

# CHEMICAL & BIOLOGICAL ENGINEERING (CBE-GY)

## CBE-GY 902X Guided Studies in Chemical Engineering (3-6 Credits)

*Typically offered Fall and Spring*

These studies involve selections, analyses, solutions and presentations of engineering reports of problems in products, processes or equipment design, or other fields of chemical engineering practices under faculty supervision. Conferences are scheduled. Master's-degree candidates are required to submit three unbound copies of their reports to advisers one week before the last day of classes. | Prerequisite: Adviser's approval

**Grading:** Satisfactory/Unsatisfactory

**Repeatable for additional credit:** Yes

## CBE-GY 903X GUIDED STUDIES IN BIOMOLECULAR ENGINEERING (6 Credits)

These studies involved selections, analyses, solutions and presentations of engineering reports of problems in products, processes or equipment design, or other fields of biomolecular engineering practices under faculty supervision. Conferences are scheduled. Master's-degree candidates are required to submit three unbound copies of their reports to adviser one week before the last day of classes. | Prerequisite: Adviser's approval.

**Grading:** Grad Poly Graded

**Repeatable for additional credit:** No

## CBE-GY 997X MS THESIS IN CHEMICAL & BIOLOGICAL ENGINEERING (3-9 Credits)

*Typically offered Fall and Spring*

Theses for the master's degree in chemical engineering should give results of original investigation of problems in chemical engineering or the application of physical, chemical or other scientific principles to chemical engineering. Theses may involve experimental research, theoretical analyses or process designs, or combinations thereof. Master's-degree candidates are required to submit four unbound copies to advisers before the seventh Wednesday before commencement. | Prerequisite: Adviser's approval.

**Grading:** Satisfactory/Unsatisfactory

**Repeatable for additional credit:** Yes

## CBE-GY 998X Research in Chemical & Biomolecular Engineering (3-9 Credits)

*Typically offered occasionally*

Dissertation research for PhD students who have not completed their qualifying examination. No more than a maximum of 9 credits can be taken or counted toward the PhD dissertation. Minimum registration is 3 credits. Prerequisites: Admission into the CBE PhD degree program & consent of PhD academic and thesis advisors.

**Grading:** Satisfactory/Unsatisfactory

**Repeatable for additional credit:** Yes

**Prerequisites:** Admission into the CBE PhD degree program & consent of PhD academic and thesis advisors.

## CBE-GY 999X PHD DISSERTATION IN CHEMICAL AND BIOLOGICAL ENGINEERING (3-12 Credits)

*Typically offered Fall and Spring*

Theses for the PhD degree must give results of independent investigations of problems in chemical engineering and may involve experimental or theoretical work. Theses must show ability to do creative work and must show that original contributions, worthy of publication in recognized journals, are made to chemical engineering. Candidates are required to take oral examinations on thesis subjects and related topics. Doctoral-degree candidates must submit five unbound thesis copies to advisers before or on the seventh Wednesday before commencement. | Prerequisite: Adviser's approval and students must have passed the doctoral qualifying examination.

**Grading:** Satisfactory/Unsatisfactory

**Repeatable for additional credit:** Yes

**Prerequisites:** RE-GY 9990 AND Restriction: Academic Plan = PHD Chemical Engineering-PHD.

## CBE-GY 6153 APPLIED MATHEMATICS IN ENGINEERING (3 Credits)

*Typically offered Fall*

This course covers mathematical formulation of chemical engineering problems in terms of ordinary, partial differential and differential equations. Topics include solutions of boundary and initial value problems using Green's functions and other techniques; characterization of second-order partial differential equations and properties of their solutions; asymptotic methods and numerical techniques. | Prerequisite: MA-UY 2122 and MA-UY 2132 or adviser's approval.

**Grading:** Grad Poly Graded

**Repeatable for additional credit:** No

## CBE-GY 6333 Transport Phenomena (3 Credits)

*Typically offered Spring*

The topics in this course include vector analysis review; diffusive fluxes; conservation equations for chemical species and thermal energy; boundary conditions; scaling and approximation techniques; solution methods for conduction and diffusion problems; transient unidirectional diffusion and conduction; momentum diffusion and viscous stress; conservation equation for momentum and the Navier-Stokes equations; unidirectional and lubrication flows; and low- and high-Reynolds number flows. | Prerequisite: CBE-UY 3313 or adviser's approval.

