

COURSES OF INSTRUCTION

This list includes for each course the catalog number, title, credit hours, class and laboratory hours per week, description, and prerequisites.

A secondary listing in parentheses indicates that this course is cross-listed with another program.

Graduate credit may be earned only for courses numbered 600 or above. Each 600-level course carries a 400-level undergraduate counterpart. Students who receive graduate credit in such courses must do extra work of an appropriate nature as determined by the department and are graded according to graduate standards. Students who receive credit for the 400-level course may not receive credit later for the same course at the 600 level.

Courses at the 700 level are designed primarily for the degrees that emphasize professional practice rather than research.

COURSE ABBREVIATIONS

Accounting	ACCT
Aerospace Studies	A S
African American Studies	A A S
Agricultural and Applied Economics	AP EC
Agricultural Education	AG ED
Agricultural Mechanization	AG M
Agriculture	AGRIC
Agriculture, Forestry, and Life Sciences	AFLS
American Sign Language	A S L
Animal and Veterinary Sciences	AVS
Animal Physiology	AN PH
Anthropology	ANTH
Architecture	ARCH
Art	ART
Art and Architectural History	A A H
Astronomy	ASTR
Athletic Leadership	A L
Automotive Engineering	AU E
Biochemistry	BIOCH
Bioengineering	BIO E
Biological Sciences	BIOSC
Biology	BIOL
Biomolecular Engineering	BMOLE
Biosystems Engineering	B E
Botany	BOT
Business	BUS
Business Administration	M B A
Calhoun Honors Seminar	C H S
Career and Technology Education	CTE
Ceramic and Materials Engineering	C M E
Chemical Engineering	CH E
Chemistry	CH
Chinese	CHIN
City and Regional Planning	C R P
Civil Engineering	C E
Clemson University	C U
College of Engineering and Science	CES
Communication Studies	COMM
Community and Rural Development	C R D
Computer Science	CP SC
Construction Science and Management	C S M
Crop and Soil Environmental Science	CSENV
Dance	DANCE
Design Studies	DSIGN

Early Childhood Education	ED EC
East Asian Studies	E A S
Economics	ECON
Education	ED
Educational Counseling	ED C
Educational Foundations	ED F
Educational Leadership	ED L
Electrical and Computer Engineering	E C E
Elementary Education	ED EL
Engineering	ENGR
Engineering Graphics	E G
Engineering Mechanics	E M
English	ENGL
Entomology	ENT
Environmental and Natural Resources	E N R
Environmental Design and Planning	EDP
Environmental Engineering and Science	EE&S
Environmental Science and Policy	EN SP
Environmental Toxicology	ENTOX
Executive Leadership and Entrepreneurship	E L E
Experimental Statistics	EX ST
Family and Community Studies	FCS
Finance	FIN
Food Science	FD SC
Food Technology	FD TH
Forest and Recreation Resources	F&RR
Forestry	FOR
Forestry and Natural Resources	F N R
French	FR
Genetics	GEN
Geography	GEOG
Geology	GEOG
German	GER
Graduate Studies	G S
Graphic Communications	G C
Great Works	G W
Health	HLTH
Health Administration	M H A
Health, Education, and Human Development	HEHD
Historic Preservation	H P
History	HIST
Horticulture	HORT
Human Resource Development	H R D
Humanities	HUM
Industrial Engineering	I E
Integrated Pest Management	I P M
Italian	ITAL
Japanese	JAPN
Landscape Architecture	LARCH
Language	LANG
Language and International Trade	L&IT
Latin	LATIN
Law	LAW
Leisure Skills	L S
Management	MGT
Marketing	MKT
Materials Science and Engineering	MS&E
Mathematical Sciences	MTHSC
Mechanical Engineering	M E
Microbiology	MICRO
Military Leadership	M L
Music	MUSIC
Nonprofit Leadership	NPL
Nursing	NURS
Nutrition	NUTR
Packaging Science	PKGSC
Parks, Recreation, and Tourism Management	PRTM

Performing Arts	P A
Philosophy	PHIL
Physical Science	PH SC
Physics	PHYS
Plant and Environmental Sciences	PES
Plant Pathology	PL PA
Plant Physiology	PL PH
Policy Studies	PO ST
Political Science	PO SC
Polymer and Fiber Chemistry	PFC
Portuguese	PORT
Psychology	PSYCH
Reading	READ
Real Estate Development	RED
Religion	REL
Rhetorics, Communication, and Information Design	RCID
Rural Sociology	R S
Russian	RUSS
Secondary Education	EDSEC
Sociology	SOC
Spanish	SPAN
Special Education	ED SP
Technology and Human Resource Development	THRD
Textiles	TEXT
Theatre	THEA
Vocational-Technical Education	VT ED
Wildlife and Fisheries Biology	W F B
Women's Studies	W S
Zoology	ZOOL

ACCOUNTING

ACCT 604 Individual Taxation 3(3,0) Interpretation of federal income tax laws, regulations, and court decisions with practice in application of these laws to the returns of individuals, partnerships, and corporations. *Prq:* ACCT 311 with a C or better.

ACCT 801 Financial Accounting Theory and Research 3(3,0) Evolution of financial accounting theory and its application to contemporary reporting. Emphasis is on learning to research, document, and present a rationale for a recommended alternative. Research problems are derived from actual audit disputes concerning financial presentation. *Prq:* ACCT 313 or equivalent.

ACCT 802 Auditing Seminar 3(3,0) Professional Standard for independent auditors. Taught by the case method; includes a discussion of contemporary auditing problems and cases. *Prq:* ACCT 415 or equivalent.

ACCT 803 Accounting Information Systems 3(3,0) Accounting systems including database concepts, systems design and evaluation, systems controls, and systems implementation. *Prq:* ACCT 303, 313, and 322; or equivalent.

ACCT 804 The Environment of Accounting 3(3,0) Professional, legislative, judicial, and social environments in which the accounting profession operates. *Prq:* ACCT 415 or equivalent.

ACCT 806 Advanced Accounting Problems 3(3,0) Study of specialized aspects of financial accounting including business combinations accounting and reporting practices of regulated and nonregulated industries, emerging practices and developments in financial accounting, fund accounting, and corporate reorganizations and liquidations. *Prq:* ACCT 313 or equivalent.

ACCT 814 Taxation of Business Entities 3(3,0)
Discusses the interrelationship of taxation and business decisions. Designed for students not specializing in taxation. *Preq:* ACCT 404 or equivalent.

ACCT 815 Federal and State Income Taxation of Corporations 3(3,0) Discusses tax principles and concepts involved in corporate-shareholder transactions, tax planning of corporations, Subchapter C, and related provisions of the Internal Revenue Code. *Preq:* ACCT 404 or equivalent.

ACCT 816 Tax Aspects of Financial Planning 3(3,0) Covers federal estate and gift tax laws; federal income tax laws related to trusts and estates. *Preq:* ACCT 404 or equivalent.

ACCT 817 Tax Research 3(3,0) Tax research methodology as applied to the solution of routine and complex tax problems emphasizing the methodology of solution rather than a specific tax area. *Preq:* ACCT 404 or equivalent.

ACCT 818 Taxation of Partnerships 3(3,0) Covers tax principles and concepts involved in partnership transactions, tax planning, and tax shelters. *Preq:* ACCT 404 or equivalent.

ACCT 819 Current and Special Topics in Taxation 3(3,0) Study of specialized and contemporary topics in federal taxation and tax practice. *Preq:* ACCT 404 or equivalent.

ACCT 820 Advanced Topics and Planning in Taxation 3(3,0) Planning element for federal and state taxes in business decisions including current sophisticated developments in taxation. *Preq:* ACCT 404 or equivalent.

ACCT 821 Controllorship 3(3,0) Advanced internal accounting emphasizing accounting implications for management decision making. *Preq:* ACCT 303 or equivalent.

ACCT 845 Operational Auditing Seminar 3(3,0) Covers management control and operational systems. Includes opportunities for improvement and development of practical and cost effective solutions to managerial problems using selected readings from case studies and industry monographs provided by the Institute of Internal Auditing. *Preq:* ACCT 340 or 415 or consent of instructor.

ACCT 899 Professional Exam Review 0(0,0) Preparation for professional examination of the student's choice: the Certified Public Accountant, Certified Management Accountant, or Certified Internal Auditor exam. Must be completed prior to receiving MPAcc degree. Does not contribute hours toward degree completion. To be taken Pass/Fail only.

AFRICAN AMERICAN STUDIES

A A S 698 Seminar on African American Studies 3(3,0) Research/writing seminar on the African American experience. Selected topics and themes from 1900 to present. *Preq:* A A S 301, HIST 311, 312, or 339.

AGRICULTURAL AND APPLIED ECONOMICS

APEC 602 Production Economics 3(3,0) Economic analysis of agricultural production involving the concept of the farm as a firm, principles for decision making, the quantitative nature and use of production and cost functions and their interrelations, and application of these principles to resource allocation in farms and among areas. Offered fall semester only. *Preq:* AP EC 308, ECON 314.

AP EC 603 Land Economics 3(3,0) Study of the characteristics of land and of the physical, legal, social, and economic principles and problems relating to the control and use of land resources. Offered spring semester only. *Preq:* AP EC 202 or ECON 200.

AP EC 609 Commodity Futures Markets 3(3,0) Introduction to the economic theory, organization, and operating principles of agricultural commodity futures markets in the United States. Emphasis is placed on speculating, hedging, and investing in agricultural commodity futures contracts from the standpoint of the agribusiness entrepreneur. *Preq:* AP EC 202 or ECON 211.

