Chemical Engineering (CHEG)

Keisha B. Walters
Professor and Department Head
3202 Bell Engineering Center
479-575-7455
Email: keisha.walters@uark.edu

Heather Walker
Associate Department Head for Undergraduate Programs
3202 Bell Engineering Center
479-575-5382
Email: hlw@uark.edu

Ralph E. Martin Department of Chemical Engineering Website (https://chemical-engineering.uark.edu/)

Chemical engineering deals with the creation, design, operation, and optimization of processes that derive practical benefits from chemical or physical changes principally involving chemical and biochemical reactions. The profession is quite broad and has traditionally provided the technology for: supplying energy and fuel; synthesizing materials such as plastics, chemicals, fertilizers, and pharmaceuticals; and managing environmental and safety concerns of physical and chemical processes. Some new applications of the principles of chemical engineering at nanoscales are being made in sustainable energy production and detection of gene mutations, protein configurations, and virus serotypes as well as thermal destruction of cancer cells.

Chemical engineers have a variety of traditional job opportunities in industries such as petroleum production and processing, chemical manufacturing, food processing, pharmaceutical production, and process equipment manufacturing. Job opportunities may involve research, development, design, manufacturing, sales, or teaching as professional activities. The chemical engineer can also move easily into environmental engineering, nuclear engineering, oceanography, biomedical engineering, pharmacology, law, medicine, or other multidisciplinary fields.

In chemical engineering, students obtain a broad foundation in chemistry, mathematics, physics, communication skills, economics, and the humanities. Courses in material and energy balances, thermodynamics, reaction kinetics, fluid mechanics, heat and mass transfer, process control, computer methods, safety, and design provide students with the background and learning skills required of the practicing chemical engineer. The curriculum includes elective courses that enable a student to prepare for immediate employment or further study at the graduate level or the professional level, such as for medical school. The chemical engineering program also serves as an excellent preparation for dental, pharmacy, or law school.

The educational objective of the undergraduate program in the Ralph E. Martin Department of Chemical Engineering is to prepare students for careers and professional accomplishment after graduating, including:

- Successfully practicing as an engineer or in another professional pursuit, including traditional or emerging fields of chemical engineering, to make a positive impact locally and globally.
- Actively involved in professional lifelong learning, both informal and formal, that deepens their knowledge and readiness to contribute to advancing science, technologies and solutions essential for the future, including successfully participating in a graduate or professional program.

The program prepares graduates to achieve these educational objectives through development of their skills as outlined in our educational outcomes and taught in our curriculum.

Completion of the degree requirements provides graduates with the following learning outcomes:

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- An ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and for global, cultural, social, environmental, economic, and other factors as appropriate to the discipline
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- An ability to communicate effectively with a range or audiences
- 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
- An ability to recognize the ongoing need to acquire new knowledge, to choose appropriate learning strategies, and to apply this knowledge
- An ability to function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment

Requirements for B.S. in Chemical Engineering

Each student in chemical engineering is required to complete 128 hours of coursework including the 35-hour University Core. To be eligible for graduation, all students must complete at least 30 hours of Chemical Engineering (CHEG) classes at the University of Arkansas, Fayetteville that are required for the degree. Each student in chemical engineering is also required to complete six semester hours of technical electives, three semester hours of Advanced Science electives, three semester hours of Chemical Engineering electives, and three semester hours of Advanced Science or Chemical Engineering electives. As discussed in the department's Undergraduate Advising Manual, students can select elective courses to better prepare for employment or further study in areas such as:

- Biotechnology
- Biomedical engineering
- Environmental engineering
- Food process engineering
- Materials engineering
- Microelectronics
- Nanotechnology
- Nuclear engineering
- Pre-medicine
- Simulation and optimization

Additional opportunities are available to enhance the educational experience of students in these areas. Students should consult their academic adviser for recommendations.

Chemical Engineering B.S.Ch.E. Eight-Semester Degree Program

The following section contains the list of courses required for the Bachelor of Science in Chemical Engineering degree. Not all courses are offered every semester, so students who deviate from the suggested sequence must pay careful attention to course scheduling and course prerequisites. Students wishing to follow the eight-semester degree plan should see the Eight-Semester Degree Policy (http://catalog.uark.edu/undergraduatecatalog/academicregulations/eightsemesterdegreecompletionpolicy/) in the Academic Regulations chapter for university requirements of the program. Entering freshmen will be required to participate in selected Freshman Engineering Student Services.

