441. Law of Contracts and Business Organizations  
Fall, Winter, Spring, Summer. Senior approval of department.  
Analysis of the role of the executive secretary.  

442. Property, Sales, Negotiable Instruments  
Spring. 4(4-0) 441.  
Law of real and personal property, including business organizations, sales, and negotiable instruments. Case study method used.  

443. Real Estate Law  
Winter. 3(3-0) 441.  
Law of real and personal property, including business organizations, sales, and negotiable instruments. Case study method used.  

444. Interstate and International Business Law  
Spring. 3(3-0) 341, 440 or 441.  
Laws of contracts, sales, negotiable instruments, agency, business associations in the interstate and international sphere. Maritime contracts. International commercial arbitration. Area directed studies.  

445. Hotel Law  
Fall, Winter. 4(4-0) 440.  
Negotiable instruments, warranties, property, torts, civil rights, agency, partnerships, corporations as applied to hotel and restaurant management.  

486. Business Risks and Insurance  
(AFA 486.) Winter, 5(5-0) 350 or 5(5-0) 350 or Senior approval in business administration.  
Business insurance as it relates to business risks and decision making. Emphasis on business exposure, coverage, and problems of the risk manager.  

487. Management of Insurance Enterprise  
(AFA 487.) Spring. 5(5-0) 350 or approval of department.  
Organizational requirements and functional operations of insurance enterprise with emphasis on methods of underwriting, reserves, financial statements and investments, investment requirements, loss adjustment, underwriting, and marketing. Statutory limitations on management freedom.  

446. The Legal Environment of Business  
Winter, Summer. 4(4-0) 441.  
Critical examination of the environment in which business operates. Analysis of the component elements of the legal environment of business and the structural framework in which law functions.  

448. Legal Environment of International Business  
Spring. 4(4-0) 441.  
Commercial and financial transactions in international business, foreign agencies, branches, subsidiaries. Aspects of labor relations, antitrust, taxation, and transportation as related to foreign operations. Litigation and arbitration in the international business community.  

871. Seminar: Office Administration  
Winter, Summer. 3 credits. May re-enroll for a maximum of 6 credits. Approval of department.  
Problems, practices, and policies involved in office administration. Methods of establishing, analyzing, standardizing, and controlling administrative systems and procedures in the office.  

878. Seminar in Business Law  
Fall, Spring. 4(4-0) May re-enroll for a maximum of 8 credits. 448 or approval of department.  
Public policy with regard to contracts, antitrust, security transactions, labor relations of the firm, viewed from the legislative, judicial, and executive vantage points.  

884. Insurance Companies as Financial Institutions  
(AFA 884.) Winter. 4(4-0) 448.  
Analysis of insurance company investment behavior in the capital market. Emphasis on liquidity requirements, interest rates, legal and organizational requirements affecting investment decisions. Micro and macro aspects are investigated.  

886. Seminar in Insurance Problems  
(AFA 886.) Spring. 4(4-0) 448.  
Analysis of insurance problems affecting the public interest. Special emphasis on problems due to changing economic and social conditions. Insurance regulatory, financial, marketing and social problems are evaluated.  

890. Special Problems  
Fall, Winter, Spring, Summer. Variable credit. Approval of department.  

CHEMICAL ENGINEERING  

CHE College of Engineering  

300. Material and Energy Balances  
(300.) Fall, 3(3-0) 181; Winter, 3(3-0) 181.  
One year general chemistry; MTH 121.  
Chemical engineering calculations. Material and energy balances in physical and chemical non-flow and flow systems. Behavior of ideal and real gas systems. Flows of reactions. Applications to chemical engineering systems.  

311. Thermodynamics for Chemical Engineering  
(311.) Winter, 3(3-0) 361.  

312. Transfer Processes and Separations I  
Winter, 3(3-0) 300, MTH 215.  
Thermodynamics of fluid flow. Frictional effects for laminar and turbulent motion of compressible and incompressible fluids. Dimensional analyses and similarity. Treatment of fluid flow as a momentum transfer process.  

313. Transfer Processes and Separations II  
Spring. 3(3-0) 312.  

314. Transfer Processes and Separations III  
Spring. 3(3-0) 311, 313 or concurrently.  
Mass transfer in continuous contacting systems. Mass transfer in single use systems, transport analogies, interphase transfer and contacting of immiscible phases.  

361. Chemical Thermodynamics  
Fall, Spring. 3(3-0) 464.  
One year general chemistry; one year general physics; MTH 213.  
Interdepartmental and jointly administered with the Chemistry Department.  

381. Chemical Engineering Analysis  
Fall, Spring. 3(3-0) 311, 313; MTH 213.  
Interdepartmental with the Mathematics Department.  
Formulation of ordinary and partial differential equations describing chemical systems. Boundary value problems, numerical methods, matrices, and applications to chemical engineering systems.  

