

leoecologic interpretation of most sedimentary accumulations and rocks. (Includes certain algae, protozoans, similar organisms of uncertain affinity and dissociated fragments of larger organisms.)

835. Morphogenesis of Reproductive Structures
Spring of even numbered years. 4(3-4)

Principles underlying the differentiation and growth of reproductive plant structures with special emphasis upon their functional and developmental genetic relationships.

836. Advanced Mycology: Current Biological Advances
Spring of even-numbered years. 4(4-0)
Approval of department.

Recent and current advances in the biology of fungi, with emphasis upon experimental studies of structural and functional differentiation during outogeny.

837. Advanced Mycology: Morphology and Taxonomy
Spring. 4(3-2) 402.

Recent morphological studies, taxonomic methods, and phylogeny. The laboratory will be devoted to special problems related to the student's interests.

838. Advanced Paleobotany
Winter. 3(2-4) Approval of department. Interdepartmental with the Geology Department.

Morphology, anatomy, phylogenetic relationships and classification of fossil plants. Microscopic analysis of tissues and organs prepared by thin section, transfers, peels, polished and etched surfaces, and macerations.

839. Population Ecology
Summer. 6 credits. Approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with and administered by the Zoology Department.

An experimental-field approach to the study of populations and communities. Selected topics will deal with population growth, composition, predation, community structure and species abundance. This course is intended to complement ZOL 892.

841. Physiology of the Algae
Spring of even-numbered years. 4(3-2)
Approval of department.

Physiology, chemistry, biochemistry, and aspects of the ultra-structure of the various algal divisions. Discussion of use of algae for the study of classical physiological and developmental problems.

845. Current Problems in Plant Metabolism
Fall, Winter, Spring. 1(1-0) 414.

846. Seminar in Plant Pathology
Fall, Winter, Spring. 1(1-0) Approval of department.

855. Effects of Ionizing Radiations on Plants
Spring of odd-numbered years. 3(3-0)
Approval of department.

Nature of ionizing radiations related to their effects upon plant growth and development including aspects of radiation sensitivity, dosimetry, direct and indirect effects, genetic, evolution and environmental implications related to modes of action at the cell, organism, and population levels.

880. Plant Virology
Fall. 5(2-6) 405 or approval of department.

External and internal symptomatology, transmission, interactions, purifications, assay and serology of plant viruses.

881. 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; tumorigenesis; metabolic consequences of infection; nature of disease resistance; and parasitism.

883. Plant Disease Control
Fall of even-numbered years. 3(2-3) 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.

890. 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, fungicidal action, and soil microbiology.

899. 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, phycology, physiology, and taxonomy.

918. 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 phenogenesis.

920. Advanced Plant Taxonomy
Spring of even-numbered years. 4(4-0) 824, ZOL 441.

Consideration of the recent scientific developments affecting plant classification.

930. Advanced Plant Ecology
Spring of odd-numbered years. 3(2-4) 415, 450, 824.

Fundamental theories and modern research horizons.

951. Advanced Plant Physiology I
(943.) Fall of even-numbered years. 3(3-0) Approval of department.

Selected topics concerning absorption and inorganic nutrition.

952. Plant Physiology and Biochemistry I
(944.) Winter of odd-numbered years. 3(3-0) Approval of department. Interdepartmental with and administered by the Biochemistry Department.

Selected topics concerning photosynthesis and related processes.

953. Advanced Plant Physiology II
(945.) Spring of odd-numbered years. 3(3-0) Approval of department.

Selected topics concerning the chemistry, physiology and mechanism of action of plant growth hormones.

954. Advanced Plant Physiology III
(946.) Fall of odd-numbered years. 3(3-0) Approval of department.

Selected topics from environmental physiology.

955. Plant Physiology and Biochemistry II
(947.) Winter of even-numbered years. 3(3-0) Approval of department. Interdepartmental with and administered by the Biochemistry Department.

Metabolic pathways of unique significance to plants.

956. Advanced Plant Physiology IV
(948.) Spring of even-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 thesis at the doctor's degree level in one of the following fields: anatomy, cytology, ecology, genetics, lichenology, morphology, mycology, paleobotany, pathology, physiology, and taxonomy.

