

# Chemical Engineering (CHEG)

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## Mission Statement

The chemical engineering department is dedicated to providing educational opportunities in chemical engineering to a highly selective, predominantly undergraduate student body of talented individuals. The department encourages close interactions between students and the faculty, who are dedicated to education and are actively engaged in scholarship that enriches the educational program. The program emphasizes active learning with a strong laboratory component. The department nurtures the intellectual, professional and personal development of its students and faculty in order to prepare and encourage them to be highly competent professionals and responsible members of society.

## Program Educational Objectives

Following the definition presented by ABET, the department's educational objective statement broadly reflects the career accomplishments and expectations of alumni who graduate from the program:

*Alumni will experience success in a variety of postgraduate environments, including, but not limited to, chemical engineering professional practice and advanced study.*

## Student Outcome Categories

The statements above are supported by a number of student outcomes, the attainment of which is regularly evaluated. In particular, these are designed to guide student growth and achievement in the four broad categories of:

- Technical Competency
- Intellectual Development
- Societal Responsibility
- Professional Development

For a complete listing of all individual student outcomes, please visit the department web page [bucknell.edu/ChemicalEngineering](http://bucknell.edu/ChemicalEngineering)

## Bachelor of Science in Chemical Engineering

The Bachelor of Science in chemical engineering requirements are:

### First Year

| First Semester | Credits  | Second Semester | Credits    |
|----------------|----------|-----------------|------------|
| ENGR 100       |          | 1 CHEM 222      | 1          |
| MATH 201       |          | 1 CHEG 200      | 1          |
| PHYS 211       |          | 1 ENGR 215      | .5         |
| Elective       |          | 1 MATH 202      | 1          |
|                |          | CHEG 101        | 0          |
|                |          | Elective        | 1          |
|                | <b>4</b> |                 | <b>4.5</b> |

### Sophomore

| First Semester | Credits    | Second Semester | Credits  |
|----------------|------------|-----------------|----------|
| CHEM 211       |            | 1 CHEM 212      | 1        |
| ENGR 240       |            | 1 CHEM 231      | 1        |
| MATH 211       |            | 1 ENGR 233      | 1        |
| ENGR 211       |            | .5 CHEG 210     | 1        |
| Elective       |            | 1 CHEG 102      | 0        |
|                | <b>4.5</b> |                 | <b>4</b> |

### Junior

| First Semester | Credits | Second Semester | Credits |
|----------------|---------|-----------------|---------|
| CHEM 343       |         | 1 CHEG 310      | 1       |
| CHEG 300       |         | 1 CHEG 315      | .5      |
| CHEG 302       |         | .5 CHEG 103     | 0       |

|                       |                |                        |                |
|-----------------------|----------------|------------------------|----------------|
| Two electives         | 2              | Three electives        | 3              |
|                       | <b>4.5</b>     |                        | <b>4.5</b>     |
| <b>Senior</b>         |                |                        |                |
| <b>First Semester</b> | <b>Credits</b> | <b>Second Semester</b> | <b>Credits</b> |
| CHEG 320              | 1              | CHEG 330               | 1              |
| CHEG 400              | 1              | CHEG 410               | 1              |
| Two electives         | 2              | CHEG 104               | 0              |
|                       |                | Two electives          | 2              |
|                       | <b>4</b>       |                        | <b>4</b>       |

Total Credits: 34

The following sequence of courses emphasizes design across the curriculum and develops the professional skills of communication, problem-solving, teamwork, and independent learning:

|          |                                      |    |
|----------|--------------------------------------|----|
| CHEG 200 | Chemical Engineering Principles      | 1  |
| ENGR 233 | Chemical Engineering Fluid Mechanics | 1  |
| CHEG 300 | Heat and Mass Transfer               | 1  |
| CHEG 315 | Unit Operations Laboratory           | .5 |
| CHEG 400 | Process Engineering                  | 1  |
| CHEG 410 | Project Engineering                  | 1  |

The 12 elective courses shown above are distributed as follows:

