

**462. Agricultural and Rural Development in Developing Nations**

Fall. 3(3-0) PAM 201 or EC 201; PAM 260 recommended. Interdepartmental with Agriculture and Natural Resources, and Food Systems Economics and Management. Administered by Food Systems Economics and Management.

Traditional agricultural systems and the incentive environment for economic growth in rural areas. Adjustment to technological, institutional and human change. Strategies for rapid agricultural transformation.

**480. Independent and Supervised Study**  
Fall, Winter, Spring, Summer. 1 to 9 credits. May reenroll for a maximum of 9 credits. Approval of department.

**490. Supervised Field Experience**  
Fall, Winter, Spring, Summer. 3 to 9 credits. May reenroll for a maximum of 9 credits. PAM Juniors, approval of department. Supervised field work in federal, state, or local government or organizations dealing with government.

**AGRICULTURAL  
ENGINEERING**

**A E**

**College of Agriculture and Natural Resources  
College of Engineering**

**152. Introduction to Agricultural Engineering**

Winter. 1(1-0) Interdepartmental with Agricultural Engineering Technology.

An introduction to the agricultural engineering profession with an examination of existing problems.

**352. Heat and Mass Transfer in Biological Processing**

Winter. 4(4-0) CEM 361 or M E 311 or CHE 311.

Basic scientific principles and engineering theory applied to biological systems and products.

**353. Engineering Principles of Plant Environment**

Fall. 4(4-0) CPS 112, MTH 310; CEM 152 or CEM 143.

Physical processes and properties of the biosphere as related to engineering the plant environment.

**354. Thermodynamic Applications in Biological Processes**

Spring. 3(3-0) A E 352. Psychrometrics and refrigeration. Engineering applications in animal production and food processing. Environmental control.

**356. Electric Power and Control**  
Winter. 4(3-2) PHY 288.

Alternating current calculations; sizing conductors of single- and three-phase loads; electric motors, their control and protection; switching logic; microprocessor applications. Examples drawn from agricultural applications.

**376. Food Process Engineering**

Spring. 3(2-2) A E 352, C E 321.

Analysis of unit processes involved in handling, processing, and distribution of liquid and solid biological materials. Flow of liquids, heating and cooling, freezing, concentration, dehydration, and separation.

**394. Systems of Agricultural Machines**

Fall. 4(3-2) MMM 211.

Functional requirements and operational characteristics of agricultural machines. Engineering principles of machines dealing with soil and plant materials. Aspects of agricultural machinery management and economics.

**410. Professional Ethics and Responsibilities**

Spring. 1(2-0) Senior majors.

Personal and professional ethics and social responsibilities will be addressed as related to the professions of engineering and engineering technology.

**461. Design of Agricultural Structures**

Fall. 4(4-0) MMM 211, MMM 215.

The analysis of structural systems and the design of components and connections. Examples selected from agricultural machinery and buildings.

**474. Processing Biological Products**

Spring. 3(3-0) A E 352, M E 311 or CEM 361.

Engineering principles of unsteady-state heat transfer, heat exchangers, drying, storage and refrigeration as applied to the processing of biological products.

**480. Special Problems**

Fall, Winter, Spring, Summer. 1 to 5 credits. May reenroll for a maximum of 5 credits. Approval of department.

Individual student research and study in: agricultural machines and tractors, waste management, food processing, structures and environment, materials processing and handling, water management, meteorology and climatology, agricultural systems analysis.

**481. Soil and Water Conservation Engineering**

Winter. 4(5-0) C E 321, A E 353.

Engineering analysis, design and construction of drainage, irrigation and erosion control systems.

**482. Irrigation Design Management**

Spring. 4(3-2) A E 481.

Water supply including wells, water transport, pumping and pump selection, water requirements, power supplies and irrigation equipment with emphasis on sprinkler and trickle methods and design for agricultural application.

**490. Special Topics in Agricultural Engineering**

Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 12 credits if different topics are taken. Approval of department.

Design topics in agricultural engineering such as food process engineering, machinery systems, structures, soil and water systems.

**492. Tractors and Power Transmission Systems**

Winter. 4(4-0) A E 394.

Functional requirements, operational characteristics, analysis and design of tractors including power trains, hydraulics, traction, hitches, vehicle dynamics and operator comfort.

**493. Power and Control Hydraulics**

Winter. 4(3-2) CPS 112, C E 321.

Properties of hydraulic fluids; performance parameters of fixed and variable displacement pumps and motors; characteristics of control valves and components; analysis and design of hydraulic systems.