First Year	Units	
	Fall	Spring
MATH 24004 Calculus I (ACTS Equivalency = MATH 2405) (Satisfies General Education Outcome 2.1)[1]	4	
CHEM 14103 University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture)	3	
ENGL 10103 Composition I (ACTS Equivalency = ENGL 1013) (Satisfies General Education Outcome 1.1)	3	
GNEG 11101 Introduction to Engineering I	1	
Fine Arts Core Elective (satisfies General Education Outcome 3.1)[2]	3	
Select one of the following to satisfy General Education Outcome 4.2:		
HIST 20003 History of the American People to 1877 (ACTS Equivalency = HIST 2113) or HIST 20103 History of the American People, 1877 to Present (ACTS Equivalency = HIST 2123) or PLSC 20003 American National Government (ACTS Equivalency = PLSC 2003)	3	
MATH 25004 Calculus II		4
CHEM 14203 University Chemistry II (ACTS Equivalency = CHEM 1424 Lecture)		3
CHEM 14201 University Chemistry II Laboratory (ACTS Equivalency = CHEM 1424 Lab)		1
ENGL 10303 Technical Composition II (ACTS Equivalency = ENGL 1023) (Satisfies General Education Outcome 1.2)		3
GNEG 11201 Introduction to Engineering II		1
PHYS 20304 University Physics I (ACTS Equivalency = PHYS 2034) (Satisfies General Education Outcome 3.4)		4
Year Total:	17	16

Second Year	Units	
	Fall	Spring
MATH 25804 Elementary Differential Equations	4	
CHEM 36053 Organic Chemistry I	3	
CHEM 36051 Organic Chemistry I Laboratory	1	
CHEG 21103 Introduction to Chemical Engineering I	3	
PHYS 20404 University Physics II (ACTS Equivalency = PHYS 2044 Lecture) (Satisfies General Education Outcome 3.4)	4	
MATH 26004 Calculus III		4
CHEM 36203 Organic Chemistry II		3
CHEM 36201 Organic Chemistry II Laboratory		1
CHEG 21303 Fluid Mechanics or CHEG 213H3 Honors Fluid Mechanics		3
CHEG 23103 Thermodynamics of Single-Component Systems or CHEG 231H3 Honors Thermodynamics of Single-Component Systems		3
Social Sciences State Mimimum Core Elective (Satisfies General Education Outcomes 3.3 and 4.1)[3]		3
Year Total:	15	17

Third Year	Units	
	Fall	Spring
CHEM 38103 Elements of Biochemistry or CHEM 481H3 Honors Biochemistry I	3	
CHEG 31404 Heat and Mass Transfer	4	
CHEG 33203 Thermodynamics of Multi-Component Systems or CHEG 332H3 Honors Thermodynamics of Multi-Component Systems	3	
Select one of the following to satisfy General Education Outcome 3.3:		
ECON 21403 Basic Economics: Theory and Practice or ECON 21003 Principles of Macroeconomics (ACTS Equivalency = ECON 2103)	3	
Humanities State Minimum Core Elective (Satisfies General Education Outcomes 3.2 and 5.1)[4]	3	
CHEG 37103 Chemical Engineering Materials Technology		3
CHEG 33303 Chemical Engineering Reactor Design or CHEG 333H3 Honors Chemical Engineering Reactor Design		3
CHEG 32503 Chemical Engineering Computer Methods		3
CHEG 32303 Chemical Engineering Laboratory I		3
Social Sciences State Minimum Core Elective (Satisfies General Education Outcome 3.3)[5]		3
Technical Elective		3
Year Total:	16	18

Fourth Year	Units	
	Fall	Spring
CHEG 41603 Separation Processes or CHEG 416H3 Honors Separation Processes	3	