AP EC (C R D) 611 Regional Impact Analysis 3(3,0) See C R D 611.

AP EC (C R D) 612 Regional Economic Development Theory and Policy 3(3,0) See C R D 612.

AP EC 613 Advanced Real Estate Appraisal 3(3,0) Topics include highest and best use analysis, data collection and analyses. Advanced appraisal procedures for income, cost, and comparable sales approach to real estate valuation are stressed. Eminent domain, the appraisal of property in transition, and specialized property are covered. Offered spring semester only. *Preq:* AP EC 313, FIN 307, or consent of instructor.

AP EC 620 World Agricultural Trade 3(3,0) Review of practical considerations of agricultural trade and trade policy analysis. Considers the role of international institutions. Special emphasis is placed on concepts of agricultural trade, analysis of trade policies of major trading partners/competitors, and export/import marketing of products. Offered spring semester only. *Preq:* AP EC 309, ECON 412, or consent of instructor.

AP EC 621 Globalization 3(3,0) Utilizes basic principles of international economics (comparative advantage, free trade vs. protectionism, exchange rate determination, etc.) to analyze the contemporary problems and issues of the world economy. Emphasizes application of economic principles to current globalization trends. *Preq:* ECON 310 or 412 or 413 or consent of instructor.

AP EC (CSENV) 626 Cropping Systems Analysis 3(2,2) See CSENV 626.

AP EC 633 Agricultural Law and Related Environmental Issues 3(3,0) Introduction to agricultural and agricultural-related environmental legal issues. Topics include a review of laws, agencies, programs, court structure, torts, taxation, biotechnology, land and water use, regulated industry, and environment liabilities as they relate to agriculture and natural resources. Offered spring semester only. *Preq:* LAW 322 or consent of instructor.

AP EC 652 Agricultural Policy 3(3,0) Review of public agricultural policy programs in the United States and a critical examination of current and proposed government policies and programs affecting the agricultural sector of the economy. Includes economic considerations as related to past and current farm price and income problems. Offered spring semester only. *Preq:* AP EC 302, 309.

AP EC 656 Prices 3(3,0) Review of the basic theory of price under competitive conditions and various modifications; nature, measurement, and causes of daily, seasonal, and cyclical price fluctuations; geographical price relationships; nature, function, and behavior of futures markets; government price programs. Offered spring semester only. *Preq:* AP EC 308, ECON 314, EX ST 462.

AP EC 657 Natural Resource Economic Theory and Policy 3(3,0) Focuses on analysis of actual, efficient, and sustainable use of natural resources. Topics may vary but include land-use change and regulation, water use and marketing, harvesting trees or fish on farms, harvesting and developing property rights to open-access resources, renewable versus nonrenewable energy use, and sustainable development. *Preq:* MTHSC 102; C R D 357 or ECON 314.

AP EC 658 Economics of Risk Management 3(3,0) Focuses on cost-benefit analysis of risks, incorporation of economic considerations into risk assessments, and microeconomic analysis of activities, insurance, and policies that reduce, mitigate, or increase these risks. Possible topics include climate change, wildland fire, erosion, pests and invasive species, pestilence, food contamination, and hurricanes. *Preq:* MTHSC 102 and C R D 357 or ECON 314.

AP EC 660 Agricultural Finance 3(3,0) Study of the principles and technique of financing in the agricultural sector. Topics include the capital situation in agriculture, concepts of farm financial management, use of credit, capital markets, lending agencies, and estate planning. Offered spring semester only. *Preq:* ACCT 201, AP EC 202.

AP EC 675 Economics of Wildlife Management and Policy 3(3,0) Integrated approach to the study of the economics of wildlife. Topics include determination of market and nonmarket value, single and multiple species management, enterprise cost and returns, marketing wildlife, leasing methods, complementarity and competitiveness with agricultural and forestry enterprises, and timber and crop damage cost estimates and control. *Preq:* AP EC 202, ECON 200, FOR 304, W F B 306, or consent of instructor.

AP EC (ECON) 800 History of Economic Thought 3(3,0) See ECON 800.

AP EC (ECON) 801 Microeconomic Theory 3(3,0) See ECON 801.

AP EC (ECON) 802 Advanced Economic Concepts and Applications 3(3,0) See ECON 802.

AP EC (ECON) 804 Applied Mathematical Economics 3(3,0) Discusses mathematical tools needed in economic analysis; matrix algebra, differentiation, unconstrained and constrained optimization, integration and linear programming.

- AP EC (ECON) 806 Econometrics I 3(3,0)**
Application of econometric techniques and stochastic models to economic problems. Considers distribution theory, simple and multiple regression modeling, hypothesis testing, and other issues in regression analysis.
- AP EC (ECON) 807 Econometrics II 3(3,0)**
See ECON 807.
- AP EC (ECON) 808 Econometrics III 3(3,0)**
See ECON 808.
- APEC (ECON) 809 Advanced Natural Resource Economics 3(3,0)** Applications of economic theory to problems of natural resource management, epistemological considerations, rent theory, public and private investment criteria, benefit-cost analysis, and general equilibrium management models. Offered spring semester only. *Preq:* ECON (AP EC) 802 or consent of instructor.
- AP EC (ECON) 810 Natural Resources Management and Policy 3(3,0)** Economic, institutional, and legal aspects of control and management of natural resources; concepts of economic science applied to public policy questions related to land and water resources. Specialized background in economics not necessary. Offered fall semester only. *Preq:* Consent of instructor.
- AP EC (ECON) 811 Economics of Environmental Quality 3(3,0)** See ECON 811.
- AP EC (ECON) 816 Labor Economics 3(3,0)**
See ECON 816.
- AP EC (ECON) 817 Advanced Production Economics 3(3,0)** Discusses production economics theory in a quantitative framework; technical and economic factor-product, factor-factor, and product-product relationships in single- and multi-product firms under conditions of perfect and imperfect competition in both factor and product markets. Offered spring semester only. *Preq:* APEC (ECON) 804 or consent of instructor.
- AP EC 819 Futures and Options Markets 3(3,0)** Introduction to the economic theory and operation of futures and options markets in the United States. Includes determination of prices and price differences, speculation, and the use of these markets for forward pricing and price risk management. *Preq:* Consent of instructor.
- AP EC (ECON) 820 Public Finance 3(3,0)** See ECON 820.
- AP EC (ECON) 822 Contemporary Public Policy 3(3,0)** Covers contemporary public policy, including price and resource policy, affecting rural areas. Discusses public participation, or the lack thereof, related to programs designed to implement public policy. Offered spring semester only.
- AP EC (ECON) 824 Organization of Industry 3(3,0)** See ECON 824.
- AP EC (ECON) 826 Economic Theory of Government Regulation 3(3,0)** See ECON 826.
- AP EC (ECON) 827 Economics of Property Rights 3(3,0)** See ECON 827.
- AP EC (ECON) 828 Market Structure in Agricultural Industries 3(3,0)** Market structure and other approaches related to agricultural marketing. Individual assignments in the student's field of interest are required. *Preq:* Consent of instructor.
- AP EC (ECON) 831 Economic Development 3(3,0)** See ECON 831.
- AP EC (ECON) 832 Community and Regional Economics 3(3,0)** Covers economic theory and research methods needed to understand happenings in the regional and community economy and how local and non-local decisions influence local economic change. Offered fall semester only. *Preq:* C R D (AP EC) 612 or consent of instructor.
- APEC (ECON) 840 International Trade Theory 3(3,0)** See ECON 840.
- AP EC (ECON) 841 International Finance 3(3,0)** See ECON 841.
- AP EC 852 Research Methods for Agricultural Economists I 2(2,0)** Covers linear models and their application to problems related to the economics of agriculture. Includes simplex method, developing farm planning LP models, solving LP problems using the MPSX computer program, parametric analysis techniques, and other LP applications related to rural problems. Offered spring semester only.
- AP EC (ECON) 855 Financial Economics 3(3,0)**
See ECON 855.
- AP EC 881 Internship in Community and Resource Development 1-6** Supervised employment in an agency dealing with socioeconomic aspects, community development, and/or natural resource management. Monthly reports covering the student's experience are required. *Preq:* 18 semester hours of graduate credit.
- AP EC (ECON) 888 Directed Reading in Economics 1-3(1-3,0)** See ECON 888.
- AP EC 891 Master's Thesis Research 1-12**
- AP EC (ECON) 899 Selected Topics 1-3(1-3,0)**
Selected topics under the guidance of a professor. May be repeated for a maximum of six credits.
- AP EC (ECON) 901 Price Theory 3(3,0)** See ECON 901.
- AP EC 903 General Equilibrium and Welfare Theory 3(3,0)** Second in a two-course sequence in advanced price theory covering the capital theory and the determination of the rate of interest. Offered spring only. *Preq:* ECON (AP EC) 901.
- AP EC (ECON) 904 Seminar in Resource Economics 3(3,0)** Special problems and recent periodical literature relating to the control, management, development, and use of land and water resources in the U.S. and in other parts of the world. Offered fall semester only. *Preq:* AP EC 603.
- AP EC (ECON) 905 Advanced Macroeconomic Issues 3(3,0)** See ECON 905.
- AP EC (ECON) 906 Seminar in Area Economic Development 3(3,0)** Consideration of recent research developments in economic development. Includes a review of research publications, journal articles, and other literature. Objectives, analytical techniques, and procedures are used in area or regional development efforts. Offered spring semester only. *Preq:* AP EC (ECON) 806.
- APEC (ECON) 917 Advanced Seminar in Labor Economics 3(3,0)** See ECON 917.
- AP EC (ECON) 950 Monetary Economics 3(3,0)**
See ECON 950.
- AP EC (ECON) 991 Doctoral Dissertation Research 1-12**
- ## AGRICULTURAL EDUCATION
- AG ED 601 Instructional Methods in Agricultural Education 3(2,3)** Appropriate methods of teaching vocational agriculture in high schools. Includes procedures for organizing teaching programs, teaching high school students, and directing FFA activities.
- AG ED 603 Principles of Adult/Extension Education 3(3,0)** Overview of adult/extension education and adult learning. Selection of adult education providers is reviewed with emphasis on extension. *Preq:* Junior standing or consent of instructor.
- AG ED 609 Agriscience Institute: Applications of Agriscience to the Secondary Curriculum 3(2,2)** Designed for pre-service and in-service agricultural educators or secondary level counselors. Surveys current developments in agriscience with an emphasis on modern practices, current job opportunities, and meeting state and national science and math education standards through agricultural instruction. Students construct lesson plans and career planning modules for high school. *Preq:* AG ED 102.
- AG ED 615 Leadership of Volunteers 3(3,0)**
Provides an overview of volunteer management. Examines the knowledge, skills, and abilities required of professional managers to involve volunteers effectively in the work of organizations.
- AG ED 616 Ethics and Issues in Agriculture and the Food and Fiber System 3(3,0)** Explores ethical theories, concepts of critical thinking, and major ethical issues in American agriculture. The major social, political, economic, and ethical issues that arise in connection to the "food and fiber system" are examined and potential solutions considered.
- AG ED 623 Curriculum 2(2,0)** Curriculum goals and related planning for career and continuing education programs.
- AG ED 625 Teaching Agricultural Mechanics 2(1,3)** Organizing course content, conducting and managing an agricultural mechanics laboratory, shop safety, microteaching demonstrations of psychomotor skills, and methods of teaching manipulative abilities.
- AG ED 628 Special Studies in Agricultural Education 1-3(1-3,0)** Students study, individually or collectively, selected topics and/or problems in agricultural education to meet the particular needs of the clientele enrolled. May be repeated for a maximum of six credits.
- AG ED 631 Methods in Environmental Education 3(3,0)** Study of various techniques appropriate for teaching environmental education. Instruction is applicable to elementary, high school, and adult-level teachers. Offered summer session only.
- AG ED 640 Program Development in Adult/Extension Education 3(3,0)** Principles, theory, and practice in planning and conducting educational programs in adult/extension settings. *Preq:* Junior standing or consent of instructor.
- AG ED (ED F, THRD) 680 Educational Applications of Microcomputers 3(2,2)** See ED F 680.
- AG ED (ED F, THRD) 682 Advanced Educational Applications of Microcomputers 3(2,2)**
See ED F 682.

