

CHEMICAL ENGINEERING (CHEG)

Faculty

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Mission Statement

The chemical engineering department is dedicated to providing educational opportunities in chemical engineering to a highly select, 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 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 webpage 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 205 | 1 |
| MATH 201 | 1 | CHEG 200 | 1 |
| PHYS 211 | 1 | MATH 202 | 1 |
| Elective | 1 | ENGR 211 | .5 |
| | | CHEG 101 | 0 |
| | | Elective | 1 |
| | 4 | | 4.5 |

Sophomore

| First Semester | Credits | Second Semester | Credits |
|----------------|---------|-----------------|---------|
| CHEM 233 | 1 | CHEM 211 | 1 |
| ENGR 240 | 1 | CHEG 210 | 1 |
| MATH 211 | 1 | ENGR 215 | .5 |
| CHEG 302 | .5 | ENGR 233 | 1 |
| Elective | 1 | CHEG 102 | 0 |
| | | Elective | 1 |
| | 4.5 | | 4.5 |

| Junior | | | |
|-----------------------|----------------|------------------------|----------------|
| First Semester | Credits | Second Semester | Credits |
| CHEM 212 | 1 | CHEG 310 | 1 |
| CHEM 343 | 1 | CHEG 315 | .5 |
| CHEG 300 | 1 | CHEG 103 | 0 |
| Elective | 1 | Three electives | 3 |
| | | 4 | 4.5 |
| Senior | | | |
| First Semester | Credits | Second Semester | Credits |
| CHEG 320 | 1 | CHEG 330 | 1 |
| CHEG 400 | 1 | CHEG 410 | 1 |
| Two electives | 2 | CHEG 104 | 0 |
| | | Two electives | 2 |
| | | 4 | 4 |

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 courses selected from any of the following: social science courses, arts & humanities courses, university courses, residential college courses, or foundation seminars. These five courses must include:
 - *One course in arts & humanities*
 - *One course in social sciences*
- Three courses in each student's program must also fulfill the University's writing requirement. One course in each student's program must also fulfill the college's global perspectives requirement.
- Two courses selected from the list of approved technical electives published by the department that can be found on the department webpage bucknell.edu/ChemicalEngineering.
- Two additional courses in chemical engineering.
- Three unrestricted electives in any department or program of the University.

Three courses in each student's program must fulfill the University writing requirement that 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 that may be used toward a concentration, and other associated requirements, are maintained on the department webpage: bucknell.edu/ChemicalEngineering.

The attainment of Student Outcomes is regularly evaluated. In particular, these are designed to guide student growth and achievement in four broad categories:

Technical Competency

- Students will display basic competency in each of the technical areas identified as essential to chemical engineers.
- Students will be able to apply knowledge of technical concepts beyond the specific course where material is first taught.
- Students can apply material beyond simple recall of facts.
- Students will have familiarity with, and ability to operate, modern laboratory equipment.
- Students gain an appreciation of health and safety concerns in the laboratory.

- Students will have the ability to apply appropriate software tools to help them solve problems.

Intellectual Development

- Students learn to solve realistic engineering problems that may not be fully specified and do not have a single answer.
- Students will exhibit skills for planning, designing, and conducting experiments or research, and analyzing information.

Societal Responsibility

- Students will be exposed to a balanced and broad-based curriculum, and will enhance their awareness of global and societal issues.
- Students will learn to analyze problems that include ethical, regulatory, and/or political issues.
- Students can identify and assess potential hazards throughout the design and operation of chemical processes.

Professional Development

- Students will achieve a satisfactory level of mastery of oral and written communication.
- Students will experience presenting their work to peers and/or professionals.
- Students will demonstrate a mastery of skills for effectively leading and participating in team activities.
- Students will demonstrate independent learning skills, particularly in the capstone design and laboratory courses.
- Students will recognize the importance of continual professional development.

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 1NT. Chemical Engineering Non-traditional Study. .25-2 Credits.

Offered Fall, Spring, Summer; Lecture hours:Varies

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

CHEG 200. Chemical Engineering Principles. 1 Credit.

Offered Spring Semester Only; Lecture hours:4,Lab: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,Lab: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 2NT. Chemical Engineering Non-traditional Study. .25-4 Credits.

Offered Fall, Spring, Summer; Lecture hours:Varies

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

CHEG 300. Heat and Mass Transfer. 1 Credit.**Offered Fall Semester Only; Lecture hours:4,Lab: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 302. Separation Processes. .5 Credits.**Offered Either Fall or Spring; Lecture hours:2,Lab: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 302L.

