855. Effects of Ionizing Radiations on Plants
Spring of odd-numbered years. 3(3-0)
Approval of department.
Nature of ionizing radiation related to their effects upon plant growth and development including aspects of radiation sensitivity, dosage, direct and indirect effects, genetic evolution, and environmental implications related to modes of action at the cell, organism, and population levels.

863. Advanced Environmental Physiology
Winter. 3(3-0) 415 or approval of department.
The plant in relation to its environment: energy exchange; coupling between CO₂ assimilation and transpiration; hydraulics in the stationary and nonstationary states; transport of ions, carbohydrates, and hormones; stress physiology.

865. Advanced Growth and Development
Fall. 3(3-0) 415 or approval of department.
Advanced treatment of the physiological processes of growth and development. The mechanisms underlying these processes and the rules played by hormones, light, etc., in controlling them will be analysed.

871. Biology of Nematodes
Spring. 4(3-0) 470 or approval of department. Interdepartmental with and administered by the Department of Entomology. Ontogeny, taxonomy, morphology, pathology and ecology of nematodes, with special reference to plant-parasitic and phytopathogenic species.

873. Comparative Limnology
Summer. 6 credits. Approval of department. Interdepartmental with and administered by the Department of Zoology. Theoretical concepts and methods of analysis of environmental factors influencing productivity of freshwater. Comparative field investigations of lakes, streams, and other aquatic habitats.

876. Plant Virology
Fall of odd-numbered years. 5(2-6)
405 or approval of department.
External and internal symptomatology, transmission, interactions, purification, assay and serology of plant viruses.

878. Pathogenesis and Disease Resistance
Winter of odd-numbered years. 4(3-2)
405 and 415, or approval of department. Lectures, readings, and discussions on mechanisms of pathogenicity and infectivity, physiology and biochemistry of disease development; tumorogenesis; metabolic consequences of infection; nature of disease resistance; and parasitism.

883. Plant Disease Control
Fall of even-numbered years. 3(2-2)
405. Principals and methods in controlling plant diseases. Considerable emphasis is placed on the chemistry of fungicides, and their role in controlling plant diseases. Other factors affecting disease epidemiology are covered.

885. Plant Diseases in the Field
Spring. 4 credits. 405 and approval of department. Diagnosis, distribution and sequential developments of plant diseases in the field.

589. Advanced Genetics
Winter of odd-numbered years. 3(3-0)
Approval of department. Role of the gene in differentiation and development, with special emphasis upon the genetic mechanisms responsible for the control of phenogenes.

590. Selected Topics in Plant Pathology
Fall, Winter, Spring. 2 to 5 credits. Approval of department. Topics will be selected from the following areas: parasitism, plant viruses, ecology, genetics, nematology, fungal action, and soil microbiology.

591. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Research for thesis at the master's degree level in one of the following fields: anatomy, cytology, ecology, genetics, lichenology, morphology, mycology, pathology, psychology, physiology, and taxonomy.

890. Advanced Plant Taxonomy
Spring of even-numbered years. 4(4-0)
824, ZOL 441. Consideration of the recent scientific developments effecting plant classification.

891. Advanced Plant Ecology
Winter of odd-numbered years. Summer of even-numbered years. Given at W. K. Kellogg Biological Station summer term. 3(2-4) Approval of department. Fundamental theories and modern research horizons.

902. Plant Physiology and Biochemistry I
Winter of odd-numbered years. 3(3-0)
Approval of department. Interdepartmental with and administered by the Department of Biochemistry. Selected topics concerning photosynthesis and related processes.

903. Plant Physiology and Biochemistry II
Winter of even-numbered years. 3(3-0)
Approval of department. Interdepartmental with and administered by the Department of Biochemistry. Metabolic pathways of unique significance to plants.

907. Advanced Plant Physiology IV
Spring of odd-numbered years. 3(3-0)
Approval of department. Factors influencing vegetative and reproductive physiology.

999. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Research for dissertation at the doctor's degree level in one of the following fields: anatomy, cytology, ecology, genetics, lichenology, morphology, mycology, paleobotany, pathology, physiology, and taxonomy.

BIOLOGICAL SCIENCES - DESCRIPTIONS

BUSINESS LAW AND OFFICE ADMINISTRATION*

College of Business

201. Shorthand I
Fall, Winter, Spring, Summer. 3(4-0)
234 or 1 term typing.
Gregg shorthand theory, dictation and transcription for students with no previous training.