AG ED 736 Internship Teaching 3(1,6) Increases professional competency and program development through classroom and practical experiences in planning, conducting, and evaluating educational programs. Offered spring semester only.

AG ED 737 Internship in Agribusiness Firms 3(1,6) Provides classroom and practical experiences in selected agricultural businesses and industries. Students identify and practice entry-level competencies required in selected agribusiness and natural resource management enterprises. Offered summer session only.

AG ED 750 Special Institute Course: Selected Topics in Agricultural Education 1-3(1-3,0) Subject areas organized according to institute needs. Topics vary from course to course. May be repeated for a maximum of nine credits. *Preq:* Consent of instructor.

AG ED 801 Systems for Technology Transfer 3(3,0) Development of a philosophical foundation and utilization of cooperative learning strategies and techniques to disseminate effectively technological change for expanding clientele and diverse socioeconomic environments.

AG ED 803 Evaluation of Instructional Programs 3(2,3) Measurement and evaluation in general and as applied to agricultural and vocational education; selection and/or development and use of instruments for appraising educational outcomes of student achievement and total programs. Offered fall semester of odd-numbered years only. *Preq:* Consent of instructor.

AG ED 804 Special Problems 3(2,3) Planning, conducting, and reporting a special problem in agricultural and vocational education appropriate to students' needs.

AG ED 805 Administration and Supervision in Agricultural Education 3(3,0) Developing a philosophy of education including application of administrative concepts in supervising agricultural education programs. Offered spring semester of even-numbered years only. *Preq:* Experience in agricultural education.

AG ED 810 Clinical Research in Agricultural Education 1-6(0,3-18) Individual work on an assigned research topic in agricultural education. May be repeated for a maximum of nine credits. *Preq:* AG ED (CTE, ED) 889, EX ST 801.

AG ED 812 Development of Supervised Agricultural Experience Programs 3(3,0) Provides secondary agriculture teachers with strategies for supervising and guiding students' supervised agricultural experiences (SAE). *Preq:* Student teaching in agricultural education.

AG ED 815 Teaching Agricultural and Power Mechanics 3(2,3) Methods of determining course content, organizing teaching modules in logical sequence, equipping shop, teaching agricultural and power mechanics to farm and agribusiness clientele, providing individualized instruction, and developing off-farm experience programs. Offered summer session of odd-numbered years only.

AG ED 821 Theories and Practices of Adult Education 3(3,0) Study of recent research on adult learning. Includes a comparison of the assumptions supporting pedagogy and andragogy and teaching adults through formal classes and community organizations. Offered spring semester only. *Preq:* ED 302 or PSYCH 201 or equivalent.

AG ED 869 Seminar 1-3(1-3,0) Students and faculty review current topics in agricultural education.

AG ED (CTE, ED) 889 Research in Education 3(3,0) Includes problem selection. Investigates types of educational research and techniques employed. Includes the use of ERIC system and computer program packages. Requires interpretation of research findings.

AGRICULTURAL MECHANIZATION

AG M 602 Drainage, Irrigation, and Waste Management 3(2,3) Basic soil-water-plant relationships are used to determine the need for and methods of irrigation, drainage, and waste management. Topics include irrigation methods, drainage needs, drainage methods, and waste-treatment methods.

AG M 605 Agricultural Structures and Environmental Control 3(2,3) Technical considerations of buildings used for agriculture with emphasis on structural materials, structural adequacy, environmental control, and indoor air quality. *Preq:* AG M 221, 303, PHYS 200.

AG M 606 Mechanical and Hydraulic Systems 3(2,3) Study of power transmission systems for agricultural production with emphasis on mobile equipment. Characteristics, requirements, and design of both V-belt drive and roller-chain drives are presented. Emphasizes hydraulic power transmission systems, including pumps, actuators, control devices, and hydraulic circuitry. *Preq:* AG M 206, PHYS 200 or 207, or consent of instructor.

AG M 610 Precision Agriculture Technology 3(2,3) Includes principles and hands-on application of technologies supporting precision agriculture. Topics include Global Positioning System (GPS) and Geographic Information System (GIS) software, variable rate technologies, collection of spatial data, automated guidance of equipment, spatial data mapping and analysis, remote sensing, and economic considerations. *Preq:* Graduate standing.

AG M 652 Mobile Power 3(2,3) Study of tractors with emphasis on internal combustion engines and support systems necessary for their proper functioning; application of power, maintenance, adjustment, and general repair. *Preq:* PHYS 200, 207, or consent of instructor.

AG M 660 Electrical Systems 3(2,3) Students in agriculture and related curricula study electric and other utilities on the farm and in the home. Selection, installation, and maintenance of wiring systems, lighting systems, motors, controls, water systems, and waste disposal systems are emphasized. *Preq:* Junior standing.

AG M 712 Farm Machinery Management 3(2,3) Investigates selection, functional analysis, and maximum utilization of existing and developing farm machinery. Discusses computer applications to programming of field operations, available capital and labor, machine size, critical field operations, growing degree days, weather, and maintenance equipment, procedures, and scheduling.

AG M 771 Selected Topics in Agricultural Mechanization 1-3(1-3,0) Selected topics not covered in other courses. Performance is measured by oral or written reports or examinations. May be repeated for a maximum of six credits.

AG M 781 Special Problems 1-3(1-3,0) Independent analysis through literature review and laboratory or field research. Requires written documentation. May be repeated for a maximum of six credits.

AGRICULTURE

AGRIC 640 Microclimatology 3(3,0) Study of energy balance in the earth's atmosphere and soil: solar and thermal radiation, air and soil temperature, humidity, evaporation and the hydrologic cycle, wind fields. Weather variables to describe microclimates and the energy balance of plants, animals, and insects. Modification of microclimates. Rural and urban climates. *Preq:* PHYS 240 or equivalent or consent of instructor; second semester Junior standing.

ANIMAL AND VETERINARY SCIENCES

AVS 600 Avian Physiology 2(2,0) Detailed study of the structure and function of organ systems of avian species with emphasis on digestion and reproduction. Students are given an opportunity to study organ system(s) of their choice using quantitative physiological techniques. Offered spring semester of even-numbered years only. *Preq:* AVS 201, 301, or consent of instructor.

AVS 601 Beef Production 4(3,2) Discusses breeding, feeding, reproduction, and management of beef cattle. Emphasizes production systems integrating disciplines of animal agriculture into management plans and alternatives. Practical applications of beef production and management practices are also presented. Offered fall semester only. *Preq:* AVS 202, 370.