CHEG 310. Chemical Engineering Thermodynamics. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Lab: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,Lab: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 300. Corequisite: CHEG 310.

CHEG 320. Chemical Reaction Engineering. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Lab:2**

Rate forms for homogeneous, catalytic, and biological 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 Modeling, Dynamics, and Control. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Lab:2**

Modeling the dynamics of chemical processes with and without control. Design, analysis and tuning of control systems using analytical and computational tools. Instrumentation and computer-based data acquisition and control for chemical systems. Introduction to process safety considerations. With experimental laboratory. Prerequisites: CHEG 210 or MATH 212 and CHEG 300.

CHEG 3NT. Chemical Engineering Non-traditional Study. .25-4 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. 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. Crosslisted as CHEG 610.

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. Crosslisted as CHEG 630.

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. Crosslisted as CHEG 441 and CHEG 640 and CHEG 641.

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. Crosslisted as CHEG 440 and CHEG 640 and CHEG 641.

CHEG 442. Food Science & Technology. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4**

Fundamentals of food science, food engineering, and food systems at scales from experimental to industrial production. Exploration of food processing and preservation, reactions in food systems, surface chemistry, regulations, ethics, and food product and process development. Crosslisted as CHEG 642.

CHEG 445. Experiments in Polymer Science and Technology. .5 Credits.**Offered Occasionally; Lecture hours:1,Lab:3**

Laboratory investigation into problems involving the synthesis, characterization, and processing of polymeric materials. Prerequisite: ENGR 240 or ENGR 242.

CHEG 450. Polymer Science. 1 Credit.**Offered Either Fall or Spring; 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. Crosslisted as CHEG 650.

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. Crosslisted as CHEG 652.

CHEG 453. Product and Process Chemistry. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4**

Examination of the internal structure of the chemical industry. The roles of key chemicals and intermediates in chemical synthesis are emphasized to provide an overview of current industrial production methods. Product and process history, design and improvement are covered through discussions, simulations and case studies. Prerequisite: junior or senior status. Crosslisted as CHEG 653.

CHEG 454. Pharmaceutical Engineering. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4**

Applications of core chemical engineering concepts to pharmaceutical processes. Development of fundamentals used in the pharmaceutical industry. Introduction to the development and approval of pharmaceutical process, along with social, regulatory, historical and ethical issues present in the pharmaceutical industry. Prerequisite: CHEG 300 or BMEG 400 or permission of the instructor. Crosslisted as CHEG 654.

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. Crosslisted as CHEM 365 and CHEG 655.

CHEG 457. Applied Colloid, Surface, and Nanoscience. 1 Credit.**Offered Either Fall or Spring; 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. Corequisite: CHEM 341 or CHEM 343. Crosslisted as CHEG 657.

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

Classes of biomaterials, their applications, and current trends in biomaterials research and technology. Medical/ethical implications of biomaterials development and research. Open to juniors and seniors in chemical engineering, others by permission of the instructor. Crosslisted as CHEG 660.

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. Crosslisted as CHEG 665.

CHEG 468. Particle Technology. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4**

Addresses engineering principles involved in the production, processing and measurement of particles sized from the nanoscale to the macroscale applied to pharmaceutical production, drug delivery, air pollution, nanotechnology, paints and coatings, industrial chemicals and agricultural products. Topics: particle motion, size distributions, analysis methods, storage, flow, mixing, segregation, safety and hazards. Crosslisted as CHEG 668.

CHEG 470. Special Topics in Chemical Engineering. 1 Credit.

Offered Either Fall or Spring; Lecture hours:4; Repeatable

Advanced, in-depth courses developed from areas of chemical engineering science or technology. Prerequisite: junior or senior status. Crosslisted as CHEG 670.

CHEG 472. Special Topics in Chemical Engineering. 1 Credit.

Offered Either Fall or Spring; Lecture hours:4; Repeatable

Advanced, in-depth courses developed from areas of chemical engineering science or technology. Prerequisite: junior or senior status. Crosslisted as CHEG 672.

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. Prerequisites: CHEG 320 and senior status. Crosslisted as CHEG 681.

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: CHEG 310. Only open to seniors. Crosslisted as CHEG 683.

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: CHEG 300. Open to juniors and seniors. Crosslisted as CHEG 685.

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: junior or senior status. Crosslisted as CEEG 495 and ECEG 495 and ECEG 695 and MECH 495 and ENGR 695.

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.