202. Shorthand II
Fall, Winter, Spring, Summer. 3(3-1)
201, 234 or 1 term shorthand and typewriting.
Development of theory and transcription competency, speed building.

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(3-2) 234 or approval of department.
Improvement of speed and accuracy, arrangement of business letters, tabulation and transmittal, production typewriting.

236. Advanced Typewriting
Fall, Winter, Spring, Summer. 3(3-1)
235 or 1½ to 2 years typewriting.
Instruction in specialized typewriting problems developing high-level competency.

239. Advanced Shorthand
Fall, Winter, Spring. 3(3-1) May enroll for a maximum of 6 credits. 202, 235.
Continuation of 202.

239. Secretarial Administration I
Winter. Spring. 4(4-0) 236, 304.
Sophomores. Development of proficiency in transcription skills.

239. Secretarial Administration II
Fall, Winter, Spring. 4(4-0) 236, Sophomores. Machine dictation-transcription; duplication and copying processes; machine calculations; record management.

341. Survey of Business Law
Fall, Winter, Spring. 4(4-0) Juniors.
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 bailments and liens. Textbook and lecture rather than case approach.

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


BUILDING CONSTRUCTION

See Agricultural Engineering
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, 4(4-0) Seniors or approval of department. Analysis of the role of the executive secretary.

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 citizen and businessman to governmental agencies. Torts, crimes.

441. Contracts and Sales
Fall, Winter, Spring, Summer. 3(3-0) Contracts, including concept of freedom of contract and limitations. Sales. Case study method.

442. Agency, Partnerships and Corporations
Winter, 3(3-0) 441. The law dealing with agency and business organizations. Case study method.

443. Negotiable Instruments, Secured Transactions, Property
Spring, 3(3-0) 441. The law of negotiable instruments, secured transactions, and property. Case study method.

445. Real Estate Law
Winter, 3(3-0) 341 or 441. Law of the real estate business. Combined text and case approach.

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

447. Hotel Law
Winter, Spring, 4(4-0) 440. Legal aspects of the hospitality industry.

448. Field Studies
Fall, Winter, Spring, Summer. Variable credit. May be repeated for a maximum of 8 credits. Approval of department. Planned program of observation and work in selected business firms. Analysis and reports.

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

489. 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 transportation as related to foreign operations. Litigation and arbitration in the international business community.

571. 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.

578A. Seminar in Business Law
(878) Winter. 4(4-0) 846 or approval of department. Agency, partnerships and corporations, viewed from the judicial, legislative and executive vantage points.

578B. Seminar in Business Law
Spring. 4(4-0) 846 or approval of department. Agency, partnerships and corporations, viewed from the judicial, legislative and executive vantage points, as they affect entrepreneurial decision making.

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

CHEMICAL ENGINEERING

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. Acidification of soils. Overtaking waste facilities. Depicting natural resources. Interaction of engineers, industry, government, and the public in creating and combating these problems.

300. Material and Energy Balances
(301.) Fall. 4(3-2) One year general chemistry, MYH 214 or concurrently, CPS 120 or concurrently. Chemical engineering calculations. Synthesis of chemical process systems. Analysis of chemical processes systems by material and energy balances. Behavior of gases. Enthalpy calculations for changes of temperature, phase changes, chemical reactions.

305. Transfer Processes and Separations I
Fall. 4(3-2) MYH 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

307. Transfer Processes and Separations III
Spring. 4(3-2) 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
(202.) Spring. 3(3-0) CHEM 301. First and second laws. Energy, entropy, 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 381 and CHEM 381. MYH 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) 311. Properties in solutions. Deviations from ideality. Liquor-solvent equilibria. Chemical equilibria in the gas, liquid, and solid states. Electrochemical and irreversible systems.

423. Chemical Engineering Laboratory
(422.) Spring. 3(1-6) 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) 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) CHEM 301 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

443. Chemical Engineering of the Solid State
Spring, 3(3-0) CHEM 301. Structure and properties of inorganic and organic solids. Relation of bond type and stereo configuration to mechanical, electrical, thermal, optical properties. Macroscopic structure influences on physical properties. Surface phenomena. Applications.