Chemical and Molecular Engineering (CME)

Major in Chemical and Molecular Engineering

Department of Materials Science and Engineering, College of Engineering and Applied Sciences

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Minors of particular interest to students majoring in Chemical and Molecular Engineering: Pharmacology (BCP), Business (BUS), Chemistry (CHE)

Faculty
Please see the faculty listing in the entry for the Engineering Science major.

The Department of Materials Science and Engineering offers two majors leading to the Bachelor of Engineering (B.E.) degree, Engineering Science (see entry in the alphabetical listings of Approved Majors, Minors, and Programs) and Chemical and Molecular Engineering. The program in Chemical and Molecular Engineering is designed to meet the expanding demand for chemical engineers in the nanotechnology, neuromaceutical, pharmaceutical, environmental, and energy industries. It emphasizes engineering at the molecular level rather than traditional large-scale process engineering. In a rigorous cross-disciplinary environment, the program provides students with knowledge in the basic physical sciences, mathematical techniques, and computational modeling tools that form the foundation of modern chemical and molecular engineering. A broad spectrum of courses prepares students to assimilate and apply their knowledge creatively to solve complex problems involving not only scientific but also ethical and moral considerations, and utilizing effective communication skills for working in an interdisciplinary team. Employment opportunities for graduates of the program include high-technology industries and institutions that are engaged in research and advanced manufacturing related to nanotechnology, pharmaceuticals, biotechnology, future fuels, waste management, and the synthesis of new materials.

The program’s mission is to serve the community by becoming a resource for regional economic development and to serve the nation by training students who can assume leadership in technological innovation, public service, and ethical standards. Its goal is to achieve international recognition as a center of excellence in molecularly based chemical engineering education and research.

Program Educational Objectives
The undergraduate program in chemical and molecular engineering has the following four specific program educational objectives:

1. The students will be prepared to assume positions in industry or research institutions that require knowledge of chemical engineering principles.
2. The students will be prepared to demonstrate leadership, teamwork, and communication skills.
3. The students will be committed to lifelong learning, ethical conduct, and be able to meet the constantly emerging needs of the chemical engineering profession.
4. The students will be educated in chemical engineering fundamentals and modern computational tools that enable them to succeed in graduate programs and research in chemical engineering.

Program Outcomes
To prepare students to meet the above program educational objectives, a set of program outcomes that describes what students should know and be able to do when they graduate, have been adopted. We expect students to gain:

a. the ability to apply knowledge of mathematics, science, and engineering to chemical engineering problems;
b. the ability to design and conduct experiments, as well as to analyze and interpret data;
c. the ability to design a system, component, or process to meet desired needs;
d. the ability to function on multidisciplinary teams;
e. the ability to identify, formulate, and solve engineering problems;
f. the understanding of professional and ethical responsibility;
g. the ability to communicate effectively;
h. the broad education necessary to understand the impact of engineering solutions in a global and societal context;
i. the recognition of the need for and an ability to engage in lifelong learning;
j. a knowledge of contemporary issues;
k. the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Courses Offered in Chemical and Molecular Engineering

CME 101  Introduction to Chemical and Molecular Engineering
CME 199  Introduction to Undergraduate Research
CME 201-H  Sustainable Energy
CME 300  Writing in Chemical and Molecular Engineering
CME 304  Chemical Engineering Thermodynamics I
CME 310  Chemical Engineering Laboratory I: Unit Operation and Fundamentals
CME 312  Material and Energy Balance
CME 314  Chemical Engineering Thermodynamics II
CME 315  Numerical Methods for Chemical Engineering Analysis
CME 318  Chemical Engineering Fluid Mechanics
CME 320  Chemical Engineering Laboratory II: Chemical and Molecular Engineering
CME 322  Chemical Engineering Heat and Mass Transfer
CME 323  Reaction Engineering and Chemical Kinetics
CME 327  Molecular Modeling for Chemical Engineers
CME 330  Principles of Engineering for Chemical Engineers
CME 333  Business Economics for Engineers
CME 369  Polymer Engineering

