962. Workshop on Planning and Implementation of Agricultural Development
Spring. 3(3-0) 682; one year of graduate study in agricultural economics or economics of approval of department.

972. Methodological Approaches to Research
Fall of even-numbered years, Summer of odd-numbered years. 3(3-0) Two terms of graduate study in social science or approval of department. Interdepartmental with the Economics Department.

990C. Mathematical Economics and Econometrics Workshop
Fall, Winter, Spring. 3 to 16 credits. EC 512. 832, or approval of department. Interdepartmental with and administered by the Economics Department.

999. Research
Fall, Winter, Summer. Variable credits. Approval of department.

AGRICULTURAL ENGINEERING AE

College of Agriculture and Natural Resources

202. Physical Principles of Metalurgical Processes
Fall, Spring. 3(1-4)
Theory and skills in metallurgy, heat treating, cold metal, sheet metal, plumbing, arc and oxy-acetylene welding and machine operations.

220. Engineering Principles Applied to Agriculture
Winter. 3(3-2) MTH 105.
Physical principles and their application to agricultural production, distribution and processing.

352. Physical Principles of Biological Processes
Fall. 3(3-0) MTH 215, PHY 289.
Basic scientific principles and engineering theory applied to biological systems and products.

353. Physical Principles of Plant Environment
Winter. 3(3-0) 352, SLS 210.
Physical processes and properties of the biosphere as related to engineering the plant environment.

354. Physical Principles of Animal Environment
Spring. 3(2-2) 352.
Interrelationship of environmental factors and physiological responses of animals for planning, design and control of optimum environmental systems.

492. Teaching Agricultural Mechanics
Winter, Spring. 5(2-6) Juniors.
Teaching theory and developing skills in agricultural mechanics in secondary and vocational schools. School and farm planning and management. Emphasis on equipment and material selection, metalurgy, metal work and welding.

416. Agricultural Structures
Fall, Spring. 4(3-2) Juniors.
Functional planning and principles of environmental control, cost estimation, structural component analysis and properties of building materials.

421. Electric Power
Fall, Spring. 4(3-2) 220.
Application of electric energy to production and living: selection, installation, operation and control of electrical equipment.

423. Principles of Processing Equipment
Winter. 3(2-3) 220.
Principles of equipment used in the processing and storage of biological products.

425. Farmstead Materials Handling
Spring. 3(3-2) Juniors.
Systems and equipment for handling grain, hay, fertilizer, water and wastes on the farm. System design and evaluation.

431. Principles of Irrigation, Drainage and Erosion Control
Spring. 4(3-3) SLS 210.
Use of surveying, design, construction and cost estimates of drainage, irrigation and water control systems.

432. Introduction to Meteorology
For course description, see Interdisciplinary Courses.

433. Introductory Meteorology Laboratory
For course description, see Interdisciplinary Courses.

437. Principles of Food Engineering
Winter. 5(5-0) 220.
Principles and use of electricity, steam, refrigeration and hydraulics in food plants. Emphasis will be placed on specialized processing equipment, their design features, materials of construction and automatic control.

443. Internal Combustion Engines
Fall, Spring. 3(3-2) 220.
Introduction to spark ignition and compression ignition engines with emphasis on principles of operation, combustion, fuels, lubricants and engine performance.

444. Agricultural Production Machinery
Spring. 3(3-2) 220.
Basic principles of agricultural machines. Selection, care and operation of agricultural machinery for obtaining optimum conditions for crop production.

459. Special Problems
Fall, Winter, Spring, Summer. 1 to 5 credits. May re-enroll for a maximum of 5 credits. Approval of department.

461. Light Structure Analysis, Design and Synthesis
Fall. 4(3-2) MMM 211.
Physical and chemical properties of engineering materials and their interactions with bioclimatic conditions. Analysis and design of light structures. Functional planning and system synthesis.

471. Electricity and Radiation
Winter. 3(2-3) E E 345.
Characteristics, measurement and control of power and radiation in agriculture.

474. Processing Biological Products
Spring. 4(3-2) 359, M E 511.
Engineering principles of unsteady-state heat transfer, heat exchangers, drying, storage and refrigeration as applied to the processing of biological products.

475. Introduction to Operations Research
Winter. 4(4-0) MTB 215, CPS 120.
Interdepartmental with Systems Science.

481. Soil and Water Engineering
Spring. 3(4-2) M E 332.
Engineering analysis, design and construction of drainage, irrigation and erosion control systems.

493. Energy Conversion Systems
Spring. 4(3-2) 311.
Principles of energy conversion with emphasis on the internal combustion engine. Thermo-dynamic analysis, performance characteristics, and power transmission.

494. Systems of Agricultural Machines
Fall. 4(3-2) 355.
Systems of machines used in field and farmstead operations. Engineering principles for machines dealing with biological materials.

504. Agricultural Mechanization in Developing Countries
Spring. 3(3-0) Approval of department.

505. Environmental Measurements
Fall. 3(2-2)
Methods and techniques for accurate measurement and interpretation of environmental parameters. Temperature, humidity, wind and air flow characteristics, radiation, light intensity, moisture and particulate concentrations in atmospheric microclimates will be discussed.

