2021 Graduate Curriculum
Chemical and Biomolecular Engineering
Course descriptions (short)

Fall I

CHEG 800 Chemical and Biomolecular Engineering Seminar (1 credit). Responsible and effective research practices in Chemical and Biomolecular Engineering. Topics include expectations in graduate school, the graduate student-advisor relationship, work-life balance and self-care, time management, teamwork and collaboration, mentor-mentee relationships, goal setting and prioritization, planning the career transition, self-advocacy, and becoming a leader.

CHEG 802 Introduction to Data and Systems Analysis (2 credits). To introduce basic linear algebra principles and the underlying minimum mathematical and numerical concepts necessary to modern Chemical Engineering research, from the analysis of experimental data, to the handling of big data and mathematical modeling and simulations.

CHEG 810 Molecular Thermodynamics (2 credits). Introduction to statistical thermodynamics of molecular systems. Topics include ensembles and partition functions; monatomic and polyatomic gases; intermolecular potentials; monatomic crystals; lattice models; liquid-state theory; integral equation theories; perturbation theory; computer simulation.

CHEG 820 Kinetic Processes (2 credits). Students will learn to think about chemical reactions at a multi-scale level: from molecular to macroscopic. They will integrate molecular theories of reaction rates within complex reaction networks and develop simplified kinetic models that describe physical and biological systems of engineering and scientific interest.

Fall II

CHEG 807 Modeling, Analysis, and Acquisition of Data (2 credits). Provides a fundamental understanding of uncertainty in data to facilitate efficient data analysis and data acquisition. Topics include Probability as a fundamental tool for modeling and rigorous analysis of randomly varying phenomena; Statistics, as a complement to probability, for efficiently describing and extracting information contained in data, to enable confident data-based decision-making; and Design of Experiment, as a coherent collection of strategies for systematically acquiring informative data.

CHEG 811 Chemical Interfaces and Surfaces (2 credits). Principles of the chemistry of interfaces and surfaces. Topics include: Surface forces; electrolyte solutions and Poisson-Boltzmann theory; van der Waals forces; Lifshitz theory; physisorption and chemisorption; adhesion and wetting phenomena; friction and lubrication; force-measuring techniques.

CHEG 821 Diffusive Transport Processes (2 credits). This course develops a conceptual understanding of diffusive transport processes ranging from simple molecular models of transport in gases and liquids to macroscopic processes. Methods to formulate, simplify and develop approximate solutions to transport problems are presented. These approaches are used as a basis to understand transport in complex materials such as polymers, porous catalysts, ionic solutions and biological tissues.

Spring I

CHEG 803 Advanced Scientific Communication (2 credits). Written and oral communication skills in science and engineering. Topics include evaluating the audience, creating documents and presentations with scientific clarity, persuasive writing and speaking, applying constructive editing, and communicating effectively using in-person and online platforms. (Full semester)

CHEG 830 Continuum Transport in Materials (2 credits). Continuum mechanics of fluids and solids; low and high-Reynolds number flows; boundary layer theory; microhydrodynamics and creeping flows; scaling and asymptotic analysis; electrokinetics; convective mass transfer.

CHEG 840 Rate Processes & Dynamics for Microbial Systems (2 credits). Analysis of microbial systems. Topics include enzyme reactions, transcription and translation, gene regulation, flux analysis, cell growth, stochastic networks and oscillatory behaviors, chemotaxis, and quorum sensing.

CHEG 850 Electrochemical Processes (2 credits). This course covers the fundamental concepts and principles of electrochemistry, including electrochemical thermodynamics, electrokinetics, transport, the electrochemical interface, and electroanalytical techniques (e.g., cyclic voltammetry, electrochemical impedance spectroscopy, and polarization).

CHEG 860 Process Systems Engineering: Mathematical Modeling and Optimization Principles (2 credits). Provides instruction on the mathematical programming techniques used in the solution of process design, and operations problems. Educate students to structure and solve complex problems and integrate material from diverse range of engineering disciplines - a systems approach to problem solving. Topics include mathematical programming techniques, foundation of process optimization involving linear, nonlinear and mixed integer problems, sensitivity analysis, feasibility evaluation to incorporate the effects of uncertainty, stochastic optimization, surrogate model building, simulation based and multi-objective optimization.

Spring II

CHEG 832 Soft Materials, Colloids, and Polymers (2 credits). Integration of continuum and molecular descriptions of matter are the basis for engineering soft materials. Topics of this course will include polymer dynamics; rubber elasticity theory; stability and phase transitions; colloidal stability; scattering methods in soft materials; protein interactions; polyelectrolytes; polymer adsorption; glasses and gels.

CHEG 843 Rate Processes & Dynamics for Mammalian Cellular Systems (2 credits). Analysis of mammalian cellular systems. Topics include cell signaling, cell proliferation and growth, cell adhesion and migration, cell phenotype and function, collective/multicellular processes including considerations of specific tissues and applications in biotechnology, and engineering approaches in controlling these cellular processes as well as quantitative analysis of key time and size scales.

CHEG 851 Applied Thermodynamics (2 credits). This course covers a review and applications of the basic principles of continuum thermodynamics, including interpretation using molecular and statistical thermodynamics. Applications emphasize the relevance of energy and entropy balances to contemporary problems including energy conversion in biological and non-biological systems as well as the characteristics of phase separation in synthesizing specialized materials.

CHEG 861 Data Science for Chemical and Biomolecular Engineering (2 credits). This course builds upon the introduction to data science and probability and statistics courses to provide advanced coverage of small and big data applications and methods. It uses Python and different software tools to integrate theory and computation of data science methods applied to the chemical and biomolecular engineering domain.