CHEMICAL ENGINEERING

Faculty

Professors: Jeffrey Csernica, Michael J. Prince, Timothy M. Raymond (Chair), Margot Vigeant, Katsuyuki Wakabayashi, Wendelin J. Wright

Associate Professors: Daniel P. Cavanagh, Dabrina Dutcher, Erin L. Jablonski (Director for the Perricelli-Gegnas Center for Entrepreneurship & Innovation), Kenny Mineart, Elif Eda Miskioglu, Ryan Snyder, Brandon M. Vogel

Assistant Professors: Jude Okolie, Hannah Comstock Yocum

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 Outcomes

Graduates of the program shall demonstrate the following at the time of graduation:

1. An ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics.

2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors.

3. An ability to communicate effectively with a range of audiences.

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts.

5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives.

6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies.

The chemical engineering program at Bucknell University is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (https://www.abet.org/).

Bachelor of Science in Chemical Engineering

The Bachelor of Science in Chemical Engineering requirements are:

First Year			
First Semester	**Credits**	**Second Semester**	**Credits**
ENGR 099	0	CHEM 205	1
ENGR 100	1	CHEG 200	1
MATH 201	1	MATH 202	1
PHYS 211	1	ENGR 211	.5
Foundation Seminar (W1)	1	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 343	1	CHEG 310	1
CHEG 300	1	CHEG 315[May be taken in First Semester of Junior Year instead]	.5
Two electives	2	CHEG 103	0
		Three electives	3
	4		**4.5**

Senior

First Semester	Credits	Second Semester	Credits
CHEG 320	1	CHEG 330[May be taken in Second Semester of Junior Year instead]	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 13 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 selected from the list of approved technical electives published by the department that can be found on the department webpage: bucknell.edu/ChemicalEngineering (http://www.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 semester, foundation seminar (FOUN or RESC), and two subsequent W2 courses. One course in each student's program must also fulfill the college's global perspectives requirement. Any of the 13 electives may also count toward other University majors and minors.

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, computing, environmental, materials and process. Declaration of a concentration is optional. Updated listings of courses that may be used toward a concentration and other associated requirements are maintained on the department webpage: bucknell.edu/ChemicalEngineering (http://www.bucknell.edu/ChemicalEngineering/).

Bachelor of Arts/Management for Engineers - Bachelor of Science in Chemical Engineering

The requirements for the degree Bachelor of Arts/Management for Engineers - Bachelor of Science in Chemical Engineering requirements are:

First Year

First Semester	Credits	Second Semester	Credits
ENGR 099	0	CHEM 205	1
ENGR 100	1	CHEG 200	1
MATH 201	1	MATH 202	1
PHYS 211	1	ENGR 211	.5
Foundation Seminar (W1)	1	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 343	1	CHEG 310	1
CHEG 300	1	CHEG 315[May be taken in First Semester of Junior Year instead]	.5
Two electives	2	CHEG 103	0
		Three electives	3
	4		**4.5**

Senior

First Semester	Credits	Second Semester	Credits
CHEG 320	1	CHEG 330[May be taken in Second Semester of Junior Year instead]	1
CHEG 400	1	CHEG 410	1
Two electives	2	CHEG 104	0
		Two electives	2
	4		**4**

Five Year

First Semester	Credits	Second Semester	Credits
Four electives	4	Four electives	4
	4		**4**

Total Credits: 42

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 21 elective courses shown above are distributed as follows:

- Eight courses selected to satisfy the major requirements for the Bachelor of Arts/Management for Engineers major. Courses used to fulfill the General Education (https://coursecatalog.bucknell.edu/collegeofengineeringcurricula/curriculaoverview/) requirements for engineering students should also fulfill the College of Arts & Sciences Core Curriculum (CASCC) (https://coursecatalog.bucknell.edu/collegeofartsandsciencescurricula/curriculaoverview/collegecorecurriculum/) requirements for those in the 5-year Engineering & Liberal Arts dual degree program or the Freeman College of Management General Education Curriculum (https://coursecatalog.bucknell.edu/collegeofmanagementcurricula/curriculaoverview/gened/) requirements for those in the 5-year Engineering & Management dual degree program.
- 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 selected from the list of approved technical electives published by the department that can be found on the department webpage: bucknell.edu/ChemicalEngineering (http://www.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 semester, foundation seminar (FOUN or RESC), and two subsequent W2 courses. One course in each student's program must also fulfill the college's global perspectives requirement. Any of the 13 electives may also count toward other University majors and minors.