CHEG 44103 Chemical Engineering Design I or CHEG 441H3 Honors Chemical Engineering Design I	3	
CHEG 48103 Chemical Process Safety or CHEG 481H3 Honors Chemical Process Safety	3	
Advanced Science Elective	3	
Technical Elective	3	
CHEG 43302 Chemical Engineering Laboratory II		2
CHEG 44203 Automatic Process Control or CHEG 442H3 Honors Automatic Process Control		3
Satisfies General Education Outcome 6.1:		
CHEG 44403 Chemical Engineering Design II or CHEG 444H3 Honors Chemical Engineering Design II		3
Advanced Science or Chemical Engineering Elective		3
Chemical Engineering Elective		3
Year Total:	15	14

Total Units in Sequence:	**128**

[1] Students have demonstrated successful completion of the learning indicators identified for learning outcome 2.1, by meeting the prerequisites for MATH 24004.

[2] The Fine Arts Elective courses which satisfy General Education Outcome 3.1 include: ARCH 10003, ARHS 10003, COMM 10003, DANC 10003, LARC 10003, MUSC 10003, MUSC 100H3, MUSC 10103, MUSC 101H3, MUSC 13303, THTR 10003, THTR 10103, or THTR 101H3.

[3] The Social Sciences Elective courses which satisfy General Education Outcomes 3.3 and 4.1 include: ANTH 10203, COMM 10203, HDFS 14003, HDFS 24103, HIST 11193, HIST 11293, HIST 20903, HUMN 111H4, HUMN 211H4, INST 28103, INST 281H3, PLSC 20103, PLSC 28103, PLSC 281H3, RESM 28503, SOCI 10103, SOCI 201H3, or SOCI 20103.

[4] The Humanities Elective courses which satisfy General Education Outcomes 3.2 and 5.1 include: CLST 10003, CLST 100H3, CLST 10103, HUMN 112H4, PHIL 20003, PHIL 200H3, PHIL 21003.

[5] The Social Sciences Elective courses which satisfy General Education Outcome 3.3 include: AGEC 11003, AGEC 21003, ANTH 10203, COMM 10203, ECON 21003, ECON 22003, ECON 21403, EDST 20003, HDFS 14003, HDFS 24103, HDFS 26003, HIST 11193, HIST 111H3, HIST 11293, HIST 112H3, HIST 20003, HIST 20103, HIST 20903, HUMN 111H4, HUMN 211H4, INST 28103, INST 281H3, PLSC 20003, PLSC 20103, PLSC 21003, PLSC 28103, PLSC 281H3, PSYC 20003, RESM 28503, SOCI 10103, SOCI 201H3, SOCI 20103. Note, courses cannot be counted twice in degree requirements.

Elective Options in Chemical Engineering

Each student in chemical engineering is required to complete six semester hours of technical electives and nine semester hours of Advanced Science electives. At least three semester hours must be taken from the list of Science Electives.

Technical Electives

In general, any upper level (3000-level or above) course in the sciences, math or engineering may serve as a technical elective, with prior approval by your academic adviser. BIOL 20003, BIOL 24103, BIOL 23373 and BIOL 24003 are 2000-level courses that can also serve as technical electives, and are also useful for students applying to medical school. INEG 23303, INEG 24103 and INEG 35103 are statistics-oriented classes, and may be used for technical elective credit. Upper-level courses in non-technical areas such as business may also serve as technical electives with prior approval by your academic adviser. There is no specific list of approved technical electives.

Advanced Science and Chemical Engineering Electives

A list of the approved Advanced Science or Chemical Engineering courses is shown below. Once again, each student in chemical engineering is required to complete nine semester hours of Advanced Science electives. At least three semester hours must be taken from the list of Science electives. Courses not on the list *may* satisfy the requirement with student appeal and approval by the Chemical Engineering faculty.

