# AERO–AEROSPACE ENGINEERING

**AERO 102 General Aviation (4)**

Fundamentals of flight aerodynamics and principles. Introduction to power systems, instrumentation, flight planning, modern air navigation, weather data interpretation, flight computer uses, meteorology. Hands-on cockpit/taxi familiarization. Private pilot's examination preparation. Not a technical elective for engineering students. Field trip may be required. 4 lectures.

**AERO 103 Instrument Aviation (4)**

Introduction to advanced aircraft instrumentation, flight planning, interpretation of weather data, and meteorology. Instrument navigation, uses of flight computer, subjects covered in instrument pilot's examination. Not acceptable as technical elective to engineering students. 4 lectures. Prerequisite: Private pilot certification.

**AERO 121 Aerospace Fundamentals (2)**

Introduction to the engineering profession including the aeronautical and aerospace fields. Engineering approach to problem-solving and analysis of data obtained from experiments. Basic nomenclature and design criteria used in the aerospace industry. Applications to basic problems in the field. Miscellaneous course fee may be required–see *Class Schedule*. 1 lecture, 1 laboratory.

**AERO 200 Special Problems for Undergraduates (1–4)**

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units. Prerequisite: Consent of department head.

**AERO 210 History of Aviation (4)**

History of technological innovations which led to modern aviation. People and circumstances that contributed to the major breakthroughs in aeronautics and astronautics. Impact of aviation on society. Discussion of current events in aviation. 4 lectures.

**AERO 215 Introduction to Aerospace Design (2)**

Introduction to problem solving techniques and team-centered design projects in aerospace engineering. Primary emphasis on the solution of design problems in aerospace engineering using computers. 2 laboratories. Prerequisite: AERO 121, MATH 143, CSC 231 or CSC 234. Recommended: CSC 111.

**AERO 240 Additional Engineering Laboratory (1–4) (CR/NC)**

Total credit limited to four units. Credit/No Credit grading. 1-4 laboratories.

**AERO 301, 302, 303 Aerothermodynamics (5) (5) (5)**

Properties and characteristics of fluids, fluid statics and dynamics, the thermodynamic relations, laminar and turbulent flows, subsonic and supersonic flows as applied to flight vehicles. Introduction to heat transfer. 5 lectures, fall, winter and spring. Prerequisite: ME 211, MATH 242.

**AERO 304 Experimental Aerothermodynamics (2)**

Laboratory experiments verify the momentum and energy equations. Fan performance, boundary layer measurements, diffuser performance, and induction pump performance experiments are evaluated. 1 lecture, 1 laboratory. Prerequisite: ENGL 148. Concurrent: AERO 302.

**AERO 306 Aerodynamics and Flight Performance (4)**

Introduction to theoretical aerodynamics. Primary emphasis in the subsonic region, including compressibility effects. Basic aerodynamic theory: Airfoil theory, wing theory, lift and drag. Team-centered aerodynamic design. Flight performance. 4 lectures. Prerequisite: AERO 215, AERO 301, AERO 315. Concurrent: AERO 302.

**AERO 307 Experimental Aerodynamics (2)**

Wind tunnel testing of basic aerodynamic properties of airfoils, finite wings, aircraft models, and aircraft flight performance. Emphasis on both static and dynamic responses of aircraft. Various measurement techniques, data reduction schemes, and analysis methods. 2 laboratories. Prerequisite: AERO 302, AERO 306, ENGL 148.

**AERO 310 Air and Space (4)** **GE Area F**
**(Also listed as HNRS 310)**

Technological innovations that have led to modern aircraft and spacecraft as viewed from an historical perspective. Development of aerodynamics, propulsion systems, light-weight structures, and control systems. How aviation has affected, and been affected by, history. Impact of aviation on society, including civil and military aircraft/spacecraft. Federal regulation of aviation, including air traffic control and airlines. Future developments in air and space technology. 4 lectures. Prerequisite: Completion of GE Area B and junior standing.

**AERO 315 Aerospace Engineering Analysis (4)**

Analysis methods for aerospace engineering problems. Applications for solving problems in aerodynamics, aerospace structures, stability and control, and astronautics. 3 lectures, 1 laboratory. Prerequisite: AERO 215, MATH 242. Co-requisite: CE 205.

**AERO 320 Fundamentals of Guidance and Control (4)**

Introduction to state-space and transfer function models for aircraft, spacecraft, missiles, and helicopters. Elementary classical and modern analysis techniques using computers. 3 lectures, 1 laboratory. Prerequisite: AERO 215. Concurrent: AERO 315.

**AERO 330 Aerospace Structural Analysis (4)**

Deflection analysis. Principles of fictitious displacement, virtual work, unit load method. Energy methods: Dummy load method, Castigliano's theorem, Maxwell-Betti reciprocal theorem, minimal principles, Rayleigh-Ritz's method, Galerkin's method. The shearlag problem and airworthiness and aeroelasticity. 4 lectures. Prerequisite: AERO 315.

**AERO 360 Creative Problem Solving in Engineering Design (2)**

The creative problem solving process for an engineering design team. How to explore context and causes as part of defining a design problem; the principles of brainstorming, synthesis, and judgment. Role of iteration, implementation, and communication. Importance of a diverse view, including: customers, products, processes, systems, ethics, and professional responsibility. Team-based applications to case studies and real-world engineering design problems. 2 laboratories. Prerequisite: PSY 350.

**AERO 400 Special Problems for Advanced Undergraduates (1–4)**

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 8 units.

**AERO 401 Propulsion Systems (4)**

Power plant types, components, characteristics, and requirements. Principles of thrust and energy utilization. Thermodynamic processes and performance of turboprop, turboshaft, turbofan, turbojet, ramjet, and rocket engines. 3 lectures, 1 laboratory. Prerequisite: AERO 303, AERO 306, CHEM 124.

**AERO 404 Gas Dynamics (4)**

Fundamental theory of one dimensional gas dynamics: Isentropic flow, flow in converging-diverging nozzles, shock propagation, normal and oblique shock theory, Prandtl-Meyer expansions, Fanno line flow, and measurement methods. 4 lectures. Prerequisite: AERO 302.

**AERO 405 Supersonic and Hypersonic Aerodynamics (4)**

Review of gas dynamics, shock-wave and boundary-layer interaction, aerodynamic design. 2-dimensional supersonic flows around thin airfoil; finite wing in supersonic flow. Local surface inclination methods for high-speed flight, boundary-layer and aerodynamic heating, viscous interactions. 4 lectures. Prerequisite: AERO 303, AERO 306.

**AERO 407 Reentry Aerodynamics (4)**

Near planet environments. Transition from orbital to aero-dynamic motion. Aerodynamic heating and effects on design. 4 lectures. Prerequisite: AERO 405. Concurrent: AERO 451.

**AERO 409 Flight Test (4)**

Overview of flight tests, test equations, and supporting facilities. Principles of team-centered flight testing with applications to performance, stability and control, and avionics systems testing. Test planning, instrumentation, data analysis and reports. 2 lectures, 2 laboratories. Prerequisite: AERO 306. Concurrent: AERO 320.

**AERO 416 Principles of Rotary Wing Flight (4)**

Introduction to analysis of rotary wing aircraft. Overview of avionics systems. Performance figures of merit. Stability and control of helicopters. Equations of motion for forward flight. 4 lectures. Prerequisite: AERO 306 and AERO 315.

**AERO 419 Simulation of Aerospace Vehicles and Systems (4)**

Overview of flight simulators, aerospace avionics systems, and supporting facilities including simulation equations for flight mechanics and land navigation. Team-centered projects, reports, and presentations are emphasized with a strong focus on computer simulation of piloted flight. 2 lectures, 2 laboratories. Prerequisite: AERO 420.

**AERO 420 Stability and Control of Aerospace Vehicles (4)**

Stability and control derivatives, reference frames, steady-state static analysis and perturbed dynamic analysis for aircraft and spacecraft. Transfer function, state-space, and modal representations of system dynamics in response to control inputs. Design guidelines and introduction to augmentation systems. 4 lectures. Prerequisite: AERO 306, AERO 320, and ME 212.

**AERO 430 Aerospace Composite Structures Analysis (4)**

Review of isotropic material behavior. Behavior of unidirectional fiber composites. Macromechanical and micromechanical behavior of a lamina. Macromechanical behavior of a laminate. Strength and hygrothermal behavior of composite materials. 3 lectures, 1 laboratory. Prerequisite: AERO 330.

**AERO 435 Aerospace Numerical Analysis (4)**

Taylor series. Finite difference calculus. Interpolation and extrapolation. Finite difference method. Basic equations of elasticity. Global stiffness matrix. Rayleigh-Ritz method. Galerkin method. Bernoulli-Euler beam element. Finite element formulation. Dynamic analysis. 3 lectures, 1 laboratory. Prerequisite: AERO 315, AERO 330.

**AERO 442 Preliminary Aircraft Design (4)**

Preliminary definition of an aircraft using design and calculation techniques developed in previous aeronautical engineering courses. Background provided to synthesize knowledge from previous courses into a preliminary aircraft design. Preparation of necessary drawings and a report. 2 lectures, 2 laboratories. Prerequisite: Senior standing, AERO 306, AERO 320, AERO 330, and CAD drawing skills.

**AERO 443, 444, 445 Aircraft Design (2) (4) (4)**

Preliminary layout of a typical aircraft vehicle using design and calculation techniques developed in previous aerospace engineering courses. Design of a flight vehicle, including its structures and systems. Preparation of necessary drawings and a report. AERO 443: 2 laboratories. AERO 444 and AERO 445: 2 lectures, 2 laboratories. Prerequisite: Senior standing, IME 144, AERO 215, AERO 303, AERO 306, AERO 330. Concurrent: AERO 401, AERO 405, AERO 420, AERIO 430. Open to students enrolled in the multidisciplinary design minor.