**494. Food Process Engineering**

Fall. 3(3-0) C E 321, A E 376.

Design of fluid handling equipment, mixers, and freezing systems for food.

**495. Fundamentals of Design**

Fall. 3(3-0) Senior majors or approval of department.

Problem identification, working media, models, procedures, and developing specifications. Selection of individual design problems for A E 496.

**496. Design Project Laboratory**

Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 4 credits. A E 495.

Individual or team pursuit of the design project selected in A E 495. Activities include information expansion, developing alternatives, evaluation and selection, and concluding project.

**809. Finite Element Method**

Fall, Winter, Spring. 4(4-0) Approval of department. Interdepartmental with the departments of Metallurgy, Mechanics, and Materials Science; and Civil Engineering. Administered by the Department of Metallurgy, Mechanics, and Materials Science.

Theory and application of the finite element method to the solution of continuum type problems in heat transfer, fluid mechanics and stress analysis.

**812. Bio-Processing Engineering**

Winter. 3(3-0) Approval of department.

Topics will be presented pertaining to thermodynamics, 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**

Spring. 3(3-0)

Theory, method and techniques of measuring temperature, pressure, flow, humidity, and moisture for biological materials. Associated recording and indicating equipment.

**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)

**Description — Agricultural Engineering of Courses**

**840. Advanced Power and Machinery**  
*Winter of even-numbered years. 3(2-2)*  
 A E 394, A E 492.

Analysis of agricultural machine components and systems. Emphasis on hydraulic power transmission, controls, and management of machinery systems.

**850. Dimensional Analysis and Similitude Modelling**  
*Spring of odd-numbered years. 3(2-2)*  
 Approval of department.

Use of dimensional analysis to develop general prediction equations of physical systems. Model theory, distorted models, and analogies. Application to the problems in agricultural engineering.

**880. Special Problems**  
*Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 9 credits.*  
 Approval of department.

Individual student research and study in: agricultural machines and tractors, waste management, food processing, structures and environment, materials processing and handling, water management, meteorology and climatology, agricultural systems analysis.

**890. Advanced Topics in Agricultural Engineering**  
*Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 12 credits if different topics are taken. Approval of department.*

New developments in agricultural engineering. Topics will be chosen from advanced finite element methods, water management, post-harvest processing, animal housing, automation and robotics, scale-up methods in food engineering machinery systems.

**899. Master's Thesis Research**  
*Fall, Winter, Spring, Summer. Variable credit. Approval of department.*

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

**Agricultural Engineering Technology AET**

**152. Introduction to Agricultural Engineering**  
*Winter. 1(1-0) Interdepartmental with and administered by the Department of Agricultural Engineering.*

An introduction to the agricultural engineering profession with an examination of existing problems.

**201. Technical Agricultural Mechanics Skills**  
*(A E 402.) Fall. 3(2-3) Major or minor in vocational agriculture or major or minor in Agribusiness and Natural Resources Education or approval of department.*

Basic principles, applications, techniques, tools, materials, and resources in agricultural mechanics skills.

**202. Agricultural Metalworking**  
*Spring. 3(2-2)*

Principles, skills and safety for welding, soldering, brazing, cutting, bench work, metallurgy, fastening and shop tools. Maintenance metalworking for farm and agribusiness shops will be emphasized.

**245. Agricultural and Automotive Engines**  
*(AET 243, AET 244.) Fall. 3(2-2)*

Construction, maintenance and operating principles of gasoline and diesel engines used in agricultural and automotive applications. Ignitions, fuels, lubricants, emission controls, and performance. Laboratory experiences in engine maintenance procedures.

**258. Technical Skills**  
*Fall, Winter, Spring. 1 to 7 credits. May reenroll for a maximum of 10 credits. Majors or approval of department.*

Selection, operation, and maintenance of physical components of electrical, mechanical, environmental and water management systems in agriculture and natural resources industries, including system design and component installation.

**265. Hydraulic Power Systems**  
*Winter. 3(2-2)*

Hydraulic power in mobile equipment. Operation and characteristics of system components and circuits. Laboratory includes component disassembly, system diagnosis and testing, and patch-board work.

**311. Management Principles for Physical Systems**  
*Fall. 3(3-0) CPS 115 or CPS 112; MTH 111 or MTH 109.*

Quantitative methods applicable to management of agricultural and construction systems; linear programming, PERT, queueing, decision theory and simulation.

