Courses

460. Regional Economics
   Winter. 4(4-0) R D 417 or EC 324.

461. Regional Economics Laboratory

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 to federal, state, or local government or organizations dealing with government.

495. Senior Seminar in Policy Analysis
   Spring. 2(2-0) PAM 320, PAM 321, PAM 494.
   Practicum on planning, performing and presenting studies of public policy issues. Supervised group projects on current local or state policy issues.

AGRICULTURAL ENGINEERING

A E

College of Agriculture and Natural Resources
College of Engineering

152. Introduction to Agricultural Engineering
   Winter. 1(4-0)
   An introduction to the agricultural engineering profession with an examination of existing problems.

354. Thermodynamic Applications in Biological Processes
   Spring. 3(3-A) A E 352.
   Psychrometry and refrigeration. Engineering applications in animal production and food processing. Environmental control.

355. 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.

374. Principles of Food and Agricultural Machines
   Spring. 4(3-C) E CE 321 or CHE 340; MMM 306.
   Physical properties of biological materials. Soil tillage. Metering, distribution, atomization, separation, conveying fluidization, and other physical processes performed by food and agricultural machines.

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 311.
   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 engineering profession.

461. Design of Agricultural Structures
   Fall. 4(4-0) MMM 311, MMM 315.
   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-A) M 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 design of 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.

486. Fundamentals of Design Methodology
   Fall. 2(2-0) A E 374, Seniors.
   Concepts, methods, and procedures uniquely associated with the design process. Emphasis is on total design process from problem identification to final specifications.

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-C) E CE 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.

509. 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 freezing of biological products or biological processes.
Descriptions — Agricultural Engineering

of Courses

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)

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.

850. Special Problems
Fall, Winter, Spring. 1 to 4 credits. May be repeated 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. 1 to 4 credits. May be repeated 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 and machinery systems.

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

899. Doctoral Dissertation Research
Fall, Winter, Spring. Variable credit. Approval of department.

Agricultural Technology and Systems Management

ATM

202. Agricultural Metalworking
(AET 202.) Winter. 3(2-2)
Principles, skills and safety for welding, soldering, brazing, cutting, bench work, metalurgy, fastening and shop tools. Maintenance metalworking for farm and agribusiness shops will be emphasized.

231. Land and Soil Surveying Technology
Fall, 2(1-2), MTH 108 or MTH 111.
Concepts of land and soil surveying: distance and area measurements, differential leveling, land surveys and mapping, soil surveys, physical properties of soils, building site evaluation.

240. Principles of Agricultural Tractors and Machinery
Fall. 2(1-2)
Principles, operating characteristics, and applications of agricultural tractors and machinery for tillage, planting, cultivating and harvesting field crops.

245. Agricultural and Automotive Engines
(AET 243, AET 244, AET 245.) 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.

255. Technical Skills
(AET 255.) Fall, Winter, Spring. 1 to 7 credits. May be repeated 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. Fluid Power Systems
(AET 265.) Winter. 3(2-2)
Fluid power in mobile equipment. Operation and characteristics of system components and circuits. Laboratory includes component disassembly, system diagnosis and testing, and patchboard work.

311. Management Principles for Physical Systems
(AET 311.) Fall. 3(3-0), CPS 115, MTH 108 or MTH 111.
Quantitative methods applicable to management of agricultural and construction systems: linear programming, PERT, queuing, decision theory and simulation.

312. Structural Design
Winter. 4(5-0), PHY 237, BCM 215 or approval of department. Interdepartmental with 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
(AET 289.) Fall. 4(4-0), 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. Technology of Agricultural Tractors and Machinery
(AET 323, AET 340.) Spring. 3(3-0), MTH 108 or MTH 111, CPS 115, ATM 240, PHY 237 recommended.
Technology, analysis and performance of agricultural tractors and machinery for tillage, planting, cultivating, and harvesting field crops.

415. Occupational and Personal Safety
(AET 415.) Winter. 3(3-0) Juniors.
Principles of safety problem solving. Accident causation and prevention; laws and regulations; machinery, electrical, chemical, animal and fire safety; security; and safety program development.

421. Electrical Equipment Technology
(AET 421.) Spring. 4(5-2), PHY 238 or approval of department.
Application of electrical energy; selection, operation and control of electrical equipment. Planning of electrical systems.

426. Production and Storage Systems
(AET 418, AET 426.) Winter. 4(4-0), MTH 108 or MTH 110, CPS 108 or CPS 112 or CPS 115, Juniors.
Layout of buildings and material handling systems; interior environment and its control; requirements for livestock production and crop storage.