**AERO 447, 448, 449 Spacecraft Design (2) (4) (4)**

Preliminary layout of typical space vehicle using design and calculation techniques developed in previous aerospace engineering courses. Design of selected components and preparation of necessary drawings. AERO 447: 2 laboratories. AERO 448 and AERO 449: 2 lectures, 2 laboratories. Prerequisite: IME 144, AERO 215, AERO 303, AERO 306, AERO 330, senior standing. Concurrent: AERO 401, AERO 420, AERO 430, AERO 451. Open to students enrolled in the multidisciplinary design minor.

**AERO 450 Aerospace Systems Engineering (4)**

Aerospace systems and subsystems. Systems integration. Development of system requirements. Analysis, modeling and simulation of complex systems. Project management. Cost analysis. Optimization and trade studies. 4 lectures. Prerequisite: Senior standing or consent of instructor.

**AERO 451 Spaceflight Dynamics I (4)**

Motion of a body in the central force field. Space vehicle trajectories, guidance systems, power generators for interplanetary travel, structural loading, and principles of space vehicle design. Introduction to rigid spacecraft attitude dynamics. 4 lectures. Prerequisite: ME 212. Concurrent: AERO 315.

**AERO 452 Spaceflight Dynamics II (4)**

Orbital motion, perturbing forces. Aspherocity of the earth, aerodynamic drag, third-body tidal forces, etc. Enke and Cowell solution techniques. Restricted 3-body problem. Satellite attitude dynamics, rigid body-symmetric and asymmetric semirigid bodies. Attitude control, spinning/fixed gravity gradient. 4 lectures. Prerequisite: AERO 451.

**AERO 461, 462 Senior Project (2) (3)**

Selection and completion of a project which is typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum 150 hours total time. Prerequisite: Senior standing.

**AERO 463, 464 Senior Project Laboratory (2) (3)**

Selection and completion of a project by individuals or team which is typical of problems which graduates must solve in their fields of employment. Project involves, but is not limited to, physical modeling and testing of integrated design and may include students from other disciplines. Formulation of outline, literature review, and project schedule. AERO 463: 2 laboratories. AERO 464: 3 laboratories. Prerequisite: Senior standing.

**AERO 470 Selected Advanced Topics (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Consent of instructor.

**AERO 471 Selected Advanced Laboratory (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories. Prerequisite: Consent of instructor.

**AERO 485 Cooperative Education Experience (6) (CR/NC)**

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**AERO 495 Cooperative Education Experience (12) (CR/NC)**

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent ofinstructor.

**AERO 500 Individual Study (1–4)**

Advanced study planned and completed under the direction of a member of the department faculty. Open only to graduate students who have demonstrated ability to do independent work. Enrollment by petition. Total credit limited to 12 units. Prerequisite: Consent of department head, graduate adviser and supervising faculty member.

**AERO 515 Continuum Mechanics (4)**

Vectors and tensors stress analysis. Analysis of deformation. Velocity fields and compatibility conditions. Constitutive equations. Isotropy. Mechanical properties of real fluids and solids. Field equations and boundary conditions in fluid mechanics problems and applications in elasticity. Active remodeling of structures. Distance Learning Lab fee may be required--see *Class Schedule.* 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**AERO 520 Applied Airplane Aerodynamics (4)**

Fundamentals of analytic aerodynamics; potential flow, Kutta-Joukowski theorem. Schwarz-Christoffel transformation, lifting line theory, thin wing theory, three-dimensional lift and drag of wings, slender body theory. Panel methods. Boundary-layer effects on aerodynamics. Viscous flow. Distance Learning Lab fee may be required--see *Class Schedule.* 4 seminars. Prerequisite: AERO 306, MATH 502, graduate standing or consent of instructor.

**AERO 521 Missile and Launch Vehicle Aerodynamics (4)**

The aerodynamics of missile configurations in subsonic, transonic, supersonic, and hypersonic flows. Slender bodies and wings at high angles of attack. Asymmetric flow separation and vortex shedding. Wing-body interactions. Control effectiveness. Drag prediction methods and aerodynamic heating. The impact of low observability on aerodynamic design. Missile configuration design. Distance Learning Lab fee may be required--see *Class Schedule.* 4 lectures. Prerequisite: AERO 405, graduate standing, or consent of instructor.

**AERO 522 Boundary-Layer Theory (4)**

Concept of boundary-layer. Boundary-layer equations, similarity transformation, integral and differential methods for steady, two-dimensional laminar and turbulent boundary layers. Distance Learning Lab fee may be required--see *Class Schedule*. 4 lectures. Prerequisite: AERO 302, graduate standing or consent of instructor. Concurrent: MATH 501.

**AERO 523 Turbulence (4)**

Flow physics of turbulence. Turbulence scales and structures. Reynolds equations. Vorticity dynamics. Energy production, convection, and dissipation. Similarity rules and turbulence modeling for jets, wakes, mixing and boundary layers. Effect of turbulence on noise, combustion, heat transfer, and flow control. Distance Learning Lab fee may be required--see *Class Schedule*. 4 lectures. Prerequisite: AERO 302, graduate standing or consent of instructor.

**AERO 524 Low Gravity Fluid Dynamics and Heat Transfer (4)**

Low gravity environment. Mass, momentum and energy transport equations. Free and forced convections. Materials processing. Two-phase flows. Combustion and flame propagation. Turbulence. Fluid management in space. Students are expected to do self-study and make a presentation for the seminar. Distance Learning Lab fee may be required--see *Class Schedule*. 3 lectures, 1 seminar. Prerequisite: AERO 301, AERO 302, and AERO 303, graduate standing or consent of instructor.

**AERO 525 Computational Fluid Dynamics (4)**

Classification of partial differential equations. Numerical methods applicable to the solution of elliptic, parabolic, and hyperbolic partial differential equations. Consideration of accuracy and stability of numerical methods. Application to the fundamental equations of fluid dynamics, grid generation, turbulence modeling. Distance Learning Lab fee may be required--see *Class Schedule.* 4 lectures. Prerequisite: AERO 3O3, CSC 340, graduate standing or consent of instructor.

**AERO 530 Inelastic Structural Analysis (4)**

Inelastic stress analysis. Yield criteria. Strain hardening. Plastic straining and bending. Elastic-plastic problems. Plastic instability. Slip-line fields for plains. Plastic strain problems and analysis and introduction to viscoplasticity. Distance Learning Lab fee may be required--see *Class Schedule*. 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**AERO 532 Advanced Aerospace Composite Design (4)**

Behavior of composite materials. ending, buckling, and vibration of laminated plates. Fatigue and fracture mechanics analysis of composite structures. Optimum design of composite pressure vessels. 2 seminars, 2 laboratories. Prerequisite: Graduate standing or consent of instructor.

**AERO 534 Aerospace Structural Dynamics Analysis (4)**

Fundamentals of structural dynamics and aeroelasticity of flight vehicles. Undamped and damped, free and forced vibration of a single and multi degree-of-freedom linear systems. Finite elements and vibrational analysis. Distance Learning Lab fee may be required--see *Class Schedule*. 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**AERO 535 Advanced Aerospace Structural Analysis (4)**

Types of failure. Theories of failure. Stability of structures. Advanced flight vehicle and fracture mechanics analysis and design. Fundamentals and applications of modern fatigue analysis in the aerospace industry. Distance Learning Lab fee may be required--see *Class Schedule*. 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**AERO 540 Elements of Rocket Propulsion (4)**

Thrust and impulse equations, propellant composition and mixture ratios, nozzle expansion ratios, solid and liquid propellant combustion, internal ballistics, thermo-chemical computations, chemical kinetics, and combustion instability, nozzle design and exhaust plumes. Distance Learning Lab fee may be required--see *Class Schedule.* 4 seminars. Prerequisite: AERO 303, AERO 401, graduate standing or consent of instructor.

**AERO 541 Air Breathing Propulsion (4)**

Aerothermodynamics of propulsion systems, power plant selection and design, on-off design performance, component characterization, component design, component matching, optimization, and introduction to power plant and airframe integration systems for aircraft. Distance Learning Lab fee may be required--see *Class Schedule*. 4 seminars. Prerequisite: AERO 401 or ME 443, graduate standing or consent of instructor.

**AERO 550 Analysis and Design of Flight Control Systems (4)**

Fundamental principles of flight control design and the application of the Cooper-Harper test and evaluation tool to modern aerospace vehicles. Human factors, issues, and automation, case study of the space shuttle. Distance Learning Lab fee may be required--see *Class Schedule*. 3 lectures, 1 laboratory. Prerequisite: AERO 420 or ME 422, graduate standing or consent of instructor.

**AERO 551 Global Positioning Satellite Navigation Systems (4)**

Principles of Global Positioning Satellite navigation systems. Kalman filter design and application to integrated navigation and guidance systems. Statistical evaluation and test methods in aerospace. Interactive computer simulations. Distance Learning Lab fee may be required--see *Class Schedule*. 3 lectures, 1 laboratory. Prerequisite: AERO 420, graduate standing or consent of instructor.