AVS 602 Poultry Management 4(3,2) Emphasizes management, decision making, and application of technology to the commercial production of poultry and poultry products. Offered spring semester only.

AVS 603 Laboratory Techniques 3(2,3) Research and quality control techniques commonly used in dairy science and related agrisciences. Offered fall semester only. *Preq:* CH 102.

AVS 604 Dairy Cattle Feeding and Management 4(3,2) Fundamental principles in the care, feeding, and management of dairy cattle of all ages. Topics include general consideration in selecting a breed and the individual cow, calf raising, growth and development of dairy heifers, care and maintenance of the milking herd, and feeding for milk production. *Preq:* AVS 202, 370.

- AVS 607 Equine Theriogenology 3(2,2)** Review of reproductive anatomy and physiology in the mare and stallion; induction of estrus and ovulation; practices for optimal reproductive efficiency; semen collection, preservation, and transport; embryo transfer; regulatory aspects of reproduction by various breed registries; noninfectious and infectious diseases affecting reproduction; reproductive health management. Offered fall semester only. *Preq:* AVS 453.
- AVS 608 Pork Production 4(3,2)** Breeding, feeding, grading, marketing, and management of swine. Practical applications from all phases of the production cycle are outlined in problem form to develop the student's problem-solving ability. Offered spring semester only. *Preq:* AVS 202, 370.
- AVS 610 Domestic Animal Behavior 3(3,0)** Provides knowledge and understanding of behavior related to perception, learning, sociality, reproduction, feeding, and health for application in production, training, and design of environments for optimum health and welfare of domestic animals. *Preq:* AVS 150, 151.
- AVS 611 Animal Growth and Development 3(3,0)** Integration of the nutritional, physiological, and genetic basis for animal growth and development with application to livestock and poultry production. Includes the cellular and molecular mechanisms controlling these processes and emphasizes the genes that regulate animal products (meat, eggs, wool, and milk). *Preq:* AVS 301.
- AVS 612 Advanced Equine Management 4(3,2)** Further discussion of special considerations of the equine regarding housing, manure management, nutrition, reproduction, transportation, and behavior. Students gain insight into how horses differ from other livestock species and their unique requirements for the above systems. *Preq:* AVS 370.
- AVS (BIOSC, MICRO) 614 Basic Immunology 4(3,3)** See MICRO 614.
- AVS 615 Contemporary Issues in Animal Science 3(3,0)** Provides knowledge, understanding, and critical analytical skills on current issues in animal agriculture in diverse regional, national, and global social-cultural and political environments as they impact animals and man. *Preq:* AVS 150, 151, Junior standing in Animal and Veterinary Sciences.
- AVS 618 Muscle Biology and Lean Meats 3(2,2)** Biology of animal muscle, connective, fat, and bone tissue with laboratory emphasis on low-fat sausages and restructured, value-added meat products. *Preq:* AVS 202.
- AVS 620 Poultry Science On-line 3(3,0)** On-line course covering the physiology, nutrition, health, reproduction, genetics, breeding, housing, and management of commercial poultry species including the processing of meat and egg products.
- AVS 625 Poultry Products Grading and Technology 3(2,3)** Factors important in the quality of poultry products are considered. The effects of production, handling, packaging, and storage on consumer acceptability are discussed. Quality evaluation is considered from the standpoint of tenderness, flavor, microbiology, and USDA grades. Offered spring semester of odd-numbered years only. *Preq:* AVS 108, 202.
- AVS (FD SC) 630 Dairy Processing I 4(3,3)** Processing and distribution of fluid milk and other dairy products with emphasis on composition, quality control, chemical, microbiological, and public health aspects. Offered fall semester of alternate years only. *Preq:* BIOL 104, CH 102.
- AVS (FD SC) 631 Dairy Processing II 4(3,3)** Continuation of AVS 630, with emphasis on processing of cultured dairy products and frozen dairy products; processing procedures, quality control, ingredients, formulations; compositional and cultural characteristics of cultured and frozen dairy products are discussed. Offered spring semester of alternate years only. *Preq:* AVS 430.
- AVS 651 Poultry Nutrition 2(2,0)** Nutrient requirements of chickens, turkeys, and game birds and methods of determining these requirements. Deficiencies and excesses of vitamins and minerals and the effects of naturally occurring toxins are considered. Hand formulation and linear programming are discussed. Offered fall semester of odd-numbered years only.
- AVS 652 Poultry Nutrition Laboratory 1(0,3)** Provides training in basic laboratory skills and common laboratory methods used in poultry nutrition.
- AVS 653 Animal Reproduction 3(2,2)** Reproductive physiology and endocrinology of mammals with emphasis on farm animals and frequent reference to reproduction in laboratory animals and humans. *Preq:* AVS 150, 301.
- AVS 655 Animal Reproductive Management 1(0,3)** Physiology and endocrinology of pregnant and nonpregnant cows are discussed. Emphasis is on methods of artificial insemination, pregnancy detection, and computer record keeping for achieving a high level of reproductive efficiency in cattle. *Preq:* AVS 150, 301; AVS 453 (or concurrent enrollment).
- AVS 658 Avian Microbiology and Parasitology 3(3,0)** Agents causing poultry diseases; the diagnosis, prevention, and treatment of specific diseases; their economic and public health significance. Offered fall semester of even-numbered years only.
- AVS 661 Physiology of Lactation 2(2,0)** Anatomy and development of the mammary gland; physiological and biochemical regulation of mammary growth and milk secretion with emphasis on farm animals and reference to other mammals. Offered spring semester only *Preq:* AVS 202, BIOCH 305.
- AVS 670 Animal Genetics 3(3,0)** Fundamental principles relating to the breeding and improvement of livestock including variation, heredity, selection, linebreeding, inbreeding, crossbreeding, and other related subjects. *Preq:* AVS 150.
- AVS (BIOSC) 680 Vertebrate Endocrinology 3(3,0)** See BIOSC 680.
- AVS 801 Selected Topics 1-3(1-3,0)** Current topics of special interest in animal, dairy, or veterinary sciences not covered in other courses. May be repeated for credit. *Preq:* Consent of coordinating instructor.
- AVS 802 Meat Technology 3(3,0)** Biochemistry, histology, and microbiology of fresh, frozen, cured, smoked, and processed meats; quality of meats and meat products; processing methods; nutritive value; research techniques. *Preq:* AVS 353.
- AVS 803 Physiology of Reproduction and Milk Secretion 3(3,0)** Advanced concepts of steroidogenesis, gametogenesis, fertilization, placentation, embryogenesis, embryonic-endometrial relationships, parturition, and lactation and the influence of hormones on these processes. Students evaluate the most recent scientific literature in these areas for information, experimental methods, and validity of authors' conclusions and select a problem, review related literature, and write a research proposal for solving the problem. *Preq:* AVS 453 and 461 or consent of instructor.
- AVS 804 Methods in Animal Breeding 3(3,0)** Gene and zygotic frequency, system of mating, heritabilities, genetic consequences of selection, and criteria for evaluating improvement in all domestic livestock. *Preq:* AVS 652.
- AVS 808 Industrial Dairy and Meat Science 3(1,6)** Managerial training for operating food plants with particular emphasis on regulations, policy, and decision making for dairy plants and meat plants. *Preq:* Consent of instructor.
- AVS 820 Animal and Veterinary Sciences Graduate Seminar 1(1,0)** Ongoing research, evaluation of research needs, research techniques, critical reviews, and discussions of published research in all areas of the animal, dairy, and veterinary sciences.
- AVS 822 Special Problems 1-3(0,3-9)** Laboratory, library, or field study of problems related to animal, dairy, and veterinary sciences emphasizing development and testing of hypotheses and reporting of results. May be repeated for a maximum of four credits. *Preq:* Consent of instructor supervising study.
- AVS 825 Immunobiology 3(3,0)** Conceptual approach to immunobiology emphasizing the molecular and cellular aspects. Classical and current literature is the major source for the discussion/lecture format. Offered spring semester only. *Preq:* Consent of instructor.
- AVS 891 Master's Thesis Research 1-12**

ANIMAL PHYSIOLOGY

- AN PH (BIOSC) 801 Electron Microscopy of Biological Specimens 3(1,6)** Concepts and practice in preparing biological specimens for electron microscopy: fixing; embedding; thin-sectioning; staining; operating microscopes; and photographing, developing, printing, and interpreting micrographs. Students must achieve proficiency with selected specimens including writing brief research proposals, preparing specimens, studying specimens with electron microscope, and interpreting micrographs. *Preq:* Consent of instructor.
- AN PH 802 Selected Topics 1-3(1-3,0-3)** Current topics of special interest in animal physiology not covered in other courses. May be repeated for a maximum of six credits. *Preq:* Consent of instructor.

AN PH 806 Care and Use of Research Animals 3(1,6) Demonstration and practice of humane use and care of animals in research. Considers pain, analgesia, and anesthesia; regulatory aspects of the use of animals in teaching and research; and surgical techniques and sample collection. Offered fall semester only. *Preq:* BIOSC 659 or consent of instructor.

AN PH 807 Special Problems in Animal Physiology 1-3(1-3,0) Research not related to a thesis. May include a comprehensive review of related literature.