401. Applied Process Analysis  
Spring. 3(3-0) 130 or 141; MTH 121; 311, 313 or approval of department. Students may not earn credit in both 401 and 300.  
Techniques of process analysis applied to natural environmental, and physical systems. Material and energy balances; diffusion, heat conduction and viscous flow. For majors in natural sciences and non-chemical engineering.  

415. Transfer Processes and Separations IV  
Fall. 3(3-0) 314.  
Mass transfer in stage processes. Counter-current processes, fractionation, contacting efficiency, and simultaneous momentum, heat and mass transfer.  

423. Chemical Engineering Laboratory  
(423.) Winter, 3(3-0) 415.  
Assign laboratory problems, requiring team effort. Experimental work, involving momentum, heat and mass separation processes, such as distillation, filtration, and drying; reactor kinetics; automatic process control.  

424. Transport Phenomena and Physical Properties Laboratory  
Spring. 3(3-0) 313 or concurrently.  
Experiments involving the transport processes and measurement of physical, chemical and thermodynamic properties of various materials. Comparison of theoretical and experimental results.
425. Chemical Reaction Engineering
Fall, 3(3-0) 361 or approval of department.
Quantitative treatment of mechanisms and rates of chemical reactions. 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, 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.

466. Polymerization
Fall, 3(3-0) One year organic chemistry, elementary physical chemistry. Interdepartmental with and administered by the Chemistry Department. Formation and characterization of polymers of high molecular weight will be emphasized.

451. Process Systems Control
Winter, 3(3-0) 425.
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 3 credits.
Senior, approval of department.
Library and laboratory investigations of problems relating to departmental research.

461. Process Selection and Optimization
Winter, 3(3-0) 415.
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(1-0) 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 or knowledge of linear algebra. Interdepartmental with Systems Science.
Methods for determining optimum design and operating conditions of systems of varying complexity. Includes classical methods, mathematical programming and modern methods.

481. Transport Phenomena
Fall, 3(3-0) 314, 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) 415.
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) 801.
Continuation of 801.

811. Advanced Chemical Engineering Thermodynamics I
Fall, 3(3-0) 361; CEM 461.
Advanced treatment of the laws of thermodynamics. Cytogenetic processes. Corresponding state and higher parameters in computing properties of chemical compounds and solutions.

817. Advanced Chemical Reaction Engineering I
Spring, 3(3-0) 425.
Steady and unsteady state heat transfer. Conduction and convection in flow and non-flow systems.

825. Theory, Applicability and Engineering of Radiisotopes
Winter, 3(3-0) MTH 465 or approval of department.
Principles of utilization of radiisotopes in research and production problems for engineering and science majors. Fundamentals and preparation techniques of radiisotopes. Selection, specification, measurement and disposal for typical technical problems.

832. Distillation, Absorption and Extraction II
Fall, 3(3-0) 415.
Mass transfer in distillation, absorption, and extraction processes. Continuous and stagewise phase contacts. Column hydrodynamics and plate efficiency.

841. Advanced Transport Phenomena
Winter, 3(3-0) MTH 215, B.S. in engineering or physical science.

847. Physical Chemistry of Macromolecules
Winter of odd-numbered years. 3(3-0) 446 or approval of department. Interdepartmental with the Chemistry Department. Thermodynamics—phase equilibria of polymer solutions; configuration and conformation of polymer 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) or approval of department.
May re-enroll 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 technological 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 be re-enrolled 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. 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
(EGR 899) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

912. Advanced Chemical Engineering Thermodynamics II
Winter of odd-numbered years. 3(3-0) Approval of department.

915. Advanced Chemical Reaction Engineering II
Spring of even-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.

942. Transport Properties  
Spring of odd-numbered years. 3(3-0)  
Approval of department.  

965. Special Topics in Optimal Process Theory  
Spring of odd-numbered years. 3(3-0)  
SYS 828 or approval of department. Interdepartmental with Systems Science.  
Continuation of 828 and special topics from the literature in nonlinear, stochastic, and dynamic programming.

999. Research  
(EGR 999)  
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

CHEMISTRY

College of Natural Science

Credit cannot be earned in more than one course of each of the following groups: 108 and 141; 131 and 141; 132 and 141 or 241; 135 and 241 or 351; 311 and 411, 353 and 461, 361 and 384, 394 and 472.

130. Introductory Chemistry I  
Fall, Winter, Summer. 4(3-3) MTH 112 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  
Winter, Spring, Summer. 3(3-0) 130; 161 concurrently.  
Continuation of 130. Chemical kinetics and equilibrium; ionic equilibrium; acids and bases.

132. Introductory Chemistry: Carbon Compounds  
Fall, Spring, Summer. 3(3-2) 131 or 141: 161.  
Chemistry of carbon compounds, introducing the alphabetic 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 111 or concurrently; satisfactory grade on placement examination; 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) 131 or 161.  
Reactions and behavior of inorganic compounds.

