Appendix 2 Chemical and Biomolecular Engineering Courses

Course Number/Name	Description
BMOLE 6030 – Biotransport Phenomena	Analysis of single and multidimensional steady-state and transient problems in momentum, mass, and energy transfer in biological systems. Mathematical similarities and differences in these mechanisms are stressed, and mathematical descriptions of physiological and engineering systems are formulated. Preq: CHE 3300 and MATH 2080.
CHE 6120 - Polymer Engineering	Design-oriented course in synthetic polymers. Topics include reactor design used in polymer production, effect of step versus addition kinetics on reactor design, epoxy curing reactions, polymer solubility, influence of polymerization and processing conditions on polymer crystallinity. Preq: CH 2240 and CH 3320. 3 Credits
CHE 6130 - Polymer Composite Engineering	Presents fundamental concepts of polymeric composite materials. Main topics include classification of polymeric matrices; flow behavior and visco-elastic properties of fiber precursors and polymeric matrices; and physical and mechanical properties of composites. Preq: CH 2240; and CHE 4120 or MSE 4150; or consent of instructor. 3 Credits
CHE 6140 - Green Engineering	Green chemistry/engineering principles are applied to process and product design. Green engineering metrics are applied to quantify the sustainability, life cycle and environmental impact of chemical technologies, processes and products. Emphasis is placed on industrial sustainability, product innovation, risk assessment, policy and societal implications. Preq: CHE 2110 and MATH 1080 or consent of instructor. 3 Credits
CHE 6150 - Alternative Energy	Addresses the technological environmental, political, social and economic fundamentals associated with using alternative energy sources to meet global energy needs. Engineering analysis is used to evaluate several alternative energy technologies, including biomass, geothermal, hydropower, nuclear, solar and wind. Preq: CHE 2200 and CHE 2300 or consent of instructor. 3 Credits
BMOL 6250 – Biomolecular Engineering	Introduction to basic principles of biomolecular engineering: the purposeful manipulation of biological molecules and processes applied to problems and issues in the life sciences, biotechnology, and medicine. Topics include carbohydrates, proteins, nucleic acids, and lipids with emphasis on their structure-property-function relations; molecular recognition; biochemical pathway engineering; and cell growth. Preq: CHE2200 and CH 2300.
BMOL 6270 – Membranes for Biotechnology & Biomedicine	Students learn principles of membrane science and technology and study membrane applications in the biotechnology and biomedical industries. Advanced topics include surface modification of membranes, synthesis of porous membranes for biomedical applications such as tissue engineering, environmentally responsive membranes, and membrane-based biomedical devices. Preq: CHE 3300.

Course Number/Name	Description
BMOL 6290 – Bioprocess Engineering	Chemical engineering principles are applied to bioprocess design. Emphasis is placed on designing bioreactors and bioseparation unit operations used in industrial biotechnology and the chemical process industry. Application of bioreaction and bioseparation operations to other chemical processes are discussed. Preq: CHE 3300 and CHE 4500.
CHE 6450 - Selected Topics in Chemical Engineering	Topics not covered in other courses, emphasizing current literature, research and practice of chemical engineering. Topics vary from year to year. May be repeated, but only if different topics are covered. Preq: Consent of instructor. 3 Credits
CHE 8010 - Graduate Research Skills and Ethics	Introduction to graduate research, with a focus on ethics, safety and universal research skills. Topics include ethics, lab safety, chemical literacy, scientific presentations, grant writing, experimental design, and career development. 1 Credit
CHE 8040 - Chemical Engineering Thermodynamics	Study of equilibria of physical and chemical systems and generalized properties of hydrocarbons. Includes application of thermodynamic methods in equipment design. 3 Credits
CHE 8050 - Chemical Engineering Kinetics	Kinetics of chemical reactions, particularly in design and operation of chemical reactors. 3 Credits
CHE 8140 - Applied Numerical Methods in Process Simulation	Numerical solution techniques as applied to chemical process systems; finite difference techniques for partial differential equations stressing applied numerical methods rather than theoretical numerical analysis. Standard methods for ordinary differential equations are reviewed. Preq: Consent of instructor. 3 Credits.
CHE 8180 – Polymer Processing	Processing of polymeric materials; polymer flow characterization; extrusion; mixing; filtration; injection molding; fiber and film formation; physical science principles such as fluid flow, heat transfer, crystallization and rheology applied to polymer processing operations. 3 Credits.
CHE 8190 – Viscoelastic Properties of Polymers and Polymer Composites	Time- and frequency-dependent behavior of structural polymers and their composites; interrelationship between various viscoelastic properties; influence of aging; prediction of composite viscoelastic response by application of the Viscoelastic Correspondence Principle. 3 Credits.
CHE 8230 – Mass Transfer and Stagewise Contacts Operations	Stagewise contact operations emphasizing distillation; vapor-liquid equilibria; integral and differential distillation; binary and multicomponent rectification; analytical methods; batch rectification; azeotropic and extractive distillation. 3 Credits.