Science Electives

CHEM 22671	Analytical Chemistry Laboratory	1
CHEM 22673	Analytical Chemistry Lecture	3
CHEM 32003	Forensic Chemistry	3
CHEM 34601	Elements of Physical Chemistry Laboratory	1
CHEM 34603	Elements of Physical Chemistry	3
CHEM 35004	Physical Chemistry I	4
CHEM 35204	Physical Chemistry II	4
CHEM 41203	Advanced Inorganic Chemistry I	3
CHEM 42101	Instrumental Analysis Laboratory	1
CHEM 42203	Instrumental Analysis	3
CHEM 42803	Energy Conversion and Storage	3
CHEM 484H3	Honors Biochemistry II	3
CHEM 48503	Biochemical Techniques	3
CHEM 52803	Energy Conversion and Storage	3
FDSC 43004	Food Chemistry	4
PHYS 31103	Analytical Mechanics	3
PHYS 34503	Electromagnetic Theory I	3
PHYS 34603	Electromagnetic Theory II	3
PHYS 35404	Optics	4
PHYS 36003	Introduction to Modern Physics	3
PHYS 3620V	Introduction to Modern Physics Laboratory	1-3
PHYS 36103	Modern Physics	3
PHYS 40703	Introduction to Quantum Mechanics	3
PHYS 43303	Thermal Physics	3
PHYS 46103	Introduction to Biophysics and Biophysical Techniques	3

Chemical Engineering Electives

- Any graduate Chemical Engineering class (excluding seminar)--instructor permission is required
- Any senior level Chemical Engineering elective class excluding research, co-op/internship, special problem or ChE Car

Students are encouraged to select elective courses to better prepare for employment or further study in areas such as:

- Biotechnology
- Biomedical engineering
- Environmental engineering
- Food process engineering
- Materials engineering
- Microelectronics
- Nanotechnology
- Nuclear engineering
- Pre-medicine
- Simulation and optimization

Additional opportunities are available to enhance the educational experience of students in these areas. Students should consult their academic adviser for recommendations.

Honors Program Requirements

Chemical engineering students enrolled in the Honors College are encouraged to complete the requirements to graduate with honors. In addition to grade point requirements, Honors College students must complete a total of at least 12 hours of honors course credits including a minimum of 6 hours of honors course credits in chemical engineering. The student must also participate in a design or research project culminating in an Honors Thesis. Thesis credit in the department will be satisfied by Honors College students in one of the following ways:

- Completion of the American Institute of Chemical Engineers Design Competition Problem individually following contest rules as part of CHEG 44403 Chemical Engineering Design II;
- Completion of a design contest problem as part of a team, such as the WERC competition in CHEG 44403 Chemical Engineering Design II; or
- Completion of CHEG 4880V Special Problems at the direction of a faculty mentor.

Regardless of the thesis project, an Honors Thesis and oral presentation will be prepared by the student and approved by the Department Honors Committee and the faculty mentor.

Ackerson, Michael D., Ph.D. (University of Arkansas), M.S., B.S. (University of Missouri-Rolla), Associate Professor, 1986, 1997.
Almodovar Montanez, Jorge L., Ph.D. (Colorado State University), Associate Professor, Ralph E. Martin Professorship in Chemical Engineering, 2018.
Beitle, Karen, M.S.(University of Arkansas), B.S. (University of Pittsburgh), Instructor, .
Beitle, Robert R., Ph.D., M.S.Ch.E., B.S.Ch.E. (University of Pittsburgh), Professor, Jim L. Turpin Professorship in Chemical Engineering, 1993, 2006.
Clausen, Ed, Ph.D., M.S.Ch.E., B.S.Ch.E. (University of Missouri-Rolla), University Professor, Charles W. Oxford Professorship in Chemical Engineering, 1981, 2018.
Hestekin, Christa, Ph.D. (Northwestern University), B.S.Ch.E. (University of Kentucky), Associate Professor, Ansel and Virginia Condray Endowed Professorship in Chemical Engineering, 2006, 2013.
Hestekin, Jamie A., Ph.D. (University of Kentucky), B.S.Ch.E. (University of Minnesota-Duluth), Professor, Maurice E. Barker Chair in Chemical Engineering, 2006, 2017.
Kim, Daesoo, Ph.D., M.S. (University of Arkansas), B.S. (Suncheon National University), Instructor, 2022.
Monroe, Jacob, Ph.D. (University of California, Santa Barbara), B.S. (University of Virginia), Assistant Professor, Ray C. Adam Endowed Chair in Chemical Engineering, .
Mourot, Michael, B.S. (University of Arkansas), Instructor, .
Nayani, Karthik, Ph.D. (Georgia Institute of Technology), B.S.Ch.E. (Indian Institute of Technology, Kanpur), Assistant Professor, 2020.
Richardson, Will, Ph.D. (Texas A&M University), B.S. (University of Arkansas), Associate Professor, Bates Teaching Professorship in Chemical Engineering, .
Spicer, Tom O., Ph.D., M.S., B.S. (University of Arkansas), Professor, Robert E. Babcock Sr. Professorship in Chemical Engineering, 1981, 1997.
Vega, Jose L., Ph.D. (University of Arkansas), M.S., Licenciatura (Universidad de Santiago de Compostela), Instructor, 2020.
Walker, Heather L., Ph.D., M.S.Ch.E., B.S.Ch.E. (University of Arkansas), Teaching Assistant Professor, 2008, 2014.
Walters, Keisha, Ph.D., M.S., B.S. (Clemson University), Professor, Kevin W. and Marie L. Brown Department Head Chair in Chemical Engineering, Ralph E. Martin Leadership Chair in Chemical Engineering, 2021.
Wickramasinghe, Ranil, Ph.D. (University of Minnesota-Twin Cities), M.S., B.S. (University of Melbourne, Australia), Distinguished Professor, Ross E. Martin Chair in Emerging Technologies, 2011, 2021.

