

# CHEMICAL AND BIOMOLECULAR ENGINEERING

## THE GEORGE R. BROWN SCHOOL OF ENGINEERING

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## **DEGREES OFFERED: BA, BSChE, MChE, MS, PHD**

This major gives undergraduates a sound scientific and technical grounding for further development in a variety of professional environments. Courses in mathematics, chemistry, physics, and computational engineering provide the background for the chemical engineering core, which introduces students to chemical process fundamentals, fluid mechanics, heat and mass transfer, thermodynamics, kinetics, reactor design, process control, and process design. Course electives may be used to create a focus area in one of the following 4 disciplines: bioengineering, environmental engineering, materials science/engineering, and computational engineering. Upon completing either the flexible BA requirements or the more scientific and professional BSChE requirements, students may apply for a 5th year of study leading to the nonthesis Master of Chemical Engineering (MChE) degree. A joint MBA/MChE degree also is available in conjunction with the Jesse H. Jones Graduate School of Management.

Students admitted for graduate studies leading to the MS or PhD degrees must complete a rigorous program combining advanced course work and original research that must be formalized in an approved thesis. Graduate research is possible in a number of areas, including catalysis and nanotechnology, thermodynamics and phase equilibria, interfacial phenomena, colloids, microemulsions, rheology and fluid mechanics, biosystems engineering, biocatalysis and metabolic engineering, cell population heterogeneity and biological pattern formation, cellular and tissue engineering, energy and sustainability, gas hydrates, enhanced oil recovery, reservoir characterization, and pollution control.

## **DEGREE REQUIREMENTS FOR BS IN CHEMICAL ENGINEERING**

For general university requirements, see Graduation Requirements (pages 14–15). The BS degree is accredited by the Accreditation Board for Engineering

and Technology (ABET). Through careful selection of other engineering and science courses, a student can develop a focus (or concentration) area in any of the following 4 engineering disciplines: environmental science/engineering, bioengineering, materials science/engineering, and computational engineering. These elective programs can be completed within the framework of a BS in chemical engineering. Students majoring in chemical engineering must complete 96 hours in the courses specified below for a minimum of 132 hours at graduation.

The undergraduate curriculum is designed so that outstanding students interested in careers in research and teaching may enter graduate school after earning either bachelor's degree.

### ENGINEERING BREADTH AND FOCUS AREA OPTIONS

To complete their technical education, Rice students seeking a BS degree in chemical engineering take course electives in at least 2 other engineering disciplines to satisfy a "breadth" requirement.

Or, they can use their electives to create a focus (or concentration) area in 1 of the following four disciplines:

- biotechnology/bioengineering
- computational engineering
- environmental engineering
- materials science and engineering

Consult our department web page for a detailed list of courses that can be used to satisfy the engineering breadth or focus area requirements.

### DEGREE REQUIREMENTS FOR BSChE IN CHEMICAL ENGINEERING

#### **Chemistry**

CHEM 121/122 *General Chemistry with Laboratory* or

CHEM 151/152 *Honors Chemistry with Laboratory*

CHEM 211/212 *Organic Chemistry*

CHEM 217 *Organic Chemistry Lab*

CHEM 311/312 *Physical Chemistry*

Any 2 of CHEM 212, CHEM 311, or CHEM 312

#### **Chemical and Biomolecular Engineering**

CHBE 301 *Chemical Engineering Fundamentals*

CHBE 303 *Computer Programming in Chemical Engineering*

CHBE 305 *Computational Methods for Chemical Engineers*

CHBE 343 *Chemical Engineering Lab I*

CHBE 390 *Kinetics and Reactor Design*

CHBE 401/402 *Transport Phenomena I and II*

CHBE 403 *Design Fundamentals*

CHBE 404 *Product and Process Design*

CHBE 411/412 *Thermodynamics I and II*

CHBE 443 *Chemical Engineering Lab II*

CHBE 470 *Process Dynamics and Control*

#### **Mathematics**

MATH1 101/103 *Single Variable Calculus I and II*

MATH 211 *Ordinary Differential Equations and Linear Algebra*

MATH 212 *Multivariable Calculus or equivalent honors courses*

CAAM 336 *Differential Equations in Science and Engineering or*

MATH 381 *Introduction to Partial Differential Equations*

#### **Physics**

PHYS 101 or 111 *Mechanics*

PHYS 102 or 112 *Electricity and Magnetism*

#### **Mechanical Engineering**

MECH 211 *Engineering Mechanics*

Students pursuing the BA degree in chemical engineering must meet all of the requirements for the BSChE degree with the following exceptions: CHBE 404 and 470 are not required. Also, they do not have to satisfy the requirements for

either the engineering breadth or the focus area. Free electives may be substituted for these requirements to reach at least 132 semester hours for graduation.

**Prerequisites for Chemical Engineering Courses**—Before undergraduates may register for courses in chemical engineering at the 300-level and above, they must satisfy the following prerequisites.

**For CHBE 301**

Math 101/102

CHEM 121/122 or CHEM 151/152

Corequisite: CHBE 303

**For CHBE 390**

CHBE 301, 303, and 305

MATH 211/212

**For CHBE 401**

CHBE 411

MATH 211/212

PHYS 101/102

Co/Prerequisite: CHBE 305

**For CHBE 402**

CHBE 401

Co/Prerequisites: CAAM 336 or MATH 381

**For CHBE 403**

CHBE 390, 402, and 412

Co/Prerequisites: CHBE 470 and MECH 211

**For CHBE 404**

CHBE 403

**For CHBE 411**

CHBE 301 and 303

**For CHBE 412**

CHBE 411

**For CHBE 470**

CHBE 390, 402, and 412

## DEGREE REQUIREMENTS FOR MChE, MS, AND PHD IN CHEMICAL ENGINEERING

For general university requirements, see Graduate Degrees (pages 57–58).

**MChE Program**—For the MChE degree, students must complete at least 30 hours of courses beyond those counted for their undergraduate degree. At least 6 of the courses taken must be upper-level courses in chemical engineering and 1 must be an approved mathematics course. The chemical engineering courses selected should include process design (2 semesters) and process control, unless courses in these subjects were taken during the student's undergraduate studies.

**MS Program**—Candidates for the MS degree must:

- Complete at least 18 approved semester hours with high standing
- Submit an original research thesis
- Defend the thesis in a public oral examination

**PhD Program**—Candidates for the PhD degree must:

- Demonstrate competence in the areas of applied mathematics, thermodynamics, transport processes, and chemical kinetics and reactor design by passing qualifying examinations, usually during the 1st year of study
- Complete at least 36 approved semester hours with high standing (with department approval, the course requirements may be reduced to 24 hours for students already holding an MS degree)
- Submit a thesis that provides evidence of their ability to carry out original research in a specialized area of chemical engineering
- Defend the thesis in a public oral examination

**See CHBE in the Courses of Instruction section.**