**AERO 552 Advanced Control of Spacecraft and Aircraft (4)**

Model following and digital control of aerospace craft, including dynamic estimation of vehicle states using Kalman filters and adaptive compensation. Team-centered projects involving optimal attitude control in deep space, hovering vehicles, and aeroelastic systems. Survey of non-linear, fuzzy, and neural net controllers for aerospace applications. 2 lectures, 2 laboratories. Prerequisite: AERO 550.

**AERO 555 Piloted Flying Qualities of Aerospace Vehicles (4)**

Flying qualities prediction from flight test data and reduced-order analytical models of vehicles, systems, and human pilots. Application of the Cooper-Harper flight test scale to fly-by-wire aircraft, the space shuttle, and remotely controlled vehicles include rotorcraft. Team-centered projects, reports, and presentations are required. 2 lectures, 2 laboratories. Prerequisite: AERO 420.

**AERO 560 Spacecraft Dynamics and Control (4)**

Orbit determination and control. Orbit maneuvering and rendezvous. Attitude control of rigid spacecraft via reaction wheels, control moment gyros and thrusters. Modeling, analysis and control of flexible spacecraft. Distance Learning Lab fee may be required--see *Class Schedule.* 4 lectures. Prerequisite: AERO 420, AERO 452, graduate standing or consent of instructor.

**AERO 565 Advanced Topics in Aircraft Design (4)**

Application of advanced analytic engineering methods to aircraft design problems. Analysis and synthesis of advanced topics related to design of aircraft. Distance Learning Lab fee may be required--see *Class Schedule*. 4 lectures. Prerequisite: AERO 522, AERO 530 and AERO 550, graduate standing or consent of instructor. Concurrent: AERO 520.

**AERO 570 Selected Advanced Topics (4)**

Directed group study of selected topics for graduate students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. Distance Learning Lab fee may be required--see *Class Schedule*. 4 lectures. Prerequisite: Graduate standing or consent of instructor.

**AERO 599 Design Project (Thesis) (2) (2) (5)**

Each individual or group will be assigned a project for solution under faculty supervision as a requirement for the master's degree, culminating in a written report/thesis. Prerequisite: Graduate standing.

# AG–AGRICULTURE

**AG 100 Agriculture Enterprise Project (1–4) (CR/NC)**

Selection and completion of a management/production project under faculty supervision. Project participation is subject to approval by the department head and the Cal Poly Foundation. Degree credit limited to 12 units. Registration is through department offices and subtopics will list the department supervising the project. Credit/No Credit grading only.

**AG 243 Competitive Intercollegiate Rodeo (2) (CR/NC)**

Beginning through advanced skills in the event areas of college rodeo. Areas include saddle bronc, bareback, and bull riding; calf, team, and breakaway roping; steer wrestling, goat tying, and barrel racing. Minimum of 10 hours of laboratory per week. Total credit limited to 8 units. Credit/No Credit grading. Enrollment limited to those qualified to compete in intercollegiate rodeo. Consent of coach required.

**AG 250 Computer Application to Agriculture (3)**

Microcomputers and commercial software used in agricultural industries. Word processing, spreadsheets, data base management programs, and programs applied to agriculturally oriented problems. Miscellaneous course fee may be required–see *Class Schedule.* 3 lectures.

**AG 301 Agriculture and American Life (4)**

Overview of agriculture and effect on American life; wise use of natural resources; animal and plant production; role of machines, labor, and chemicals in producing food and fiber; processing and marketing of commodities; nature of farm life; leadership development in agriculture. Not open to students with majors in agriculture. 4 lectures. Prerequisite: Junior standing.

**AG 339 Internship in Agriculture (1–12) (CR/NC)**

Selected students will spend up to 12 weeks with an approved agricultural firm engaged in production or related business. Time will be spent applying and developing production and managerial skills and abilities. One unit of credit may be allowed for each full week of completed and reported internship. Credit/No Credit grading. Prerequisite: Consent of internship instructor.

**AG 439 Internship in Integrated Ranch Operations (6–12) (CR/NC)**

Work experience in all activities/projects associated with the production of crops, livestock and timber at Swanton Pacific Ranch. Students will be responsible for all activities associated with ranch operation including supervising. For students working and living at Swanton Pacific Ranch. Credit/No Credit grading only. Total credit limited to 18 units. Prerequisite: Senior or graduate standing and consent of instructor.

**AG 450 Holistic Resource Management (4)**

Application of Holistic Resource Management, a goal-oriented, value-driven thought process using guidelines which cause decisions to be made that are ecologically, economically, and socially sound. Holistic approach to management of land-based resources aimed toward greater biodiversity and sustainability. Miscellaneous course fee may be required–see *Class Schedule*. 3 lectures, 1 laboratory. Prerequisite: Any life sciences course, and junior standing.

**AG 485 Cooperative Education Experience (6) (CR/NC)**

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**AG 495 Cooperative Education Experience (12) (CR/NC)**

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**AG 500 Individual Study (1–6)**

Advanced independent study planned and completed under the direction of a member of the college faculty. Total credit limited to 6 units. Prerequisite: Consent of department head, graduate adviser and supervising faculty member.

**AG 539 Graduate Internship in Agriculture (1–9)**

Application of theory to the solution of problems of agricultural production or related businesses in the field. Analyze specific management problems and perform general management assignments detailed in a contract between the student, the firm or organization, and the faculty adviser before the internship commences. Degree credit limited to 6 units. Prerequisite: Consent of internship instructor.

**AG 585 Cooperative Education Experience (6) (CR/NC)**

Advanced study analysis and part-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Total credit limited to 9 units. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

**AG 595 Cooperative Education Experience (12) (CR/NC)**

Advanced study analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Total credit limited to 9 units. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

**AG 598 Reading and Conference (1–12) (CR/NC)**

Systematic development of an agricultural thesis research project including literature searches, reports and experimental design.

Repeatable for up to 12 units. Credit/No Credit grading only. Prerequisite: Graduate standing and instructor consent.

**AG 599 Thesis (1–9)**

Systematic research of a significant problem. Thesis will include problem identification, significance, methods, data analysis, and conclusion. Students must enroll every quarter in which facilities are used or advisement is received. Degree credit limited to 6 units. Prerequisite: Graduate standing and consent of instructor.

## AGB–AGRIBUSINESS

**AGB 101 Introduction to Agribusiness (4)**

Orientation to the agribusiness sector of agriculture. An overview of the breadth, size, scope and management aspects of the agricultural business complex. 4 lectures.

**AGB 200 Special Problems for Undergraduates (1–2) (CR/NC)**

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Credit can only be used to satisfy free electives. Credit/No Credit grading only. Prerequisite: Consent of department head.

**AGB 201 Agribusiness Sales and Service (3)**

Emphasis on relationship selling focusing on building trust and providing valuable service. Critical skills of self-management, communication, and interpersonal values through role playing and presentations. Sales opportunities in the entire food industry surveyed, ranging from input industries such as seeds and fertilizers, to output industries such as produce and wine. 3 lectures.

**AGB 202 Sales, Communication and Leadership in Agribusiness (4)**

Self management, communication, and interpersonal skills necessary in developing managerial abilities, leadership qualities, and facilitating teamwork within the agribusiness sector. Industry opportunities ranging from input and output products and services along with government and special interest groups will be surveyed. 4 lectures. Prerequisite: AGB 101.

**AGB 212 Agricultural Economics (4)**

Theoretical development of factors affecting demand and supply for food and fiber and for agricultural inputs. Methods of selecting optimal levels of agricultural production and consumption variables. Evaluation of market structure and price formulation for agricultural products and resources. 4 lectures.

**AGB 213 Agricultural Economic Analysis (4)**

Advanced agricultural microeconomics with emphasis on mathematical problem solving; production and cost functions, single and multiple input allocation, agricultural output combinations, agricultural market structures, and economies of size. 4 lectures. Prerequisite: AGB 212, MATH required for major.

**AGB 300 Successful California Farms (2)**

Visits to successful California farms involving many types of farming. Farm resources and organization, techniques of operation, yields, problems. Different regions visited on different trips. Miscellaneous course fee required–see *Class Schedule*. Can only be taken once for credit in the major.

**AGB 301 Food and Fiber Marketing (4)**

Food and fiber marketing, examining commodity, industrial, and consumer product marketing from a managerial viewpoint. A global perspective in understanding consumer needs and developing the knowledge of economic, political, social and environmental factors that affect food and fiber marketing systems. 4 lectures. Prerequisite: AGB 212.

**AGB 302 Agricultural Associations and Cooperatives (4)**

Purpose, kinds, organization and management of agricultural cooperatives. Evaluating cooperative performance. Emphasis on California cooperatives, international agricultural cooperatives, and strategic alliances. One-day field trip visiting agricultural cooperatives included. 4 lectures. Prerequisite: AGB 301.

**AGB 303 Introduction to the Horse Racing Industry (4)**

Descriptive analysis of horse racing industry: breeding farms, race tracks, trade associations, training issues, and auction sales. Industry structure, economic flows, contributions to state and local taxes, and racing law. Cultural influences of racing in Europe, Australasia, and Latin America. 4 lectures. Prerequisite: Junior standing.

**AGB 307 World Food Economy (4)**

International agricultural production, economics, and distribution. Comparative and competitive advantage in world agriculture. Food security issues and regional analysis of agriculture policies. The future of agriculture from a global perspective. 4 lectures. Prerequisite: AGB 312.

**AGB 310 Agribusiness Credit and Finance (4)**

Financing California's agricultural industry. Sources of credit and types of loans used by agribusinesses. Costs of credit. Financial analysis of agricultural borrowers. Future and present value techniques used in evaluating agricultural investments. Agricultural financial management. Financial capital markets and leasing. 4 lectures. Prerequisite: One quarter of accounting or AGB 321.