BUILDING CONSTRUCTION

See Packaging

BUSINESS LAW AND OFFICE ADMINISTRATION BOA
College of Business

201. Shorthand I
Fall, Winter, Spring, Summer. 3(4-0) 234 or 1 term typewriting.

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(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 1½ to 2 years typewriting.

Instruction in specialized typewriting problems to develop high-level competency.

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

Continuation of 202.

- 308. Secretarial Administration I**
Fall, Winter, Spring. 4(4-0) 236,
304. Sophomores.
Development of proficiency in transcription skills.
- 309. Secretarial Administration II**
Fall, Winter, Spring. 4(4-2) 236,
Sophomores.
Machine dictation-transcription; duplication and copying processes; machine calculations; records management.
- 326. Business Writing**
Fall, Winter, Spring, Summer. 4(4-0)
Juniors.
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)
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. Office Administration**
Fall, Winter, Spring, Summer. 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.
- 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. Law of Contracts and Business Organizations**
Fall, Winter, Spring, Summer. 5(5-0)
440.
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 fixtures, 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.
- 446. 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 spheres. Maritime contracts. International commercial arbitration. Area directed studies.
- 447. Hotel Law**
Winter, Spring. 4(4-0) 440.
Negotiable instruments, warranties, property, torts, civil rights, agency, partnerships, corporations as applied to hotel and restaurant management.
- 468. Field Studies**
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 8 credits. Business majors and approval of department.
Planned program of observation and work in selected business firms. Analysis and reports.
- 848. The Legal Environment of Business**
Winter, Summer. 4(4-0)
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.
- 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, anti-trust, 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. 848 or approval of department.
Public policy with regard to contracts, anti-trust, 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 CHE**
- 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 bal-

ances, behavior of gases, equilibrium relations and reaction rates.

- 202. Thermodynamics for Chemical Engineering**
Winter, Spring. 3(3-0) 201, MTH 215 or concurrently.
First and second laws. Internal energy, enthalpy, entropy, free energy, and work functions. Application to batch and flow processes, open and closed systems, reacting and nonreacting systems. Interrelationships of thermodynamic properties for perfect gases and for real substances.
- 301. Transfer Processes and Separations**
Fall, Winter. 4(4-0) 201; 361 or concurrently; MTH 215.
Thermodynamics of fluid flow. Application to flow equipment. Frictional effects for laminar and turbulent motion of compressible and incompressible fluids. Dimensional analysis and similitude. Continuity and flow equations in tensor notation. Treatment of fluid flow as a momentum transfer process. Analogous treatment of heat flow. Heat transfer in solids and flowing fluids.
- 302. Transfer Processes and Separations**
Winter, Spring. 4(4-0) 301.
Heat transfer in condensing and boiling systems. Application to engineering equipment. Condensers, interchangers, and multiple effect evaporators. Radiation. Mass transfer. Analogies with momentum and heat. Continuous and stagewise contactors.
- 303. Transfer Processes and Separations**
Fall, Spring. 4(4-0) 302.
Simultaneous heat and mass transfer. Humidification. Gas absorption. Distillation, ideal, non-ideal, binary and multicomponent. Extraction. Azeotropic and extractive distillation. Mass transfer with chemical reaction.
- 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.
Thermodynamics. Properties of gases. Laws of thermodynamics, properties of ideal and non-ideal solutions, thermodynamics of chemical reactions, activities in non-ionic systems.
- 401. Applied Process Analysis**
Spring. 3(3-0) CEM 130 or 141; MTH 113; or approval of department. Students may not earn credit in both 401 and 201.
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 engineers.
- 422. Chemical Engineering Laboratory**
Fall, Winter. 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.
- 428. Chemical Reaction Engineering**
Fall. 3(3-0) 303; CEM 362, 461.
Quantitative treatment of mechanisms and rates of chemical reactions. Catalysis. Design and analysis of flow and non-flow reactors. Interpretation of laboratory kinetic data.
- 443. Chemical Engineering of the Solid State**
Spring. 4(4-0) CEM 461.
Polymeric, crystalline, organic, and inorganic solids. Relation of bond type and steric con-