### 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)

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#### Faculty

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

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#### 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.

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#### 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.

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#### 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
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 101 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 or MAT 125, 126, 127
or MAT 141, 142
or 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.
   ESM 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 Polymer Engineering
   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 pharmaceutical 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 Business specialization consists of 12 credits of any upper division (300 level or above) Business courses not required for the CME major.

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 12 credits of any upper division (300 level or above) Physics 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.