811. Technical Problems
Fall, Winter, Spring, Summer. 1 to 4 credits. May re-enroll for a maximum of 9 credits.

812. Bio-Processing Engineering
Winter. 3(3-0) Approval of department.
Topics will be presented pertaining to thermo-dynamics, heat and mass transfer, thermal processing, fluid flow, dehydration and freeze drying of biological products or biological processes.

814. Physical Properties of Agricultural Products
Winter. 3(3-0) Approval of department.
Physical and mechanical behavior of fruits and vegetables, forages, grains and other agricultural products under constant and dynamic loading related to design parameters for production, handling and processing machinery.

815. Instrumentation for Agricultural Engineering Research
Fall. 3(3-0)
Theory, method and techniques of measuring temperature, pressure, flow, humidity, and moisture for biological systems. Associated recording and indicating equipment.
817. **Electronics in Agricultural Engineering**  
Spring. 3(2-3) E E 345 or EHY 419.  
Electronic and control circuits for agricultural industries and research. Analysis and development of measurement and control systems.

820. **Research Methods in Agricultural Engineering**  
Fall. 1(1-0)  
Discussion of procedures for initiating, developing, carrying out, and completing research projects.

822. **Seminar**  
Spring. 1(1-0)  

840. **Advanced Power and Machinery**  
Spring. 3(2-2) 492, 493.  
Analysis of agricultural machine components and systems. Emphasis on hydraulic power transmission, controls, and management of machinery systems.

899. **Research**  
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

990. **Advanced Topics in Agricultural Engineering**  
Fall, Winter, Spring. 3(3-0) May re-enroll for a maximum of 9 credits. Approval of department.

New developments in agricultural engineering. Subjects to be covered include atmospheric turbulence, optimization of agricultural systems, measurement systems, food engineering, and agricultural rheology.

991. **Soil Dynamics**  
Winter. 3(2-3) Approval of department.  
Dynamic soil strength, Soil stress and strain analysis of traction and tillage devices, Experimental techniques for traction and tillage studies.

999. **Research**  
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

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**AGRICULTURE**

**College of Agriculture and Natural Resources**

450. **United States Agriculture for Upperclass Students**  
Fall. 3(3-0) Advanced undergraduate or graduate students from countries other than the United States or Canada.


462. **World Agriculture and Economic Development**  
Fall. Summer of even-numbered years. 3(3-0) AEC 240 or EC 201. Interdepartmental with and administered by the Agricultural Economics Department.

Food and agricultural problems of the world. Role of agriculture in the process of economic development. Relationships of agricultural trade patterns, farming systems and economic growth.

592. **Agriculture Administration**  
Winter. 3(3-0) AEC 462 or approval of department.

Administrative relationships and principles involved in agricultural development in the world's emerging countries. Case studies used to illustrate the process of change in institutions that serve agricultural economies in transition.

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**AMERICAN STUDIES**

**AMS**

**College of Arts and Letters**

301. **Issues in American Civilization**  
Fall, Winter, Spring. 3(2-0) May re-enroll for a maximum of 9 credits. ATL 111. Not applicable to major requirements. Selected issues in American life past and present, with materials drawn from such disciplines as history, social sciences, philosophy, literature and the arts. Topics vary.

410. **Perspectives in American Studies**  
Fall. 3 credits. Juniors in American Studies or approval of American Studies Committee.  
Methods and significant works, for majors in the American Studies program. Offered by members of the relevant departments.

411. **Problems in American Civilization**  
Winter, Spring. 3 credits. Majors must re-enroll for a maximum of 6 credits. 410, Juniors in American Studies or approval of American Studies Committee.  
Seminar approach to selected problems in American life employing the objectives and approaches of interdisciplinary studies. Offered by members of relevant departments, for majors in the American Studies program.

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**ANATOMY**

**ANT**

**College of Human Medicine**

**College of Veterinary Medicine**

316. **General Anatomy**  
Fall, Spring. 5(5-0) N S 193.  
Designed to impart the basic concepts of the broad field of anatomy. Special requirements of the various disciplines will be met in their respective laboratories.

401. **Undergraduate Seminar**  
Fall, Winter, Spring. 1 credit.

413. **Problems in Anatomy**  
Fall, Winter, Spring, Summer. 1 to 2 credits. May re-enroll for a maximum of 6 credits. Approval of department.  
Additional study in one or more of the various fields of anatomy such as gross anatomy, histology, hematology and embryology.

420. **Microscopic Anatomy and Embryology**  
(365A) Fall. 5(2-8) Medical Technology students or approval of department.  
Course 420 devoted to microscopic structure of cells and tissues and beginning embryology; 421 to structure of organs and systems and completion of embryology.

421. **Microscopic Anatomy and Embryology**  
(368B) Winter. 5(2-8) 440.  
Continuation of 420.

521. **Gross and Microscopic Anatomy**  
Fall, Spring. 8(4-14) First-term Veterinary Medicine students, approval of department for graduate students.  
Gross anatomy of a representative animal, the dog, is studied. Cytology, embryology, comparative histology, and anatomy and embryology are combined with dissection, demonstration and practical applications to give complete coverage.

522. **Gross and Microscopic Anatomy**  
Winter, Summer. 6(3-11) 521.  
Continuation of 521.