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, computing, environmental, materials and process. Declaration of a concentration is optional. Updated listings of courses that may be used toward a concentration and other associated requirements are maintained on the department webpage: bucknell.edu/ChemicalEngineering (http://www.bucknell.edu/ChemicalEngineering/).

Any of these electives may also count toward other university majors and minors.

Graduates of the program shall demonstrate the following student outcomes at the time of graduation:

1. An ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics.

2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental and economic factors.

3. An ability to communicate effectively with a range of audiences.

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts.

5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives.

6. An ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusions.

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

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 230. Engineering Car Design. .25 Credits.
Offered Both Fall and Spring; Lecture hours:Varies,Other:2; Repeatable
The Chem-E Car Competition challenges interdisciplinary teams to design, build, and compete with a shoe box sized vehicle that must travel a specified distance carrying a specific load in under two minutes and stop closest to the finish line. Interdisciplinary student teams design and build these cars. Crosslisted as UNIV 235.

CHEG 242. Introduction to Food Science and Engineering for non-majors. 1 Credit.
Offered Summer Session Only; Lecture hours:2,Other:2
Introduction to engineering and science principles in the context of food science and engineering, including chemistry, heat transfer, fluid flow, thermodynamics, and product and process design. Course includes laboratory and design projects with exploration of food processing, regulations, and interplay between technical and social concerns. Crosslisted as UNIV 242.

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.

CHEG 310. Chemical Engineering Thermodynamics. 1 Credit.
Offered Spring Semester Only; Lecture hours:3,Lab:1
Laws of thermodynamics and application to chemical engineering processes, thermodynamic modeling of phase and chemical behavior, chemical reaction equilibrium. With computational laboratory. Prerequisites: CHEG 302 and CHEM 341 or CHEM 343.

CHEG 315. Unit Operations Laboratory. .5 Credits.
Offered Either Fall or Spring; 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 300 302. 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 and CHEG 210 or MATH 212 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:2
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 300, CHEG 310, and CHEG 315.

CHEG 410. Project Engineering. 1 Credit.
Offered Spring Semester Only; Lecture hours:1
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. .25-.5 Credits.
Offered Either Fall or Spring; Lecture hours:1,Other:5; Repeatable
Variable credit (0.25-0.50) 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 440. Chemical Engineering Research. 1 Credit.
Offered Both Fall and Spring; Lecture hours:1,Other:11; 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 640.

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 444. Genetic Engineering. 1 Credit.
Offered Either Fall or Spring; Lecture hours:4
Genetic engineering is a powerful technology with applications in many fields, including medicine and agriculture. This course considers both the basic science and societal impact of genetic engineering. Topics include basic principles, techniques/technologies of genetic engineering, societal implications, ethical considerations, and historical case studies. A biology background is not required. Crosslisted as CHEG 644.

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. Corequisite: 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 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 458. Fermentation Processes. 1 Credit.
Offered Either Fall or Spring; Lecture hours:2,Other:2
Overview of chemicals production via fermentation and other industrially relevant processes. Analysis of key aspects of process chemistry, development and economics. Consideration and assessment of social and environmental impacts as well as sustainability in the context of process engineering. Prerequisite: permission of the instructor. Crosslisted as CHEG 658.

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. Prerequisite: ENGR 240, or ENGR 242, or equivalent. 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 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. Prerequisites: CHEG 300 or MATH 212 or equivalent, and any course on fluid mechanics, heat transfer, mass transfer or continuum physics. 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. .25-4 Credits.
Offered Fall, Spring, Summer; Lecture hours:Varies
Non-traditional study in chemical engineering. Prerequisite: permission of the instructor.