CHEMICAL ENGINEERING CHE

College of Engineering

222. *Pollution of the Environment--Causes and Cures*

Spring. 3(3-0) Nonmajors; no science or technical background required.

Pollution of air, water and land. Adulteration of foods. Overtaxing waste facilities. Depleting natural resources. Interaction of engineers, industry, government, and the public in creating and combating these problems.

300. *Material and Energy Balances*

Fall. 4(3-2) One year general chemistry, MTH 214 or concurrently, CPS 120 or concurrently.,

Chemical engineering calculations. Synthesis of chemical process systems. Analysis of chemical process systems by material and energy balances. Behavior of gases. Enthalpy calculations for changes of termperature, phase changes, chemical reactions.

305. *Transfer Processes and Separations I*

Fall. 4(3-2) MTH 215; CHE 300 or concurrently.

Thermodynamics of fluid flow. Treatment of fluid flow as a momentum transfer process. Laminar and turbulent motion of compressible and incompressible fluids. Heat transfer in solids and flowing fluids.

306. *Transfer Processes and Separations II*

Winter. 4(3-2) CHE 305.

Heat transfer in condensing and boiling systems. Multiple effect evaporation. Radiant heat transfer. Application to engineering equipment. Mass transfer in single-phase systems, transport analogies interphase transfer and contacting of immissible phases.

307. *Transfer Processes and Separations III*

Spring. 4(3-2) CHE 306.

Mass transfer in continuous contacting systems and stagewise processes. Counter-current processes, fractionation, contacting, efficiency, and simultaneous momentum, heat, and mass transfer.

311. *Thermodynamics for Chemical Engineering*

Spring. 3(3-0) CEM 361.

First and second laws. Energy, enthalpy, entrophy, free energy, the mathematics of property relationships. Energy conversion processes. Thermodynamics of flow.

381. *Chemical Engineering Analysis*

Fall, Spring. 3(3-0) Students may not receive credit in both CHE 381 and MTH 341. MTH 215. Interdepartmental with the Department of Mathematics.

Formulation of ordinary and partial differential equations describing chemical systems. Boundary value problems, numerical methods, matrices, and applications, to chemical engineering systems.

411. *Phase and Chemical Equilibria*

Fall. 3(3-0) CHE 311.

Properties in solutions. Deviations from ideality. Liquid-vapor equilibria. Chemical equilibria in the gas, liquid, and solid states. Electrochemical and irreversible systems.

423. *Chemical Engineering Laboratory*

Spring. 3(1-6) CHE 307 or concurrently.

Assigned laboratory problems, requiring team effort. Experimental work, involving momentum, heat and mass transfer; separation processes, such as distillation, filtration, and drying; reactor kinetics; automatic process control.

424. *Transport Phenomena and Physical Properties Laboratory*

Fall. 3(1-6) CHE 307.

Experiments involving the transport processes and measurement of physical, chemical and thermodynamic properties of various materials. Comparison of theoretical and experimental results.

428. *Chemical Reaction Engineering*

Fall. 3(3-0) CEM 361 or approval of department.

Quantitative treatment of mechanisms and rates of chemical reactions. Catalysis. Design and analysis of flow and non-flow reactors. Interpretation of laboratory kinetic data.

442. *Polymer Science and Engineering*

Winter. 3(3-0) One year organic chemistry. CEM 361.

Structure of polymers. Polymerization reaction kinetics. Polymer characterization. Solution rheology. Polymer processing and fabrication. Commercial polymerization processes.

443. *Chemical Engineering of the Solid State*

Spring. 3(3-0) CEM 361.

Structure and properties of inorganic and organic solids. Relation of bond type and steric configuration to mechanical, electrical, thermal, optical properties. Macroscopic structure influence on physical properties. Surface phenomena. Applications.

446. *Polymerization*

Fall. 3(3-0) One year organic chemistry, elementary physical chemistry. Interdepartmental with and administered by the Department of Chemistry.

Formation and characterization of polymers of high molecular weight will be emphasized.

451. *Process Systems Control*

Winter. 3(3-0) CHE 428.

Foundation of control theory for chemical processes. Integration of present and developing practice with modern theory.

460. *Problems and Reports*

Fall, Winter, Spring. 1 to 9 credits. Seniors, approval of department.

Library and laboratory investigations of problems relating to departmental research.

461. *Process Selection and Optimization*

Winter. 5(5-0) CHE 307.

Application of chemical engineering principles in design calculations. Selection of the optimum design for equipment, functional units, and for the overall process. Influence of design on capital investment, operating cost, product loss, and product quality.

462. *Process Design*

Spring. 3(1-6) CHE 461.

Integrated design of the complete chemical engineering process. Process engineering, project engineering, instrumentation, and layout.

465. *Process Optimization Methods*

Fall, Spring. 3(3-0) MTH 215, knowledge of linear algebra. Interdepartmental with Systems Science.

Methods for determining optimum design and operating policies of systems of varying complexity. Includes classical methods, mathematical programming and modern methods.

