

# CHEMICAL ENGINEERING

Department Website (<http://www.che.sc.edu/>)

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The Department of Chemical Engineering offers research-oriented graduate study programs leading to the Master of Science and Doctor of Philosophy degrees in chemical engineering, as well as a program for professional development culminating in the Master of Engineering degree in chemical engineering.

Advanced course work in chemical engineering has three objectives: to give students a solid foundation in core concepts at the graduate level, to prepare students for independent research in a field of specialization, and to expose students to a broad range of knowledge in chemical engineering and allied disciplines. The M.S. and Ph.D. programs emphasize independent research leading to the submission of a thesis or dissertation and publication of results in peer-reviewed technical journals. Students in the M.E. program may, at their option, propose a program of independent study, supervised by a faculty member, that may replace up to six hours of lecture courses.

In all cases, students should prepare and receive approval of a formal program of study that lists the specific courses to be used for their degree. In addition, proposals for independent study as a part of the M.E. degree program must be reviewed and approved by the faculty of the department before the work is initiated. Programs of study and plans for independent study and research should be developed in collaboration with the graduate director or the student's research advisor.

Graduates from the Department of Chemical Engineering readily find entry-level employment in engineering research, development, management, marketing, sales, production, and design. Recent graduates have assumed positions in industry, government service, and academe.

## Fields of Specialization

The research interests of the faculty span all of the traditional core areas of chemical engineering and extend into many frontiers. Ongoing research may be found in fluid mechanics, heat and mass transfer, separations, kinetics and reactor design, process control, and process design. Building upon this traditional core, the department has developed more specialized research strengths in heterogeneous catalysis, electrochemical and battery engineering, advanced soft materials engineering, and AI-accelerated materials design. A complete description of the current research interests of the faculty may be found in the department's brochure or on its Web page, located at <http://www.che.sc.edu>.

## Accelerated B.S.E./Master's Education Plans

The accelerated B.S.E./master's plans in chemical engineering allows students to complete both the B.S.E. degree and a master's degree in chemical engineering in as few as five years. The use of dual credit—courses that can be used toward both degrees—enables acceleration of the program, reducing the total enrollment of the student by one semester.

Chemical engineering students may apply for approval of an accelerated education plan in the semester in which they will complete 90 hours of undergraduate course work. In addition, students must have a sufficient

foundation in chemical engineering course work to enable them to take graduate-level courses. University and department regulations stipulate that applicants must have a minimum GPA of 3.40, both overall and in chemical engineering courses. Students may apply by submitting an accelerated education plan, an application for senior privilege, and a copy of a Graduate School application to the graduate director in chemical engineering. The dean of The Graduate School has final authority for approving accelerated education plans.

Only graduate-level courses (numbered 500 and above) may be used for dual credit. No more than nine credit hours may be used as dual credit. The graduate courses used for dual credit must be taken during the student's final undergraduate year. The student graduates with the B.S.E. degree after completing the B.S.E. degree requirements. At that time, the student is admitted to the graduate program with up to nine hours of graduate credit.

## Admission Requirements

Requirements for admission to graduate degree programs in chemical engineering (M.E., M.S., Ph.D.) conform to the general regulations of The Graduate School, as well as more stringent departmental requirements as described below. In general, the admissions process is highly competitive. Admissions decisions are based on the quality of the applicant's previous university-level academic work (as reflected by grade point average), letters of recommendation, and other evidence of past accomplishments.

Students holding B.S. degrees may apply for direct admission to the doctoral program; it is not necessary to complete a master's degree first. Applicants with degrees (B.S. or higher) in other engineering disciplines or chemistry may be admitted with additional remedial course requirements in chemical engineering at the undergraduate level. The required remedial courses will typically include the prerequisites to required graduate courses and may include additional undergraduate courses in chemical engineering, mathematics, and chemistry. The detailed specification of course requirements and substitutions of courses from other universities will be considered on a case-by-case basis.

International applicants must also submit TOEFL, IELTS Intl. Academic Course Type 2 exam scores, or equivalent. All applicants should submit a statement of purpose (or similar essay) that describes the applicant's background, research interests, and whether or not financial aid is required. Students admitted to the Ph.D. degree program usually receive financial aid. However, the department does not normally provide financial aid to students in the M.E. or M.S. degree programs.

## Programs

- Chemical Engineering, M.E. (<https://academicbulletins.sc.edu/graduate/engineering-computing/chemical-engineering/chemical-engineering-me/>)
- Chemical Engineering, M.S. (<https://academicbulletins.sc.edu/graduate/engineering-computing/chemical-engineering/chemical-engineering-ms/>)
- Chemical Engineering, Ph.D. (<https://academicbulletins.sc.edu/graduate/engineering-computing/chemical-engineering/chemical-engineering-phd/>)

## Courses

### ECHE 520 - Chemical Engineering Fluid Mechanics (3 Credits)

Multi-phase pressure drop, phase contacting, flow through porous media, fluidization, mixing, and turbulence.

