202. Shorthand II
Fall, Winter, Spring, Summer. 4(4-0)
201, 234 or 1 term shorthand and typing, writing.
Continuation of 201. Vocabulary, dictation, and transcription.

203. Shorthand III
Fall, Winter, Spring. 4(4-0) 202, 235.
Continuation of 202 with development of speed and accuracy.

204. Advanced Shorthand
Fall, Winter, Spring. 4(4-0) 203, 236.
Continuation of 203. Speed writing from dictation.

234. Typewriting I
Fall, Winter, Spring, Summer. 2(2-2)
Approval of department.
Mastery of keyboard; building speed and accuracy; elementary typewriting problems.

235. Typewriting II
Fall, Winter, Spring. 2(2-2) 234 or approval of department.
Improvement of speed and accuracy; arrangement of business letters, tabulation and manuscripts; production typewriting.

236. Advanced Typewriting
Fall, Winter, Spring, Summer. 3(3-1) 235 or 1 1/2 to 2 years typewriting.
Instruction in specialized typewriting problems to develop high-level competency.

306. Secretarial Administration I
Fall, Winter, Spring. 5(4-0) 204, 236.
Sophomores.
Development of proficiency in transcription skills.

309. Secretarial Administration II
Fall, Winter, Spring. 5(5-0) 236, Sophomores.
Machine dictation-transcription; duplication and copying processes; machine calculations; records management.

326. Business Writing
Fall, Winter, Spring, Summer. 4(4-0) Seniors.
Study and analysis of business and industrial communication problems; extensive instruction and practice in writing.

326H. Writing in a Business Culture
Fall, Winter. 4(4-0) Honors College students.
This intensive honors course in business writing ranges from letters to review articles on professional journals. Historical and linguistic study to illuminate business and technological culture.

341. Survey of Business Law
Fall, Winter, Spring, Summer. 4(4-0) Seniors.
Not open to business administration students.
Historical development of the law; courts, court procedures and civil remedies, torts, crimes; contracts, agency, sales, negotiable instruments, real and personal property, including real and personal property, including chattel and liens. Textbook and lecture rather than case approach.

370. Office Administration
Fall, Winter, Spring, Summer. 3(3-0) Seniors.
Analysis of office function and relationship to business organization; information handling and data processing; office design and layout; responsibilities of office administrators.

400H. Honors Work
Fall, Winter, Spring, Summer. 1 to 15 credits. Approval of department.
Independent and informal study in law, office administration or business communications.

416. Secretarial Administration III: Seminar
Winter, Spring. 5(5-0) Seniors or approval of department.
Analysis of the role of the executive secretary.

427. Business and Technical Reports
Fall, Winter, Spring, Summer. 4(4-0) Juniors.
Discussion and illustration of report writing techniques, study of use, form, and structure of different types; practice in preparing the most frequently used. One complete research report required.

440. Law and Society
Fall, Winter, Spring, Summer. 3(3-0) Seniors or approval of department.
Legal reasoning and legal institutions. Court systems and court procedures. Relationships of citizens and business to governmental agencies. Torts, crimes.

441. Law of Contracts and Business Organizations
Fall, Winter, Spring, Summer. 5(5-0) Law of contracts, including the concept of freedom of contract and its importance as the focal point of business transactions. Study of the legal framework within which formal business organizations must operate.

443. Property, Sales, Negotiable Instruments
Spring. 4(4-0) 441.
Law of real and personal property, including bailments, liens and security transactions, sales, and negotiable instruments. Case study method used.

445. Real Estate Law
Winter. 3(3-0) 441.
Law of real and personal property, including mortgages, easements, land descriptions, titles, deeds, recording requirements, brokers, land contracts, escrows, closing of sale, abstracts, mortgages, mechanics liens, co-ownership, descent and distribution, administration of estates, zoning, taxes, landlord and tenant. Combined text and case approach.

448. Interstate and International Business Law
Spring. 3(3-0) 341, 449 or 441.

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

465. Field Studies
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 6 credits. Business majors and approval of department.
Planned program of observation and work in selected business firms. Analysis and reports.