152. Principles of Chemistry II  
Winter, Spring. 3(3-0) 131 or 141; MTH 112 or concurrently. Grade of C or better in 131 or 141 recommended.  
Thermochemistry and applications of thermochemical principles; equilibrium and electrochemistry.

153. Introductory Inorganic Chemistry  
Fall, Spring. 3(3-0) 152.  
Descriptive inorganic chemistry with further discussion of bonding; introduction to radiochemistry.

161. Introductory Chemistry Laboratory  
Fall, Winter, Spring, Summer. 1(0-3) 131 or 141 concurrently.  
Laboratory work in chemistry including quantitative physical or analytical experiments and chemical syntheses.

162. Quantitative Analysis  
Fall, Winter, Spring, Summer. 2(0-6) 101 or 141; 161.  
Laboratory work in quantitative chemistry.

163. Introductory Inorganic Laboratory  
Spring. 2(0-6) 162.  
Qualitative analysis and inorganic preparations.

241. Organic Chemistry  
Fall, Winter, Summer. 4(4-0) 131 or 141; 161.  
Common classes of organic compounds with emphasis on nomenclature, structural principles, reactions and reaction mechanisms.

242. Organic Chemistry  
Winter, Spring. 4(4-0) 241.  
Continuation of 241 with emphasis on polyfunctional compounds, particularly groups of compounds having biological significance.

243. Organic Chemistry Laboratory  
Fall, Winter, Summer. 1(0-3) 241 or concurrently.  
Introduction to standard organic laboratory techniques.

244. Organic Chemistry Laboratory  
Winter, Spring, Summer. 1(0-3) 241, 243.  
Organic preparations and qualitative analysis.

245. Organic Chemistry  
Spring. 3(3) 243.  
Special topics in organic chemistry. Reactions of technical and biological interest, stereochemistry, reaction mechanism, etc.

311. Inorganic Chemistry  
Fall, Summer. 4(4-0) 384 or 463 or concurrently; approval of department.  
The chemistry of selected non-metals and metals. Elementary coordination chemistry and solid-state theory. Bonding in inorganic compounds. The periodic table and table.

333. Instrumental Methods  
Spring. 4(2-0) 132 or 241 or 351; 162.  
Principles, applications of separation and instrumental analysis. Atomic emission, absorption, fluorescent spectrometry; UV, visible, IR, X-ray, fluorospectrophotometry; molecular fluorescence; gas and other chromatography; electroanalytical chemistry, electrochemistry, radiometry.

351. Organic Chemistry  
Fall. 3(4-0) 152.  
A comprehensive introduction to the fundamentals of organic chemistry, designed for chemistry majors but open to others who desire a rigorous, modern treatment of the subject.

352. Organic Chemistry  
Winter. 3(4-0) 351.  
Continuation of 351.

353. Organic Chemistry Laboratory  
Spring. 3(4-0) 352.  
Continuation of 352.

354. Organic Chemistry Laboratory  
Winter. 2(0-6) 162, 353.  
A laboratory course in modern techniques of organic chemistry, including qualitative organic analysis.

355. Organic Chemistry Laboratory  
Spring. 2(0-6) 352, 354.  
Continuation of 354.

355. Organic Chemistry Laboratory  
Fall. 2(0-6) 355.  
Continuation of 355.

361. Chemical Thermodynamics  
Fall, Spring. 3(4-0) One year general chemistry, one year general physics; MTH 215. Interdepartmental and jointly administered with the Chemical Engineering Department.  

362. Analytical-Physical Chemistry I  
Winter. 3(4-0) 361.  
Applications of thermodynamics. Activity coefficients, ionic solutions, cell potentials, ionic equilibria including acid-base, complexation, solubility and redox equilibria, phase equilibria, distillation, extraction, chromatography.

363. Analytical-Physical Chemistry II  
Spring. 3(4-0) 362.  
Chemical kinetics. Homogeneous kinetics, reaction mechanisms, temperature dependence of reaction rates, transport processes, heterogeneous kinetics, electro kinetics, X-ray diffraction, crystal structure.

372. Analytical-Physical Chemistry Laboratory I  
Winter. 2(1-3) 169; 383 or 361.  
Measurement techniques. Temperature measurement and control, pressure, temperature, pH, acid-base titrations, ionic potentials, treatment of data.

373. Analytical-Physical Chemistry Laboratory II  
Spring. 2(1-3) 372.  
Instrumental measurements. Electrode potentials, chromatography, spectrophotometry, electrolytic conductance, solution kinetics.

383. Physical Chemistry: Introductory  
Fall, Summer. 3(4-0) 132 or 241 or 351; MTH 113.  
Classical and chemical thermodynamics. Introduction to the laws and their applications in treating chemical reactions, pure substances, ideal and non-ideal mixtures, and colligative properties.