AN PH 812 Digestive-Metabolic, Excretory, and Respiratory Physiology 5(4,3) Advanced concepts of mechanisms and functions of the gastrointestinal tract (mastication, salivation, digestion, absorption, metabolism, excretion), kidney (anatomy, filtration, secretion, reabsorption), and respiratory systems (transport, exchange, and utilization of gases); the action of the nervous system, hormones, and pharmacologic agents on these organ systems. Offered fall semester of even-numbered years only. *Preq:* BIOSC 659 or consent of course coordinator.

AN PH 814 Membrane, Cardiovascular, and Neuromuscular Physiology 5(4,3) Advanced concepts in membrane physiology (permeability, action potentials, specialized functions), cardiovascular physiology (functions of the heart, blood-vascular system in maintaining acid-base balance, clotting mechanisms, homeostasis, circulation), neuromuscular physiology (anatomy and function of the nervous system, special senses, reflexes, control of muscular activity), the action of several pharmacologic agents on muscle and nerve functions. Offered spring semester of even-numbered years only. *Preq:* BIOSC 659 or consent of course coordinator.

AN PH 851 Animal Physiology Seminar 1(1,0) Current research and development in animal physiology through related literature and student and faculty participation. May be repeated for a maximum of two credit hours.

AN PH 891 Master's Thesis Research 1-12

AN PH 991 Doctoral Dissertation Research 1-12

ANTHROPOLOGY

ANTH 603 Qualitative Methods 3(3,0) Methods and techniques of qualitative field research including participant observation, ethnographic interviewing, data analysis, and report writing. *Preq:* ANTH 201 or consent of instructor.

ARCHITECTURE

ARCH 603 The Modern Architecture Movement 3(3,0) Seminar in the analysis and criticism of architectural and town building works. Course sequence includes historic and contemporary examples, literary searches, field trips, essays, and oral reports. *Preq:* Senior standing or consent of instructor.

ARCH 604 Current Directions in Architecture 3(3,0) Critical analysis of the development and current directions of modern movements in architecture. *Preq:* Senior standing or consent of instructor.

ARCH 605 American Architectural Styles 1650–1950 3(3,0) Survey of American architectural styles and the architects responsible for them, from the Colonial period to our recent past. Emphasis is on identifying architectural elements that serve as clues in determining a building's architectural style.

ARCH 612 Architectural History Research 3(3,0) Directed investigations related to the art and architectural history of Europe. May be repeated for a maximum of six credits. *Preq:* Junior standing or consent of instructor.

ARCH 614 Design Seminar 3(3,0) Exploration of topical issues in architecture, art, construction, and planning. May be repeated for a maximum of six credits. *Preq:* Junior standing or consent of instructor.

ARCH 615 Field Sketching 3(0,6) Study of media and techniques for expression, representation, and visual analysis through freehand perspective field drawing of the built and natural environment. *Preq:* Junior standing in School of Design and Building or consent of instructor.

ARCH 616 Field Studies in Architecture and Related Arts 3(0,9) Documentation and analysis of architectural structures observed during European travels in graphic and written form. May be repeated for a maximum of six credits. *Preq:* Junior standing or consent of instructor.

ARCH 624 Product Design 3(0,9) Furniture and product system design with emphasis on ergonomics and the relationship of form and materials. *Preq:* Senior standing and consent of instructor.

ARCH 625 Energy in Architecture 3(3,0) Climate design methodology and its influence on building energy patterns and architectural form. *Preq:* Senior standing and consent of instructor.

ARCH 626 Architectural Color Graphics 3(3,0) Architectural color graphics by computer. Theories of color classification and interaction; application of color theories to art and architecture. *Preq:* Consent of instructor.

ARCH 627 Advanced Color Graphics 3(3,0) Theories of color classification and interaction; three-dimensional color modeling by computer; advanced application of color theories to art and architecture. *Preq:* ARCH 426 or consent of instructor.

ARCH 628 Computer-Aided Design 3(2,3) Introduction to the concepts, skills, and applications of computer-aided design as they relate to the practice of architecture. *Preq:* Senior standing or consent of instructor.

ARCH 629 Architectural Graphics 3(3,0) Provides students with an understanding of concepts, skills, techniques, and strategies of visual presentation/graphics as they relate to the design professions—architects/landscape architects. *Preq:* Graduate standing or consent of instructor.

ARCH 630 Theories and Philosophies of Technology and Architecture 3(3,0) Theoretical and practical examination of technology and architecture from pre-modern and modern viewpoints to study its nonneutral role in shaping and reflecting knowledge, beliefs, and actions within a cultural context.

ARCH 631 Virtual Reality in Architecture 3(3,0) Introduction and exploration of the theories and concepts of virtual reality and their use in modeling three-dimensional spaces; computer modeling, lighting and texture mapping. Projects focus on the creation and presentation of a virtual environment. *Preq:* Junior standing or consent of instructor.

ARCH 640 New York Field Study 3(3,0) Study of architecture, art, planning, and urban design of New York. Two weeks' residence are required with scheduled field trips to relevant sites in all five boroughs, with counseling to determine research interests. Guidance is provided to resources in the city. A final report is required. Offered Maymester only.

ARCH 685 Health Care Facilities 3(3,0) Introduces concepts, organization, and direction of health and health-care services within the context of health-care delivery systems. Special emphasis is placed on mental and physical health-care facilities concepts. *Preq:* Consent of instructor.

ARCH 688 Health Care Programming 3(3,0) Seminar on recent research and innovations in health-care facilities programming and original investigation of assigned programming problems. *Preq:* Consent of instructor.

ARCH 699 Selected Topics in Architecture 1-3(1-3,0) Study of selected topics in architecture. May be repeated for a maximum of nine credits, but only if different topics are covered. *Preq:* Junior standing or consent of instructor.

ARCH 801 Architecture Seminar 3(3,0) Contemporary issues in the architectural profession.

ARCH 802 Phenomenology of Architecture 3(3,0) Basic principles of phenomenological methods as they apply to the theoretical understanding of modern architecture. Emphasis is on selected writings of Heidegger, Harries, and Norberg-Schulz. *Preq:* ARCH 803.

ARCH 803 Theories of Architecture 3(3,0) Evolution of architectural theories from Vitruvius to the present. Emphasis is on the writings of leading architects and theorists and the impact of these theories on architectural solutions.

ARCH 804 Seminar in Modern Masters 3(3,0) In-depth examination of one or more related groups of architects from the 20th century (Kahn, Scarpa, Barrigan, Wright, Corbusier, etc.). Content varies from semester to semester.

ARCH 805 Architecture and the City 3(3,0) Seminar examining contemporary theories of urban design and the design of urban buildings; real and ideal visions of cities; their representation, archaeology, and iconography (Rossi, Kries, Ungers, Venturi, Duan, etc.).

ARCH 820 Building Design and Construction Principles 3(3,0) Essential principles for quality design and construction. Emphasis is on design, programming, and sustainability issues for different project types. Nature and characteristics of construction materials, equipment, and systems used in modern buildings are presented as well as how they affect function and feasibility. *Preq:* Consent of instructor.

