CME

Chemical and Molecular Engineering

CME 501: Fluid Mechanics

This course aims to provide graduate-level students with fundamental concepts of fluid mechanics; mass, energy and momentum balances; fluids flow in pipes; Couette flows, Poiseuille flows, unsteady flows; viscous flow; fluid flow in porous media; laminar boundary layer and other unidirectional flow; turbulent flow; fluctuations and time-averaging, two phase flow and fluidization; non-Newtonian fluids; microfluidics and electro-kinetic flow effects; compressible flows and computational fluid dynamics.

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

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 503: Chemical Engineering Thermodynamics

This course aims to provide graduate-level students with understanding on the equilibrium thermodynamics and classical statistical thermodynamics, and to apply them to analyze chemical engineering problems down to molecular-scale. It contains mainly the following subjects: Fundamentals of Equilibrium Thermodynamics; Thermodynamic Properties of Fluids and Fluid Mixtures; Phase Transition and Critical Phenomena; Classical Statistical Mechanics; Statistical Thermodynamics of Ideal Gases and Liquid Mixtures; and Other Topics of Interest.

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 511: Transport Phenomena

This course covers topics in advanced transport phenomena. Topics include, equations of change for isothermal systems, viscosity, momentum transport, laminar and creeping flow, multi-variable velocity potential, turbulent flow, Interphase transport, friction factors, rheology of polymeric liquids, non-Newtonian viscosity and generalized Newtonian models, equations of change for non-isothermal systems, temperature distributions and unsteady heat conduction in solids, temperature distributions in turbulent flow and heat flux, diffusivity and mass transport, mass and molar transport by convection.

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

CME 512: Non-equilibrium Thermodynamics

This course provides in depth graduate level instruction in non-equilibrium thermodynamics and statistical mechanics. Topics include a qualitative comparison of equilibrium and non-equilibrium systems, the description of thermodynamic ensembles, the concept of system fluctuations, Brownian motion, fluctuation-dissipation processes, Markov processes, Chapman-Kolmogorov equation, the Fokker-Planck equation, the Einstein-Smoluchowski equation, stochastic processes and boundary conditions, auto-catalytic chemical reactions, bistability, transport processes, relaxation time approximation, stability of far-from equilibrium systems; pattern formation and self-assembly.

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

CME 513: Rheology

This course aims to provide graduate-level students with an in-depth acquaintance with important topics in rheology. Topics include a discussion of the role of rheology in science and engineering, the definition of viscosity, the classification of various types of viscous fluids and flows, deformation and stress, relaxation functions, relaxation time, conversion among response functions, complex modulus, glass transition, time-temperature superposition rule, WLF equation; stress expression in polymers, tension, free-energy and distribution-function of subchains, the Rouse and Zimm models, derivation of stress and relaxation modulus, discussion on the relaxation behavior, the deGennes reptation model, and contour length fluctuation in polymer chains. 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 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, Xray 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 519: Electrochemistry and Electrochemical Materials Science

This course will survey electrochemistry and electrochemical materials science. Topics will include fundamental measurements in electrochemistry, galvanostatic and potentiostatic methods, the electrochemical double layer, corrosion and passivation. Relevant applications such as fuel cells, batteries, and supercapacitors will be discussed.

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.)

CME 590: Surfactants, dispersion technology and novel delivery vehicles

In the first part of the course the students will learn the structures of monomeric, polymeric, and biopolymeric surfactants. Students will be taught how to prepare and characterize surfactants. In the second part students will learn how surfactants arrange on surfaces and how they self-assemble in solution. Micellar solutions and their properties such as interfacial tension, aggregation number, and solubilization will be studied. Also, preparation of micro emulsions; solubilization of bioactives; stability/instability parameters, and thermodynamic stability/instability mechanism of emulsions, creaming, flocculation and coalescence will be discussed. In addition, steric and depletion stabilization will be discussed as well as double emulsions, their characterization and stabilization by biopolymers. Foams and ¿solid in liquid¿ will be explored and compared to emulsions. In the entire course examples from the cosmetic, cosmeceuticals and dermal and transdermal applications will be discussed. In the last prat industrial and practical problems will be discussed.

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

CME 591: Sustainable Future Through Renewable Energy- Advanced

The course will expose students to the role of engineering, chemistry, climate change in defining energy options, and a basic understanding of chemical engineering and technology in developing broad energy options in developing countries. The course combines lectures with utilization of carbon management tools to calculate carbon footprint in a specific country in a virtual environment.

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

CME 599: Research

Offered Fall and Spring

0-9 credits, S/U grading
May be repeated for credit.

CME 695: Graduate Internship

Participation in private corporations, public agencies, or non-profit institutions for ongoing research activities related to thesis research. Students will be required to have a faculty coordinator as well as a contact in the outside organization, to participate with them in regular consultations on the project, and to submit a final report to both.

Letter graded (A, A-, B+, etc.)

CME 696: Special Topics in Chemical and Molecular Engineering

This course will provide an introduction to numerical methods for engineering problems in Python. You will learn the foundations of scientific computing that can be applied to a broad range of engineering problems. We will cover the fundamental mathematical bases of numerical methods used to describe physical phenomena encountered in chemical processes and will then describe how to implement them using Python. The course will introduce you to Python programming language and some of the benefits it offers. Topics covered basic data structure, solution of equations, data fitting, plotting, function minimization, and differential equations. No previous computing experience is assumed.

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

CME 697: Chemical and Molecular Engineering Colloquium

A weekly series of lectures and discussions by visitors, local faculty, and students presenting current research results.

0-3 credits, S/U grading

CME 698: CME 698 Practicum in Teaching

Practicum in teaching under faculty supervision.

0-3 credits, S/U grading
May be repeated for credit.

CME 699: Dissertation Research on Campus

Major portion of research must take place on SBU campus, at Cold Spring Harbor, or at Brookhaven National Lab.

0-9 credits, S/U grading
May be repeated for credit.

CME 700: Dissertation Research off Campus

Major portion of research will take place off-campus, but in the United States and/or U.S. provinces.

0-9 credits, S/U grading
May be repeated for credit.

CME 701: Dissertation Research off Campus-International

Major Portion of research will take place outside of the United States and/or U.S. provinces.

0-9 credits, S/U grading
May be repeated for credit.

CME 800: Full Time Summer Research

This course may be only taken by Ph.D. candidates who are defending in the summer

S/U grading