties of materials, electron microscopy, thin films and interfaces, composites, electrochemical engineering, physical chemistry of polymers, solid state reaction kinetics, electronic structure of materials, electronic properties and applications of organic materials, electronic ceramics, dislocations and interfaces, epitaxial thin film growth, and 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 chemical engineering or 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

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- Paper Based - Total Score: 560
- IELTS
  - Total Score: 6.5
- MELAB
  - Final score: 80

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

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 CHEN core 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

Take 4 or more course(s) totaling 12 or more credit(s) from the following:

- CHEN 8101 - Fluid Mechanics (3.0 cr)
- CHEN 8201 - Applied Math (3.0 cr)
- CHEN 8301 - Physical Rate Processes I: Transport (3.0 cr)
- CHEN 8401 - Physical and Chemical Thermodynamics (3.0 cr)
- CHEN 8402 - Statistical Thermodynamics and Kinetics (3.0 cr)
- CHEN 8501 - Chemical Rate Processes: Analysis of Chemical Reactors (3.0 cr)

Thesis Credits

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

Electives

The remaining credits may be chosen from this list or consult with advisor for further options.
AEM 5321 - Modern Feedback Control (3.0 cr)
AEM 5501 - Continuum Mechanics (3.0 cr)
AEM 5503 - Theory of Elasticity (3.0 cr)
AEM 8201 - Fluid Mechanics I (3.0 cr)
AEM 8202 - Fluid Mechanics II (3.0 cr)
AEM 8203 - Fluid Mechanics III (3.0 cr)
AEM 8251 - Finite-Volume Methods in Computational Fluid Dynamics (3.0 cr)
AEM 8421 - Robust Multivariable Control Design (3.0 cr)
AEM 8541 - Mechanics of Crystalline Solids (3.0 cr)
BIOC 4332 - Biochemistry II: Molecular Mechanisms of Signal Transduction and Gene Expression (4.0 cr)
BIOC 5528 - Spectroscopy and Kinetics (4.0 cr)
BIOC 6021 - Biochemistry (3.0 cr)
BIOC 8002 - Molecular Biology and Regulation of Biological Processes (3.0 cr)
BMEN 5001 - Advanced Biomaterials (3.0 cr)
BMEN 5201 - Advanced Biomechanics (3.0 cr)
BMEN 5311 - Advanced Biomedical Transport Processes (3.0 cr)
BMEN 5351 - Cell Engineering (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)

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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 8011 - Mechanisms of Chemical Reactions (4.0 cr)
CHEM 8021 - Computational Chemistry (4.0 cr)
CHEM 8151 - Analytical Separations and Chemical Equilibria (4.0 cr)
CHEM 8152 - Analytical Spectroscopy (4.0 cr)
CHEM 8201 - Materials Chemistry (4.0 cr)
CHEM 8211 - Physical Polymer Chemistry (4.0 cr)
CHEM 8221 - Synthetic Polymer Chemistry (4.0 cr)
CHEM 8361 - Interpretation of Organic Spectra (4.0 cr)
CHEM 8551 - Quantum Mechanics I (4.0 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 4214 - Polymers (3.0 cr)
CHEN 5751 - Biochemical Engineering (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 8221 - Synthetic Polymer Chemistry (4.0 cr)
CHEN 8301 - Physical Rate Processes I: Transport (3.0 cr)
CHEN 8401 - Physical and Chemical Thermodynamics (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)
CSCI 5302 - Analysis of Numerical Algorithms (3.0 cr)
CSCI 5304 - Computational Aspects of Matrix Theory (3.0 cr)
CSCI 8363 - Numerical Linear Algebra in Data Exploration (3.0 cr)
EE 5163 - Semiconductor Properties and Devices I (3.0 cr)
EE 5164 - Semiconductor Properties and Devices II (3.0 cr)
EE 5181 - Micro and Nanotechnology by Self Assembly (3.0 cr)
EE 5231 - Linear Systems and Control (3.0 cr)
EE 5239 - Introduction to Nonlinear Optimization (3.0 cr)
EE 5657 - Physical Principles of Thin Film Technology (4.0 cr)
EE 8161 - Physics of Semiconductors (3.0 cr)
GCD 4034 - Molecular Genetics and Genomics (3.0 cr)
GCD 8151 - Cellular Biochemistry and Cell Biology (2.0 - 4.0 cr)
GCD 8161 - Advanced Cell Biology and Development (2.0 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 4223W - Polymer Laboratory [WI] (2.0 cr)
MATS 5517 - Microscopy of Materials (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 8211 - Physical Chemistry of Polymers (4.0 cr)
MATS 8221 - Synthetic Polymer Chemistry (4.0 cr)

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MATS 8301 - Physical Rate Processes I: Transport (3.0 cr)
ME 5113 - Aerosol/Particle Engineering (4.0 cr)
ME 5446 - Introduction to Combustion (4.0 cr)
ME 8341 - Conduction (3.0 cr)
ME 8390 - Advanced Topics in the Thermal Sciences : Biostabilization in Biomedicine, and Biotechnology (1.0 - 3.0 cr)
MICA 8002 - Structure, Function, and Genetics of Bacteria and Viruses (4.0 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 - Infrared Technology and Environmental Sensing
Math 8450 Topics in Numerical Analysis - Applications of Continuum Mechanics in Biology
Mats 8995 Special Topics - Scattering from Soft Materials

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