**312. Structural Design**  
*Winter. 4(5-0) PHY 237, BCM 215 or approval of department. Interdepartmental with and administered by Building Construction Management.*

Concepts of structural mechanics, material strengths and section properties are developed and applied to design using wood, steel and concrete.

**329. Unit Operation and Food Processing I**  
*Fall. 4(3-2) PHY 237, MTH 109. Interdepartmental with Food Science.*

Engineering concepts related to the unit operations found in the food industry. Fluid mechanics, heat transfer and rate processes including psychrometrics and refrigeration.

**340. Principles of Agricultural Tractors and Machinery**  
*(AET 323.) Spring. 4(3-2) MTH 109 or MTH 111; CPS 115.*

Principles, analysis, performance, and operating characteristics of agricultural tractors and machinery for tillage, planting, cultivating, and harvesting field crops.

**415. Agricultural and Natural Resources Safety**  
*Winter. 3(3-0) Juniors.*

Principles of safety problem solving. Accident causation and prevention; laws and regulations; machinery, electrical, chemical, livestock, shop and fire safety; security; and safety program development.

**421. Electrical Energy Utilization**  
*Spring. 4(3-2) PHY 238 or approval of department.*

Efficient utilization of electrical energy; selection, operation and control of electrical equipment. Design of electrical systems.

**426. Production and Storage Systems**  
*(AET 416.) Winter. 4(4-0) AET 311, BCM 312.*

Layout of buildings and material handling systems; interior environment and its control; requirements for livestock production and crop storage.

**431. Irrigation, Drainage and Erosion Control Systems**  
*Spring. 4(3-2) CSS 210 or approval of department.*

Use of surveying, design, construction and cost estimates of drainage irrigation and water control systems.

**436. Microclimatology**  
*Winter of even-numbered years. 3(3-0) MTH 109 or MTH 111. Interdepartmental with the Department of Geography.*

Physical environment in the lower few hundred meters of the atmosphere and within the biosphere.

**440. Agricultural Tractor and Machinery Systems**  
*(AET 443.) Fall. 4(4-0) AET 340; AET 311 or approval of department.*

Management and analysis of agricultural tractor and machinery systems. Tractor - implement matching. Economics of operation and ownership. Interaction with weather conditions, farming types and techniques, crop rotation, labor and energy.

**480. Special Problems**  
*Fall, Winter, Spring, Summer. 1 to 5 credits. May reenroll for a maximum of 5 credits.*  
 Approval of department.

Individual student research and study in: agricultural machines and tractors, waste management, food processing, structures and environment, materials processing and handling, water management, meteorology and climatology, agricultural systems analysis.

**490. Special Topics in Agricultural Engineering Technology**  
*Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 8 credits if different topics are taken. Approval of department.*

Topics such as computer access to technology; technology in natural resource management; entrepreneurship; technology in agricultural management.

**804. Agricultural Mechanization in Developing Countries**  
*Fall of odd-numbered years. 3(3-0)*  
 Approval of department.

Appropriate agricultural mechanization with emphasis on hand, animal, and mechanical equipment for the smaller farms. Machine selection, local manufacturing, public and private costs, ownership patterns; increasing production and decreasing post production losses.

**806. Analysis of Agricultural Systems**  
*Winter. 3(3-0) AET 440.*

Identification and definition of systems problems in agriculture. Model formulation and estimation. Several models of current interest are considered.

**807. Human Factors Engineering**  
*Fall of even-numbered years. 3(3-0)*  
 Approval of department.

Analysis of machine design, operation and working environment in relation to human limitations and capabilities, analysis of procedures used to develop maximum compatibility between people and machine.

**808. Environmental Measurements**

Spring of odd-numbered years. 4(3-3) MTH 109 or MTH 111, STT 422; or approval of department. Interdepartmental with the Department of Geography.

Methods and techniques for accurate measurement and interpretation of environmental parameters. Temperature, humidity, wind and air flow characteristics, radiation, light intensity, gaseous and particulate concentrations in atmospheric microclimates will be discussed.

**820. Research Methods**

Fall. 1(1-0) Approval of department. Interdepartmental with Building Construction Management.

Procedures for initiating, developing, carrying out and completing research projects.

**822. Seminar**

Spring. 1(1-0) Approval of department.

**880. Special Problems**

Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 6 credits. Approval of department.

Individual study or research on selected topics.

**890. Advanced Topics in Agricultural Engineering Technology**

Fall, Winter, Spring. 3(3-0) May reenroll for a maximum of 12 credits if different topics are taken. Approval of department.

