CHEMICAL ENGINEERING
(CHE)

CHE 199, SPECIAL TOPICS, 1-16 Credits
Equivalent to: CHE 199H
This course is repeatable for 99 credits.

CHE 199H, SPECIAL TOPICS, 1-16 Credits
Attributes: HNRS – Honors Course Designator
Equivalent to: CHE 199

CHE 299, PROFESSIONAL WORKSKILLS, 1-16 Credits
Equivalent to: CHE 299H
This course is repeatable for 99 credits.
Available via Ecampus

CHE 311, THERMODYNAMICS, 3 Credits
Entropy, the second law of thermodynamics, equations of state, and thermodynamic network.
Prerequisite: (CBEE 212 with C or better or CBEE 212H with C or better or CBEE 280 with C or better) and (MTH 256 [C] or MTH 256H [C])

CHE 312, CHEMICAL ENGINEERING THERMODYNAMICS, 3 Credits
Thermodynamic mixtures, fugacity, phase equilibrium, and chemical reactions equilibrium.
Prerequisite: CHE 311 with C or better

CHE 320, SAFETY, ENGINEERING ETHICS AND PROFESSIONALISM, 3 Credits
Introduction to engineering ethics and safety concepts. Topics include professional engineering responsibility, codes of ethics, ethical assessment, conflicts of interest, loyalty and dissent, life-long learning, hazard identification, risk and safety, and process safety management.
Lec/rec.
Prerequisite: CBEE 212 with C or better or CBEE 212H with C or better or CBEE 280 with C or better

CHE 331, TRANSPORT PHENOMENA I, 4 Credits
Fundamentals and application of momentum and energy transfer phenomena to fluid flow for the design of industrial chemical engineering equipment.
Prerequisite: (MTH 256 with C or better or MTH 256H with C or better) and (CBEE 212 (may be taken concurrently) [C] or CBEE 212H (may be taken concurrently) [C])
Equivalent to: CHE 323, CHE 331H

CHE 331H, TRANSPORT PHENOMENA I, 4 Credits
Fundamentals and application of momentum and energy transfer phenomena to fluid flow for the design of industrial chemical engineering equipment.
Attributes: HNRS – Honors Course Designator
Prerequisite: (MTH 256 with C or better or MTH 256H with C or better) and (CBEE 212 (may be taken concurrently) [C] or CBEE 212H (may be taken concurrently) [C])
Equivalent to: CHE 331

CHE 332, TRANSPORT PHENOMENA II, 3 Credits
A unified treatment using control volume and differential analysis of heat transfer, prediction of heat transport properties, and introduction to heat transfer operations.
Prerequisite: CHE 311 with C or better and (CHE 331 [C] or CHE 331H [C])
Equivalent to: CHE 332H

CHE 332H, TRANSPORT PHENOMENA II, 3 Credits
A unified treatment using control volume and differential analysis of heat transfer, prediction of heat transport properties, and introduction to heat transfer operations.
Attributes: HNRS – Honors Course Designator
Prerequisite: CHE 311 with C or better and (CHE 331 [C] or CHE 331H [C])
Equivalent to: CHE 332

CHE 333, TRANSPORT PHENOMENA III, 3 Credits
A unified treatment using control volume and differential analysis of binary mass transfer, prediction of mass transport properties, and introduction to mass transfer operations. Lec/studio.
Prerequisite: CHE 331 with C or better or CHE 331H with C or better or CHE 332 with C or better or CHE 332H with C or better
Equivalent to: CHE 333H

CHE 333H, TRANSPORT PHENOMENA III, 3 Credits
A unified treatment using control volume and differential analysis of binary mass transfer, prediction of mass transport properties, and introduction to mass transfer operations. Lec/studio.
Attributes: HNRS – Honors Course Designator
Prerequisite: CHE 331 with C or better or CHE 331H with C or better or CHE 332 with C or better or CHE 332H with C or better
Equivalent to: CHE 333