- Five social science and humanities courses selected from the list of approved courses provided in *Information for Engineering Students Handbook* (published by the College of Engineering) to fulfill the General Education Component required of all engineering students. These courses must be distributed as follows: 1) a minimum of two courses in humanities; 2) a minimum of two courses in social sciences. Two of these five electives must be taken in one department OR at least one elective must be taken at the 200+ level in any department. One of the five courses must satisfy the global and societal perspectives requirement.
- Two courses selected from the list of approved technical electives published by the department which may be found on the department web page [bucknell.edu/ChemicalEngineering](http://bucknell.edu/ChemicalEngineering).
- One approved biological-science course selected from the list of approved biological-science electives published by the department which may be found on the department web page [bucknell.edu/ChemicalEngineering](http://bucknell.edu/ChemicalEngineering).
- Two additional courses in chemical engineering.
- Two unrestricted electives in any department or program of the University.

Three courses in each student's program must fulfill the University writing requirement which includes a W1 course taken in the first year and two subsequent W2 courses.

Through judicious choice and curricular planning, students may be able to select a concentration – a series of electives that will allow development of expertise in a particular sub-discipline of chemical engineering. The following concentrations are available: Biological, Environmental, Materials, and Process. Declaration of a concentration is optional. Up-to-date listings of courses which can be used toward a concentration, and other associated requirements, are maintained on the department web page [bucknell.edu/ChemicalEngineering](http://bucknell.edu/ChemicalEngineering).

## Faculty

**Professors:** Jeffrey Csernica, William E. King, James E. Maneval, Michael J. Prince, William J. Snyder, Margot Vigeant

**Associate Professors:** Michael D. Gross, Erin L. Jablonski, Timothy M. Raymond (Chair), Brandon M. Vogel, Katsuyuki Wakabayashi, Daniel P. Cavanagh, Wendelin Wright

**Assistant Professor:** Ryan Snyder

**Visiting Assistant Professor:** Dabrina Dutcher

## Courses

**CHEG 101. Chemical Engineering Seminar. 0 Credits.****Offered Spring Semester Only; Lecture hours:1**

A joint seminar for all chemical engineering students and faculty. Variety of engineering-related topics presented by industrial, academic, alumni, and student speakers. Presentations and discussions on professional development and interpersonal skills in the work place, ethics, and societal issues, professional society activities, and other topics relevant to the profession.

**CHEG 102. Chemical Engineering Seminar. 0 Credits.****Offered Spring Semester Only; Lecture hours:1**

A joint seminar for all chemical engineering students and faculty. Variety of engineering-related topics presented by industrial, academic, alumni, and student speakers. Presentations and discussions on professional development and interpersonal skills in the work place, ethics, and societal issues, professional society activities, and other topics relevant to the profession.

**CHEG 103. Chemical Engineering Seminar. 0 Credits.****Offered Spring Semester Only; Lecture hours:1**

A joint seminar for all chemical engineering students and faculty. Variety of engineering-related topics presented by industrial, academic, alumni, and student speakers. Presentations and discussions on professional development and interpersonal skills in the work place, ethics, and societal issues, professional society activities, and other topics relevant to the profession.

**CHEG 104. Chemical Engineering Seminar. 0 Credits.****Offered Spring Semester Only; Lecture hours:1**

A joint seminar for all chemical engineering students and faculty. Variety of engineering-related topics presented by industrial, academic, alumni, and student speakers. Presentations and discussions on professional development and interpersonal skills in the work place, ethics, and societal issues, professional society activities, and other topics relevant to the profession.

**CHEG 200. Chemical Engineering Principles. 1 Credit.****Offered Fall Semester Only; Lecture hours:4,Other:2**

Introduction to the concepts of material and energy balances and phase equilibria for chemical engineering processes. Introduction to problem solving methodologies and computer simulation. With experimental laboratory. Prerequisite: MATH 201.

