## CHEMICAL AND BIOMOLECULAR ENGINEERING (CHME)

### CHME 113 Introduction to Chemical Engineering I
**Description:** The profession of chemical engineering. Chemical engineers' impact on today's societal issues, team problem solving, communication skills, and the introduction of chemical process flow sheets.

**Credit Hours:** 2  
**Max credits per semester:** 2  
**Max credits per degree:** 2  
**Grading Option:** Graded with Option

### CHME 114 Introduction to Chemical Engineering II
**Prerequisites:** MATH 106 or parallel, CHEM 109A and 109L or CHEM 113A and 113L or parallel  
**Description:** Analytical and computational methods for solving problems related to chemical process measurements, properties of single compounds, properties of mixtures, stoichiometry.

**Credit Hours:** 2  
**Max credits per semester:** 2  
**Max credits per degree:** 2  
**Grading Option:** Graded with Option

### CHME 202 Mass and Energy Balances
**Prerequisites:** CHEM 110 or CHEM 114; MATH 107 or parallel.

**Description:** Application of the principle of conservation of mass and energy in the analysis of steady-state chemical processes. Topics in physical, chemical, and thermal property estimation.

**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Prerequisite for:** CHME 212; CHME 223; ENVE 410

### CHME 204 Carbon Footprints: From Greenhouse Gases to Global Warming
**Prerequisites:** MATH 101, 103, or Placement into MATH 102 or above.

**Description:** Introduction to the concepts of carbon footprints of various human activities, household items and devices, and basic calculations of "carbon accounting". Discuss the global, regional and local impact of carbon accounting.

**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**ACE:** ACE 9 Global/Diversity

### CHME 212 Introduction to Chemical Engineering Computation
**Prerequisites:** MATH 107 or MATH 107H, CHME 202

**Description:** Numerical solution of linear and nonlinear systems of equations, matrix eigenvalue analysis, linear programming and optimization, data regression and model identification. Numerical methods and mathematical packages such as MATLAB that form the basis for computational methods will be emphasized.

**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded  
**Prerequisite for:** CHME 312

### CHME 223 Chemical Engineering Thermodynamics I
**Prerequisites:** A grade of C- or better in CHME 202.

**Description:** Application of the three fundamental laws to chemical engineering problems.

**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Prerequisite for:** CHME 331; CHME 332

### CHME 312 Chemical Engineering Computation
**Prerequisites:** MATH 221, CSCE 155N or CHME 212

**Description:** Computational methods in orthogonal polynomials, numerical integration, matrix operations and ordinary differential equations as they apply to chemical engineering problems such as separations, reactor design, transport operations and control.

**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Prerequisite for:** CHME 330; CHME 333

### CHME 315 Energy Science and Engineering
**Prerequisites:** Sophomore and Junior standing in science and engineering

**Description:** Focuses on energy fundamentals, energy types, energy production, energy conversion, energy storage, energy conservation and coupling. Also discusses clean energy technologies, energy economics, energy management, and sustainability of energy systems. Develops understanding of energy problems and their solutions.

**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded  
**Offered:** FALL

### CHME 323 Chemical Engineering Thermodynamics and Kinetics
**Crosslisted with:** CHME 823

**Prerequisites:** CHME 223

**Description:** Application to multi-component systems; thermodynamics, phase equilibria, chemical reaction equilibria, and process analysis.

**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Prerequisite for:** CHME 324; CHME 805; CHME 825; CHME 845; CHME 847, CHME 447; CHME 935; CHME 995

### CHME 324 Molecular Processes and Applications
**Prerequisites:** CHME 323 or parallel

**Description:** Microscopic processes, such as statistical thermodynamics and molecular kinetics are introduced. Emphasis is placed on an engineering approach to developing problem-solving skills in systems requiring molecular-level understanding.

**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option
CHME 330 Chemical Engineering Laboratory I  
**Prerequisites:** CHME 312 or parallel, 331, 332; CHME 333 or parallel.  
**Description:** Selected experiments in chemical engineering thermodynamics, heat and momentum transfer, and separations. Emphasis on interpretation of results and written reports.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Course and Laboratory Fee:** $25  

CHME 331 Equilibrium Stage Operations  
**Prerequisites:** MATH 107; CHME 223 or parallel.  
**Description:** Phase equilibrium and mass and energy balances applied to staged mass transfer operations.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  

CHME 332 Transport Operations I  
**Prerequisites:** MATH 208; CHME 223  
**Description:** Macroscopic and microscopic phenomena in fluid mechanics applied to chemical processes. Basic conservation laws, flow kinematics, laminar flow, non-viscous and viscous flow of incompressible fluids, and boundary layer theory.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Prerequisite for:** CHME 330, CHME 408  