Course Number/Name	Description
CHE 8340 - Polymer Thermodynamics	Classical and statistical thermodynamics applied to problems in chemical engineering emphasizing modern methods of predicting thermophysical properties of gases and liquids. Students' and instructor's interests influence course content but usually include fundamentals of applied statistical mechanics, molecular theory of dense fluids, descriptions of intermolecular forces, gas-liquid and liquid-liquid critical phenomena, theories of interfacial phenomena and adsorption, statistical mechanics of polymeric systems, statistical mechanics of polydispersed systems, computer simulation of fluids by Monte Carlo, molecular dynamics and stochastic dynamics methods. Preq: CHE 8040. 3 Credits
CHE 8450 – Modern Biomolecular Engineering	This course covers modern literature in the general field of biomolecular engineering. The student presenting the papers is meant to lead the discussion on the major findings, and analyze the methods used, their applicability, and discuss their impact on the field and their own work. 3 Credits.
CHE 8450 – Multiscale Modeling	This course will cover fundamentals of quantum, atomistic, mesoscopic and continuum modeling, highlight the fundamental theory and implementation at each scale and on methods and algorithms that facilitate bridging these scales, focus on the practical applications of these approaches in tackling scientific problems to explain macroscopic and observable phenomena, and discuss common recipes to overcome the challenges and pitfalls of these approaches. 3 Credits.
CHE 8450 – Systems Biology	This course is a survey of contemporary methods and approaches used in systems biology and pharmacology. We will cover theory of the methods, how they work, and then apply them in practice to real datasets using python (primarily). We cover three areas: bioinformatics/big data; dynamic models; pharmacology. 3 Credits.
CHE 8450 – Molecular Modeling	The goal of this course is to provide the student with an understanding of the methods, capabilities, and limitations of molecular simulation (quantum and molecular mechanics simulations). It is expected that completion of this course will leave the student with a much deeper understanding of the molecular basis for the physical behavior of matter. 3 Credits.
CHE 8450 – Catalysis	This course will address many of the key principles of chemical catalysis including: types of catalysts (enzymatic, homogeneous, heterogeneous), chemical reactor design, catalyst design, catalyst characterization, modeling of diffusion and reaction phenomena, and other related topics. 3 Credits.
CHE 8450 – Diffusion in Polymers	The primary goal of this course is to understand the fundamentals that govern the mass transfer of small and large molecules in polymeric materials. The student should gain more knowledge in the areas of transport, thermodynamics, and polymer physics. 3 Credits.
CHE 8450 – Energy Storage	This course covers many topics relevant to carbon nanomaterial synthesis, characterization and manufacturing with a focus on energy applications. 3 Credits

Course Number/Name	Description
in Carbon Nanomaterials	
CHE 8900 - Mentoring	This course guides mentors to become more reflective and effective mentors. Students will learn, implement, and evaluate various approaches to mentoring. 1 Credits
CHE 8950 - Chemical Engineering Graduate Seminar	Series of weekly, one-hour seminars given by students, faculty and guests on topics of current interest. Credits earned in this course do not apply to or alter the required minimum of six research hours for the MS degree or the required 30 research credit hours for the PhD degree. To be taken Pass/No Pass only. 1 Credits
CHE 9910 – Doctoral Dissertation Research	Doctoral dissertation research. 1-12 Credits.

Courses for non-traditional students.

CHE 2110-Mass and Energy Balances	Introduction to fundamental concepts of chemical engineering, including mass and energy balances, PVT relationships for gases and vapors, and elementary phase equilibria; problem-solving and computer skills are developed in lab. Preq: CH 1020 and MATH 1080 and PHYS 1220 and CHE 1300. Coreq: CHE 2111. 4 Credits
CHE 2200-Chemical Engineering Thermodynamics	Topics include first and second laws of thermodynamics, ideal gases, PVT properties of real fluids, energy balances with chemical reactions, and thermodynamic properties of real fluids. Preq: CHE 2110 and MATH 2060. 3 Credits
CHE 2300-Fluids/Heat Transfer	General principles of chemical engineering and study of fluid flow, fluid transportation, and heat transmission. Special emphasis is placed on theory and its practical application to design. Preq: CHE 2110. Preq or concurrent enrollment: CHE 2200 and MATH 2060. 4 Credits
CHE 3300 - Mass Transfer and Separation Processes	Study of mass transport fundamentals and application of these fundamentals to separation technologies, with emphasis on gas absorption, stripping, distillation, and liquid-liquid extraction. Preq: CHE 2200 and CHE 2300. Preq or concurrent enrollment: CHE 3210. 4 Credits
CHE 4500-Chemical Reaction Engineering	Review of kinetics of chemical reactions and an introduction to the analysis and design of chemical reactors. Topics include homogeneous and heterogeneous reactions, batch and continuous flow reaction systems, catalysis, and design of industrial reactors. Preq: CHE 3210 and CHE 3300. 3 Credits