**CHEG 210. Applied Mathematics for Chemical Engineering. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:1**

Mathematical modeling and methods. Topics include ordinary and partial differential equations, Laplace transforms, and matrices with analytical and computer solutions. With computational laboratory. Prerequisite: MATH 211 or equivalent.

**CHEG 300. Heat and Mass Transfer. 1 Credit.****Offered Fall Semester Only; Lecture hours:4,Other:2**

Conductive, convective and radiation heat transfer; analytical and numerical solutions of heat transfer problems, estimation of heat transfer coefficients, and heat exchanger design. Fundamentals of mass transfer (diffusion and convection) with applications to unit operations. With experimental laboratory. Prerequisites: ENGR 233, CHEG 200 and CHEG 210 or MATH 212.

**CHEG 301. Transport of Heat and Mass. 1 Credit.****Offered Occasionally; Lecture hours:4**

Conductive, convective and radiation heat transfer; analytical and numerical solutions of heat transfer problems, estimation of heat transfer coefficients, and heat exchanger design. Fundamentals of mass transfer. Corequisite: CHEG 303. Prerequisites: ENGR 233, CHEG 200, and CHEG 210 or MATH 212.

**CHEG 302. Equilibrium Stage Processes. .5 Credits.****Offered Fall Semester Only; Lecture hours:2,Other:1**

Analysis of binary and multicomponent separations by analytical, graphical, and computer methods. Topics include gas absorption, distillation, liquid-liquid extraction as well as selected novel separation processes. With computational laboratory. Prerequisite: CHEG 200. Corequisite: CHEG 300.

**CHEG 303. Separation Processes. 1 Credit.****Offered Occasionally; Lecture hours:2**

Analysis of binary and multicomponent separations by analytical, graphical, and computer methods. Topics includes gas absorption, distillation, liquid-liquid extraction as well as selected novel separation processes. Corequisite: CHEG 301. Prerequisites: ENGR 233, CHEG 200 and CHEG 210. Minimum grade of a D.

**CHEG 310. Chemical Engineering Thermodynamics. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:1**

Laws of thermodynamics, thermodynamic properties of materials, equations of state, refrigeration and engine cycles, physical and chemical reaction equilibrium, and solution thermodynamics. With computational laboratory. Prerequisites: CHEG 302 and CHEM 341 or CHEM 343.

**CHEG 315. Unit Operations Laboratory. .5 Credits.****Offered Spring Semester Only; Lecture hours:1,Other:3**

A laboratory course in pilot-scale processes involving momentum, heat and mass transfer. Project definition, experimental operation, analytical procedures, data analysis, technical reports and oral presentations. Prerequisite: CHEG 302. Corequisite: CHEG 310.

**CHEG 320. Chemical Reaction Engineering. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other:3**

Rate forms for homogeneous and catalytic reactions; isothermal and nonisothermal reactor design and analysis; interpretation of laboratory data; introduction to nonideal flow and residence-time distributions. With experimental laboratory. Prerequisites: CHEM 341 or CHEM 343, CHEG 210, and CHEG 310.

**CHEG 330. Process Control. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:2**

Dynamics of open and closed-loop processes. Design, analysis and tuning of PID feedback control based on transient, Laplace domain, and frequency response methods. Instrumentation and computer-based data acquisition and control for chemical processes. With experimental laboratory. Introduction to feedforward, cascade and advanced control strategies. Prerequisites: CHEG 300 and CHEG 302.

**CHEG 3NT. Chemical Engineering Non-traditional Study. .5-2 Credits.****Offered Fall, Spring, Summer; Lecture hours:Varies**

Non-traditional study course in chemical engineering. Prerequisite: permission of the instructor.

**CHEG 400. Process Engineering. 1 Credit.****Offered Fall Semester Only; Lecture hours:3**

Applications of engineering, economic, environmental, and ethical principles in preliminary process design using computer aids such as process simulators. Problem definition literature survey, flowsheet development, material and energy balances, equipment design, profitability analysis, oral and written communication. With design laboratory. Prerequisites: CHEG 310 and CHEG 315.

