484. **Environmental Education**  
Spring, 3(3-0)  
P: AEC 101 or FRH 320 or RD 581 or TE 150. R: Not open to freshmen and sophomores. Methods, materials and theory for teaching environmental education in formal and informal educational settings.

490. **Independent Studies of Fisheries and Wildlife Problems**  
Fall, Spring, Summer. 1 to 5 credits. A student may earn a maximum of 5 credits in all enrollments for this course.  
P: BS 110. R: Not open to freshmen and sophomores. Approval of department and application required. Special topics in fisheries and wildlife.

810. **Human Dimensions Research in Fisheries and Wildlife**  
Fall of even-numbered years. 3(3-0)  
Methods of surveying, educating and involving the public to achieve fish and wildlife management goals. Review of human dimensions research and current case studies.

814. **Environmental Chemodynamics**  
Spring of even-numbered years. 4(4-0)  
Chemical and environmental factors controlling the distribution of organic and inorganic chemicals in air, water and soil. Monitoring.

817. **Ecology and Evolution in Aquatic Systems**  
Summer. 4 credits. Given only at W.K. Kellogg Biological Station. Interdepartmental with Zoology, and Botany and Plant Pathology. Administered by Zoology.  
P: ZOL 250 or ZOL 431. Experimental field studies of population and community ecology of freshwater lakes and streams. Emphasis on interactions among species and between biotic and abiotic factors.

824. **Analysis of Wildlife Populations**  
Spring of even-numbered years. 3(3-0)  
Statistical and ecological concepts, methods, and computer techniques needed to analyze and interpret demographic data from fish and wildlife studies.

826. **Ecology and Management of Waterfowl**  
P: FW 412, FW 424. Fall of even-numbered years. 3(2-2)  
Population genetic principles applied to ecology and management of fish and wildlife.

828. **Conservation and Genetics**  
Full of odd-numbered years. 3(3-0)  
P: ZOL 341 or CSS 359 or ANS 314. Population genetic principles applied to ecology and management of fish and wildlife.

831. **Aquatic Toxicology**  
Spring of odd-numbered years. 4(3-2)  
R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, Human Medicine, Natural Science, Osteopathic Medicine, and Veterinary Medicine. Techniques for assessing acute and chronic effects of toxicants on biochemical, physiological, organismal, population, community and ecosystem levels of organization.

860. **Wildlife Nutrition**  
Fall of odd-numbered years. 3(2-2)  
P: Open only to graduate students in the Colleges of Agriculture and Natural Resources, and Natural Science. Nutritional ecology of wild species. Techniques for analyzing and improving nutritional qualities.

872. **Fishery Habitat Analysis and Management**  
Spring of odd-numbered years. 3(3-0)  
R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, and Natural Science. Fish habitat use. Analysis and manipulation of habitats to enhance fish production in freshwater ecosystems.

875. **Advanced Aquaculture**  
P: FW 475. R: Open only to seniors and graduate students. Adaptations and responses of aquatic organisms to environmental change in aquaculture systems. Research methods and applications for aquaculture planning and management decisions.

876. **Applied Limnology**  
Spring of even-numbered years. 3(3-0)  
R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, Engineering, and Natural Science. Applied aquatic ecology. Quantitative relationships between physical, chemical, and biological parameters in polluted and unpolluted lakes.

879. **Fish Population Dynamics**  
Fall of even-numbered years. 3(3-0)  
R: Open only to graduate students in the Colleges of Agriculture and Natural Resources, and Natural Science. Quantitative analysis of fish populations. Evaluation, causes, and impacts of the rates of change in survival, growth, reproduction, and recruitment for fish populations and their yield.

880. **Wildlife Nutrition**  
Fall of odd-numbered years. 3(2-2)  
P: Open only to graduate students in the Colleges of Agriculture and Natural Resources, and Natural Science. Nutritional ecology of wild species. Techniques for analyzing and improving nutritional qualities.

887. **Community and Ecosystem Ecology**  
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 10 credits in all enrollments for this course.  
P: Open only to graduate students in Fisheries and Wildlife. Master's degree Plan B research paper.

889. **Master's Thesis Research**  
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 99 credits in all enrollments for this course.  
P: Open only to graduate students in Fisheries and Wildlife.

943. **Techniques of Analyzing Unbalanced Research Data**  
Spring, 4(4-0) Interdepartmental with Animal Science, Forestry, Crop and Soil Sciences, and Horticultural Science. Administered by Animal Science.  
P: SIT 422, MTH 124. R: Open only to graduate students in the College of Agriculture and Natural Resources. Linear model techniques to analyze research data characterized by missing and unequal number of observations in classes. Simultaneous consideration of multiple factors. Estimable comparisons. Hypothesis testing. Computational strategies. Variance and covariance components. Breeding values.

976. **Multivariate Methods in Agriculture and Natural Resources**  
Spring, 4(4-0) Interdepartmental with Forestry and Animal Science. Administered by Forestry.  
P: SIT 422, MTH 314. R: Open only to graduate students in the College of Agriculture and Natural Resources and in the Interdepartmental Graduate Specializations in Ecology and Evolutionary Biology. Application of multivariate methods to research problems. Hotelling's T-test, profile analysis, discriminant analysis, canonical correlation, principal components, principal coordinates, correspondence analysis, and cluster analysis.

999. **Doctoral Dissertation Research**  
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course.  
P: Open only to Doctoral level graduate students in Fisheries and Wildlife.