Courses

CHEG 21103. Introduction to Chemical Engineering I. 3 Hours.
Introduction to the field of chemical engineering. Industries, careers, and the curriculum are discussed. Basic chemical engineering terms, concepts, and calculations are presented. Mass balance calculations are performed and the application of computers to chemical engineering problems is introduced. Pre- or Corequisite: CHEM 14203 or CHEM 12283. (Typically offered: Fall and Spring)

CHEG 21303. Fluid Mechanics. 3 Hours.
Analysis and design of fluids handling equipment and systems. Application of the principles of fluid statics, fluid dynamics, compressible flow, etc. Prerequisite: MATH 25804 or MATH 25804. Pre- or Corequisite: MATH 26004 or MATH 26004 and (CHEG 21103 or BENG 26302 or BMEG 26104). (Typically offered: Fall, Spring and Summer)

CHEG 213H3. Honors Fluid Mechanics. 3 Hours.
Analysis and design of fluids handling equipment and systems. Application of the principles of fluid statics, fluid dynamics, compressible flow, etc. Prerequisite: MATH 25804 or MATH 25804. Pre- or Corequisite: MATH 26004 or MATH 26004 and (CHEG 21103 or BENG 26302 or BMEG 26104). (Typically offered: Fall, Spring and Summer)

CHEG 23103. Thermodynamics of Single-Component Systems. 3 Hours.
A detailed study of the thermodynamic "state principles," energy and entropy balances, and their application to the solution of problems involving single-component physical systems and processes. Prerequisite: MATH 25804. Pre- or Corequisite: CHEG 21103 or BENG 26302 or BMEG 26104. (Typically offered: Fall, Spring and Summer)

CHEG 231H3. Honors Thermodynamics of Single-Component Systems. 3 Hours.
A detailed study of the thermodynamic "state principles," energy and entropy balances, and their application to the solution of problems involving single-component physical systems and processes. Prerequisite: MATH 25804. Pre- or Corequisite: CHEG 21103 or BENG 26302 or BMEG 26104. (Typically offered: Fall, Spring and Summer)

CHEG 31404. Heat and Mass Transfer. 4 Hours.
Applications of the principles of conduction, convection and radiation to the analysis and design of chemical processing heat transfer equipment and systems. Fundamentals of chemical diffusional and convection processes. Pre- or Corequisite: CHEG 33203. Prerequisite: CHEG 21303 with a C or above, and MATH 25804. (Typically offered: Fall and Spring)

CHEG 314H4. Honors Heat and Mass Transfer. 4 Hours.
Applications of the principles of conduction, convection and radiation to the analysis and design of chemical processing heat transfer equipment and systems. Fundamentals of chemical diffusional and convection processes. Pre- or Corequisite: CHEG 33203. Prerequisite: CHEG 21303 with a C or above, and MATH 25804. (Typically offered: Fall and Spring)