CHE 334, TRANSPORT PHENOMENA LABORATORY, 3 Credits
Engineering lab practices and the application of the macroscopic balances of mass, energy, and chemical species; fluid flow, heat and mass transfer experiments by teams for demonstrations of principles established in previous transport phenomena courses.
Prerequisite: CBEE 213 (may be taken concurrently) with C or better and (CHE 333 (may be taken concurrently) [C] or CHE 333H (may be taken concurrently) [C])
CHE 361, CHEMICAL PROCESS DYNAMICS AND SIMULATION, 3 Credits
Fundamental principles for process dynamic modeling used in the control of process variables such as pressure, temperature, flow rate and chemical composition.
**Prerequisite:** (MTH 256 with C or better or MTH 256H with C or better) and (CHE 331 [C] or CHE 331H [C])
**Recommended:** CBEE 102 and completion of concurrent enrollment in (CHE 331 or CHE 331H)

CHE 399, SPECIAL TOPICS, 0-16 Credits
This course is repeatable for 16 credits.

CHE 401, RESEARCH, 1-16 Credits
Equivalent to: CHE 401H
This course is repeatable for 16 credits.

CHE 403, THESIS, 1-16 Credits
This course is repeatable for 16 credits.

CHE 405, READING AND CONFERENCE, 1-16 Credits
Equivalent to: CHE 405H
This course is repeatable for 16 credits.

CHE 405H, READING AND CONFERENCE, 1-16 Credits
**Attributes:** HNRS – Honors Course Designator
Equivalent to: CHE 405
This course is repeatable for 16 credits.

CHE 406, PROJECTS, 1-16 Credits
This course is repeatable for 16 credits.

CHE 408, WORKSHOP, 1-16 Credits
This course is repeatable for 16 credits.

CHE 410, INTERNSHIP, 1-16 Credits
Available via Ecampus

CHE 411, MASS TRANSFER OPERATIONS, 4 Credits
Mass transfer operations; design of separation processes. Lec/rec.
**Prerequisite:** CHE 312 with C or better and (CHE 333 [C] or CHE 333H [C])

CHE 415, CHEMICAL ENGINEERING LABORATORY I, 3 Credits
Theoretical and empirical analysis of several unit operations, use of formal work processes, safety, teamwork, oral and written communication, and personal accountability. Lec/lab/rec.
**Prerequisite:** CBEE 414 with C or better and CHE 411 [C] and CHE 443 [C] and CHE 361 (may be taken concurrently) [C]
**Equivalent to:** CHE 415H, ENVE 415

CHE 417, INSTRUMENTATION IN CHEMICAL, BIOLOGICAL, AND ENVIRONMENTAL ENGINEERING, 4 Credits
Equips students with a toolbox of instrumental techniques important in chemical, biological, and environmental engineering and the background required to determine the appropriate instrumental technique to address a specific problem. Lec/lab/rec.
**Prerequisite:** CH 332 with C or better or CH 335 with C or better
**Recommended:** (CH 231 or CH 231H) and (CH 261 or CH 261H) and (CH 232 or CH 232H) and (CH 262 or CH 262H) and (CH 233 or CH 233H) and (CH 263 or CH 263H)

CHE 431, CHEMICAL PLANT DESIGN I, 3 Credits
Short-cut techniques and other abbreviated and useful methods for specifying equipment sufficient for the preliminary design of processes and equipment; estimating capital and manufacturing costs based on equipment specifications.
**Prerequisite:** CHE 312 with C or better and CHE 411 [C] and CHE 443 [C]

CHE 432, CHEMICAL PLANT DESIGN II, 3 Credits
Transformation of preliminary design to detailed design; introduction to safety, ethical, economical, and environmental considerations in chemical plant design.
**Prerequisite:** CHE 431 with C or better

CHE 443, CHEMICAL REACTION ENGINEERING, 4 Credits
Design of chemical reactors for economical processes and waste minimization. Contacting patterns, kinetics and transport rate effects in single phase and catalytic systems.
**Prerequisite:** CHE 312 with C or better and (CHE 333 [C] or CHE 333H [C])

CHE 444, THIN FILM MATERIALS PROCESSING, 4 Credits
Solid state devices are based on the patterning of thin films. This lecture and lab course is primarily an introduction to the technology associated with processing thin films. Topics include chemical vapor deposition, physical vapor deposition, plasma etching, and thin-film characterization. Lec/lab/rec.
**Prerequisite:** CHE 443 (may be taken concurrently) with C or better
**Recommended:** CHE 443