- ARCH 821 Research Methods 3(3,0)** Covers foundations and procedures of architectural research. Explores alternate research methodologies and their philosophical and epistemological limits.
- ARCH 850 Architecture Studio 6(0,18)** Architectural design studies in the context of the Genoa urban setting. May substitute for ARCH 853 or 854 and for ARCH 857 with consent of advisor.
- ARCH 853 Architecture Studio 6(0,18)** Architectural design studies with emphasis on selected problem issues.
- ARCH 854 Architecture Studio 6(0,18)** Architectural design studies involving structured and situational problems. *Preq:* ARCH 853.
- ARCH 857 Architecture Studio 6(0,18)** Architectural design studies dealing with comprehensive problem-solving situations. *Preq:* ARCH 854.
- ARCH 858 Thesis Research 3(0,9)** Architectural predesign inventory and analysis for the thesis project. *Preq:* ARCH 854.
- ARCH 859 Thesis Manuscript 1-3(0,3-9)** Architectural predesign synthesis of research for the thesis project. *Preq:* ARCH 858.
- ARCH 878 Lighting for Architecture 3(3,0)** Studies interrelationships among the fields that constitute lighting and impact on building form, materials and spatial use. Also considers contributions of daylight and electric light to human response and performance. *Preq:* Consent of instructor.
- ARCH 881 Delivery of Architecture 3(3,0)** Considers ethical, legal, and business issues in the architectural profession. *Preq:* Professional degree program status.
- ARCH 886 Health Care Components 3(3,0)** Components and service functions of physical and mental health care delivery systems and facilities.
- ARCH 890 Directed Studies 1-5(1-5,0)** Special topics in architecture undertaken on an individual basis with faculty guidance. *Preq:* Consent of advisor.
- ARCH 891 Thesis Project 3-9(0,9-27)** Complex architectural project emphasizing design exploration and independent work. To be taken Pass/Fail only. *Preq:* ARCH 857, 858.
- ARCH 892 Comprehensive Studio 6(0,18)** Architectural design studies addressing comprehensive building projects. Topics include site design, programming, building systems design, and materials selection. Final product is a complete building design with detailed drawings and models. *Preq:* ARCH 857.
- ART**
- ART 605 Advanced Drawing 3(0,6)** Advanced-level studies of drawing which explore the synthesis of refined drawing skills and philosophies of art. Student's understanding of drawing as a form of art is developed through studio practice augmented by critiques, demonstrations, lectures, field trips, and independent research. *Preq:* ART 305 or consent of instructor.
- ART 607 Advanced Painting 3(0,6)** Advanced studio course in painting. Study of contemporary painters and directions is included. Students select painting media and are expected to develop a strong direction based on prior painting experience. *Preq:* ART 307 or consent of instructor.
- ART 609 Advanced Sculpture 3(0,6)** Intensive independent studio concentration to further develop personal direction and content. Emphasis is on continued investigation of sculptural context, materials and processes, and relative historical research. *Preq:* ART 309 or consent of instructor.
- ART 611 Advanced Printmaking 3(0,6)** Culmination of process, techniques, and individual development. Students are expected to have mastered process and technique for the benefit of the image produced. Creativity and self-expression are highly emphasized as students select a process for concentrated study. *Preq:* ART 311 or consent of instructor.
- ART 613 Advanced Photography 3(0,6)** Continuation of ART 313. Advanced problems in photography. *Preq:* ART 313 or consent of instructor.
- ART 617 Advanced Ceramic Arts 3(0,6)** Students are directed toward further development of ideas and skills. Glaze calculation and firing processes are incorporated to allow for a dynamic integration of form and ideas. *Preq:* ART 317 or consent of instructor.
- ART 620 Selected Topics in Art 1-3(0,6-9)** Intense course in studio art. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* Senior standing or consent of instructor.
- ART 690 Directed Studies 1-5(0,2-10)** Study of areas in the visual arts not included in other courses or additional advanced work. Must be arranged with a specific instructor prior to registration. May be repeated for a maximum of 18 credits. *Preq:* Consent of instructor.
- ART 803 Fundamentals of Visual Art 3(0,6)** Intensive introduction of visual art and design fundamentals. Includes two- and three-dimensional studio work with emphasis on time-based media and design.
- ART 805 Visual Arts Seminar on Theories and Practice I 3(3,0)** Issues related to the practice of the artist, emphasizing theories and criticism of contemporary art.
- ART 806 Visual Arts Seminar on Theories and Practice II 3(3,0)** Continuation of ART 805.
- ART 813 Photo-Based Imaging Theories and Techniques 3(0,6)** Offers in-depth examination of photographic imaging processes for artistic expression, utilizing both traditional and digital tools and concepts. *Preq:* Master of Fine Arts student or consent of instructor.
- ART 821 Visual Arts Seminar on Art and Technology 3(3,0)** Explores the relationship between art and technology in the age of electronic media. *Preq:* Consent of instructor.
- ART 840 Visual Arts Studio 3-6(0,9-18)** Studio work in visual arts with adjunct lectures and gallery tours. May be substituted for ART 800-level visual arts studio.
- ART 850 Visual Arts Studio 3(0,9)** Concentrated and advanced work in ceramics, drawing, painting, printmaking, sculpture, photography, graphic design, or multimedia. *Preq:* Consent of department chair or instructor.
- ART 851 Visual Arts Studio 3-6** Continuation of ART 850. May be repeated for maximum of six credits. *Preq:* Consent of department chair or instructor.
- ART (CP SC) 860 Studio Computer Research 3-15(0,6-30)** Application of computer technology for the production of art. Computer research facilitates the creative approach to self-expression. Internships at animation production houses may be used for credit in this course. May be repeated for a maximum of 27 credits. *Preq:* Consent of instructor.
- ART 870 Visual Arts Studio 6(0,16)** Advanced theory; directed research in art criticism; applied work in ceramic arts, drawing, painting, sculpture, photography, graphic design, or multimedia. *Preq:* Consent of department chair or instructor.
- ART 871 Visual Arts Studio 3-6(0,8-16)** Continuation of ART 870. May be repeated for maximum of six credits. *Preq:* Consent of department chair or instructor.
- ART 880 Visual Arts Studio 3-15(0,6-30)** Continuation of ART 871. May be repeated for maximum of 15 credits. *Preq:* Consent of department chair or instructor.
- ART 891 Master's Thesis Research 3-15(0,6-30)** May be repeated for maximum of 15 credits. *Preq:* Consent of department chair or instructor.

ART AND ARCHITECTURAL HISTORY

- A A H 611 Directed Research in Art History I 3(3,0)** Comprehensive studies and research of special topics not covered in other courses. Emphasis is on field studies, research activities, and current developments in art history.
- A A H 612 Directed Research in Art History II 3(3,0)** Continuation of A A H 611.
- A A H 623 Studies in the Art and Architecture of the Renaissance I 3(3,0)** Consideration of the visual arts and architectural monuments of the Renaissance (Western Europe from the 15th–18th centuries), with a study in depth of selected examples from the period. *Preq:* A A H 204 or 206 or consent of instructor.
- A A H 624 Studies in the Art and Architecture of the Renaissance II 3(3,0)** Consideration of the visual arts and architectural monuments of the Renaissance (Western Europe from the 15th–18th centuries), with a study in depth of selected examples from the period. *Preq:* A A H 423.
- A A H 628 Nineteenth Century Visual Arts 3(3,0)** Consideration of the visual arts of the 19th century: painting, sculpture, printmaking, ceramics, and so forth, in relation to the factors that have influenced the artist and the consequence on society. *Preq:* A A H 427.
- A A H 630 Twentieth Century Art I 3(3,0)** Acquaints students with the major artists' monuments and issues of the Modern period in art. Through lecture/discussions and the reading of primary sources, course places the major modern movements in the context of the period (1860s–1945). *Preq:* Consent of instructor.

A A H 632 Twentieth Century Art II 3(3,0)
Overview of trends in art and architecture since World War II. Specific artists, artworks, and movements are presented in a socio/historic context with specific emphasis on the transition from a late-modernist to a post-modern perspective. *Preq:* Consent of instructor.

A A H (PHIL) 633 Issues in Contemporary Art and Philosophy 3(3,0) See PHIL 633.

A A H 635 Studies in Precolumbian Art and Architecture 3(3,0) Familiarizes students with the art and architecture of the Western Hemisphere's Precolumbian culture in Mexico, Central, and South America. *Preq:* A A H 102 or 210 or consent of instructor.

A A H 815 Art and Architectural History Seminar I 3(3,0) Particular aspect of period of art/architectural history. *Preq:* Consent of instructor.

A A H 816 Art and Architectural History Seminar II 3(3,0) Continuation of A A H 815.

A A H (COMM, ENGL) 840 Selected Topics 3(3,0) See ENGL 840.

ASTRONOMY

ASTR 802 Stellar Structure and Evolution 3(3,0)
Physical principles governing the structure, power, luminosity, and evolution of stars; equation of state, equations for pressure and thermal balance, heat transport, thermonuclear power, and numerical techniques of structure calculation. *Preq:* PHYS 455 or equivalent or consent of instructor.

ASTR 803 Galactic Structure 3(3,0) Kinematics, dynamics, and content of the Milky Way galaxy; galactic rotation, galactic distance scale, stellar populations, spiral structure, the galactic center, and the evolution of the Milky Way and other galaxies. *Preq:* Consent of instructor.

ASTR 875 Selected Topics 1-3(1-3,0) Study of one or more advanced topics in contemporary astrophysics. May be repeated for credit, but only if different topics are covered. *Preq:* Consent of instructor.

ATHLETIC LEADERSHIP

A L 653 Athletic Injuries: Prevention, Assessment and Rehabilitation 3(3,0) Gives students an understanding of prevention, treatment, and rehabilitation procedures of injured athletes. *Preq:* A L 349.

AUTOMOTIVE ENGINEERING

AU E 805 Ground Vehicle Aerodynamics 3(3,0)
Basic and applied aspects of aerodynamics relevant for internal and external design for performance, including drag, handling, noise, and ventilation. Wind tunnel and track testing methods and computational modeling approaches are utilized.

AU E 816 Engine Combustion and Emissions 3(2,3) Spark and compression ignition engines are investigated in terms of design, performance, and emissions. Includes exergy models. Integrates theory of fuel air cycles with laboratory breakdown and dynamometer testing to correlate prevalent mathematic models with test results.

AU E 817 Alternative Energy Sources 3(3,0) Demand for petroleum alternative propulsion sources has focused attention on hybrid vehicles with fuel cells, electric motors, and battery packs and internal combustion engines burning hydrogen and reformulated fuels. Comparison of performance, emissions, fuel efficiency, operational requirements, and vehicle configurations is studied.

AU E 825 Automotive Sensors and Actuators 3(3,0) Study of automotive sensor and actuator requirements, design, and selections as well as future needs. Sensor and actuator networks, noise and interference issues, wired and wireless systems are examined as well as integrated smart sensors and actuators with applications to traditional and intelligent vehicle systems.

AU E 826 On-Board Vehicle Diagnostics and Reliability 3(3,0) Discussion of legislated state, federal, and international requirements. On-board automotive sensors to monitor vehicle operation and typical diagnostic algorithms are studied. Includes analytical methods for designing fault-tolerant systems and assessing vehicle reliability including safety-critical systems and "limp-home" modes, as well as use of hand-held scanners and specialized diagnostic equipment to classify faults.

AU E 827 Automotive Control Systems Design 3(3,0) Investigation into derivation of models and design of control strategies for powertrain and chassis control modules and integration into automotive platforms. Also presents software design, sensor selection, system architecture, diagnostics, and reliability issues. Application is made to engine management, transmission and chassis systems with a consideration of vehicle performance, safety, and information provision. *Preq:* M E 416 or equivalent.