**CHEG 410. Project Engineering. 1 Credit.****Offered Spring Semester Only; Lecture hours:3**

Second of two capstone experiences for chemical engineering majors. Students refine a general problem statement in order to plan, execute and assess a project that achieves specific goals. Design, construction, and testing of an apparatus, system, or simulation. Problem-solving, teamwork, communication, professional development, and laboratory work are emphasized. With design laboratory. Prerequisite: CHEG 400.

**CHEG 430. Chemical Engineering Project. .5 Credits.****Offered Either Fall or Spring; Lecture hours:1,Other:5; Repeatable**

Individual work with a faculty adviser on a development or design project beginning with a written plan and culminating with a deliverable product and a written report. Problem analysis involving information synthesis, experimentation, mathematical modeling or software development. Prerequisite: permission of the instructor.

**CHEG 431. Chemical Engineering Project. .5 Credits.****Offered Either Fall or Spring; Lecture hours:1,Other:5; Repeatable**

Individual work with a faculty adviser on a development or design project beginning with a written plan and culminating with a deliverable product and a written report. Problem analysis involving information synthesis, experimentation, mathematical modeling, or software development. Prerequisite: permission of the instructor.

**CHEG 440. Chemical Engineering Research. 1 Credit.****Offered Both Fall and Spring; Lecture hours:1,Other:9; Repeatable**

Independent study with a faculty adviser on a research project. Submit a project proposal for group review, conduct the work, and culminate with a written report and an oral presentation before a faculty group. Prerequisite: permission of the instructor.

**CHEG 441. Chemical Engineering Research. 1 Credit.****Offered Both Fall and Spring; Lecture hours:1,Other:10; Repeatable**

Independent study with a faculty adviser on a research project. Submit a project proposal for group review, conduct the work, and culminate with a written and an oral presentation before a faculty group. Prerequisite: permission of the instructor.

**CHEG 445. Experiments in Polymer Science and Technology. .5 Credits.****Offered Occasionally; Lecture hours:1**

Laboratory investigation into problems involving the synthesis, characterization, and processing of polymeric materials. Prerequisite: ENGR 240 or ENGR 242. Not open to students who have taken CHEG 450 prior to Fall 2012.

**CHEG 448. Electrochemical Energy Conversion. 1 Credit.****Offered Either Fall or Spring; Lecture hours:4**

Principles of electrochemistry including electrochemical thermodynamics, kinetics, and catalysis. Related emerging energy applications such as fuel cells and advanced batteries. Prerequisite: CHEM 201, CHEM 221 or CHEM 222.

**CHEG 450. Polymer Science. 1 Credit.****Offered Spring Semester Only; Lecture hours:4**

Structure, characterization and properties of polymeric materials. Chemistry and kinetics of polymerization. Processing and application of polymers. Prerequisite: CHEM 341 or CHEM 343.

**CHEG 452. Bioprocess Engineering. 1 Credit.****Offered Either Fall or Spring; Lecture hours:4**

Survey course in biochemical engineering. Introduction to microbiology, biochemistry, cell metabolism and genetic control. Enzyme structure and function; enzyme kinetic mechanisms. Emphasis on the design of biochemical reactors and separation processes utilizing fundamental principles of kinetics, thermodynamics and heat, mass and momentum transfer. Prerequisite: CHEG 302. Corequisite: CHEG 320.

**CHEG 453. Product and Process Chemistry. 1 Credit.****Offered Spring Semester Only; Lecture hours:4**

Examination of the internal structure of the chemical industry. The roles of key chemicals and intermediates in chemical synthesis will be emphasized to provide an overview of current industrial production methods. Product and process history, design and improvement will be covered through discussions, simulations and case studies. Prerequisite: permission of the instructor.

**CHEG 455. Atmospheric Chemistry and Physics. 1 Credit.****Offered Either Fall or Spring; Lecture hours:4**

Addresses the relationships of chemistry, physics, and engineering principles in understanding processes in the Earth's atmosphere. Topics include overview of the Earth's atmospheric history and problems of current environmental concerns including urban ozone, acid rain, particulate pollution, and global change. Prerequisite: permission of the instructor. Open to juniors and seniors in chemistry, physics, or any engineering major.