Fall 2008: updates since Spring 2007 are in red
CME 370  Cell Biology for Chemical Engineers
CME 371  Biomedical Polymers
CME 375  Fundamentals of Professional Chemical & Molecular Engineering
CME 401  Separation Technologies
CME 410  Chemical Engineering Laboratory III: Instrumentation, Material Design, and Characterization
CME 420  Chemical Engineering Laboratory IV: Senior Thesis
CME 440, 441  Process Engineering and Design I, II
CME 470  Polymer Synthesis
CME 475  Undergraduate Teaching Practicum
CME 488  Industrial Internship
CME 499  Research in Chemical Engineering

Acceptance into the Major in Chemical and Molecular Engineering

Freshman and transfer applicants who have specified their interest in the major in Chemical and Molecular Engineering may be accepted directly into the major upon admission to the University. Applicants admitted to the University but not immediately accepted into the Chemical and Molecular Engineering major may apply for acceptance at any time during the academic year by contacting the director of the undergraduate program. Final decisions on admission will be made by the undergraduate program director. Minimum requirements for acceptance are as follows:

1. Students must have a grade of B or higher in all math, physics and chemistry courses required by the major that have been completed.
2. Students must have an overall g.p.a. of 3.0 with not more than one grade of C or lower in any course, unless permission to waive is granted by the undergraduate program director.
3. Department must receive completed course evaluations for all transferred courses that are to be used to meet requirements of the major.

Requirements for the Major in Chemical and Molecular Engineering (CME)

The curriculum begins with a focus on mathematics, physics, and chemistry, followed by courses covering specific chemical engineering topics as well as an intensive laboratory sequence. In addition, each student chooses a four-course sequence as an area of specialization which may also qualify the students for a minor in the respective department. The program culminates in the submission and acceptance of a senior thesis or original research project completed by the student which is defended at the end of the senior year. The students are encouraged to select original research projects which can be published in peer reviewed journals.

Completion of the major requires approximately 117 credits.

1. Mathematics
   a. AMS 151, 161 Applied Calculus I, II
   b. AMS 261 or MAT 203 or MAT 205 Calculus III
   c. AMS 361 or MAT 303 or MAT 305 Calculus IV

   Note: The following alternate calculus course sequences may be substituted for AMS 151, 161:
   - MAT 131, MAT 132
   - MAT 125, 126, 127
   - MAT 141, 142
   - MAT 171

2. Natural Sciences
   a. Chemistry
      - CHE 131, 132 General Chemistry I, II or CHE 141, 142
CHE 133, 134 General Chemistry Laboratory I, II or CHE 143, 144
CHE 321 Organic Chemistry I and CHE 326 Organic Chemistry IIIB
CHE 383, 384 Introductory and Intermediate Synthetic and Spectroscopic Laboratory Techniques

b. Physics
PHY 131, 132 Classical Physics I, II
PHY 133, 134 Classical Physics Laboratory I, II
PHY 251 Modern Physics and PHY 252 Modern Physics Laboratory or ESG 281 Engineering Introduction to the Solid State

Note: The following alternate physics course sequences may be substituted for PHY 131/133, 132/134:

PHY 125, 126, 127 or PHY 141, 142

3. Computer Programming
one of the following:
CSE 130 Introduction to Programming in C
ESG 111 C Programming for Engineers
ESE 124 Computer Techniques for Electronic Design

4. Chemical Engineering
CME 101 Introduction to Chemical and Molecular Engineering
CME 304, 314 Chemical Engineering Thermodynamics I, II
CME 312 Material and Energy Balance
CME 315 Numerical Methods for Chemical Engineering Analysis
CME 318 Chemical Engineering Fluid Mechanics
CME 322 Chemical Engineering Heat and Mass Transfer
CME 323 Reaction Engineering and Chemical Kinetics
CME 327 Molecular Modeling for Chemical Engineers or 300-level BUS course
CME 330 Principles of Engineering for Chemical Engineers
CME 333 Business Economics for Engineers
CME 401 Separation Technologies

CME 310, 320, 410, 420 Chemical Engineering Laboratory I, II, III, IV
CME 440, 441 Process Engineering and Design I, II

5. Specializations in Chemical and Molecular Engineering
Chemical and Molecular Engineering students must choose from one of the eight specializations offered. Each specialization requires the completion of four technical elective courses at the 300 level or higher.