431. Management of Irrigation and Drainage Systems
(AET 431.) Spring. 4(5-2), ATM 231, CSS 210 or approval of department.
Surveying, planning, construction and cost estimation of irrigation, drainage, and water control systems.

436. Microclimatology
(AET 436.) 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, AET 440.) Fall. 3(3-0), ATM 340, ATM 311 or approval of department.
Management, analysis and economics of agricultural tractor and machinery systems considering weather conditions, farming types and techniques, crop rotation, labor and energy. Application of computer programs.

450. Special Problems
(AET 460.) Fall, Winter, Spring. 1 to 4 credits. May be repeated for a maximum of 5 credits. Approval of department.
Individual student research and study in: agricultural machines and tractors, waste management, food processing and environment, materials processing and handling, water management, meteorology and climatology, agricultural systems analysis.

490. Special Topics in Agricultural Technology and Systems Management
(AET 490.) Fall, Winter, Spring. 1 to 4 credits. May be repeated 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.

504. Agricultural Mechanization in Developing Countries
(AET 504.) 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.
Agricultural Engineering — Descriptions of Courses

415. Special Problems
Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 12 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
Fall. (1-0) Senior majors.
Professional practice, business ethics, market trends, and structure of the construction industry.

420. Construction Management
Spring. (4-0) Senior majors.
Systems management techniques for building organizations: development, operations, planning, scheduling and control, and administrative procedures.

820. Research Methods
Fall. (1-0) Approval of department.
Interdepartmental with Agricultural Technology and Systems Management.
Procedures for initiating, developing, carrying out and completing research projects.

850. Special Problems
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 in Agricultural Engineering
Fall. (3-0) MTH 109 or MTH 111, STAT 422, or approval of department. Approval of department.
New developments in agricultural technology and systems management.

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
Fall, Spring. (3-0)
Residential and light commercial construction industry in America. Impacts of government, finance, zoning ordinances, codes, aesthetics, construction technology, demographics, energy and society.

201. Building Construction Mechanics (A E 492, AET 201.) Fall. 3(2-3)
Approval of department.
Basic principles, applications, techniques, tools, materials, and resources in building construction mechanics skills.

215. Architectural Drafting I
Fall, Summer. 4(2-4)
Residential design including site plans, floor plans, foundation plans, elevations, sections and details.

216. Architectural Drafting II
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
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
Winter. 3(3-0) BCM 215, MTH 106 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
Winter. 4(5-0) PHY 337 or approval of department. Approval of department.
Concepts of structural mechanics, material strengths and section properties are developed and applied to design using wood, steel and concrete.

313. Construction Systems
Spring. 4(3-0) B C 413. Spring. 4(2-4) BCM 200, BCM 215, CPS 215.
Primary construction systems employed in the residential and light commercial construction industry. Interrelationships between planning, processes, costs and management.

412. Utilities Design
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
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
Winter. 4(2-4) BCM 312 or concurrently.
Methods of cost estimating. Effects of codes and production practices on costs.

417. Construction Management Finance
Winter. 4(4-0)
Financing methods for the construction, rehabilitation, and purchase of real estate.

433. Dehydration of Biological Materials
Spring. 3(3-0) CHE 341.
Principles and applications of the dehydration of biological products, including fixed bed, fluidized bed, tray, rotary, drum, spray, pneumatic, microwave, and solar drying of food and feed products.

473. Unit Operations in Food Engineering
Fall. 3(3-0) CHE 341.
Transport phenomena. Unit operations in food process engineering. Physicochemical changes in food materials during unit processes.

475. Rheology of Non-Newtonian Fluids
Fall. 3(3-0) F E 473.
Rheology and non-Newtonian fluid dynamics. Pipeline design. Mixing and agitation. Freezing. Mechanical separation: filtration, sedimentation, centrifugation, extension.
477. Thermal Process Engineering
Winter. 3(2-0) F E 475.

487. Food Engineering Design
Winter. 3(3-0) F E 477 or concurrently, A E 485.

AGRICULTURAL TECHNOLOGY AND SYSTEMS MANAGEMENT

See Agricultural Engineering.

AGRICULTURE AND NATURAL RESOURCES

ANR

College of Agriculture and Natural Resources

220. Plants and Their Environment
Winter. 3(0-0) 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.

250. 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.