470. *Theory of Nuclear Reactors*

(821.) Winter. 3(3-0) PHY 289 and MTH 215 or approval of department.

Theory and design of nuclear research and power reactors. Nuclear transformation, fission, and energy conversion. Derivation of chain reaction design criteria, and calculation of flux-power distribution. Analysis of reactor safety, reliability and economics.

481. *Transport Phenomena*

Winter. 3(3-0) CHE 307, CHE 381.

Fundamental treatment of momentum, energy and mass transport. Use of partial differential equations and equations of change for chemical engineering applications. Analogies among the phenomena, dimensional analysis, and boundary layer theory.

801. *Advanced Chemical Engineering Calculations I*

Fall. 3(3-0) CHE 307.

Chemical engineering applications of advanced mathematical methods. Formulation and solution of mathematical equations which describe physical problems. Computer solutions.

802. *Advanced Chemical Engineering Calculations II*

Winter. 3(3-0) CHE 801.

Continuation of CHE 801.

806. *Thermodynamics and Kinetics in Chemical Engineering*

Summer. 4(3-2) B.S. with a major in chemistry, biochemistry, or a closely allied area. Mathematics through calculus. College level physics. General physical, and organic chemistry. Not open to students with B.S. in chemical engineering for graduate credit.

Mass and energy balances in batch continuous and open systems. Process thermodynamics. Cryogenics. Properties of substances and mixtures. Phase equilibria. Chemical reaction equilibrium. Chemical reactor kinetics. Process design orientation.

807. *Transfer and Sepatation Processes*

Summer. 4(3-2) B.S. with a major in chemistry, biochemistry, or a closely allied area. Mathematics through calculus. College level physics. General physical, and organic chemistry. Not open to students with B.S. in chemical engineering for graduate credit.

Momentum, energy, and mass transfer. Laminar and turbulent flow. Fluid friction. Dimensional analysis. Heat through stationary and flowing materials. Interchangers. Condensation. Boiling. Binary and multicomponent distillation, absorption, extraction.

808. *Transport Phenomena*

Summer. 4(3-2) B. S. with a major in chemistry, biochemistry, or a closely allied area. CHE 807. Not open to students with B. S. in chemical engineering for graduate credit.

Differential equations of motion, continuity, energy and mass. Concepts of fluid behavior. Unsteady heat conduction. Radiation. Numerical and analytical solutions. Diffusion. Convective coefficients. Boundary layers. Simultaneous momentum, mass, heat transfer and chemical reaction.

809. *Chemical Process Design*

Summer. 4(3-2) B.S. with a major in chemistry, biochemistry, or a closely allied area. CHE 806 and CHE 807. Not open to students with B.S. in chemical engineering for graduate credit.

Integrated design of complete processes. Flowsheets. Instrumentation. Optimization of equipment design. Energy consumption. Operating cost. Capital investment. Product loss. Product quality. Economic evaluation of chemical and microbiological processes.

811. *Advanced Chemical Engineering Thermodynamics I*

Fall. 3(3-0) CHE 311, CHE 411. CEM 361.

Advanced treatment of the laws of thermodynamics. Cryogenic processes. Corresponding state and higher parameters in computing properties of chemical compounds and solutions.

817. *Advanced Chemical Reaction Engineering I*

Winter. 3(3-0) CHE 428.

Treatment of absorption and catalysis and their application to catalytic reactors. Heat, momentum, and mass-transfer in fixed-bed and fluidized-bed reactors. Noncatalytic heterogeneous reactions. Homogeneous chain reactions and free radical mechanisms. Computer applications to solution of complex kinetic problems.

825. *Theory, Applicability and Engineering of Radioisotopes*

Winter of even-numbered years. 3(3-0) PHY 498 or PHY 430 or approval of department.

Principles of utilization of radioisotopes in research and production problems for engineering and science majors. Fundamentals and preparation techniques of radioisotopes. Selection, specification, measurement and disposal for typical technical problems.

826. *Flow of Heat I*

Spring. 3(3-0) CHE 307.

Steady and unsteady state heat transfer. Conduction and convection in flow and non-flow systems.

831. *Distillation, Absorption, and Extraction–Ideal Stages*

Fall. 3(3-0) CHE 307. May precede or follow CHE 832.

Stagewise calculations in distillation, absorption, and extraction processes. Computer techniques. Liquid-gas and liquid-liquid equilibria. Batch, continuous, binary and multi-component calculations.

832. *Distillation, Absorption and Extraction–Phase Contractors*

Winter. 3(3-0) CHE 307. May precede or follow CHE 831.

Mass transfer in distillation, absorption, and extraction processes. Continuous and stagewise phase contactors. Column hydrodynamics and plate efficiency.

835. *Nonlinear Optimization Models*

(SYS 828.) Winter, Summer. 4(4-0) Students may not receive credit for both SYS 835 and MGT 835. CHE 465 or MGT 834 or knowledge of linear programming. Interdepartmental with Systems Science and the Department of Management. Jointly administered by Systems Science and the Department of Management.