**Grading:** Grad Poly Graded

**Repeatable for additional credit:** No

## CBE-GY 6733 Chemical Engineering Thermodynamics (3 Credits)

*Typically offered occasionally*

This course is an organized exposition of fundamental concepts of classical thermodynamics and traditional tools that will help chemical engineers understand and analyze systems they are likely to encounter in practice and/or original research. This course is for students who seek a much deeper understanding of classical thermodynamics than a typical undergraduate course provides. Topics include phase, chemical, and reaction equilibria, ideal and non-ideal solutions, stability of thermodynamic systems and thermodynamics of surfaces.. | Prerequisite: CBE-UY 3153 or adviser's approval.

**Grading:** Grad Poly Graded

**Repeatable for additional credit:** No

**CBE-GY 6813 Chemical Reactor Analysis and Design (3 Credits)***Typically offered Spring*

The topics in this course include trends and issues in modern reactor design; kinetics of complex homogenous and heterogeneous reactions; determination of nonlinear kinetic parameters, effects of transport processes, and catalyst deactivation; analysis and design of reactors; laminar flow reactors; dispersion model; split boundary condition problems; effects of non-ideal flow on conversion; and fixed-bed, fluidized-bed and multiphase reactors. | Prerequisite: CBE-UY 3223 or adviser's approval.

**Grading:** Grad Poly Graded**Repeatable for additional credit:** No**CBE-GY 7213 POLYMER RHEOLOGY AND PROCESSING (3 Credits)**

The topics in this course include science and engineering of polymer processing; Newtonian and non-Newtonian flow phenomena; molecular and phenomenological models of polymer rheology; experimental characterization of shear flows; and the theory and application of engineering principles to extrusion, co-extrusion, blown film extrusion, injection molding and fiber spinning. | Prerequisite: CBE-UY 3313 and 3233 or adviser's approval.

**Grading:** Grad Poly Graded**Repeatable for additional credit:** No**CBE-GY 7263 Engineering Physics of Synthetic and Biological Macromolecules (3 Credits)***Typically offered occasionally*

The course covers physical states of synthetic and biological macromolecules; sizes, shapes and ordered structures; dynamics of unentangled and entangled chains; networks and gels; mechanical, dielectric and optical properties; and viscoelasticity and fracture. | Prerequisite: CBE-UY 4173 or adviser's approval.

**Grading:** Grad Poly Graded**Repeatable for additional credit:** No**CBE-GY 7283 Polymer Composites (3 Credits)**

The course covers composites of linear or cross-linked polymer matrix and reinforcing fibers: carbon, graphite, Kevlar and glass; manufacturing of composites; autoclave bag molding, filament winding, pultrusion; science and engineering of processing of composites; chemorheology, heat and mass transfer, residual stresses, monitoring and optimization of processing; mathematical models; in-situ real-time sensing; nanocomposites and "green" composites. | Prerequisite: CBE-UY 4173 or adviser's approval.

**Grading:** Grad Poly Graded**Repeatable for additional credit:** No**CBE-GY 7523 AIR POLLUTION ENGINEERING CONTROL (3 Credits)**

The course covers control of air pollutants in response to government regulation, regeneration; pollutant-emissions control and the U.S. Clean Air Act mandates; EPA control technology approaches, BACT, MACT and RACT; analysis of pollutant properties, concentrations and atmospheric boundary conditions; absorptive and reactive recovery processes for moving and stationary sources; and formation and removal of gaseous oxides (NO<sub>x</sub>, SO<sub>x</sub>, CO) of VOC's, Hg and HAP's) and of aerosols and other particulates. | Prerequisite: Adviser's approval.

**Grading:** Grad Poly Graded**Repeatable for additional credit:** No**CBE-GY 8113 Optimization in Biological Systems (3 Credits)**

This course introduces the mathematical programming approach.