350. Leadership Development for Agriculture and Natural Resources
Winter. Spring. 3(0-0) Given at W. K. Kellogg Biological Station Fall, Spring; 2 credits. May reenroll for a maximum of 6 credits. Approval of department.

399. Professional Internships in Agriculture and Natural Resources
Fall, Winter, Spring. Summer. 6 to 12 credits. May reenroll for a maximum of 12 credits. Juniors and approval of department.
Professionalized experiences in a student's major. Supervision and evaluation by faculty and cooperating agencies.

410. Environmental Toxicology
Winter. 4(0-0) B S 212, BCH 401.
Interdepartmental with and administered by the College of Natural Science.
Fate and effects of toxic chemicals in soil, plants, wildlife, and aquatic systems. Interactions between chemicals and the environment which influence their fate and ecological importance. Approved through Fall 1989.

425. Agriculture and Natural Resources Seminar
Spring. 2(2-0)
Current agricultural, natural resources, and environmental problems and solutions as presented by discussion leaders from various disciplines, arranged by undergraduate students.

445. Pest Management: Pesticide Chemistry and Application Systems for Plant Protection
Fall, 3(3-0) CEM 143, ENT 425, HRT 402 or CSS 402, BOT 405 or concurrently or approval of instructor. Interdepartmental with and administered by the College of Natural Science.
A broad overview of pesticide chemistry, efficient usage, environmental fate, legislation and application techniques.

446. Pest Management: Biological Systems for Plant Protection
Fall, 3(3-0) ENT 425, HRT 402 or CSS 402, BOT 405 or concurrently or approval of instructor. Interdepartmental with and administered by the College of Natural Science.
Management of plant pests utilizing host resistance, cultural practices, legislation, and biological systems.

447. Pest Management: Systems Management for Plant Protection
(ANR 444.) Winter. 4(3-2) NSC 445, NSC 446 or approval of instructor. Interdepartmental with and administered by the College of Natural Science.
Designed to integrate knowledge and improve the ability to arrive at pest management decisions of varying complexity in the fields of agronomy, wildlife, horticulture, entomology, and plant pathology.

450. Natural Resource Administration
Spring. 4(4-0) Seniors. Interdepartmental with the departments of Fisheries and Wildlife, Forestry, Park and Recreation Resources and Resource Development. Administered by the Department of Forestry.

455. Natural Resource Economics
Fall. 4(3-0) EC 200 or EC 201. Interdepartmental with the departments of Fisheries and Wildlife, Forestry, Park and Recreation Resources and Resource Development. Administered by the Department of Forestry.
Basic economic and institutional principles and techniques that govern the production and consumption of renewable natural resources. Natural resource valuation, project analysis, and distributive considerations.

462. Agricultural and Rural Development in Developing Nations
Fall. 3(0-0) PAM 201 or EC 201; PAM 260 recommended. Interdepartmental with Public Affairs Management, 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 changes. Strategies for rapid agricultural transformation.

475. International Studies in Agriculture and Natural Resources
Spring, Summer. 3 to 9 credits. Approval of college.
Study-travel experience emphasizing contemporary problems affecting agriculture in the world, national, and local communities. Field trips, case studies, interviews with leading experts, government officials, community leaders. Supervised individual study.

480. Selected Topics
Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 9 credits if different topics are taken. Approval of department. Juniors.
Exposition of special topics in agriculture and natural resources.

491. Natural Resources and Modern Society
Spring. 3(3-0) Juniors. Interdepartmental with the departments of Forestry, and Resource Development. Administered by the Department of Forestry.
A survey of the social and economic significance of natural resources in modern industrial and urban society. Current problems of natural resources management and use are examined in terms of the society in which they exist.

AMERICAN STUDIES

AMS

College of Arts and Letters

301. Issues in American Civilization
Fall. 3(3-0) May reenroll for a maximum of 6 credits. Sophomores. 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.

377. The Natural Environment: Perceptions and Practices
Fall. 4(4-0) Sophomores. Interdepartmental with Lyman Briggs School. Administered by Lyman Briggs School.
Factors which have influenced U.S. environmental attitudes as reflected in art and literature. Ways in which changing attitudes have led to changes in legislation and practice.

378. Popular Culture and Technical Change
Winter. 4(4-0) Juniors or approval of department. Interdepartmental with and administered by Lyman Briggs School.
Interrelationships among elements of mass culture and technical change. Introduction to relevant research methods.

410. Perspectives in American Studies
Winter. 3(3-0) Juniors, approval of American Studies adviser.
Methods and significant works, for majors in the American Studies program. Offered by members of the relevant departments.