AU E 828 Fundamentals of Vehicle Drivelines and Powertrain Integration 3(3,0) Study of vehicle powertrain arrangement, manual and automatic transmissions, automotive axles, four-wheel and two-wheel drives, and design and manufacturing of gearing systems. Other topics, such as powertrain control to address dynamics in shifting, engine balancing, and fuel economy, are addressed. Modeling and computer simulation are used extensively to analyze dynamic performance of various transmissions. *Preq:* M E 405, 416, or consent of instructor.

AU E 829 Tire Behavior and Its Influence on Vehicle Performance 3(3,0) In-depth analysis of the tire and its influence on vehicle performance including design, construction, structural response, rolling resistance, force and moment generation, and behavior under dry/wet conditions. Tire models, their limitations and governing equations, tire characteristics on vehicle handling and safety, and advanced control concepts in vehicle stability/braking are investigated. *Preq:* M E 453 or equivalent.

AU E 847 Vehicle Suspension Systems Design and Analysis 3(3,0) Study of concepts, theory, design, and application of automotive suspension systems. Discusses suspension structure, configuration, geometry, kinematics, motion, static and dynamic load conditions as well as active, semi-active, and passive systems. Suspension design factors and their effects are presented. Computer-aided engineering tools and other analytical techniques are demonstrated. *Preq:* M E 453 or equivalent.

AU E 848 Vehicle Braking Systems 3(3,0) Study of vehicle braking performance; development of system specifications; regulatory, customer, and manufacturing requirements; brake balance and effects on stability and stopping distance; ABS systems; and computer simulation for system performance. *Preq:* M E 453 or equivalent.

AU E 849 Automotive Chassis Design 3(3,0) Integrative systems approach to the design and manufacture of automotive chassis and body components. Considers influence of design and manufacture on overall structural performance of the automobile, ride comfort, safety, durability, weight, and cost. *Preq:* AU E 855 or equivalent, AU E 881.

AU E 850 Automotive Stability and Safety Systems 3(3,0) Discussion of passive/active systems and design philosophies. Investigates stability issues associated with vehicle performance and use of sensors and control system strategies for stability enhancement. Implementation and application to intelligent cruise control, lane departure warning systems, ABS, traction control, active steering systems, and vehicle dynamic control systems are also discussed. *Preq:* M E 453 or equivalent.

AU E 853 Crash Analysis Methods and Crashworthiness 3(3,0) Consideration of crash legislation and testing; design constraints for crash; computational methods to analyze the mechanical response of automotive structure, systems, and components to dynamic impact loading such as in crash situations; crush characteristics, structural collapse, and their influence on safety; large-scale finite element analysis for large-scale deformation. *Preq:* AU E 852, 855, or consent of instructor.

AU E 855 Structural/Thermal Analysis Methods for Automotive Structure, Systems, and Components 3(3,0) Methods to analyze the response of automotive structure, systems, and components to static, dynamic, and thermal loading. Includes coverage of critical loading conditions and system response objectives. Analysis methods focus on finite element approaches supplemented by simple computational methods when appropriate.

AU E 866 Advanced Materials for Automotive Applications 3(3,0) In-depth study of the broad range of engineering materials used in the construction of motor vehicles. Considers interrelations between materials microstructure, components manufacturing process, and components service behavior. *Preq:* Consent of instructor.

- AU E 867 Vehicle Manufacturing Processes I 3(3,0)** In-depth analysis of main component and subsystem prototyping, fabrication assembly, and integration processes used during production of automotive vehicles. Design for manufacturing, computer-aided manufacturing, and rapid tooling technologies are also discussed. *Preq:* Consent of instructor.
- AU E 868 Vehicle Manufacturing Processes II 3(3,0)** Continuation of AU E 867 with more emphasis placed on opportunities and challenges presented by automotive manufacturing in a global environment, integrated processes and product development, and flexible and agile manufacturing. *Preq:* AU E 867.
- AU E 875 Vehicle Development and Realization 3(3,0)** In-depth analysis of component and subsystems design, representation, data management, and analysis for vehicles. Voice of the customer, customer-driven design, product design specifications, life cycle product management, CAD/CAE representations, domestic and international standards, prototyping, design review, and supplier relationships are considered using case studies.
- AU E 876 Mass Customization Design for Vehicles 3(3,0)** Consideration of concepts of platforms and product families, identification of common functionalities, and the translation of functions into forms taking commonality into consideration. Also investigates designing product families and their role in vehicle design, the tie between market needs and appropriate manufacturing paradigm, and specific applications to vehicle systems designs: chassis, wiring harnesses, engines.
- AU E 877 Light-Weight Vehicle Systems Design 3(3,0)** Methodological approaches to weight trade-off during design of vehicle systems, accounting for other functions, cost, safety, materials characteristics, and manufacturing constraints. Includes topology optimization, multimaterial approaches, and identification of the function optimal materials and material combinations using multi-objective formulations.
- AU E 880 Vehicle Design/Manufacture Project Management 3(3,0)** Development of management, leadership, sociocultural, and technical skills training for the successful management of an automotive development or research team. Includes problem identification, team dynamics, decision making, ethics, strategy setting, project planning, scope management and implementation, target costing, marketing, design methods, and design for X-concepts.
- AU E 881 Automotive Systems: An Integrated Overview 3(3,0)** Promotes understanding of the vehicle as a complex system and interactions of its subsystems in terms of performance. Topics include propulsion systems, suspensions and steering systems, tire-road interface, structural behavior and crashworthiness, materials and manufacturing, driver/occupants-vehicle interactions, and onboard electronics. Modeling and simulation are used.
- AU E 882 Systems Integration Concepts and Methods 3(3,0)** Study of methods and tools to handle functional, geometric, production, and IT integration. Includes instruction in managing performance trade-offs from the combination of systems designed for individual functions. Topics also include optimization methods, complexity, validation, signal, and IT design and testing methods, robustness, architecture, and quality.
- AU E 883 Applied Systems Integration 3(2,3)** Application of integration methods to practical and complex vehicle design and manufacturing systems. Includes prototyping, measurements, tolerancing, and validation, as well as diagnosis and sensitivities, methods to diagnose sporadic software errors with hardware in the loop, design reviews, FMEA on function signal, geometry, production. Also includes Fault Tree analysis, innovation and change management, risk analysis, and value analysis. *Preq:* M E 882, consent of instructor.
- AU E 884 Styling Design 3(3,0)** Considers fundamentals of styling design for the outer body and the interior cockpit. Utilizes concept sketching, drawing, and prototyping, including virtual and physical, layered, and clay based. Includes 2-D and 3-D representations, brand identifications, textures, materials, lighting, colors, and their use in automotive industrial design.
- AU E 885 Vehicle Layout Engineering and Ergonomic Design 3(2,3)** Study of vehicle layout specifications and considerations related to exterior and interior design. Ergonomics methods and tools as related to occupant accommodation and driver function are presented. Issues of assembly and manufacturing ergonomics are also covered. Case studies are utilized.
- AU E 886 Vehicle Noise, Vibration, and Harshness 3(3,0)** Application of engineering tools and specifications for noise, vibrations, and harshness. Sources, mitigation methods, complexity, and influences on other vehicle functions are considered. Utilizes design, simulation, and validation methods. *Preq:* M E 845 or equivalent.
- AU E 887 Methods for Vehicle Testing 3(2,3)** Investigates test planning for various performance regimes, data acquisition and analysis, uncertainty analysis, sensor selection, noise filtering, data reduction methods, and track testing methods. Project includes actual vehicle tests.
- AU E 890 Automotive Engineering Project 1-3(0,3-9)** Industrial project work culminating in writing engineering reports. Projects cover comprehensive analytical and/or experimental treatment of phenomena of current interest in automotive engineering emphasizing modern technological problems. May be repeated for a maximum of nine credits.
- AU E 893 Selected Topics in Automotive Engineering 3(3,0)** Advanced concepts in multibody systems dynamics including kinematics and kinetics of multibody systems, various methods for equation formulation and their limitations, numerical solutions methods, and applications to automotive systems and subsystems.
- AU E 991 Doctoral Dissertation Research 1-12**
- ## BIOCHEMISTRY
- BIOCH 606 Physiological Chemistry 3(3,0)** Studies chemical basis of the mammalian physiological processes of muscle contraction, nerve function, respiration, kidney function, and blood homeostasis. Discusses composition of specialized tissue such as muscle, nerve, blood, and bone and regulation of water, electrolytes, and acid-base balance. *Preq:* BIOCH 305 or Organic Chemistry.
- BIOCH 623 Principles of Biochemistry 3(3,0)** Study of the chemistry of amino acids, monosaccharides, fatty acids, purines, pyrimidines, and associated compounds leads to an understanding of their properties and the relationship between structure and function that makes them important in biological processes. The use of modern techniques is stressed. *Preq:* CH 224 or equivalent.
- BIOCH 631 Physical Approach to Biochemistry 3(3,0)** Study of chemical and physical properties of amino acids, lipids, nucleic acids, sugars, and their biopolymers. Physical and mathematical analyses are correlated with biological structure and function. *Preq:* BIOCH 301 with a C or better or consent of instructor. *Coreq:* Physical Chemistry.
- BIOCH 632 Biochemistry of Metabolism 3(3,0)** Study of central pathways of carbohydrate, lipid, and nucleotide metabolism. Bioenergetics, limiting reactions, and the regulation and integration of the metabolic pathways are emphasized. *Preq:* BIOCH 423 or 431 or consent of instructor.
- BIOCH 633 General Biochemistry Laboratory I 2(0,4)** Experiments selected to illustrate current methods used in biochemical research. *Coreq:* BIOCH 423 or 431.
- BIOCH 634 General Biochemistry Laboratory II 2(0,4)** Continuation of BIOCH 433. *Preq:* Concurrent enrollment in BIOCH 432.
- BIOCH 636 Nucleic Acid and Protein Biosynthesis 3(3,0)** Examines how nucleic acids and proteins are synthesized in prokaryotic and eukaryotic cells. Designed for students interested in biochemistry, cell biology, molecular biology, and cell physiology. *Preq:* BIOCH 423, 431 or 432 or consent of instructor.
- BIOCH 643 Biochemical Basis of Disease 3(3,0)** Topics in heritable human metabolic disorders including clinical features and newborn screening, genetic testing, the biochemical basis, and treatment. *Preq:* BIOCH 301, GEN 302, or consent of instructor.
- BIOCH (GEN) 805 Issues in Research 2(2,0)** Scientific writing, oral presentations, and critical evaluation of them; legal and ethical issues associated with modern biochemical research. Science job hunting, time management, and creativity for professional scientists are treated. *Preq:* Graduate enrollment in Biochemistry and Molecular Biology or consent of instructor.
- BIOCH (GEN) 810 Methods in Molecular Biology 5(3,6)** Study of prokaryotic and eukaryotic gene structure, regulation of transcription initiation, regulation of protein synthesis, and analysis of protein function. Laboratory provides intensive hands-on experience using techniques that allow dissection of these processes. *Preq:* Enrollment in Genetics or in Biochemistry and Molecular Biology or consent of instructor.