**AGB 312 Agricultural Policy (4)**

Agricultural policy objectives and formulation, resource allocation and production adjustments. Survey of State and Federal agricultural policies as they influence the planning and practices of agribusiness. 4 lectures. Prerequisite: AGB 212; ECON 222.

**AGB 314 Fair and Fair Facility Management (4)**

Fundamentals of the year round operation of a fair facility to include rental opportunities, master planning, and maintenance. Principles and procedures in planning, organizing, operating, and evaluating a fair. One day field trip required. 4 lectures. Prerequisite: Upper division standing.

**AGB 315 Land Economics (4)**

Economics of agricultural and rural land use. Incorporates production economics with welfare theory to explore society's implicit and explicit land use decisions and problems in California, the West and nationwide. Incorporates land use planning and its implicit economic content. 4 lectures. Prerequisite: AGB 213.

**AGB 317 Agriculture–Consumer Relationships (2)**

Basic facts, public opinion and ways of developing greater understanding of agriculture, its nature, characteristics, problems and relationship to nonfarm persons. Consumer education programs and procedures. 2 seminars. Prerequisite: Upper division standing.

**AGB 318 Global Agricultural Marketing and Trade (4)**

Analysis of international marketing opportunities for agricultural products. Strategies for enhancing the performance of U.S. agricultural exports/imports. Impact of government trade policies and regulations, distribution systems, and the changing consumer. 4 lectures. Prerequisite: AGB 301, 312.

**AGB 321 Farm Records (4)**

Fundamentals of record keeping, kinds of records, inventory, depreciation, payrolls, cash and accrual basis of income tax reporting, financial statements and analysis. 3 lectures, 1 activity. Prerequisite: AG 250 or equivalent, upper division standing.

**AGB 322 Principles of Farm Management (4)**

Organization and operation of farm and ranch businesses. Identification of factors affecting profitability. Evaluation of the business for increased efficiency and profit. Application of budgeting to laboratory farms and independent analysis of a farm. 3 lectures, 1 activity. Prerequisite: AGB 212 and BUS 212 or AGB 321.

**AGB 323 Agribusiness Managerial Accounting (4)**

Agribusiness management with an emphasis on using accounting procedures that will provide useful information in making management decisions, setting objectives, and controlling operations. 3 lectures, 1 activity. Prerequisite BUS 212.

**AGB 324 Agricultural Property Management and Sales (4)**

Economic, legal and real estate principles in the investment, development, mortgaging and transferring of agricultural real estate. 3 lectures, 1 activity. Prerequisite: AGB 310 or consent of instructor.

**AGB 326 Farm Appraisal (4)**

Methods of farm appraisal, use of county records, appraisal practice on different types of farms, discussions with professional appraisers. 3 lectures, 1 activity. Prerequisite: AG 250 or equivalent, and upper division standing.

**AGB 331 Farm Accounting (4)**

Application of commercial accounting process to farm and ranch accounting problems. Emphasis on accounting systems that facilitate financial statement presentation, tax preparation and ADP enterprise analysis. Income tax laws pertaining to agriculture. 3 lectures, 1 activity. Prerequisite: BUS 212.

**AGB 336 Commodity Markets in Agribusiness (4)**

Commodity market history, performance, and use in management of agribusiness. Techniques of analysis, hedging, speculation with applications to the agricultural business firm. 4 lectures. Prerequisite: AGB 212 and ECON 222, or consent of instructor.

**AGB 339 Internship in Agribusiness (1-12) (CR/NC)**

Selected students will spend up to 12 weeks with an approved agricultural firm engaged in production or related agribusiness. Time will be spent applying and developing agribusiness functional and managerial skills and abilities. One unit of credit may be allowed for each full week of completed and reported internship. Degree credit limited to 6 units. Credit/No Credit grading only. Prerequisite: Consent of internship instructor.

**AGB 360 Agribusiness Information Technology (4)**

Use of information technologies and advanced computer applications in agribusiness decision-making. Information search and retrieval technologies. Computer languages and programs developed as tools to assist in agribusiness problem-solving. 4 lectures. Prerequisite: AG 250 or demonstration of computer proficiency.

**AGB 400 Special Problems for Advanced Undergraduates (1–2)**

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisite: Consent of department head or instructor.

**AGB 401 Managing Cultural Diversity in Agricultural Labor Relations (4) USCP**

Agricultural labor trends and problems as determined by changes occurring in farming and farm related industries. Labor-management relations in agriculture; principles and procedures in organizing and managing the agricultural business personnel program. 4 lectures. Prerequisite: Senior standing.

**AGB 405 Agribusiness Marketing Research Methods (4)**

Agricultural marketing research data collection and analysis. Emphasis on food sector market segmentation, product positioning, new product testing, sales forecasting, and marketing plan development through secondary and primary data sources. Experimental research design and implementation. 4 lectures. Prerequisite: STAT 221, AGB 301, AGB 318.

**AGB 406 Agribusiness Marketing Planning (4)**

Client centered course where self-managed teams develop agribusiness marketing plan. Emphasis on developing presentation skills. Integration of marketing mix, particularly promotional elements in developing agribusiness marketing strategy emphasized. 4 lectures. Prerequisite: AGB 405.

**AGB 409 California Agricultural Law (3)**

Historical and current sources of law, examination of judicial systems, application of contracts, agency, labor law, torts, property and water law, partnerships, corporations and corporate finance applicable to agricultural enterprises. 3 lectures. Prerequisite: BUS 207, senior standing or consent of instructor.

**AGB 410 Agricultural Lending (4)**

Structure and performance of the agricultural lending industry. Advanced agricultural loan analysis and risk assessment. Agricultural loan documentation, securitization of farm loans, and farm bankruptcy. Exploration of interest rate impacts on agricultural lending. 4 lectures. Prerequisite: BUS 212, AGB 310 and senior standing.

**AGB 412 Advanced Agricultural Policy (4)**

Agricultural resource allocation issues with emphasis on policies that impact the production of food and fiber and inputs used in their production. Special topics in agricultural resource allocation stressing issues and policies emphasizing economic externalities. 4 lectures. Prerequisite: AGB 312, AGB 315, and AGB 421 or AGB 433.

**AGB 418 Seminar in U.S./World Agricultural Trade Issues (2)**

Comparative analysis of agricultural infrastructures and trade policies of major U.S. trading partners within specific world regions (e.g., Latin America, Asia Pacific, Europe, etc.). Particular emphasis on cultural and geo-political influences on the development of world agricultural policies. *Class Schedule* will list topic selected. 2 seminars. Prerequisite: AGB 318.

**AGB 421 Agribusiness Operations Analysis (4)**

Principles and procedures in agricultural business operations analysis and research. Evaluation of programs and problems to achieve optimal decisions. Production and financial data, statistics, pricing, costs, inventories, production level, and plant expansion or contraction. 4 lectures. Prerequisite: AG 250, AGB 213, STAT 221.

**AGB 422 Logistics in Global Agribusiness (4)**

Scope and elements of the agribusiness logistics system including supply and distribution channels, transportation, inventory, warehousing, packaging, and order processing. 4 lectures. Prerequisite: AGB 318, STAT 221.

**AGB 427 Agricultural Estate Planning (2)**

Principles of estate planning with special emphasis on needs of owners of closely held farming businesses. How wills, property ownership, gifts, trusts and continuation agreements affect estate plans. 2 seminars. Prerequisite: Upper division standing.

**AGB 433 Agricultural Price Analysis (4)**

Application of statistical tools for price analysis. Emphasis on price making process for specific agricultural commodities. Utilization of USDA and CDFA market price reports and production estimate data in price forecasting and analysis. 2 two-hour lectures. Prerequisite: STAT 221 and AGB 213.

**AGB 435 Linear Programming in Agriculture (4)**

Application of linear programming to decision making by contemporary farm businesses. Solutions by graphical and mathematical models including appropriate computer software. Economic interpretation of solutions. Applications for multi-product, multi-function farms. Includes introduction to goal and risk programming, transportation models, and multi-period programming. 4 lectures. Prerequisite: AGB 213, and AG 250.

**AGB 440 Field Studies in Agribusiness (2)**

Visitation to selected agribusinesses. Organization, operation, services and problems considered. Miscellaneous course fee required–see *Class Schedule*. Prerequisite: Senior standing or consent of instructor. Can only be taken once for credit in the major.

**AGB 443 Branded Wine Marketing (4)**

Wine pricing as it relates to quality, packaging, and service. Distribution options with emphasis on the three tier system, promotional strategies, including public relations, mass media advertising, personal selling, and direct marketing. Domestic and international marketplaces. 4 lectures. Prerequisite: AGB 301 or BUS 346 or consent of instructor.

**AGB 444 Wine Compliance and Market Analysis (4)**

Legal aspects of wine marketing with emphasis on Federal (BATF) requirements. Application of statistical theory to the collection, interpretation, and forecasting of wine and grape industry data with emphasis on production and sales. Introduction to standard accounting ratios. 4 lectures. Prerequisite: STAT 221 or STAT 252 or equivalent.

**AGB 445 Produce Marketing (2)**

Directed group study of fresh fruit and vegetable marketing. Includes analysis of terminal markets, retail marketing (supermarkets, farmer's markets, roadside stands), limited preserving and ripening, grading and inspection, economics of transportation, international marketing. 2 seminars. Prerequisite: Senior standing and AGB 301.

**AGB 446 Wine Market Analysis (2)**

Application of statistical theory to collection and interpretation of production/sales data. Also includes introduction to forecasting and decision theory. Financial ratios and industry averages. 2 seminars. Prerequisite: AGB 301 or consent of instructor.