CHE 445, POLYMER ENGINEERING AND SCIENCE, 4 Credits
Polymer engineering and science with an emphasis on practical applications and recent developments. Topics include polymer synthesis, characterization, mechanical properties, rheology, and processing at a level suitable for most engineering and science majors. Lec/lab/rec.
**Recommended:** CH 334 and CH 335 and CH 336 and (MTH 256 or MTH 256H) and/or junior standing in engineering or science
CHE 450, CONVENTIONAL AND ALTERNATIVE ENERGY SYSTEMS, 3 Credits
Principles of energy conversion from chemical/mechanical energy to electrical energy including an overview of conventional energy systems and of likely renewable energy systems with a focus on the fundamental physico-chemical and thermodynamic concept for each technology. The economics of energy systems will also be discussed.
Prerequisite: CHE 311 (may be taken concurrently) with C or better or ME 311 (may be taken concurrently) with C or better or ME 311H (may be taken concurrently) with C or better or CH 440 (may be taken concurrently) with C or better

CHE 451, SOLAR ENERGY TECHNOLOGIES, 3 Credits
A foundation in the principles of solar energy processes is provided. Topics covered include photovoltaics and solar thermal, and will cover the fundamental solid state physics of semiconductors to applied heat transfer analysis of solar collectors. The course objective is to equip students with an adequate depth of understanding of the operational principles of solar energy systems, and to cover the breadth of the various approaches employed in active solar energy systems.
Prerequisite: CHE 311 (may be taken concurrently) with C or better or ME 311 (may be taken concurrently) with C or better or ME 311H (may be taken concurrently) with C or better or CH 440 (may be taken concurrently) with C or better
Recommended: CHE 311

CHE 452, ELECTROCHEMICAL ENERGY SYSTEMS, 3 Credits
Introduces principles and processes of electrochemical energy storage and conversion systems. Topics include fundamentals of electrochemistry and concepts of electrochemical energy storage systems. Examples from batteries, fuel cells, supercapacitors devices will be discussed. Lec/rec.
Prerequisite: CHE 311 with C or better and (CHE 333 [C] or CHE 333H [C])

CHE 461, PROCESS CONTROL, 3 Credits
Principles of PID feedback control based on models of chemical processes; analysis and implementation of proportional, integral and derivative tuning; cascade, feedforward, ratio and deadtime compensation; multivariable control and control system design issues and methods.
Prerequisite: (CHE 331 with C or better or CHE 331H with C or better) and (CHE 332 (may be taken concurrently) [C] or CHE 332H (may be taken concurrently) [C]) and CHE 361 [C]

CHE 499, SPECIAL TOPICS, 0-4 Credits
This course is repeatable for 8 credits.

CHE 501, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

CHE 503, THESIS, 1-16 Credits
This course is repeatable for 999 credits.

CHE 505, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

CHE 506, PROJECTS, 1-16 Credits
This course is repeatable for 16 credits.

CHE 510, INTERNSHIP, 1-16 Credits
This course is repeatable for 16 credits.

CHE 514, FLUID FLOW, 4 Credits
Fundamentals of fluid dynamics for Newtonian and non-Newtonian fluids; flow through porous media; two-phase flow. Lec/rec.

CHE 517, INSTRUMENTATION IN CHEMICAL, BIOLOGICAL, AND ENVIRONMENTAL ENGINEERING, 4 Credits
Equips students with a toolbox of instrumental techniques important in chemical, biological, and environmental engineering and the background required to determine the appropriate instrumental technique to address a specific problem. Lec/lab/rec.
Recommended: (CH 231 and CH 261 and CH 232 and CH 262 and CH 233 and CH 263)

CHE 520, MASS TRANSFER I, 4 Credits

CHE 525, CHEMICAL ENGINEERING ANALYSIS, 4 Credits
Modeling of physical and chemical processes; mathematical analysis of models with appropriate advanced techniques.

CHE 537, CHEMICAL ENGINEERING THERMODYNAMICS I, 4 Credits
Applications of the fundamental laws of thermodynamics to complex systems. Properties of solutions of non-electrolytes. Phase and chemical equilibrium.

CHE 540, CHEMICAL REACTORS I, 4 Credits
Catalysis, reactions coupled with transport phenomena. Reactors for high tech applications.