Topics include tree and network representations; review of the basic concepts in optimization; Kuhn-Tucker optimality conditions; non-linear programming algorithms; modeling techniques for formulating non-linear models; review of linear programming; modeling of continuous and discrete decisions; mixed-integer linear programming techniques (MILP); logical inference and MILP; mixed-integer non-linear programming algorithms (MINLP); applications in computational molecular biology; genotyping of pooled micro-satellite markers; genome rearrangement by DNA inversions; multiple alignment problems; optimization applications in protein systems; and optimization applications in metabolic networks. | Prerequisite: Adviser's approval.

**Grading:** Grad Poly Graded**Repeatable for additional credit:** No**CBE-GY 8313 Biointerfacial Engineering (3 Credits)**

The course explores design, physical properties and experimental analysis of interfaces from a bioengineering perspective. The course comprises about two-thirds lecture and one-third laboratory. Topics covered incorporate experimental characterization including electrochemical, optical and spectroscopic methods; the biochemistry of surfaces; physical properties including surface thermodynamics, electrostatics and biomolecular properties at interfaces; and select biotechnological applications. | Prerequisite: CBE-UY 3323, CBE-UY 3223, CM-UY 3314, CM-UY 2234 or adviser's approval.

**Grading:** Grad Poly Graded**Repeatable for additional credit:** No**CBE-GY 8373 Engineering Principles of Drug Delivery (3 Credits)***Typically offered occasionally*

The course covers fundamental concepts in drug delivery from an engineering perspective. Emphasis will be on materials, processing methods and characterization of drug delivery vehicles ranging from antibody drug conjugates, to nanoparticles, to hydrogels. The class will begin with an overview of drug delivery fundamentals – rationale, mechanisms, approaches – and dive into specifics – delivery vehicle material properties, processing techniques and characterization. Topics will include therapeutic modalities and mechanisms of action; engineering principles of controlled release and of drug transport; thermodynamic principles of self-assembly; physicochemical characterization of drug delivery vehicles; processing and purification methods; effects of macromolecular conformation on bio-interactions; and significance of biodistributions. Clinical and industrial examples will be presented where possible. | Prerequisite: CBE-UY 3313 and CBE-UY 3323 or adviser's approval.

**Grading:** Grad Poly Graded**Repeatable for additional credit:** No**CBE-GY 8813 Biochemical Engineering (3 Credits)***Typically offered occasionally*

The course covers biochemical and bioprocess engineering; enzyme kinetics; cellular control systems, genetic and protein engineering; metabolism, stoichiometry and metabolic engineering; cell growth kinetics; bioreactor design and operation; heat/mass transfer in biological system; and biological product purification and characterization. | Prerequisite: CBE-UY 3223 and CBE-UY 3233 or adviser's approval.

**Grading:** Grad Poly Graded**Repeatable for additional credit:** No

**CBE-GY 9403 SELECTED TOPICS IN CBE I (3 Credits)**

*Typically offered occasionally*

Topics of special interest in chemical and biomolecular engineering are announced in advance in each semester offering. | Prerequisite: Adviser's approval.

**Grading:** Grad Poly Graded

**Repeatable for additional credit:** No

**CBE-GY 9413 SELCT TPCS CHEM & BIO ENGR II (3 Credits)**

*Typically offered Fall*

Topics of special interest in chemical and biomolecular engineering are announced in advance in each semester offering

**Grading:** Grad Poly Graded

**Repeatable for additional credit:** Yes

**CBE-GY 9910 SEMINAR IN CHEMICAL & BIOLOGY ENGINEERING (0 Credits)**

*Typically offered Fall*

Recent developments in chemical and biomolecular sciences and engineering are presented by engineers and scientists from industry and academia. Four semesters are required for PhD candidates.

**Grading:** Grad Poly Pass/Fail

**Repeatable for additional credit:** Yes

**CBE-GY 9920 SEMINAR IN CHEMICAL & BIOLOGICAL ENGINEERING (0 Credits)**

*Typically offered Spring*

Recent developments in chemical and biomolecular engineering are presented by engineers and scientists from industry and academia

**Grading:** Grad Poly Pass/Fail

**Repeatable for additional credit:** Yes