CHEG 32303. Chemical Engineering Laboratory I. 3 Hours.
Experimental measurements of various physical properties and comparison with published values and theoretical predictions. Experimental investigation of fluid flow and thermodynamics. Interpretation of results using graphical, numerical and statistical tools, and presentation of results in written technical reports and oral briefings. Identification and quantification of sources of experimental error. Identification of relevant experimental parameters to achieve an objective. Pre- or Corequisite: CHEG 31404. Corequisite: Drill component. Prerequisite: CHEG 21303 and CHEG 23103, both with a C or above. (Typically offered: Fall and Spring)

CHEG 32503. Chemical Engineering Computer Methods. 3 Hours.
Application of computer methods to chemical engineering problems including a review of structured programming principles. Corequisite: Drill component. Pre- or Corequisite: CHEG 31404 and CHEG 33203. Prerequisite: MATH 25804. (Typically offered: Fall and Spring)

CHEG 33203. Thermodynamics of Multi-Component Systems. 3 Hours.
The use of the state principle and energy and entropy balance developed in CHEG 23103 is extended to allow processes. Physical and chemical equilibrium processes are considered in detail. Prerequisite: CHEG 23103 with a C or above, and MATH 26004. (Typically offered: Fall and Spring)

CHEG 332H3. Honors Thermodynamics of Multi-Component Systems. 3 Hours.
The use of the state principle and energy and entropy balance developed in CHEG 23103 is extended to allow processes. Physical and chemical equilibrium processes are considered in detail. Prerequisite: Honors standing, CHEG 23103 with a C or above, and MATH 26004. (Typically offered: Fall and Spring)

CHEG 33303. Chemical Engineering Reactor Design. 3 Hours.
Principles of kinetics of homogeneous and heterogeneous reactions, catalysis, and reactor design with applications, drawn from industrial processes. Pre- or Corequisite: CHEG 32503. Prerequisite: CHEG 33203, with a C or above. (Typically offered: Fall and Spring)

CHEG 333H3. Honors Chemical Engineering Reactor Design. 3 Hours.
Principles of kinetics of homogeneous and heterogeneous reactions, catalysis, and reactor design with applications, drawn from industrial processes. Pre- or Corequisite: CHEG 32503. Prerequisite: Honors standing, and CHEG 33203 with a C or above. (Typically offered: Fall and Spring)

CHEG 37103. Chemical Engineering Materials Technology. 3 Hours.
Selection of metals, polymers and ceramics for service in process conditions (including corrosion). In addition to static strains on materials, specialized materials such as semiconductors,, composites, and nano-materials are studied. The relationship between molecular structure and macroscopic properties is emphasized including processing and manufacture. Prerequisite: CHEG 33203 with a C or above, CHEM 36053, and PHYS 20304. (Typically offered: Spring)

CHEG 371H3. Honors Chemical Engineering Materials Technology. 3 Hours.
Selection of metals, polymers and ceramics for service in process conditions (including corrosion). In addition to static strains on materials, specialized materials such as semiconductors,, composites, and nano-materials are studied. The relationship between molecular structure and macroscopic properties is emphasized including processing and manufacture. Prerequisite: CHEG 33203 with a C or above, CHEM 36053, and PHYS 20304 and Honors Standing. (Typically offered: Spring)

CHEG 41603. Separation Processes. 3 Hours.
Applications of chemical engineering design to stagewise and continuous separations in systems approaching equilibrium. Prerequisite: CHEG 31404 with a C or above. (Typically offered: Fall and Spring)

CHEG 416H3. Honors Separation Processes. 3 Hours.
Applications of chemical engineering design to stagewise and continuous separations in systems approaching equilibrium. Prerequisite: Honors standing and CHEG 31404 with a C or above. (Typically offered: Fall and Spring)

CHEG 43302. Chemical Engineering Laboratory II. 2 Hours.
Experimental investigations of mass transfer and kinetics/reactor design. Special attention to attaining a high order of accuracy and to presenting results in complete written reports, with emphasis on quality rather than quantity work performed. Pre- or Corequisite: CHEG 33303 and CHEG 41603. Corequisite: Drill component. Prerequisite: CHEG 32303 with a C or above. (Typically offered: Fall and Spring)