**Prerequisites:** D or better in ECHE 320 or ENCP 360.

### ECHE 521 - Computational Fluid Dynamics for Engineering Applications (3 Credits)

Introduction to the use of computational fluid dynamics codes to analyze flow, heat, and mass transfer problems of practical engineering applications.

**Prerequisites:** D or better in ECHE 320, EMCH 360, ECIV 360, ENCP 360, or AESP 265.

### ECHE 530 - Intermediate Chemical Engineering Kinetics (3 Credits)

Intermediate concepts of chemical kinetics, batch and flow reactors, catalysts and reactor design, including non-ideal systems.

**Prerequisites:** C or better in ECHE 311.

**Prerequisite or Corequisite:** D or better in ECHE 321.

### ECHE 540 - Intermediate Separation Process Design (3 Credits)

Intermediate level design of stagewise chemical separation cascades; analysis of binary and ternary systems; multicomponent separations, plate and column specification procedures; distillation, crystallization, extraction, and leaching.

**Prerequisites:** C or better in ECHE 300.

**Prerequisite or Corequisite:** D or better in ECHE 311.

### ECHE 550 - Chemical-Process Dynamics and Control (3 Credits)

Fundamental physical and chemical principles in mathematically modeling the dynamic response of chemical processes; feedforward and feedback control systems; design of control schemes for selected chemical processes.

**Prerequisites:** C or better in ECHE 300 and MATH 242; D or better in ECHE 456.

### ECHE 567 - Process Safety, Health and Loss Prevention (3 Credits)

Reliability, availability, and fault-tree analyses, risk indices, hazard evaluation, vapor cloud modeling, toxicology, material safety classification and regulations, individual/corporate ethical responsibilities.

**Prerequisite or Corequisite:** D or better in ECHE 466.

### ECHE 571 - Corrosion Engineering (3 Credits)

Basic principles of corrosion engineering developed from a chemical engineering approach to thermodynamics, kinetics, mass transfer, and potential theory.

**Prerequisites:** D or better in ECHE 311.

### ECHE 572 - Polymer Processing (3 Credits)

Industrial polymers with emphasis on their characterization and on the modeling of the major polymer fabrication processes.

### ECHE 573 - Next Energy (3 Credits)

An examination of energy technologies that will enable society to move from an economy based on fossil fuels to one based on sustainable energy.

### ECHE 574 - Combustion (3 Credits)

Fundamental process and applications related to the broad field of combustion and energy generation including emissions control technologies.

**Prerequisites:** D or better in ECHE 430.

### ECHE 575 - Engineering of Soft Materials (3 Credits)

Introductory overview of fundamental concepts in science and engineering of soft materials; the relation between microstructure and macroscopic behavior in a variety of soft matter systems; key applications in chemical and biomedical engineering.

**Prerequisites:** C or better in MATH 122 or MATH 141.

**Cross-listed course:** BMEN 575

### ECHE 589 - Special Advanced Topics in Chemical Engineering (3 Credits)

Course content varies and will be announced in the schedule of classes by title. May be repeated as topic varies.

### ECHE 700 - Chemical Process Analysis (3 Credits)

Quantitative analysis of industrial chemical operations. Equilibrium relations, material and energy balances, and reaction kinetics principles are used to analyze a variety of chemical processes and systems.

### ECHE 709 - Selected Topics in Industrial Stoichiometry (3 Credits)

Special topics in industrial stoichiometry with emphasis on current research.

### ECHE 710 - Advanced Chemical Engineering Thermodynamics (3 Credits)

Mass, energy, and entropy balance analysis of complex systems; evaluation of thermodynamic property changes of pure materials; solution thermodynamics of single-phase multicomponent systems; phase and chemical reaction equilibrium.

**Prerequisites:** ECHE 311.

### ECHE 719 - Selected Topics in Chemical Engineering Thermodynamics (3 Credits)

Special topics in chemical engineering thermodynamics with emphasis on current research.

### ECHE 720 - Advanced Fluid Flow Analysis (3 Credits)

Theory and application of fluid flow phenomena; momentum equations, conformal mapping, empirical methods, boundary layers, dimensional analysis.

**Prerequisites:** ENCP 360 and MATH 242.

### ECHE 721 - Advanced Heat Flow Analysis (3 Credits)

Theory and application of heat flow phenomena; classical techniques and finite-difference numerical methods; conduction, convection, radiation, boiling.