**AGB 447 Wine Distribution and Pricing (2)**

Wine distribution channels with emphasis on agents, brokers, distributors, and retailers. Inventory management and distribution cooperatives. Domestic and international shipping regulations. The impact of price on distribution will be highlighted. 2 seminars. Prerequisite: AGB 301 or consent of instructor.

**AGB 448 Governmental Wine Regulations and Compliance (2)**

Legal aspects of wine marketing. Emphasis on federal (BATF) requirements as well as the operation and/or use of state tax laws and state monopolies that tend to restrict the free move-ment of wine. 2 seminars. Prerequisite: Consent of instructor.

**AGB 449 Wine Promotion and Packaging (2)**

All types of mass media promotional strategies and complete coverage of the following areas: personal selling, publicity, public relations, direct marketing, and direct promotions. Label design, packaging, and point of sale promotions. Ethics for responsible advertising. 2 seminars. Prerequisite: AGB 446 or consent of instructor.

**AGB 450 Agribusiness Strategy Formulation (4)**

Development of strategy for farms and farm related businesses where uncontrollable environment makes output and results highly unpredictable; emphasis on the total enterprise. Case analysis. 4 lectures. Prerequisite: Senior standing and AGB 323.

**AGB 451 Strategy and Cases in International Agribusiness (4)**

Exploration of environment, opportunities, and strategic challenges in the rapidly changing global food and fiber system. Developing coordination and control, challenges of worldwide management of functional areas of agribusiness. Focus is practical and managerial through extensive use of case studies. 4 lectures. Prerequisite: Senior standing, AGB 318, AGB 323.

**AGB 455 Advanced Fair Management Seminar (2)**

Advanced studies in fair management with emphasis on budgets, contracts, entertainment, carnivals, exhibit programs, crowd control, master planning maintenance. 2 seminars. Prerequisite: AGB 314.

**AGB 456 Crop Management Problems (4)**

Management problems of crop farms and orchards. Crop enterprise costing procedures, equipment costing and replacement, scheduling of operations to obtain efficiencies. Determination of most profitable rotations and levels of input use. Includes whole farm budget development and analysis. 4 lectures. Prerequisite: AGB 322 and senior status.

**AGB 457 Livestock Management Problems (4)**

Analysis of actual livestock enterprise. Budgeting a ranch by enterprises. Analysis of internal problems such as bull purchase economics, feed buying chart, feedyard economics, cattle price relationships, livestock systems. Includes whole farm budget development and analysis. 4 lectures. Prerequisite: AGB 322 and senior status.

**AGB 458 Dairy Management Problems (4)**

Analysis of actual dairy enterprise. Budgeting a dairy farm by enterprises. Analysis of problems such as load by load milk-feed analysis, value of milk quotas, most profitable concentrate to hay feeding. Includes whole farm budget development and analysis. 4 lectures. Prerequisite: AGB 322 and senior status.

**AGB 460 Research Methodology in Agribusiness (2)**

Empirical application of the scientific method as it relates to the design and development of Senior Project. Research plan is developed. First quarter of Senior Project. 2 seminars. Prerequisite: Senior standing and AGB 213.

**AGB 461 Senior Project (2)**

Completion of a project under faculty supervision. Research topics or projects typical of problems which graduates must solve in the agricultural, food and fiber industries. Project results are presented in a formal report. Minimum 60 hours total time. Prerequisite: Senior standing and AGB 460.

**AGB 463 Undergraduate Seminar (2)**

Individual or group presentation for discussion of subjects and problems within the agribusiness field. 2 seminars. Prerequisite: Senior standing.

**AGB 485 Cooperative Education Experience in Agribusiness (6) (CR/NC)**

Part-time work experience with an approved Agribusiness firm engaged in production or related business, industry or governmental agency. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Degree credit limited to 6 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**AGB 495 Cooperative Education Experience in Agribusiness (12) (CR/NC)**

Full time work experience with an approved Agribusiness firm engaged in production or related business, industry or governmental agency. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Degree credit limited to 6 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**AGB 500 Individual Study in Agribusiness (1–6)**

Advanced independent study planned and completed under the direction of a member of the Agribusiness faculty. Total credit limited to 6 units. Prerequisite: Consent of department head, graduate adviser and supervising faculty member.

**AGB 510 International Development and Agribusiness (4)**

Integration of agricultural development economics, developing economies, markets, and agribusiness with social and institutional limitations. 4 seminars. For students in MS in Agriculture Program/Specialization in Agribusiness. Prerequisite: Graduate standing or consent of instructor.

**AGB 514 Agribusiness Managerial Leadership and Communication (4)**

Current issues in agriculture addressed through the case analysis method. Emphasis on communication skills and leadership qualities,

identifying key success requirements. 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**AGB 515 International Agricultural Marketing (3)**

Organization and function of international agricultural markets with emphasis on developing countries. Factors inhibiting development of an improved agricultural market structure. 3 seminars. Prerequisite: Graduate standing or consent of instructor.

**AGB 516 Agricultural Program Management in Developing Countries (3)**

Overall context of decision making by program managers in developing countries. Case studies and proposal writing for effective program management. 3 seminars. Prerequisite: Graduate standing or consent of instructor.

**AGB 539 Graduate Internship in Agribusiness (1–9)**

Application of theory to the solution of problems of agricultural production or related business in the field of Agribusiness. Analyze specific management problems and perform general management assignments detailed in a contract between the student, the firm or organization, and the faculty adviser before the internship commences. Degree credit limited to 6 units. Prerequisite: Consent of internship instructor.

**AGB 543 Agribusiness Policy and Program Analysis (4)**

Economic, political, and social objectives of domestic agricultural policies and programs. Consequences of govern-ment's policies and programs to control production, allocate resources, support market prices, and provide benefits to food and fiber producers, marketers, and consumers. Topical analysis of current effort of government to direct agriculture. 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**AGB 554 Food System Marketing (4)**

Major issues facing the food system marketer. Vertical and horizontal linkages, pricing in agricultural markets, management of price risk through futures markets and hedging, and public policy and consumer impacts on the system. Student involvement through case studies simulations, and presentations. 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**AGB 555 Technological and Economic Change in Agribusiness (4)**

Ramifications and impacts in agribusiness firms from technological and economic changes. Emphasis on specific agribusiness firms and their managerial process of dealing with problems and opportunities in the operational environments of economic, technology, political, global, domestic and marketing. 4 seminars. Prerequisite: Graduate standing, or consent of instructor.

**AGB 563 International Agribusiness Trade: Cases and Theory (4)**

Changing agricultural trade dynamics in a world economy. Evaluation of firm and government policy strategies in interacting with and expanding markets for agricultural trade. Emphasis on environmental and sustainable trade issues. 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**AGB 570 Selected Topics in Agribusiness (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 12 units. 1 to 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**AGB 571 Selected Advanced Laboratory in Agribusiness (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1–4 laboratories. Prerequisite: Consent of instructor.

**AGB 585 Cooperative Education Experience in Agribusiness (6) (CR/NC)**

Advanced study, analysis and part-time work experience in the field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Total credit limited to 9 units. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

**AGB 595 Cooperative Education Experience in Agribusiness (12) (CR/NC)**

Advanced study, analysis and full-time work experience in the field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Total credit limited to 9 units. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

**AGB 599 Thesis in Agribusiness (1–9)**

Systematic research of a significant problem in Agribusiness. Thesis will include problem identification, significance, methods, data analysis, and conclusion. Students must enroll every quarter in which facilities are used or advisement is received. Degree credit limited to 6 units. Prerequisite: Graduate standing and consent of instructor.

## AGC–AGRICULTURAL COMMUNICATION

**AGC 200 Special Problems in Agricultural Communication (1-4)**

Individual investigation, research, studies or surveys of selected problems in Agricultural Communication/Agricultural Education. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of department head.

**AGC 339 Internship in Agricultural Communication (1–12) (CR/NC)**

Selected Agricultural Communication students will spend up to 12 weeks with an approved agricultural firm engaged in production or related business. Time will be spent applying and developing production and managerial skills and abilities. One unit of credit may be allowed for each full week of completed and reported internship. Degree credit limited to 6 units. Credit/No Credit grading only. Prerequisite: Consent of internship instructor.

**AGC 400 Advanced Special Problems in Agricultural Communication (1-4)**

Individual investigation, research, studies or surveys of selected problems in Agricultural Communication/Agricultural Education. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of department head.

**AGC 407 Agricultural Publications (3) (CR/NC)**

Integration of writing, editing, and layout skills in producing agricultural publications. Emphasis on using computer applica-tions in desktop publishing. Credit/No Credit grading only. Total credit limited to 9 units; may be in same term. 1 lecture, 2 activities. Prerequisite: AG 250, CSC 113, or JOUR 205.

**AGC 426 Presentation Methods in Agricultural Communication (3)**

Development, delivery and evaluation of effective means of communication by use of a variety of presentation methods and the use of technology for effective communication. 3 activities. Prerequisite: SCOM 101.

**AGC 461 Senior Project (2)**

Empirical application of the scientific method as it relates to the selection of a project under faculty supervision. Projects typical of problems that graduates must solve in their field of employ-ment. Minimum 60 hours total time. Prerequisite: AGED 460.

**AGC 462 Senior Project (2)**

Completion of a project begun in AGED 461 under faculty supervision. Projects typical of problems that graduates must solve in their field of employment. Project results are presented in a formal report. Minimum 60 hours total time. Prerequisite: AGED 461 or consent of instructor.