- BIOCH 814 Advanced Biochemistry 3(3,0)** Contemporary topics of functional and cellular aspects in biochemistry with particular focus on new observations, emerging ideas, and important techniques. *Preq:* Two-semester sequence in biochemistry or consent of instructor.
- BIOCH 815 Lipids and Biomembranes 3(3,0)** Discusses isolation, chemical and physical properties, and metabolism of lipids; purification, structure, function, and biosynthesis of biomembranes. *Preq:* BIOCH 632 or consent of instructor.
- BIOCH 816 Signal Transduction 3(3,0)** Characteristics and components of signal transduction processes in model species of plants, animals, and microbes. *Preq:* BIOCH (GEN) 810 and GEN (BIOCH) 820, or consent of instructor.
- BIOCH 818 Cellular Metabolism 3(3,0)** Evolution, regulation, characterization, and manipulation of metabolic pathways. *Preq:* BIOCH 814 and GEN (BIOCH) 820, or consent of instructor.
- BIOCH (GEN) 820 Genomics and Proteomics 5(5,0)** See GEN 820.
- BIOCH 821 Proteins 3(3,0)** Isolation, composition, structure, and properties of proteins; methods of isolation, analysis, and characterization; properties of "unusual" protein systems. *Preq:* BIOCH 623 or 631 or consent of instructor.
- BIOCH 822 Enzymes 3(3,0)** Kinetics, mechanisms of action, inhibitions, and general properties of enzymes. *Preq:* BIOCH 623 or 631.
- BIOCH (GEN) 825 Seminar I 1(1,0)** See GEN 825.
- BIOCH 828 Supramolecular Structure 3(3,0)** Cellular structures such as viruses, ribosomes, and various membrane systems, including rafts and some organelles, are described using modern methods of structural characterization. The methods and the theory of the methods are discussed along with the structures and their functions. *Preq:* BIOCH 814 or consent of the instructor.
- BIOCH 831 Physical Biochemistry 3(3,0)** Description and theory of physical methods and instrumentation used in analysis of biological macromolecules. *Preq:* BIOCH 623 or 631, one semester of physical chemistry, or consent of instructor.
- BIOCH 832 Structure and Function of Nucleic Acids 3(3,0)** Physical, chemical, and biochemical properties of nucleotides, oligonucleotides, RNA, and DNA; antisense oligonucleotides and aptmers; unusual structures of RNA and DNA; nucleic acids-protein interactions; nucleic acids-metal interactions; small RNAs and RNA interference; catalytic nucleic acids; nucleic acids repair. *Preq:* BIOCH 814 or GEN 814 or consent of instructor.
- BIOCH 841 Biochemical Genetics 3(3,0)** Regulation of replication and transcription. Students present papers from recent literature and write a research proposal. *Preq:* One year of biochemistry or consent of instructor.
- BIOCH (GEN) 851 Seminar II 1(1,0)** Investigation of current topics in biochemistry.

- BIOCH 890 Special Topics in Biochemistry 1-6(1-6,0)** Group discussions of recent developments in biochemical research. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* BIOCH 814 or consent of instructor.
- BIOCH 891 Master's Thesis Research 1-12**
- BIOCH 991 Doctoral Dissertation Research 1-12**

BIOENGINEERING

- BIO E 640 Biotechnology for Bioengineers 3(3,0)** Explores the principles necessary to use microorganisms, tissue culture, and enzymes in bioengineering applications, including molecular techniques, fermentation, process scale-up, purification processes, and FDA regulations. Emphasizes production of biopharmaceuticals derived from recombinant systems, including uses in medical systems. *Preq:* BIOCH 305 or consent of instructor.
- BIO E (C M E) 680 Research Principles and Concepts 1(1,0)** Introduces seniors and graduate students to principles and practices of scientific research. Topics include developing scientific concepts, developing projects, pursuing research, collaborating in multidisciplinary teams, patenting and publishing technical and scientific information, and reviewing professional and ethical standards of performance. To be taken Pass/Fail only.
- BIO E 800 Seminar in Bioengineering Research 1(2,0)** Original research in bioengineering; weekly one-hour seminar associated with weekly recitation covering seminar preparation, presentation, professional writing, bioengineering ethics, and related topics. To be taken Pass/Fail only.
- BIO E 801 Biomaterials 3(3,0)** Structure and properties of the main classes of materials used in artificial organs and surgical implants; metals, ceramics, polymers, composites, and materials of biological origin; mechanical properties, corrosion, and design. *Preq:* Consent of instructor.
- BIO E 802 Compatibility of Biomaterials 3(1,6)** Determining compatibility of biomaterials with the physiological environment; optical microscopy, microradiography, and ultraviolet fluorescence; normal histology of tissues, basic pathological reactions, and tissue reactions to materials.
- BIO E 803 Polymeric Biomaterials 3(3,0)** Interplay of physicochemical properties of polymeric materials and the design of biomedical devices and their in vitro and in vivo performance; critical manufacturing aspects of selected augmentation and prosthetic devices for soft and hard tissues; analysis of case studies and reports on recent research findings. *Preq:* Consent of instructor.
- BIO E 804 Metallic and Ceramic Implant Materials 3(3,0)** Interaction between implant material and host tissue, selection of materials for different applications, influences of material and host tissue performance on implant design and on in vitro testing of implant materials and devices. *Preq:* BIO E 801 and consent of instructor.

- BIO E 807 Nanotechnology and Biomaterials 3(3,0)** The emerging field of nanotechnology and its relation to solving bioengineering and health-related problems is treated. Also considers the promise of nanotechnology in the creation and utilization of materials and devices at the level of atoms and molecules. New scientific approaches, research tools, clinical tools, and devices are presented.
- BIO E 812 Orthopedic Engineering and Pathology 3(3,0)** Interdisciplinary study of orthopedic cases (bone growth, bone remodeling, osteoarthritis, implant fixation, and joint replacements); biomechanical, biomaterials, and clinical diagnosis of failed implants (total joints, fracture fixation, and spinal instrumentation); basic concepts of orthopedic pathology for engineers. *Preq:* BIO E 801, 802, 820, and 882, or consent of instructor.
- BIO E 820 Structural Biomechanics 3(3,0)** Mechanical functions of the human body treated as an engineering structure and the devices used to assist and supplement these functions; movement of the musculoskeletal system; locomotion; gait; prehension; lifting; function of artificial limbs; orthopedic prostheses and braces; effect of vibration and impact on the body; mathematical and other models of the body. *Preq:* Consent of instructor.
- BIO E 823 Vascular Engineering and Pathology 2(2,0)** Medical and bioengineering aspects of artificial vascular and cardiovascular devices; physiology and pathological aspects of patients with need for such devices; diagnostic techniques and surgical management of diseases and pathology; design aspects of current devices and selection; state-of-the-art in experiments and human clinical trials. *Preq:* BIO E 801, 802, and 846, or consent of instructor.
- BIO E 846 Biomedical Basis for Engineered Replacement 3(3,0)** Form and function of human organs, major systems, and examples of engineering repair and replacement methods are presented in light of pathological or traumatic organ malfunction. Core course for all Bioengineering graduate students, taken preferably during their first fall semester.
- BIO E 847 Transport Processes in Bioengineering 4(4,0)** Cardiovascular systems and regulation; physiology of blood, heart, and organ blood flow; properties of blood as a fluid; fluid flow equations; turbulence; pulse propagation; respiration and control of breathing; gas exchange; heart-lung bypass devices; renal function and control; artificial kidney devices; heat flow and temperature regulation. *Preq:* BIOSC 459.
- BIO E 848 Cellular Interactions with Biomaterials 4(2,2)** Cell biological concepts and issues relevant to cell-biomaterial interactions; methods for studying cell structure and function including basic cell culture techniques and in vitro biocompatibility analyses; biomaterial physio-chemical properties which influence cellular interactions; interactions between implant materials and host tissues at the cellular and molecular level; overview of tissue engineering.