6. Upper-Division Writing Requirement:
CME 300 Writing in Chemical and Molecular Engineering
All degree candidates must demonstrate skill in written English at a level acceptable for engineering majors. All Chemical and Molecular Engineering students must complete the writing course CME 300 concurrently with CME 310. The quality of writing in technical reports submitted for CME 310 is evaluated, and students whose writing does not meet the required standard are referred for remedial help. Satisfactory writing warrants an S grade for CME 300, thereby satisfying the requirement.

Grading
All courses taken to satisfy requirements 1-6 above must be taken for a letter grade of C or higher, except in CME 304 which must be taken for a letter grade of B- or higher.

Specializations
Students must complete four courses in a chosen specialization. (In some cases, there is also a pre- or co-requisite course attached to one of the courses.) In consultation with a faculty advisor, students select their area of specialization before registering for the first semester of the junior year and not later than upon earning 57 credits. Students are urged to meet regularly with their advisors regarding completion of the course requirements for the chosen specialization. Other courses may be used towards this requirement with the prior permission of the undergraduate program director.

A. Pharmacology
Ensures a sound background in pharmacology coupled with a foundation in chemical process control, distillation, and molecular modeling for students interested in pursuing a career in the food, cosmetics, or pharmaceutical industries or in medical instrumentation.
BIO 203 Fundamentals of Biology: Cellular and Organ Physiology
BIO 328 Mammalian Physiology
BCP 401 Principles of Pharmacology
BCP 402 Advanced Pharmacology

B. Materials Science
Provides a foundation in properties of materials, engineering mechanics, and electronic materials for students interested in computer-related industries, nanotechnology, and electronics.
ESG 333 Materials Science II: Electronic Properties
ESM 334 Materials Engineering
ESM 335 Strength of Materials
ESM 336 Electronic Materials

C. Polymer Science
Provides a foundation in the properties of polymers, spectroscopy of organic compounds, polymer synthesis, and polymer processing for students interested in pursuing research in major laboratories or in academia.
CME 369 Polymers
CME 370 Cellular Biology for Chemical Engineers
CME 371 Biomedical Polymers
CME 470 Polymer Synthesis

D. Tissue Engineering
Recommended for students who are interested in the biochemical foundations of cellular function and the design of materials scaffolds for tissue engineering. It is also recommended for students interested in drug delivery systems and premedical or pharmacological professions.
The following courses can be used to satisfy the CME Tissue Engineering Specialization:
BIO 202-E Fundamentals of Biology: Molecular and Cellular Biology or BIO 203-E Fundamentals of Biology: Cellular and Organ Physiology
BME 404 Essentials of Tissue Engineering
Any TWO of the following courses:
CHE 346 Biomolecular Structure and Reactivity
CME 371 Biomedical Polymers
BIO 210-E  Human Physiology  
BIO 310  Cell Biology  
BIO 311  Techniques in Molecular and Cellular Biology  
BIO 328  Mammalian Physiology  
BIO 335  Animal Physiology Laboratory  
BIO 317  Principles of Cellular Signaling  
BIO 318-H  Bioethics and Policy  

E. Business  
The Business specialization is recommended for students interested in the economic implications of chemical engineering and in financial management of intellectual property.  
The following four courses satisfy the requirement for the business specialization in the CME program. They also form the major component of a minor in business.  
BUS 215 Introduction to Business Statistics  
BUS 340 Information Systems in Management  
BUS 351 Human Resource Management  
BUS 441 Business Strategy  

F. Chemistry  
The Chemistry specialization consists of 12 credits of upper level CHE 300 courses not already required for the CME Major  

G. Physics  
The Physics specialization consists of the following courses:  
PHY 301 Electromagnetic Theory  
PHY 303 Mechanics  
PHY 335 Electronics and Instrumentation Laboratory  
Three additional credits of upper level PHY 300 courses not required for the CME major.  

H. Custom Specialization  
This category is created to allow students to choose their own specialization. Students will select four upper level courses related to the chosen specialty within the courses offered at the university and approved by the CME undergraduate program director. The goal is to provide a basic foundation for students and prepare them for the job market in the chosen specialty.