**AGC 470 Selected Advanced Topics (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Consent of instructor.

**AGC 471 Selected Advanced Laboratory (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1–4 laboratories. Prerequisite: Consent of instructor.

**AGC 500 Individual Study in Agricultural Communication (1–3)**

Advanced independent study planned and completed under the direction of a member of the Agricultural Education and Communication faculty. Total credit limited to 6 units. Prerequisite: Consent of department head, graduate adviser and supervising faculty member.

**AGC 539 Graduate Internship in Agricultural Communication (1–9)**

Application of theory to the solution of problems of agricultural production or related business in the field of Agricultural Communication. Analyze specific management problems and perform general management assignments detailed in a contract between the student, the firm or organization, and the faculty adviser before the internship commences. Degree credit limited to 6 units. Prerequisite: Consent of internship instructor.

**AGC 570 Selected Topics in Agricultural Communication (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 12 units. 1 to 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**AGC 571 Selected Advanced Laboratory in Agricultural Communication (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1–4 laboratories. Prerequisite: Consent of instructor.

**AGC 580 Special Problems in Agricultural Communication (1–3)**

Individual study of modern issues and problems conducted through research, planning and development. Field problems and in-service study in agricultural industry encouraged. Final written report required. Total credit limited to 9 units with not more than 3 units in any one quarter. Prior approval of instructor required.

**AGC 581 Graduate Seminar in Agricultural Communication (3)**

Group study of selected developments, trends and issues in the field of Agricultural Communication. 3 seminars. Prerequisite: Graduate standing or consent of instructor.

## AGED–AGRICULTURAL EDUCATION

**AGED 102 Personal Assessment (2) (CR/NC)**

Designed to increase the student's academic, career, and personal self-assessment as it relates to the educational process. Study skill methods, campus academic regulations, available resources and issues that face many university students. Credit/no credit grading only. 2 activities.

**AGED 200 Special Problems in Agricultural Education (1-4)**

Individual investigation, research, studies or surveys of selected problems in Agricultural Communication/Agricultural Education. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of department head.

**AGED 202 Introduction to Agricultural Education and Communication (2)**

Overview of agricultural education career pathways including goals and purposes. Kinds of classes and types of programs. Qualifications essential to success in teaching agriculture. Planned program of studies to meet requirement for teaching agricultural communication or international agriculture. 2 lectures.

**AGED 220 Agriculture Youth Conferences (2) (CR/NC)**

Problems encountered and practices applied during the conduct of the annual FFA State Convention. Methods, procedures and materials adapted for use by the student in developing the committee system to produce conferences, conventions and workshops of all kinds and sizes. Total credit for AGED 220 and AGED 221 limited to 6 units. Credit/No Credit grading only. 2 activities. Prerequisite: Consent of instructor.

**AGED 221 Agriculture Youth Conferences (3) (CR/NC)**

Problems encountered and practices applied during the conduct of the annual FFA State Convention. Methods, procedures and materials adapted for use by the student in developing the committee system to produce conferences, conventions and workshops of all kinds and sizes. Total credit for AGED 220 and AGED 221 limited to 6 units. Credit/No Credit grading only. 3 activities. Prerequisite: Consent of instructor.

**AGED 330 FFA and Supervised Agriculture Programs (6)**

Implementation processes and operational procedures for initiating, conducting and integrating FFA activities and SOE Programs appropriate to community, school and student needs. Demonstration, application and observation of practices and techniques utilized by agriculture instructors in conducting organized classroom, shop, school farm, laboratory and home visit instruction in agriculture, FFA and SOE activities. 3 activities, and supervision. Prerequisite: AGED 202.

**AGED 339 Internship in Agricultural Education (1–12) (CR/NC)**

Selected Agricultural Education students will spend up to 12 weeks with an approved agricultural firm engaged in production or related business. Time will be spent applying and developing production and managerial skills and abilities. One unit of credit may be allowed for each full week of completed and reported internship. Degree credit limited to 6 units. Credit/No Credit grading only. Prerequisite: Consent of internship instructor.

**AGED 400 Advanced Special Problems in Agricultural Education (1-4)**

Individual investigation, research, studies or surveys of selected problems in Agricultural Communication/Agricultural Education. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of department head.

**AGED 404 Agricultural Leadership (3)**

Emphasis upon equipping current and prospective leaders in agriculture with the background and skills to achieve their potential. Class members will assess their status as leaders and identify means to improve their effectiveness. Focus on the theoretical underpinnings of human motivation, personal leadership, and organizational development. 2 lectures, 1 activity. Prerequisite: PSY 201 or PSY 202.

**AGED 410 Computer Applications in Agricultural Education (2)**

Development of computer literacy for teaching agriculture. Analysis and specialization of hardware. Instruction in video and telecommunication technology, CATI network systems and software applicable to vocational agriculture. Recommended for Agricultural Science majors and required for teaching credential candidates. Prerequisite: AG 250 or CSC 110 and consent of instructor.

**AGED 424 Organizing and Teaching Agriculture (3)**

Determining course objectives, content, and calendar for use by the teacher in classroom, shop and field instruction while assigned to

community schools. Concurrent with student teaching. 3 activities. Prerequisite: AGED 438 and consent of instructor.

**AGED 438 Instructional Processes in Agricultural Education (3)**

Preparation for student teaching in agriculture. Orientation to classroom situation. Development of plans for teaching including daily lessons and unit plans; utilization of source information and resources. Class demonstration in teaching procedures; analysis and evaluation. 1 lecture, 2 activities.

**AGED 440 Student Teaching in Agricultural Education (6–12) (CR/NC)**

Off-campus assignment to a selected cooperating public school. Participation in all phases of agriculture teacher duties and activities including departmental organization and administration. Prior approval and appointment necessary. Total credit limited to 18 units. Credit/No Credit grading only.

**AGED 441 Student Teaching Practicum (2)**

Problems encountered and practices applied during student teaching. Methods, procedures and materials adapted for use by the teacher concurrent with student teaching. 2 activities. Prerequisite: Consent of instructor.

**AGED 460 Research Methodology in Agricultural Education and Communication (1)**

Introduction of the research process and topic selection as it relates to the design and development of the senior project within the Agricultural Sciences major. 1 lecture. Prerequisite: Junior standing.

**AGED 461 Senior Project (2)**

Empirical application of the scientific method as it relates to the selection of a project under faculty supervision. Projects typical of problems that graduates must solve in their field of employ-ment. Minimum 60 hours total time. Prerequisite: AGED 460.

**AGED 462 Senior Project (2)**

Completion of a project begun in AGED 461 under faculty supervision. Projects typical of problems that graduates must solve in their field of employment. Project results are presented in a formal report. Minimum 60 hours total time. Prerequisite: AGED 461 or consent of instructor.

**AGED 470 Selected Advanced Topics (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Consent of instructor.

**AGED 471 Selected Advanced Laboratory (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1–4 laboratories. Prerequisite: Consent of instructor.

**AGED 500 Individual Study in Agricultural Education (1–3)**

Advanced independent study planned and completed under the direction of a member of the Agricultural Education and Communication faculty. Total credit limited to 6 units. Prerequisite: Consent of department head, graduate adviser and supervising faculty member.

**AGED 513 Field Experience–Vocational Agriculture (1–3)**

Practice and techniques in management and supervision of vocational agriculture programs. Relationships among students, staff, community and school groups. Budgeting, staffing, records, reporting. Student activities and Future Farmers of America programs. Total credit limited to 6 units. Prerequisite: Prior approval and appointment.

**AGED 520 Program Development in Agricultural Education (3)**

Development of up-to-date approaches to a total integrated program based on occupational opportunities and community needs. Philosophy, organization and administration of agricultural education programs. Development in such areas as curriculum, supervised occupational experience, Future Farmers of America, and summer programs. 3 seminars.

**AGED 522 Instructional Programs in Agricultural Mechanics (3)**

Organizing the vocational agriculture mechanics curriculum and determining course content. Student demonstrations and presentations; evaluation and analysis. 1 seminar, 2 laboratories.

**AGED 539 Graduate Internship in Agricultural Education (1–9)**

Application of theory to the solution of problems of agricultural production or related business in the field of Agricultural Education. Analyze specific management problems and perform general management assignments detailed in a contract between the student, the firm or organization, and the faculty adviser before the internship commences. Degree credit limited to 6 units. Prerequisite: Consent of internship instructor.

**AGED 570 Selected Topics in Agricultural Education (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 12 units. 1 to 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**AGED 571 Selected Advanced Laboratory in Agricultural Education (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1–4 laboratories. Prerequisite: Consent of instructor.

**AGED 580 Special Problems in Agricultural Education (1–3)**

Individual study of modern issues and problems conducted through research, planning and development. Field problems and in-service study in agricultural industry encouraged. Final written report required. Total credit limited to 9 units with not more than 3 units in any one quarter. Prior approval of instructor required.

**AGED 581 Graduate Seminar in Agricultural Education (3)**

Group study of selected developments, trends and issues in the field of Agricultural Education. 3 seminars. Prerequisite: Graduate standing or consent of instructor.

## ANT–ANTHROPOLOGY

**ANT 201 Cultural Anthropology (4)** **GE D3**

Contemporary human cultures throughout the world. General patterns sought within the diversity of individual cultures. Includes such topics as: family organization; gender roles; adaptation to the environment; systems of economic exchange; political organization and leadership; religious beliefs and values; ethnicity and cultural pluralism; impact of Western culture on the developing world. 4 lectures.