CHEG 44103. Chemical Engineering Design I. 3 Hours.
Principles of cost estimation, profitability, economic analysis, and economic balances as practiced in the chemical process industries. Special emphasis on the solution of problems involving the combination of engineering principles and economics. Corequisite: Drill component. Pre- or Corequisite: CHEG 41603. Prerequisite: CHEG 31404 with a C or above, CHEG 33303 with a C or above, and (ECON 21003 or ECON 21403). (Typically offered: Fall and Spring)

CHEG 441H3. Honors Chemical Engineering Design I. 3 Hours.
Principles of cost estimation, profitability, economic analysis, and economic balances as practiced in the chemical process industries. Special emphasis on the solution of problems involving the combination of engineering principles and economics. Corequisite: Drill component. Pre- or Corequisite: CHEG 41603. Prerequisite: Honors standing, CHEG 31404 with a C or above, CHEG 33303 with a C or above, and (ECON 21003 or ECON 21403). (Typically offered: Fall and Spring)

CHEG 44203. Automatic Process Control. 3 Hours.
Application of mathematical modeling methods to the description of transient phenomena of interest to process engineers. Modes of control and principles of feedback control are introduced with applications to process engineering problems. Pre- or Corequisite: CHEG 41603. Prerequisite: CHEG 32503 with a C or above. (Typically offered: Spring)

CHEG 442H3. Honors Automatic Process Control. 3 Hours.
Application of mathematical modeling methods to the description of transient phenomena of interest to process engineers. Modes of control and principles of feedback control are introduced with applications to process engineering problems. Pre- or Corequisite: CHEG 41603. Prerequisite: Honors standing, and CHEG 32503 with a C or above. (Typically offered: Spring)

CHEG 44403. Chemical Engineering Design II. 3 Hours.
Responsibility for decision making is placed on the students in the solution of a comprehensive, open ended problem based on an industrial process. Both formal oral and formal written presentation of results are required. Students are selected for participation in some sections of the course based on academic performance, honors standing and instructor recommendations. Corequisite: Drill component. Prerequisite: CHEG 44103 with a C or above. (Typically offered: Fall and Spring)

CHEG 444H3. Honors Chemical Engineering Design II. 3 Hours.
Responsibility for decision making is placed on the students in the solution of a comprehensive, open ended problem based on an industrial process. Both formal oral and formal written presentation of results are required. Students are selected for participation in some sections of the course based on academic performance, honors standing and instructor recommendations. Corequisite: Drill component. Prerequisite: CHEG 44103 with a C or above. (Typically offered: Fall and Spring)

CHEG 48103. Chemical Process Safety. 3 Hours.
Application of chemical engineering principles to the study of safety, health, and loss prevention. Fires and explosions, hygiene, toxicology, hazard identification, and risk assessment in the chemical process industries. Corequisite: Drill component. Prerequisite: CHEG 31404 and CHEG 33203, both with a C or above. (Typically offered: Fall)

CHEG 481H3. Honors Chemical Process Safety. 3 Hours.
Application of chemical engineering principles to the study of safety, health, and loss prevention. Fires and explosions, hygiene, toxicology, hazard identification, and risk assessment in the chemical process industries. Corequisite: Drill component. Prerequisite: Honors standing, CHEG 33203 and CHEG 31404 both with a C or above. (Typically offered: Fall)

CHEG 4880V. Special Problems. 1-6 Hour.
Special problems. Prerequisite: Senior standing. (Typically offered: Fall, Spring and Summer) May be repeated for up to 6 hours of degree credit.

CHEG 49203. Introduction to Sustainable Process Engineering. 3 Hours.
This course considers the role of engineers in the pursuit of a sustainable future. Broad topics will be addressed including Principles of Sustainability, Sustainable Materials, Renewable Energies, Life Cycle Analyses, and Sustainable Process Engineering Design Principles. The course will include lectures, open-ended discussions, guest speakers, and case studies. Students may not receive credit for both CHEG 49203 and CHEG 59203. Prerequisite: CHEG 23103 or MEEG 24003. (Typically offered: Irregular)