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

871. Seminar: Office Management
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. 3(3-0) May re-enroll for a maximum of 6 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.

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

CHEMICAL ENGINEERING

College of Engineering

201. Chemical Engineering Calculations
Fall, Winter. 3(3-0) CEM 153; MTH 214; PHY 287 or concurrently.
Chemical engineering calculations. Organization of calculations. Material balances, energy balances, behavior of gases, equilibrium relations and reaction rates.

202. Thermodynamics for Chemical Engineering
Winter. 4 (4-0) 201, MTH 215 or concurrently.
First and second laws. Internal energy, enthalpy, entropy, free energy, and work functions. Applications to batch and flow processes, open and closed systems, reacting and nonreacting systems. Interrelationships of thermodynamic properties for perfect gases and for real substances.

203. Thermodynamics for Chemical Engineering
Fall, Winter. 3(3-0) 202, MTH 215.

301. Transfer Processes and Separations
Fall, Winter. 4(4-0) 201, 361 or concurrently; MTH 215.
302. Transfer Processes and Separations  
Winter, Spring. 4(4-0) 301.

303. Transfer Processes and Separations  
Fall, Spring. 4(4-0) 303.

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

404. Chemical Engineering Operations  
Spring. 3(3-0) 305 or concurrently.

422. Chemical Engineering Laboratory  
Fall. Spring. 4(0-12) 303.
Assigned projects requiring laboratory investigation. Experimental work involving transport phenomena, momentum, heat, and mass transfer; separation processes such as distillation, filtration, and drying; thermodynamics and reactor kinetics.

425. Chemical Reaction Engineering  
Fall. 3(3-0) 303; CEM 385, 461.

431. Chemical Engineering of the Solid State  
Spring. 4(4-0) CEM 461.
Polymeric, crystalline, organic, and inorganic solids. Relation of bond type and steric configuration to mechanical, electrical, thermal, and optical properties. Influence of macroscopic structure on physical properties. Surface phenomena. Applications.

451. Dynamics and Control of Chemical Engineering Systems  
Winter. 5(5-0) 303, MTH 215.

480. 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. 3(3-0) 303.
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(4-0) 461.
Integrated design of the complete chemical engineering process. Process engineering, project engineering, instrumentation, and layout.

465. Process Optimization Methods  
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.

481. Transport Phenomena  
Fall. 3(3-0) 303, 361.
Solution of engineering problems using the general principles and equations of transport of momentum, heat, and mass in an arbitrary continuum. Interphase transport.

801. Advanced Chemical Engineering Calculations I  
Fall. 3(3-0) 303.
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) 203, 361; CEM 461.
Advanced treatment of the laws of thermodynamics. Cyclic processes. Corresponding state and higher parameters in computing properties of chemical compounds and solutions.

817. Advanced Chemical Reaction Engineering I  
Winter. 3(3-0) 425.

821. Theory of Nuclear Reactors  
Fall of even-numbered years. 3(3-0) PHY 289; MTH 341; or approval of department.
Theory and design of nuclear research and power reactors. Nuclear transmutation, fission, and energy conversion. Derivation of chain reaction design criteria, and calculation of reactor powers. Analysis of reactor safety, reliability, and economics.

825. Theory, Applicability, and Engineering of Radioisopes  
Winter of even-numbered years. 3(3-0) PHY 498 or CEM 461 or approval of department.
Principles of utilization of radioisopes in research and production problems for engineering and science majors. Fundamentals and preparation techniques of radioisopes. Selection, specification, measurement and disposal for typical technical problems.

826. Flow of Heat I  
Spring. 3(3-0) 303.
Steady and unsteady state heat transfer. Conduction and convection in flow and non-flow systems.

831. Distillation, Absorption, and Extraction I  
Spring. 3(3-0) 303.

832. Distillation, Absorption and Extraction II  
Fall. 3(3-0) 303.
Mass transfer in distillation, absorption, and extraction processes. Continuous and stagewise phase contactors. Column hydrodynamics and plate efficiency.