CHE 541, CATALYSIS, 3 Credits
Introduction to topics related to catalysts and catalytic reactions. Course covers catalytic reaction mechanisms and kinetics, catalyst characterization and testing, and catalyst preparation and manufacturing processes.
CHE 542, MOLECULAR ASPECTS OF HETEROGENEOUS CATALYSIS, 3 Credits
Introducing the principles of heterogeneous catalysis from the molecular aspect with emphasis on computational molecular approaches and surface science. The role of surface structure in heterogeneous catalytic reactions and surface interactions, development and analysis of reaction kinetics through microkinetic modeling approaches will be covered. A class project will utilize Density Functional Theory software to calculate catalytic properties of model systems.
Prerequisite: CHE 540 with C or better

CHE 544, THIN FILM MATERIALS PROCESSING, 4 Credits
Solid state devices are based on the patterning of thin films. This lecture and lab course is primarily an introduction to the technology associated with processing thin films. Topics include chemical vapor deposition, physical vapor deposition, plasma etching, and thin-film characterization. Lec/lab/rec.
Recommended: CHE 443 or CHE 543

CHE 545, POLYMER ENGINEERING AND SCIENCE, 4 Credits
Polymer engineering and science with an emphasis on practical applications and recent developments. Topics include polymer synthesis, characterization, mechanical properties, rheology, and processing at a level suitable for most engineering and science majors. Lec/lab/rec.
Recommended: CH 334 and CH 335 and CH 336 and MTH 256

CHE 550, CONVENTIONAL AND ALTERNATIVE ENERGY SYSTEMS, 3 Credits
Principles of energy conversion from chemical/mechanical energy to electrical energy including an overview of conventional energy systems and of likely renewable energy systems with a focus on the fundamental physico-chemical and thermodynamic concept for each technology. The economics of energy systems will also be discussed.
Recommended: CHE 311 or ME 311 or ME 311H

CHE 551, SOLAR ENERGY TECHNOLOGIES, 3 Credits
A foundation in the principles of solar energy processes is provided. Topics covered include photovoltaics and solar thermal, and will cover the fundamental solid state physics of semiconductors to applied heat transfer analysis of solar collectors. The course objective is to equip students with an adequate depth of understanding of the operational principles of solar energy systems, and to cover the breadth of the various approaches employed in active solar energy systems.
Recommended: CHE 311

CHE 552, ELECTROCHEMICAL ENERGY SYSTEMS, 3 Credits
Introduces principles and processes of electrochemical energy storage and conversion systems. Topics include fundamentals of electrochemistry and concepts of electrochemical energy storage systems. Examples from batteries, fuel cells, supercapacitors devices will be discussed. Lec/rec.
Recommended: CHE 311 AND (CHE 333 or CHE 333H)

CHE 581, SELECTED TOPICS, 3 Credits
Non-sequence course designed to acquaint students with recent advances in chemical engineering. Topics vary from term to term and from year to year. May be repeated for credit.
This course is repeatable for 9 credits.
Available via Ecampus

CHE 599, SPECIAL TOPICS, 0-16 Credits
This course is repeatable for 16 credits.

CHE 601, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

CHE 603, THESIS, 1-16 Credits
This course is repeatable for 16 credits.

CHE 605, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

CHE 606, PROJECTS, 1-16 Credits
This course is repeatable for 16 credits.

CHE 611, ELECTRONIC MATERIALS PROCESSING, 3 Credits
Technology, theory, and analysis of processing methods used in integrated circuit fabrication. Offered alternate years. CROSSLISTED as CHE 611/ECE 611.
Equivalent to: CHE 571, ECE 611

CHE 612, PROCESS INTEGRATION, 3 Credits
Process integration, simulation, and statistical quality control issues related to integrated circuit fabrication. Offered alternate years.
CROSSLISTED as CHE 612/ECE 612.
Equivalent to: CHE 572, ECE 612
Recommended: CHE 611 or ECE 611

CHE 613, ELECTRONIC MATERIALS AND CHARACTERIZATION, 3 Credits
Physics and chemistry of electronic materials and methods of materials characterization. Offered alternate years. CROSSLISTED as CHE 613/ECE 613.
Equivalent to: CHE 573, ECE 613