CHME 333 Transport Operations II  
**Prerequisites:** CHME 312 or parallel, CHME 332  
**Description:** Heat transfer by conduction, convection, and radiation applied to chemical and biochemical processes. Heat exchanger design and performance.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Prerequisite for:** CHME 330, CHME 408; CHME 475, CHME 875; CHME 815; CHME 835; CHME 935; CHME 995  

CHME 334 Transport Operations III  
**Prerequisites:** CHME 332  
**Description:** Diffusive and convective transport of chemical species applied to chemical and biochemical processes including reaction and separation.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Prerequisite for:** CHME 408  

CHME 371 Stem Cell Engineering and Regenerative Medicine  
**Crosslisted with:** CHME 871  
**Prerequisites:** CHEM 109A and 109L or CHEM 113A and 113L.  
**Description:** Introduction to stem cells and regenerative medicine with emphasis on stem cells and their application in the treatment of diseases and translational lab-to-clinic hurdles in stem cell therapy  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  

CHME 408 Product Design and Development  
**Prerequisites:** CHME 331, CHME 333, CHME 334  
**Description:** Analysis of product design and development with the function of the product required by customers. Brainstorming toward creative models and prototypes from initial concept to completion with a feasibility study.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded  
**Offered:** FALL/SPR  

CHME 409 Process Intensification and Sustainability  
**Crosslisted with:** CHME 809  
**Prerequisites:** Senior Standing  
**Description:** Process intensification focuses on considerable improvements in tens to hundred percent in manufacturing by modification of existing operations or new designs. Optimization of manufacturing processes is at the core of PI  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded  
**Offered:** FALL/SPR  

CHME 412 Introduction to Atomistic Simulations  
**Crosslisted with:** CHME 812  
**Prerequisites:** Senior standing  
**Description:** Theory and application of quantum-based computational methods used to model, predict and analyze materials properties.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  

CHME 420 Chemical Process Safety  
**Prerequisites:** CHME 332  
**Description:** Introduction to chemical process safety with topics emphasizing industrial hygiene, toxicology, hazard identification, inherently safer design, and engineering controls.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option
CHME 430 Chemical Engineering Laboratory II
Crosslisted with: CHME 830
Prerequisites: CHME 330; CHME 442 or parallel; CHME 462 or parallel.
Description: Selected experiments in chemical engineering. Emphasis on experimental design, interpretation of results, and formal oral and written presentation.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option
Course and Laboratory Fee: $25
Experiential Learning: Case/Project-Based Learning

CHME 442 Chemical Reactor Engineering and Design
Crosslisted with: CHME 842
Prerequisites: CHME 323
Description: Basic principles of chemical kinetics are coupled with models descriptive of rates of energy and mass transfer for the analysis and design of reactor systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CHME 845

CHME 447 Principles and Applications of Catalysis in Reaction Engineering
Crosslisted with: CHME 847
Prerequisites: CHME 323.
Description: Principles and applications of heterogeneous catalysis, mechanisms, catalytic reactor types and catalyst characterization and performance. Case studies on current catalytic technologies.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CHME 452 Chemical Engineering Process Economics and Optimization
Crosslisted with: CHME 852
Prerequisites: CHME 331, CHME 333, CHME 334
Notes: Credit toward the degree may be earned only in CHME 452/852
Description: Criteria of chemical process economics: cost and asset accounting, time value of money, profitability, alternative investments, minimum attractive rate of return, sensitivity and risk analysis. Process optimization in: plant operations, unit operations, using successive calculations, linear programming and dynamic programming.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CHME 453 Chemical Engineering Process Design and Safety
Crosslisted with: CHME 853
Prerequisites: CHME 452
Description: Design, evaluation, and safety considerations of chemical engineering process applications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
ACE: ACE 10 Integrated Product
Experiential Learning: Case/Project-Based Learning

CHME 454 Chemical Process Engineering
Crosslisted with: CHME 854
Prerequisites: CHME 430, CHME 312
Description: Practical and theoretical aspects of chemical process analysis, simulation, and synthesis. Case studies used to illustrate principles. Use of the digital computer as a tool of the process engineer is stressed.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CHME 460 Automatic Process Control Laboratory
Crosslisted with: CHME 860
Prerequisites: Parallel: CHME 462.
Description: Selected laboratory experiments to demonstrate the theory of the dynamics and control of chemical processes.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Grading Option: Graded with Option
Course and Laboratory Fee: $25

CHME 462 Automatic Process Control
Crosslisted with: CHME 862
Prerequisites: MATH 221, CHME 333
Description: Analysis and design of automatic control systems. Dynamic responses of measuring instruments, control elements, stability of control systems, and process equipment included in control loops.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CHME 965

