BUSINESS BUS

The Eli Broad College of Business and The Eli Broad Graduate School of Management

309 Business Information Systems and Technology
Fall, Spring, Summer. 3(3-0) P:M: (CSE 101 or concurrently) R: Open only to juniors or seniors in the College of Business.
Role of information technology in shaping and supporting business processes in a global marketplace. Effects on organizations and individuals.

CELL AND MOLECULAR BIOLOGY CMB

College of Natural Science

800 Cell and Molecular Biology Seminar
Fall, Spring. 1(1-0) A student may earn a maximum of 5 credits in all enrollments for this course. R: Open only to students in the Cell and Molecular Biology major.
Current literature in such areas of cell and molecular biology as gene expression, intracellular transport, cell signalling, regulation of cell growth and cell structure.

880 Laboratory Rotation
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Open only to students in the Cell and Molecular Biology major.
Participation in research projects in laboratories of Cell and Molecular Biology faculty.

890 Independent Study
Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 8 credits in all enrollments for this course.
Non-thesis research for Plan B master's students.

892 Research Forum
Fall. 1(1-0) A student may earn a maximum of 4 credits in all enrollments for this course. R: Open only to students in the Cell and Molecular Biology major.
Advanced graduate students present their laboratory research.

899 Master's Thesis Research
Fall, Spring, Summer. 1 to 9 credits. A student may earn a maximum of 36 credits in all enrollments for this course.
Master's thesis research.

999 Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 120 credits in all enrollments for this course. R: Open only to students in the Cell and Molecular Biology major.
Doctoral dissertation research.

CHEMICAL ENGINEERING CHE

Department of Chemical Engineering and Materials Science College of Engineering

201 Material and Energy Balances
Fall, Spring. 3(4-0) P:M: (MTH 133) and (CEM 142 or CEM 143 or CEM 152) and (CSE 101 or concurrently or CSE 131 or concurrently)
Chemical engineering calculations. Synthesis of chemical process systems. Analysis of chemical processes using material and energy balances. Enthalpy calculations for changes in temperature, phase transitions, and chemical reactions.

301 Chemical Engineering as a Profession
Fall. 1(2-0) P:M: (CHE 201 or concurrently) RB: Junior standing in chemical engineering R: Open only to students in the Chemical Engineering major.
Professional aspects of chemical engineering. Communication skills, professionalism and ethics, teamwork skills, contemporary engineering issues, career planning, project management, industrial processes.

311 Fluid Flow and Heat Transfer
Fall. 4(5-0) P:M: (CHE 201 or concurrently and MTH 235 or concurrently) R: Open only to students in the College of Engineering. Not open to students with credit in ME 201 or MSM 351.
Thermodynamics of fluid flow. Laminar and turbulent flow. Design of flow systems. Heat transfer in solids and flowing fluids. Interphase heat transfer. Radiant heat transfer. Multiple effect evaporation. Design of heat exchange equipment.

312 Mass Transfer and Separations
Spring. 4(5-0) P:M: (CHE 201 and MTH 235 or concurrently) R: Open only to students in the College of Engineering.
Diffusion. Mass transfer coefficients. Design of countercurrent separation systems, both stagewise and continuous. Distillation, absorption, extraction. Multicomponent separations. Batch processes. Computer-aided design methods.

316 Unit Operations Laboratory
Spring. 3(1-6) P:M: (CHE 311 and CHE 312 or concurrently and CHE 321 or concurrently and CHE 431 or concurrently) and completion of Tier I writing requirement. R: Open only to students in the Department of Chemical Engineering.
Momentum, heat, and mass transfer. Separation processes: distillation, filtration, and drying. Reactor kinetics. Automatic process control. Laboratory problems requiring team effort.

321 Thermodynamics for Chemical Engineering
Spring. 4(5-0) P:M: (CHE 201)
First and second laws. Thermodynamics of flow and energy conversion processes. Properties of single and multi-component systems. Phase equilibria. Chemical equilibria in reacting systems.

422 Transport Phenomena
Spring. 3(3-0) P:M: (CHE 311 and CHE 312)
Mathematical and physical analogies among mass, energy and momentum transfer processes. Dimensional analysis and solutions to multivariable boundary value problems. Numerical solutions to nonlinear problems.

431 Chemical Reaction Engineering
Spring. 3(3-0) P:M: (CHE 311 and CHE 312 or concurrently and CHE 321 or concurrently)
Design and analysis of homogeneous flow and batch reactors. Chemical kinetics and equilibria. Reaction rate expressions from mechanisms and experimental data. Mass and heat transfer in heterogeneous reactors. Heterogeneous reactor design. Catalysis.

432 Process Dynamics and Control
Fall. 3(3-0) P:M: (CHE 431)
Mathematical modeling of process dynamics. Control theory. Design of control systems and specification of control hardware. Integration of control theory with modern practice.

433 Process Design and Optimization I
Fall. 4(5-0) P:M: (CHE 432 or concurrently) and completion of Tier I writing requirement. R: Open only to students in the Department of Chemical Engineering.
Applications of chemical engineering principles in design calculations. Selection of optimum design. Influence of design on capital investment, operating cost, product loss and quality. Mathematical programming methods for optimization.

434 Process Design and Optimization II
Spring. 2(0-4) P:M: (CHE 433)
Design project requiring an integrated design of chemical engineering processes. Process and project engineering. Instrumentation and control systems. Flowsheet layout and optimization. Process simulation.

472 Composite Materials Processing
Fall. 3(2-3) P:M: (CHE 311 or ME 332 or CE 321)
Manufacturing processes for thermoset and thermoplastic matrix composites. Mechanical and thermal evaluation of composites. Rheology and molding of fiber-filled materials.

473 Chemical Engineering Principles in Polymers and Materials Systems
Spring. 3(3-0) P:M: (CHE 311 and CHE 321 and CHE 431 and CEM 352) SA: CHE 371
Application of chemical engineering principles to polymer and materials systems. Structures and properties of metals, ceramics and polymers. Thermodynamics,synthesis, rubber elasticity, viscoelasticity, kinetics, rheology, and processing of polymers systems. Application of statistics and problem-solving skills to materials systems.

481 Biochemical Engineering
Fall. 3(2-3) P:M: (CHE 431)
Applications of microbiology and biochemistry to biochemical engineering. Kinetics and thermodynamics of biochemical reactors. Transport phenomena in biological systems. Bioreactor design and scale-up.