New developments in agricultural engineering technology.

**899. Master's Thesis Research**

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**999. Doctoral Dissertation Research**

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**Building Construction Management**

**BCM**

**200. American Housing and Building Industry**

(B C 200.) Fall, Spring. 3(3-0)

Residential and light commercial construction industry in America. Impacts of government, finance, zoning ordinances, codes, aesthetics, construction technology, demographics, energy and society.

**215. Architectural Drafting I**

(B C 215.) Fall, Summer. 4(2-4)

Residential design including site plans, floor plans, foundation plans, elevations, sections and details.

**216. Architectural Drafting II**

(B C 216.) Winter. 4(2-4) BCM 215.

Light commercial design including site plans, floor plans, foundation plans, elevations, sections and details, barrier free accessibility.

**239. Housing Conservation**

(B C 239.) Fall. 3(3-0) Interdepartmental with the Department of Human Environment and Design.

Skills and techniques in conserving, repairing and remodeling existing housing. Structural components of housing and evaluation of housing structure.

**301. Energy Conservation Systems for Buildings**

(B C 301.) Winter. 3(3-0) BCM 215, MTH 109 or MTH 111 or approval of department.

Solar energy, earth sheltered and energy conservation systems for buildings will be analyzed for operation, optimum size, construction, performance, climate, cost effectiveness and human comfort for northern climates.

**312. Structural Design**

(B C 312.) Winter. 4(5-0) PHY 237, BCM 215 or approval of department. Interdepartmental with Agricultural Engineering Technology.

Concepts of structural mechanics, material strengths and section properties are developed and applied to design using wood, steel and concrete.

**313. Construction Systems**

(B C 413.) Spring. 4(3-2) BCM 200, BCM 215, CPS 115.

Primary construction systems employed in the residential and light commercial construction industry. Interrelationships between planning, processes, costs and management.

**412. Utilities Design**

(B C 412.) Fall. 4(4-0) PHY 238, BCM 215 or approval of department.

Design and planning for mechanical and electrical utilities in residential and light commercial construction.

**415. Building Materials**

(B C 415.) Spring. 4(4-0) BCM 312 or approval of department.

Properties of building materials pertinent to their application and performance in service.

**416. Building Costs**

(B C 416.) Winter. 4(2-4) BCM 312 or concurrently.

Methods of cost estimating. Effects of codes and production practices on costs.

**417. Construction Management Finance**

(B C 417.) Winter. 4(4-0)

Financing methods for the construction, rehabilitation, and purchase of real estate.

**418. Special Problems**

(B C 418.) Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 11 credits. Written approval of department.

Special problems in the areas of acquisition and development of residential land, design, construction technology, building materials, finance, marketing, construction management and land use codes and regulations.

**419. Senior Seminar**

(B C 419.) Fall. 1(1-0) Senior majors.

Professional practices, business ethics, market trends, and structure of the construction industry.

**420. Construction Management**

(B C 420.) Spring. 4(4-0) Senior majors.

Systems management techniques for building organizations; development, operations, planning, scheduling and control, and administrative procedures.

**820. Research Methods**

(B C 820.) Fall. 1(1-0) Approval of department. Interdepartmental with and administered by Agricultural Engineering Technology.

Procedures for initiating, developing, carrying out and completing research projects.

**880. Special Problems**

(B C 880.) Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 6 credits. Approval of department.

Individual student research and study in land acquisition and development, design, construction, management, finance, marketing, and structural analysis.

**890. Advanced Topics**

Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 12 credits if different topics are taken. Approval of department.

Topics will be selected from: computer methods in construction management, advanced construction management, optimization techniques, solar energy buildings, advanced estimating, numerical structural analysis, new construction techniques and materials.

**899. Master's Thesis Research**

(B C 899.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**AGRICULTURAL  
ENGINEERING TECHNOLOGY**

See Agricultural Engineering.

**AGRICULTURE AND NATURAL  
RESOURCES ANR**

**College of Agriculture and Natural  
Resources**

**220. Plants and Their Environment**

Winter. 3(3-0) Interdepartmental with and administered by the Department of Forestry.

Relationships between plants and fundamental climatic, edaphic, and biotic factors; structure and function of different ecosystems in relation to environmental factors.

**275. Exploring International Agriculture**

Spring. 3(3-0)

Exploration of overseas assignments with international agencies; potential world food actualities and potentialities; special problems of the tropics compared with those in temperate regions.

**280. Selected Topics**

Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 6 credits if different topics are taken. Approval of department.