CHME 470 Biomanufacturing Laboratory
Prerequisites: CHME 473
Description: Selected experiments in molecular biology, bioprocess development, fermentation, purification, and analytical methods as they pertain to biomanufacturing.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CHME 473 Biochemical Engineering
Crosslisted with: CHME 873
Prerequisites: CHEM 431
Description: Engineering processes for production of biologics and metabolic products, with emphasis on biopharmaceutical production by bacteria, yeast, and mammalian systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CHME 470, CHME 474, CHME 874
CHME 474 Advanced Biochemical Engineering
Crosslisted with: CHME 874
Prerequisites: CHME 473/873.
Description: Recent theoretical and technical developments in biochemical engineering.
Credit Hours: 2-6
Min credits per semester: 2
Max credits per semester: 6
Max credits per degree: 6
Grading Option: Graded with Option

CHME 475 Biochemical Separations
Crosslisted with: CHME 875
Prerequisites: CHME 333/833
Description: Separation and purification of compounds of biological origin from an analytical perspective. Application of unit operations for these separations.
Credit Hours: 3
Min credits per semester: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CHME 476 Micro/Nano systems for Engineering and Life Sciences
Crosslisted with: CHME 876
Prerequisites: Senior standing
Description: Introduction to a number of biological problems facing living systems and show how micro/nanotechnology is being used to solve those problems. Emphasis on engineering perspectives of the life sciences.
Credit Hours: 3
Min credits per semester: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CHME 477 Molecular Bioengineering
Crosslisted with: CHME 877
Prerequisites: Senior standing or permission.
Description: Introduction to fundamentals and up-to-date developments in the field of bioengineering at the molecular level. Topics to cover include recombinant DNA methods, protein engineering, microbial cell factories, synthetic and systems biology, DNA and protein therapeutics.
Credit Hours: 3
Min credits per semester: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CHME 478 Chemical Processes in Semiconductor Manufacturing
Crosslisted with: CHME 883
Prerequisites: A grade of C or better in ECEN 211 and MATH 208
Description: Introduction to the basic chemical processes used in chip manufacturing, with emphasis on: thin-film metal and dielectric deposition, etching, ion implantation, diffusion, lithography, and planarization. Discuss material synthesis and processing and the principle physical/chemical governing phenomena.
Credit Hours: 3
Min credits per semester: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CHME 482 Polymers
Crosslisted with: CHME 882
Prerequisites: CHEM 262, 264 or 264A, and MATH 221
Description: Introduction to polymer synthesis, structure, polymer physics, thermodynamics, kinetics, polymer characterization techniques, polymer properties and applications.
Credit Hours: 3
Min credits per semester: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CHME 483 Chemical Processes in Semiconductor Manufacturing
Crosslisted with: CHME 883
Prerequisites: A grade of C or better in ECEN 211 and MATH 208
Description: Introduction to the basic chemical processes used in chip manufacturing, with emphasis on: thin-film metal and dielectric deposition, etching, ion implantation, diffusion, lithography, and planarization. Discuss material synthesis and processing and the principle physical/chemical governing phenomena.
Credit Hours: 3
Min credits per semester: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CHME 486 Electrochemical Engineering
Crosslisted with: CHME 886
Prerequisites: CHME 223 or MECH 200 or BSEN 244
Description: Thermodynamic and kinetic principles of electrochemistry are applied to the design and analysis of electrochemical processes, including chemical production, batteries, fuel cells, and corrosion prevention.
Credit Hours: 3
Min credits per semester: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CHME 489 Air Pollution, Assessment and Control
Crosslisted with: CHME 889
Prerequisites: Senior standing
Description: Survey of the present status of the air pollution problem and the application of engineering and scientific principles to its practical and effective coordinated control.
Credit Hours: 3
Min credits per semester: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CHME 496 Advanced Topics in Chemical Engineering Computation
Crosslisted with: CHME 896
Prerequisites: CHME 312 or CSCE 455/855 or MECH 480/880, and permission.
Description: Intensive treatment of special topics of current research interest in such areas as steady-state and dynamic process simulation, design optimization, chemical process synthesis, computer-aided product research, stochastic optimization, and numerical methods applied to transport problems.
Credit Hours: 1-6
Min credits per semester: 1
Max credits per semester: 6
Max credits per degree: 6
Grading Option: Graded with Option

CHME 499 Senior Problems
Prerequisites: Senior standing in chemical engineering.
Description: Research and development problems which include literature surveys, equipment design and operation, and development of correlations.
Credit Hours: 1-6
Min credits per semester: 1
Max credits per semester: 6
Max credits per degree: 6
Grading Option: Graded with Option
CHME 499H Honors Thesis

Prerequisites: Senior standing in chemical engineering, admission to the University Honors Program.

Description: Honors thesis research project meeting the requirements of the University Honors Program. Independent research project executed under the guidance of a member of the faculty of the Department of Chemical Engineering which contributes to the advancement of knowledge in the field. Culminates in the presentation of an honors thesis to the department and college.

Credit Hours: 1-6

Min credits per semester: 1
Max credits per semester: 6
Max credits per degree: 6
Grading Option: Graded