CME

Chemical and Molecular Engineering

CME 502: Mathematical Analysis & Modeling
This course aims to provide graduate-level students with a practical approach to computational methods for the development of various modeling approaches to a variety of relevant chemical, physical and engineering processes. The course will cover linear algebra, nonlinear algebraic systems, matrix eigenvalue analysis, initial value problems, numerical optimization, boundary value problems; probability theory and stochastic simulations, Bayesian statistics and parameter estimation and Fourier analysis.
3 credits, Letter graded (A, A-, B+, etc.)

CME 504: Chemical Reaction Engineering
Introduce the students to the fundamental principles of reaction engineering in order to enable them to handle kinetics and kinetic-transport interactions in a variety of situations. To introduce students to the analysis of the kinetics of homogeneous chemical reactions. To apply this analysis and the concepts of material and energy conservation to the design of idealized homogeneous chemical reactors operating both in batch and continuous modes and under both isothermally and non-isothermally conditions. To introduce the analysis of non ideal flow and, using the flow model, to quantify its effect on an idealized reactor design.
3 credits, Letter graded (A, A-, B+, etc.)

CME 514: Characterization Methods (Microscopy and Spectroscopy)
This course aims to provide graduate-level students with an in-depth acquaintance with important characterization methods that are applicable to surface science, soft materials, thin films and nanotechnology. Topics include techniques such as atomic force microscopy (AFM) including contact-mode, tapping-mode and lateral-force AFM, scanning tunneling microscopy (STM), electrostatic force microscopy (EFM), magnetic force microscopy (MFM), AFM-based nano-lithography, surface force and adhesion measurement, as well as molecular recognition, X-ray photon spectroscopy (XPS) and ultraviolet photon spectroscopy (UPS), including basic principle, instrumentation configuration, data interpretation and analysis, chemical shift, quantification, and depth-profiling; time-of-flight secondary ion mass spectrometry (ToF-SIMS), Fourier-transform infrared spectroscopy (FTIR) and Raman spectroscopy, attenuated total reflection (ATR), diffuse reflectance, and polarization modulation-infrared reflection-adsorption spectroscopy (PM-IRRAS) and finally, scanning and transmission electron microscopy (SEM and TEM). In addition to the text, the student will be exposed to classic and current literature in the field.
3 credits, Letter graded (A, A-, B+, etc.)

CME 515: Complex Fluids
This course aims to provide graduate-level students with a unified approach to complex fluids. Complex fluids, also referred to as soft materials, are materials which have the capability to self-organize to form complex structures that may be manipulated to exhibit a variety of properties essential for specific functional requirements. The materials considered under this definition are the various classes of colloids, polymers, amphiphiles, liquid crystals and biological molecules. Topics covered include an overview and definitions of soft matter and complex fluids; Intermolecular interactions; Phase transitions and order parameters, scaling laws and polydispersity; Polymer systems, thermodynamics of polymer solutions; Polymers at interfaces, adsorbed polymer layers, polymer brushes; self-assembly in bulk, weak and strong segregation, microphase separation; Self-assembly in solution, polymeric micelles, surfactant micelles, planar assemblies, microemulsions; Colloidal systems, forces, and stability, interaction between charged surfaces, colloidal dynamics, diffusion and sedimentation; Amphiphilic systems, surface activity, surfactants and monolayers, membranes; Liquid crystals, applications in microelectronics; Biological systems; Macromolecular and supramolecular assemblies.
3 credits, Letter graded (A, A-, B+, etc.)

CME 522: Heterogeneous Catalysis & Surface Reaction
Heterogeneous catalysis is central to the petroleum chemical industry and it is directly related to products efficiency. This course will emphasize the fundamental and application of heterogeneous catalysis and introduce the catalytic reaction mechanism. Students who complete the course will have attained the following outcomes: 1) Basic of heterogeneous catalyst and catalysis 2) Kinetics of heterogeneously catalyzed reaction 3) Surface characterization by spectroscopic techniques 4) Knowledge of supported metal oxide and zeolites 5) Application of theoretical calculations 6) Industrial applications of heterogeneous catalyst.
3 credits, Letter graded (A, A-, B+, etc.)

CME 523: Nanocomposites
This course aims to provide graduate-level students with an in-depth knowledge of the main types of nanocomposite materials and their specific physical and chemical properties required in applications. Topics include a discussion of the methods of preparation and characterization of specific physical properties of nanocomposite materials. The current state of theory and modeling of nanocomposites will be presented. At the end of the course, students will have enough understanding of the main concepts in nanocomposites physics, understand advantages and disadvantages of different thermoplastics and thermoset polymers as matrix materials. In addition students will gain the knowledge of different manufacturing techniques of nanocomposites. In addition to the text, the student will be exposed to classic and current literature in the field.
3 credits, Letter graded (A, A-, B+, etc.)

CME 524: Chemical Processes in Cell Biology
The course specially designed for chemical engineering students to provide an introduction to the various aspects of cell biology. The ideas of cell biology, including biochemistry and bioenergetics, DNA and protein synthesis, and mechanisms of cancer will be introduced.
3 credits, Letter graded (A, A-, B+, etc.)

CME 525: Chemical and Biological Sensors
Introduction to the field of chemosensor and biosensor, as well as an in-depth and quantitative view of the sensor design and performance analysis. Fundamental application of chemo/biosensor theory will be demonstrated including recognition, transduction, signal acquisition, and post processing/data analysis. Topics are selected to emphasize biomedical, bioprocessing, environmental, and energy application.
3 credits, Letter graded (A, A-, B+, etc.)

CME 526: Computational Methods
This course aims to provide graduate-level students with an in-depth acquaintance with use of modern computational and mathematical techniques in chemical engineering including applied numerical analysis, programming algorithms using mathematical software, and applications of computational methods to the solution of mechanical engineering. Topics include a
discussion of the different analytical methods and algorithms and how to apply these using Matlab. In addition to the text, the student will be exposed to classic and current literature in the field.

*3 credits, Letter graded (A, A-, B+, etc.)*