**ANT 202 World Prehistory (4)**

Development of the diverse human cultures of both the Old and New Worlds from the earliest times until the dawn of history; cultural growth. 4 lectures.

**ANT 250 Biological Anthropology (4)** **GE B2**

Biological aspects of human unity and diversity. Primate and human evolution, including anatomical, physiological and behavioral adaptations. Origin and diversity of modern races. 4 lectures.

**ANT 310 Archaeological Field Methods (4)**

Diversity of California Indian cultures; field studies in locating, surveying, and analyzing aboriginal sites; excavation of a site; laboratory techniques for recording, preserving, and reporting of artifacts; relating observations and finds to the natural environment in which the site is located; integrating knowledge of natural and social sciences for the use in archaeology. 3 lectures, 1 laboratory. Prerequisite: A course in anthropology or consent of instructor.

**ANT 311 Archaeological Laboratory Methods (4)**

Principles of archaeological excavation; recording, stratigraphy, dating, field conservation, and interpretation; cultural resources management. 3 lectures, 1 laboratory. Prerequisite: An anthropology course or consent of instructor.

**ANT 325 Precolumbian Mesoamerica (4) GE D5**

Cultures of Mesoamerica (Mexico and Central America) from earliest times to the Spanish Conquest. Olmec, Teotihuacano, Zapotec, Maya and Aztec civilizations. Major topics include religion, politics, warfare, art, writing, calendrics, ecology and trade. 4 lectures. Prerequisite: Completion of GE Area A, one course in D2 and one course in D3.

**ANT 344 Sex, Death, and Human Nature (4) GE D5**

How Darwinian processes of differential reproduction and mortality influence human interests, passions and behaviors. Theories of inclusive fitness, parental investment and senescence. Sex differences, sexual attraction, life histories, violence and aggression, including rape, homicide and infanticide. 4 lectures. Prerequisite: Completion of GE Area A, one course in D3 and one course in D4.

**ANT 360 Human Cultural Adaptations (4) GE D5**

Social and cultural evolution from Paleolithic times to the present. Interactions of demographic, economic and ecological factors are emphasized. Main topics include human nature/culture, sex and gender, cooperation and conflict, the "agricultural revolution", state formation, social inequality and globalization. 4 lectures. Prerequisite: Completion of GE Area A, one course in D2 and one course in D3.

**ANT 401 Culture and Health (4)**

Global perspective on the relationship between culture and health. Ecological factors influencing health and illness. Origins of disease and impact of diseases on society. Diet and nutrition. Classifications of illness causation. Kinds of curers. Relationship of gender and reproduction to illness. Pharmacology. Mental illness. Global health problems. Alternative health care modalities. Health-care needs of U.S. ethnic groups. 4 lectures. Prerequisite: Junior standing.

**ANT 405 Indonesia (4)**

Cultures and societies of Indonesia with particular emphasis on Bali. Topics include art and ritual, kinship, marriage, gender, politics, economics and colonialism. 4 lectures. Prerequisite: One upper division ANT course or consent of instructor.

**ANT 415 Native American Cultures (4) USCP**

Survey of Native American cultures from earliest times to present, emphasizing regional diversity in traditional lifeways. Origins of New World peoples, domestication, war, social organization, trade and gender roles. 4 lectures. Prerequisite: One upper division ANT course or consent of instructor.

**ANT 433 Language and Culture (4)**

A global perspective on the social and cultural factors which influence language form and language use. Topics include: language and thought; the origins and development of human language; language learning; language and cultural metaphors; language and political persuasion; language and gender; language and social stratification; dialects; bilingualism and multilingualism; language and ethnic identity. 4 lectures. Prerequisite: Junior standing.

**ANT 435 Pacific Islands Cultures (4)**

Overview of Pacific Islands cultures. Individual cultures in each of the three major cultural and geographic areas – Micronesia, Melanesia, and Polynesia – will be studied in depth using the case study approach. The impact of Western culture on the Pacific from the early explorations through colonialism, World Wars I and II to independence. 4 lectures. Prerequisite: Junior standing.

**ANT 450 Area Studies (4)**

Comparative analysis of cultural diversity and uniformity within a selected region (e.g., Latin America, Subsaharan Africa). *Class Schedule* will list topic selected. Total credit limited to 12 units. 4 lectures. Prerequisite: ANT 201 or consent of instructor.

**ANT 470 Selected Advanced Topics (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topics selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Consent of instructor.

## ARCE–ARCHITECTURAL ENGINEERING

Note: All ARCE majors must obtain a grade of C- or better in every ARCE course taken.

**ARCE 221 Elementary Structures (3)**

Forces on building structures. Static equilibrium and stability of structural systems. Shear and bending moment diagrams. 3 lectures. Prerequisite: PHYS 131, MATH 142.

**ARCE 222 Mechanics of Structural Members I (3)**

Stress-strain relationships. Stresses and deformations in structural members due to axial force, shear, torsion, and moment. 3 lectures. Prerequisite: ARCE 221.

**ARCE 223 Mechanics of Structural Members II (4)**

Advanced topics of stresses in beams. Plastic bending, unsymmetrical bending. Combined stresses. Stress transformation. Buckling. Deflection of beams. Analysis of indeterminate structures. Material test laboratory. 3 lectures, 1 laboratory. Prerequisite: ARCE 222. Concurrent: ARCE 351.

**ARCE 225 Dynamics (3)**

Dynamics of particles and rigid bodies. 3 lectures. Prerequisite: ARCE 221 and MATH 241.

**ARCE 226 Structural Systems for Architects (3)**

Description, behavior and comparison of structural building systems. Concepts of structural stability, load flow, framing schemes and building configuration related to vertical and lateral loads. For architecture and construction management students. 3 lectures. Prerequisite: ARCE 222.

**ARCE 227 Structural Analysis I (2)**

Continuation of ARCE 221. Advanced topics in two-dimensional equilibrium and three-dimensional equilibrium of structural building systems. 2 lectures. Prerequisite: ARCE 221.

**ARCE 240 Additional Engineering Laboratory (1–2)**

Total credit limited to 4 units, with a maximum of 2 units per quarter. 1 or 2 laboratories.

**ARCE 257 Structural CAD for Building Design (2)**

Emphasis on the use of computer graphics software to represent a building's structural system and its individual elements. Miscellaneous course fee may be required–see *Class Schedule.* 1 lecture, 1 laboratory. Prerequisite: EDES 113. Recommended corequisite: ARCH 231.

**ARCE 302 Structural Analysis II (3)**

Analysis of statically indeterminate structures. Energy methods. Slope-deflection. Moment distribution including sidesway. 3 lectures. Prerequisite: ARCE 223 and ARCE 227. Concurrent: ARCE 352.

**ARCE 303 Steel Design I (3)**

Analysis and design of steel structural members subjected to bending, shear and axial forces. 3 lectures. Prerequisite: ARCE 227. Concurrent: ARCE 302.

**ARCE 304 Timber Design (3)**

Analysis and design of timber structural members subjected to bending, shear, and axial forces. Wood diaphragms, shear walls and their connections. 3 lectures. Prerequisite: ARCE 223 and ARCE 227.

**ARCE 305 Masonry Design (2)**
Design of load-bearing walls, shear walls, columns and beams in masonry. 2 lectures. Prerequisite: ARCE 223 and ARCE 227.

**ARCE 306 Matrix Analysis of Structures (3)**
Analysis of statically indeterminate structures by direct stiffness method including continuous beams, plane trusses, and frames. Introduction to finite-element methods. 3 lectures. Prerequisite: ARCE 302. Concurrent: ARCE 353.

**ARCE 311 Structures for Landscape Architects (3)**
Structural concepts related to landscape architecture. Design of retaining walls, decks, trellises, bridges and large-scale covered spaces. 3 lectures.

**ARCE 321 Timber Structural Systems (3)**
Concepts related to system behavior; selection; design and construction specific to timber structures. Preliminary member design and detailing. Load flow implications related to building configurations; including vertical and lateral load resisting elements. For architecture and construction management students. 3 lectures. Prerequisite: ARCE 226. May not be taken concurrently with ARCE 322 or ARCH 323.

**ARCE 322 Steel Structural Systems (3)**
Concepts related to system behavior; selection; design and construction specific to steel structures. Preliminary member design and detailing. Load flow implications related to building configurations; including vertical and lateral force resisting elements. For architecture and construction management students. 3 lectures. Prerequisite: ARCE 226. May not be taken concurrently with ARCE 321 or ARCH 323.

**ARCE 323 Concrete Structural Systems (3)**
Concepts related to system behavior; selection; design and construction specific to concrete structures. Preliminary member design and detailing. Load flow implications related to building configurations; including vertical and lateral force resisting elements. Introduction to issues related to foundation design. For architecture and construction management students. 3 lectures. Prerequisite: ARCE 226. May not be taken concurrently with ARCE 321 or ARCH 322.

**ARCE 351 Structural Computing Analysis I (1)**
Computer calculations, programming and technical reporting. Emphasis on use of spreadsheets to generate structural analyses of buildings: the structural system and its individual elements. Miscellaneous course fee may be required–see *Class Schedule.*
1 laboratory. Prerequisite: ARCE 222, CSC 231 or CSC 234 or approved equivalent. Concurrent: ARCE 223.

**ARCE 352 Structural Computing Analysis II (1)**
Computer calculations, programming and technical reporting. Emphasis on use of two-dimensional structural analysis software to analyze a building's structural system and its individual elements. Miscellaneous course fee may be required–see *Class Schedule.* 1 laboratory. Prerequisite: ARCE 222. Concurrent: ARCE 302.