**FOOD ENGINEERING (FE)**

**Department of Agricultural Engineering**

**College of Agriculture and Natural Resources**

**College of Engineering**

329. **Fundamentals of Food Engineering**  
Spring, 3(3-0) Interdepartmental with Food Science.  
P: PSCI 211, MTH 124, PHY 231. R: Not open to freshmen and sophomores. Unit operations in food industry: fluid mechanics, heat transfer, rate processes, refrigeration, freezing, and dehydration. Thermal process calculations.
FOOD SCIENCE FSC
Department of Food Science
College of Agriculture and Natural Resources

150. Introduction to Nutrition and Food Science
Fall, Spring, Summer. 3(3-0) Interdepartmental with Human Nutrition and Foods. Administered by Human Nutrition and Foods. Nutrition needs in life stages from a human ecological perspective. Domestic and international factors affecting the availability of a safe, nutritious food supply. Relationships of food choices to health and disease.

211. Principles of Food Science
Fall. 3(3-0)
P: CEM 141.
Scientific principles, historical perspective and current status of technology related to food composition, safety, toxicology, processing, preservation and distribution.

329. Fundamentals of Food Engineering
Spring. 3(4-0) Interdepartmental with Food Engineering. Administered by Food Engineering. P: FSC 211, MTH 124, PHY 231. R: Not open to freshmen and sophomores.
Unit operations in food industry: fluid mechanics, heat transfer, rate processes, refrigeration, freezing, and dehyderation. Thermal process calculations.

338. Machinery Systems for Food Processing
Spring. 3(3-0)
P: MTH 235.
Principles of design, operation, and performance of equipment for processing raw materials into finished or intermediate products.
SA: AE 338

401. Food Chemistry Laboratory
Fall. 1(0-3)
P: FSC 211, CEM 251. R: Not open to freshmen and sophomores. Not open to students with credit in HNF 300.
Food chemistry laboratories. Chemical changes in food constituents which affect stability of food products and properties such as color, flavor and texture.

402. Food Microbiology Laboratory
Fall. 1(0-3)
P: FSC 401 or concurrently. R: Open only to majors in Food Science, Foods Technology and Management, and Food Engineering.
Chemical changes in food constituents which affect stability of food products and properties such as color, flavor and texture.

405. Application of Biotechnology to Food Science
Fall of odd-numbered years. 3(3-0)
P: MIC 205 or MIC 301.
Advances in biotechnology and their application to food safety and quality. Scientific basis and methods used in genetic engineering of plant and animal cells. Use of molecular probes in detection of toxins and important to food industry. Isolation, enumeration, characterization, identification and use of microorganisms.

407. Food and Animal Toxicology
Fall. 3(0-3) Interdepartmental with Animal Science. Administered by Animal Science.
P: BCH 200 or BCH 401. R: Not open to freshmen and sophomores.

407L. Toxicology Methods Laboratory
Fall. 2(3-0) Interdepartmental with Animal Science. Administered by Animal Science.
P: ANS 407 or concurrently. R: Not open to freshmen and sophomores.
Laboratory techniques for analyzing potential toxicity of chemicals to living systems. Field trip to industrial toxicology laboratory required.

417. Topics in Toxicology
Spring. 1(1-0) Interdepartmental with Animal Science. Administered by Animal Science.
P: ANS 407. R: Not open to freshmen and sophomores. Selected topics including regulatory toxicology, risk assessment, environmental toxicology, food safety, and handling of toxic substances.

420. Quality Assurance
Fall. 2(2-0)
P: STT 201 or FSC 330 or FSC 331 or FSC 332 or FSC 533. R: Not open to freshmen and sophomores.
Theory and application of quality assurance programs for food processing industries.

421. Food Laws and Regulations
Spring. 3(3-0)
P: HNF 150 or HNF 211 or FSC 211. R: Not open to freshmen and sophomores.
Adoption, interpretation and enforcement of laws and regulations governing food processing and foodservice systems. Impact of regulation on food production, availability, marketing and safety.

423. Advanced Food Processing: Dairy Foods
Fall of even-numbered years. 3(2-3)
P: FSC 302. R: Not open to freshmen and sophomores.
Theoretical and practical principles of the manufacture of cheese, frozen desserts, butter and powders. Concentration and fractionation techniques for producing dairy based ingredients for food systems.

423. Advanced Food Processing: Meat, Poultry and Fish
Fall of even-numbered years. 3(2-3)
P: FSC 355. R: Not open to freshmen and sophomores.
Scientific principles of processing animal tissues for food. Field trips required.

440. Food Microbiology
Spring. 3(3-0) Interdepartmental with Microbiology.
P: MIC 205. R: Not open to freshmen and sophomores. Major groups of microorganisms of importance to the food industry. Emphasis on ecological, physiological, and public health aspects.

441. Food Microbiology Laboratory
Spring. 1(0-3) Interdepartmental with Microbiology.
P: FSC 440 or concurrently; MIC 205. R: Not open to freshmen and sophomores. Open only to majors in Food Engineering, Food Science, Foods: Technology and Management, or Microbiology and Public Health.
Methods for studying major groups of microorganisms important to food industry. Isolation, enumeration, characterization, identification and use of microorganisms.

455. Food Analysis
Fall. 2(2-3)
P: BCH 200, CEM 262, FSC 401. R: Not open to freshmen and sophomores.
Principles and application of analytical techniques. Analysis for fats, proteins, carbohydrates, minerals, vitamins and additives. Techniques include spectrophotometry, fluorimetry, chromatography, electrophoresis, proximate composition.

499. Special Problems in Food Science
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Not open to freshmen and sophomores. Approval of department; application required. Individual study of selected topics in food science. Supervised independent study.