Chemical Engineering (CHEG)

Faculty

Professors: Jeffrey Csernica, William E. King, James E. Maneval, Michael J. Prince, William J. Snyder, Margot Vigeant (Associate Dean of Engineering)

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

Assistant Professor: Ryan Snyder

Visiting Assistant Professors: Dabrina Dutcher, Elif Eda Miskioglu

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

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
	4		**4.5**

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
	4.5		**4**

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
	4.5		**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 and humanities courses, university courses, residential college courses, or foundation seminars. These five courses must include
  - *One course in arts and 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 which may be found on the department web page 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.
- 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.

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 200. Chemical Engineering Principles. 1 Credit.
Offered Fall 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 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 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,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 300.

CHEG 303. Separation Processes. .5 Credits.
Offered Occasionally; Lecture hours:2
Analysis of binary and multicomponent separations by analytical, graphical, and computer methods. Topics incudes 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,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 302. Corequisite: CHEG 310.

CHEG 320. Chemical Reaction Engineering. 1 Credit.
Offered Fall Semester Only; Lecture hours:3,Lab: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,Lab: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. Crosslisted as CHEG 600.

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 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,Recitation:1
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 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 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: permission of the instructor. Crosslisted as CHEG 653.

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. Crosslisted as CHEG 655.

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. Crosslisted as CHEG 657.

CHEG 460. Biomaterials: Materials in Medicine. 1 Credit.
Offered Either Fall or Spring; Lecture hours:4,Recitation: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. Crosslisted as CHEG 660.

CHEG 465. Advanced Materials Science and Engineering. 1 Credit.
Offered Either Fall or Spring; Lecture hours:4,Recitation:1
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 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. Crosslisted as CHEG 670.

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. Crosslisted as CHEG 672.

CHEG 475. Should We Start This Company?. .5 Credits.
Offered Alternate Fall or Spring; Lecture hours:2
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 and CHEG 675.

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 heterogenous reactors. Prerequisite: permission of the instructor. Crosslisted as CHEG 681.

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. Crosslisted as CHEG 682.

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. 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: permission of the instructor. 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: permission of the instructor. Crosslisted as CENG 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.