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

888. Research Survey  
Fall, Winter, Spring, Summer. 1(0-3) 3 credits.
Literature search, problem analysis, and layout of a complete research program.

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

899. Seminar  
Fall, Winter, Spring, Summer. 1(0-3) 3 credits.
May re-enroll for a maximum of 9 credits allowed toward M.S. degree and 6 credits toward Ph.D. degree.

899. Research Seminar  
(EGR 899.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

912. Advanced Chemical Engineering Thermodynamics II  
(812.) Winter 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 specific measurements. Irreversible thermodynamics.

918. Advanced Chemical Reaction Engineering II  
(818.) 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  
Spring. 3(3-0) MTH 105 or concurrently. \( \text{CHEM} \) 131 or concurrently. 
Thermodynamics and applications of thermochemical principles; equilibrium and electrochemistry.

152. Principles of Chemistry II  
Winter. Spring. 3(3-0) 131 or 141; MTH 110 or concurrently. Grade of C or better in 131 or 141 recommended. 
Thermodynamics 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 physicochemical or analytical experiments and chemical synthesis.

162. Quantitative Analysis  
Fall, Winter, Spring. 2(0-6) 131 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. 5(4-3) 131 or 141; 161. 
Common classes of organic compounds with emphasis on nomenclature, structural principles, reactions and reaction mechanisms.

242. Organic Chemistry  
Winter, Spring. 5(4-3) 241. 
Continuation of 241 with emphasis on polyfunctional compounds, particularly groups of compounds having biological significance.

245. Organic Chemistry  
Spring. 3(3-0) 242. 
Special topics in organic chemistry. Reactions of technical and biological interest; stereochemistry, reaction mechanism, etc.

311. Inorganic Chemistry  
Fall, Summer. 4(4-0) 353 or 461 or concurrently, or approval of department. 
The chemistry of selected non-metals and metals. Elementary coordination chemistry and acid-base theory. Bonding in inorganic compounds. The periodic law and table.

333. Instrumental Methods  
Spring. 4(2-6) 132 or 241 or 351; 161. 
Principles and application of separations and instrumental methods of analysis. Flame emission/absorption, UV, visible and IR spectroscopy; thin-layer column, ion-exchange, and gas chromatography; electrochemistry.

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(3-0) 351. 
Continuation of 351.

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

354. Organic Chemistry Laboratory  
Winter. 2(0-6) 152, 241. 
A laboratory course in modern techniques of organic chemistry, including qualitative organic analysis.

355. Organic Chemistry Laboratory  
Spring. 2(0-6) 353, 354. 
Continuation of 354.

356. 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, Spring. 3(4-0) 361. 
Applications of thermodynamics. Activity coefficients, ionic solutions, cell potentials, ion equilibria including acid-base, complexation, solubility and redox equilibria, phase equilibria, distillation, extraction, chromatography.

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

372. Analytical-Physical Chemistry Laboratory I  
Winter. 2(1-3) 132 or 363. 
Measurement techniques. Temperature measurement and control, pressure, calorimeter, pH, acid-base titrations, cell potentials, treatment of data.

373. Analytical-Physical Chemistry Laboratory II  
Spring. 2(1-3) 372 or 363. 
Instrumental measurements. Electrode potentials, chromatography, spectrophotometry, electrophoretic conductance, solution kinetics.

383. Physical Chemistry: Introductory  
Fall. Summer. 3(4-0) 132 or 241 or 351; MTH 113. 
Atomic and molecular structure. Atomic and molecular orbitals and chemical bonding. Relativistic, vibrational and electronic spectra, nuclear magnetic resonance and electron spin resonance.

384. Physical Chemistry: Introductory  
Winter. 3(4-0) 383. 
Gas laws and kinetic-molecular theory. Thermodynamics and thermochemistry, solids, liquids, solutions and equilibria.

385. Physical Chemistry: Introductory  
Spring. 3(4-0) 384. 

394. Spectroscopy Laboratory  
Spring. 2(1-3) 384 or 463. 
Laboratory work in electronic, vibrational and rotational spectroscopy, mass spectrometry, nuclear and electron spin resonance, dipole moments and magnetic susceptibility.