Nonlinear optimization-examples and applications. Khun-Tucker Theory. Saddle point optimality conditions. Algorithms for problems with constraints. Unconstrained optimization; introduction to search methods.

841. *Advanced Transport Phenomena*

Spring. 3(3-0) MTH 215, B S. in engineering or physical science.

Use of equations of change in solving engineering problems. Boundary layer and penetration theories of interphase transport. Potential flow. Theories of turbulence from statistical standpoint.

847. *Physical Chemistry of Macromolecules*

Winter of odd-numbered years. 3(3-0) CHE 446 or approval of department. Interdepartmental with the Department of Chemistry.

Thermodynamics—phase equilibria of polymer solutions; configuration and conformation of chain molecules; characterization of polymer molecular weight and distribution; theoretical and experimental results for dilute solution viscosity and diffusivity; polyelectrolytes.

881. *Seminar*

Fall, Winter, Spring, Summer. 1(0-2) May reenroll for a maximum of 3 credits allowed toward M.S. degree and 6 credits toward Ph.D. degree.

Detailed library investigation of one or more specialized aspects of chemical engineering, such as recent theoretical developments in one of the unit operations; presentations of these studies to a seminar group. Participation generally required each term of residence.

886. *Selected Topics in Chemical Engineering*

Fall, Winter, Spring, Summer. 3(3-0) May reenroll for a maximum of 9 credits if a different topic is taken.

A newly developing area of chemical engineering selected by the department for offering each term. Information on the specific topic to be covered should be obtained from the department office before registration.

888. *Research Survey*

Fall, Winter, Spring, Summer. 1 to 3 credits. May reenroll for a maximum of 3 credits.

Literature search, problem analysis, and layout of a complete research program.

893. *Special Problems*

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

899. *Research*

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

912. *Advanced Chemical Engineering Thermodynamics II*

Spring of even-numbered years. 3(3-0) Approval of department.

Relation of thermodynamics to quantum theory and statistical mechanics. Computation of chemical engineering thermodynamic data from spectral measurements. Irreversible thermodynamics.

918. *Advanced Chemical Reaction Engineering II*

Fall of odd-numbered years. 3(3-0) Approval of department.

Quantitative treatment of current literature in chemical kinetics and reaction engineering.

927. *Flow of Heat II*

Fall of even-numbered years. 3(3-0) Approval of department.

Fundamentals of radiant heat transfer. Computer techniques in the design of radiant and convective heat transfer equipment.

999. *Research*

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

CHEMISTRY CEM

College of Natural Science

Credit cannot be earned in more than one course of each of the following groups: 130 and 141, 131 and 141, 142 and 153, 132 and 241 or 351, 242 and 352, 383 and 461, 361 and 384, 394 and 472.

With department approval, students with credit in CEM 141-161 may enroll in CEM 181-184H. Those with credit in CEM 152 may enroll in CEM 182H and those with credit in CEM 153 may enroll in CEM 183H. However, students with credit in an Honors Chemistry course may not receive credit in the corresponding non-Honors Chemistry course.

130. *Introductory Chemistry I*

Fall, Winter, Spring, Summer. 4 credits--Self-instructional only. MTH 108 or MTH 111 or concurrently.

General discussion of principles. Atomic and molecular structure and spectra; stoichiometry; gases, liquids, solids, solutions, and changes of state. Laboratory experiments via film, TV tape or live demonstration.

131. *Introductory Chemistry II*

Fall, Winter, Spring, Summer. 3 credit--Self-instructional only. CEM 130; CEM 161 concurrently.

Continuation of CEM 130. Chemical kinetics and equilibrium; ionic equilibrium; acids and bases.

132. *Introductory Chemistry: Carbon Compounds*

Fall, Spring, Summer. 3(3-2) CEM 131 or CEM 141; CEM 161.

Chemistry of carbon compounds, introducing the aliphatic and aromatic hydrocarbon series. Some typical compounds are prepared and their behavior studied.

141. *Principles of Chemistry I*

Fall, Winter. 4(4-0) MTH 108 or MTH 111 or concurrently; 1 year high school chemistry; CEM 161 concurrently.

Atomic and molecular structure, chemical kinetics and equilibrium; acids and bases. The solid state.

142. *Introductory Chemistry III*

Fall, Spring. 3(3-0) CEM 131 or CEM 141.

Reactions and behavior of inorganic compounds.

152. *Principles of Chemistry II*

Winter, Spring. 3(3-0) CEM 131 or CEM 141; MTH 112 or concurrently. Grade of C or better in CEM 131 or CEM 141 recommended.

Thermochemistry and applications of themochemical principles; equilibrium and electrochemistry.

153. *Introductory Inorganic Chemistry*

Fall, Spring. 3(3-0) CEM 152.

Descriptive inorganic chemistry with further discussion of bonding; introduction to radiochemistry.