**CHEG 457. Applied Colloid, Surface, and Nanoscience. 1 Credit.****Offered Fall Semester Only; Lecture hours:4**

We will explore the ways in which surfaces are different from bulk substances, and how this impacts processes such as illness, chemical processing, contaminant transport, and enzymatic activity. The topics discussed in class will be shaped by student interest. Prerequisite: permission of the instructor. Corequisite: CHEM 341 or CHEM 343.

**CHEG 460. Biomaterials: Materials in Medicine. 1 Credit.****Offered Either Fall or Spring; Lecture hours:4,Other:1**

Classes of biomaterials, their applications, and current trends in biomaterials research and technology. Medical/ ethical implications of biomaterials development and research. Open to seniors in chemical engineering, others by permission of the instructor.

**CHEG 465. Advanced Materials Science and Engineering. 1 Credit.****Offered Either Fall or Spring; Lecture hours:4**

Advanced, in-depth exploration of processing - structure - property - performance relationships of materials through real-world examples and case studies. Prerequisite: ENGR 240, ENGR 242, or equivalent.

**CHEG 470. Special Topics in Chemical Engineering. 1 Credit.****Offered Both Fall and Spring; Lecture hours:4; Repeatable**

Advanced, in-depth courses developed from areas of chemical engineering science or technology. Prerequisite: permission of the instructor.

**CHEG 472. Special Topics in Chemical Engineering. 1 Credit.****Offered Both Fall and Spring; Lecture hours:4; Repeatable**

Advanced, in-depth courses developed from areas of chemical engineering science or technology. Prerequisite: permission of the instructor.

**CHEG 475. Should We Start This Company?. 1 Credit.****Offered Alternate Fall or Spring; Lecture hours:3,Other:1**

Project-centered course in entrepreneurship, generating new business ideas, and product or service design and development through business planning. Prerequisite: permission of the instructor. Crosslisted as MIDE 375 and UNIV 375.

**CHEG 481. Topics in Reaction Engineering. 1 Credit.****Offered Either Fall or Spring; Lecture hours:4**

Reactor design and analysis applied to specific systems. Complex chemical reaction networks with emphasis on nonideal flow and transport effects on heterogeneous reactors. Prerequisite: permission of the instructor.

**CHEG 482. Topics in Chemical Engineering Applied Mathematics. 1 Credit.****Offered Either Fall or Spring; Lecture hours:4**

Analytical and numerical methods for ordinary and partial differential equations with problems drawn from chemical engineering. Topics include transform methods, matrix methods, weighted-residual methods, and finite differences. Prerequisite: permission of the instructor.

**CHEG 483. Topics in Chemical Engineering Thermodynamics. 1 Credit.****Offered Either Fall or Spring; Lecture hours:4**

Advanced study of thermodynamics applied to fluid flow, heat transfer, gas compression, air conditioning, refrigeration, and chemical equilibria. Prerequisite: permission of the instructor.

**CHEG 485. Topics in Transport Theory. 1 Credit.****Offered Either Fall or Spring; Lecture hours:4**

Mass, energy, and momentum transfer in continuous media. General equations of transfer developed and used to analyze physical systems. Development and application of mathematical techniques appropriate to the topic. Prerequisite: permission of the instructor.

**CHEG 495. Advanced Topics in Engineering Mathematics. 1 Credit.**

**Offered Fall Semester Only; Lecture hours:4**

Linear algebra and analytical/computational techniques for solving ordinary and partial differential equations relevant to engineering applications.

Prerequisite: permission of the instructor. Crosslisted as CENG 495, ELEC 495, MECH 495.

**CHEG 4NT. Chemical Engineering Non-traditional Study. .5-2 Credits.**

**Offered Fall, Spring, Summer; Lecture hours:Varies**

Non-traditional study in chemical engineering. Prerequisite: permission of the instructor.