**Prerequisites:** ECHE 321 and ECHE 720.

### ECHE 722 - Advanced Mass Transfer (3 Credits)

Diffusive and convective mass transfer. Applications of the Stefan-Maxwell equations, prediction of diffusion coefficients, convective mass transport, correlations for mass transfer coefficients, and combined mass transfer and reaction modeling.

**Prerequisite or Corequisite:** ECHE 720.

### ECHE 725 - Rheology (3 Credits)

Rheological characteristics of viscous, elastic, viscoelastic, and plastic substances; non-Newtonian fluid flow, viscometry, and rheogoniometry; rheological equations of state; engineering applications.

**ECHE 728 - Selected Topics in Fluid Mechanics (3 Credits)**

Special topics in fluid mechanics with emphasis on current research.

**ECHE 729 - Selected Topics in Heat and Mass Transfer (3 Credits)**

Special topics in heat and mass transfer with emphasis on current research.

**ECHE 730 - Chemical Reactor Design (3 Credits)**

Optimum temperature sequencing. Modeling of non-ideal reactors. Theories of catalysis with emphasis on the rate of diffusion. Interpretation of experimental catalytic data and use of these data in reactor design.

**ECHE 735 - Heterogeneous Catalysis - Fundamentals (3 Credits)**

Fundamentals of heterogeneous catalysis, with emphasis on computational catalysis.

**ECHE 736 - Heterogeneous Catalysis – Synthesis, Characterization and Evaluation (3 Credits)**

Catalyst synthesis methods; experimental characterization approaches; correlating synthesis/characterization with catalytic performance.

**ECHE 737 - Industrial Catalysis (3 Credits)**

History of catalysis; industrial applications of catalysis; development of catalytic reactions from lab to pilot to production scale.

**ECHE 739 - Selected Topics in Kinetics and Reactor Design (3 Credits)**

Special topics in kinetics and reactor design with emphasis on current research.

**ECHE 740 - Distillation (3 Credits)**

Analytical, shortcut, and computer techniques for plate contacting of multicomponent systems. Review of binary separations, V-L-E models, azeotropic and extractive distillation, effects of non-key components, computational schemes, and convergence criteria.

**ECHE 741 - Liquid-Liquid Extraction (3 Credits)**

Principles of modeling liquid-liquid extraction cascades. Evaluation of L-L-E, ternary systems, design applications for hydrometallurgical systems, interlinked cascade structures for multiple solute systems, efficiency of process equipment, and synergism.

**ECHE 742 - Adsorption Fundamentals and Processes (3 Credits)**

Advanced principles of adsorption and adsorption processes including adsorbents, thermodynamics, kinetics, fixed bed adsorption and cyclic adsorption processes.

**ECHE 749 - Selected Topics in Separations (3 Credits)**

Special topics in separations with emphasis on current research.

**ECHE 750 - Process Dynamics and Control (3 Credits)**

Advanced topics in chemical process dynamics and control. Multivariate analysis, system identification, sampling, optimal process control.

**Prerequisites:** ECHE 550.

**ECHE 759 - Selected Topics in Process Control (3 Credits)**

Special topics in process control with emphasis on current research.

**ECHE 769 - Selected Topics in Chemical Engineering Design (3 Credits)**

Special topics in chemical engineering design with emphasis on current research.

**ECHE 770 - Electrochemical Engineering (3 Credits)**

Electrochemical engineering principles developed from thermodynamic, kinetic, mass transfer, and potential theory. Numerical analysis and design of electrochemical systems. Statistical analysis of experimental data and industrial experimental designs.

**ECHE 771 - Corrosion Engineering (3 Credits)**

Corrosion engineering principles developed from thermodynamic, kinetic, mass transfer, and potential theory. Numerical analysis of corroding systems, statistical analysis of experimental data, and industrial experimental designs.

**ECHE 772 - Principles of Polymer Systems (3 Credits)**

Theory and applications of polymer systems. Structure, physical properties, rheological, and mechanical behavior of polymers. Polymerization reactions and industrial polymerization processes. Fabrication techniques.

**ECHE 789 - Selected Topics in Chemical Engineering (3 Credits)**

Approved for special topic offerings.

**ECHE 797 - Research (1-12 Credits)**

Individual research to be arranged with instructor.

**ECHE 798 - Graduate Seminar in Chemical Engineering (1-2 Credits)**

Seminar on current topics in chemical engineering. Includes oral presentations by students on research projects.

**ECHE 799 - Thesis Preparation (1-12 Credits)**

To be arranged by candidates for the master's degree with the thesis advisor.

**ECHE 865 - Chemical Process Safety and Loss Prevention (3 Credits)**

Chemical process quantitative risk analysis, consequence modeling, risk estimation, and hazards assessment; design principles including inherent safety and mitigation techniques; elements of process safety management.

**Prerequisites:** ECHE 720.

**ECHE 899 - Dissertation Preparation (1-12 Credits)**