**ARCE 353 Structural Computing Analysis III (1)**
Emphasis on the use of nonplanar structural analysis software to analyze a building's structural system and its individual elements. Miscellaneous course fee may be required–see *Class Schedule.* 1 laboratory. Prerequisite: ARCE 302. Concurrent: ARCE 306.

**ARCE 371 Structural Systems Laboratory (3)**
Studies in the relationship of structural framing to overall building geometry with emphasis on the statical stability of structural configurations and load flow. 3 laboratories. Prerequisite: ARCE 223 and ARCE 227. Co-requisite: ARCE 302.

**ARCE 372 Steel Structures Design Laboratory (3)**
Design project utilizing structural steel. 3 laboratories. Prerequisite: ARCH 231, ARCE 257, ARCE 302, ARCE 303, ARCE 352 and ARCE 371.

**ARCE 400 Special Problems for Advanced Undergraduates (1–2)**
Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisite: Consent of department head.

**ARCE 403 Advanced Steel Structures Laboratory (3)**
Advanced topics in design of steel structures with emphasis on plate girders, plastic design of continuous beams and frames and composite steel-concrete design. 3 laboratories. Prerequisite: ARCE 303, ARCE 372.

**ARCE 412 Dynamics of Framed Structures (3)**
Analysis of structures subjected to dynamic loads with single- and multi-degrees of freedom. Development of techniques for analysis of structures in response to seismic, wind, and moving loads. Solution of problems by digital computer. 3 lectures. Prerequisite: ARCE 225 or ME 212, MATH 242, CSC 342 and ARCE 306.

**ARCE 414 Precast Concrete (3)**
Precast and prestressed concrete principles, materials and techniques of construction. Design of basic precast elements and connections and prestressed concrete fundamentals as applied to precast concrete. Design potentials, aesthetics, cost and construction time as related to buildings and other structures. 3 laboratories. Prerequisite: ARCE 444.

**ARCE 421 Soil Mechanics (3)**
Principles of soil mechanics, including rudiments of geology, soil classification, gravimetric and volumetric relations, compaction, methods and testing, shear strength of soil and strength theories. 2 lectures, 1 laboratory. Prerequisite: ARCE 222, GEOL 201.

**ARCE 422 Foundation Design (3)**
Soil-bearing capacity and settlement characteristics of soils. Sizing and design of spread footings. Design and analysis of earth-retaining structures. 3 lectures. Prerequisite: ARCE 421.

**ARCE 423 Advanced Foundation Design (3)**
Design and analysis of beams on elastic foundations and mat foundations. Pile foundations and sheet pile retaining structures. 3 lectures. Prerequisite: ARCE 422.

**ARCE 444 Reinforced Concrete Laboratory (3)**
Theory and design of basic reinforced concrete elements: columns, beams, tee beams and one way slabs. 3 laboratories. Prerequisite: ARCE 371 and ARCE 372 or ARCE 451.

**ARCE 445 Prestressed Concrete Design Laboratory (3)**
Design and analysis of prestressed concrete structures. 3 laboratories. Prerequisite: ARCE 444.

**ARCE 446 Advanced Structural Systems Laboratory (3)**
Concepts and issues involved in the design of complex structures including tall buildings, shells, arches and tension structures. 3 laboratories. Prerequisite: ARCE 226 or ARCE 371.

**ARCE 447 Advanced Reinforced Concrete Laboratory (3)**
Advanced topics in the design of reinforced concrete structures with emphasis on isolated and combined foundations, retaining walls, seismic-resistant ductile frames and yield line theory. 3 laboratories. Prerequisite: ARCE 444.

**ARCE 451 Timber and Masonry Structures Design Laboratory (3)**
Design projects utilizing timber and masonry. Relationship of structural detailing to overall structural behavior. Production of structural calculations and drawings. 3 laboratories. Prerequisite: ARCH 231, ARCE 257, ARCE 302, ARCE 304, ARCE 305 and ARCE 371.

**ARCE 452 Concrete Structures Design Laboratory (3)**
Design projects utilizing reinforced concrete. Layout of the structure and preliminary design. Production of design calculations and structural drawings. 3 laboratories. Prerequisite: ARCH 231, ARCE 257 and ARCE 444.

**ARCE 453 Senior Project Laboratory (3)**

Projects by individuals or teams which involve, but are not limited to, physical modeling and testing of integrated design projects which may include students from other disciplines. 3 laboratories. Prerequisite: ARCE 451 or ARCE 452, ARCE 483.

**ARCE 460 Collaborative Design Laboratory (1)**

Investigation of the collaborative nature of the design process as it relates to the structural engineer and architect. Development of skills necessary to create a successful design tem through the development of specific projects. Total credit limited to 2 units. 1 laboratory. Prerequisite: ARCE 371 and ARCE 372 or ARCE 451 or ARCE 452.

**ARCE 470 Selected Advanced Topics (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1–4 lectures. Prerequisite: Consent of instructor.

**ARCE 471 Selected Advanced Laboratory (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1–4 laboratories. Prerequisite: Consent of instructor.

**ARCE 480 Senior Seminar (1)**

Discussion of selected topics that are of current interest to the structural engineering profession. 1 seminar. Prerequisite: Senior standing.

**ARCE 481 Structural Experimental Laboratory (1)**

Application of techniques of physical modeling to obtain solutions to structural design problems. Miscellaneous course fee may be required–see *Class Schedule.* 1 laboratory. Prerequisite: ARCE 444.

**ARCE 483 Seismic Analysis and Design (4)**

Introduction to dynamic response analysis of building structures with emphasis on earthquake ground motion. Earthquake resistant design of buildings in accordance with building codes. Application of computer programs and physical models for seismic design. Laboratory studies utilizing physical models for studying the behavior of building structures subjected to simulated ground motions. 3 lectures, 1 activity. Prerequisite: ARCE 225 or ME 212, ARCE 372, ARCE 412, CSC 342.

**ARCE 485 Cooperative Education Experience (6) (CR/NC)**

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Credits to not count toward graduation in the ARCE Degree Program. Prerequisite: Sophomore standing and consent of department head.

**ARCE 490 History of Structures (3)**

Tracing developments in structural materials, structural understanding and complete structures from ancient times through the industrial revolution and the present day. 3 lectures. Prerequisite: Junior standing.

**ARCE 495 Cooperative Education Experience (12) (CR/NC)**

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Credits to not count toward graduation in the ARCE Degree Program. Prerequisite: Sophomore standing and consent of instructor.

**ARCE 504 Finite Element Method for Building Structures (3)**

Basic concepts of equilibrium and compatibility. Stiffness and flexibility properties of various types of finite elements. Development and application of displacement and force methods. Elastic stability and dynamic response of buildings to earthquake, wind, and moving loads. Use of finite-element computer programs. 3 lectures. Prerequisite: MATH 242, ARCE 306.

**ARCE 521 Architectural Structures (3)**

Static and dynamic loads, structural equilibrium and stability, structural configurations and systems, response to dynamic loads, behavior of structures. 2 seminars, 1 activity. Prerequisite: Graduate standing in Architecture.

**ARCE 522 Structural Systems (3)**

Exploration of the relationship between structural systems and architectural form. Understanding of structural stability and structural order is developed through construction of a series of small scale models. Historical perspectives are presented along with the effects of available materials and technology on structural possibilities. 3 seminars. Prerequisite: Graduate standing in Architecture.

**ARCE 523 Seismic Design for Architects (3)**

Introduction to the earthquake resistant design of buildings. Observed behavior of buildings during earthquakes. Recent developments of seismic design procedures, provisions, and building codes. Influence of architectural form on seismic response. 3 lectures. Prerequisite: Graduate standing in Architecture.

## ARCH–ARCHITECTURE

**ARCH 101 Survey of Architectural Education and Practice (2) (CR/NC)**

Exploration of the major paradigms which have guided the development of architectural education and the profession. Survey of the roles of the architects and an introduction to curricula and programs designed to prepare students for careers in architecture. Credit/No Credit grading only. This requirement may be replaced by a professional elective for upper division transfer students. 2 lectures.

**ARCH 106 Materials of Construction (3)**

Use and application of construction processes and materials. Miscellaneous course fee required–see *Class Schedule*. 2 lectures, 1 laboratory.

**ARCH 111 Introduction to Drawing and Perspective (3)**

Basic techniques used in graphic communication. Orthographic and isometric projection. Mechanical perspective, shades and shadows. 3 laboratories.

**ARCH 121 Beginning Design and Drawing I (3)**

Principles, concepts, methods and skills pertaining to the freehand and drafted construction of drawings employing orthographic, axonometric, oblique, and lineal perspective drawings systems to visually represent ideas, objects and environments. Basic principles and concepts of two- and three-dimensional visual and architectural design. 3 laboratories.

**ARCH 122 Beginning Design and Drawing II (3)**

Continuation and development of content and issues introduced in ARCH 121, plus the principles, concepts, methods and skills pertaining to the freehand and drafted construction of shadows, physical model building, entourage and color theory. 3 laboratories. Prerequisite: ARCH 121.

**ARCH 123 Beginning Design and Drawing III (3)**

Continuation and development of content and issues introduced in ARCH 121 and ARCH 122, plus the principles, concepts, methods and skills pertaining to the freehand and visualization and communication of quantitative and qualitative information to support analyses and conceptualization. 3 laboratories. Prerequisite: ARCH 122.

**ARCH 124 Image Editing in Architectural Design and Presentation (1)**

Substantive introduction to scanning, image editing and image creation as applicable to architectural design and presentation. 1 seminar.

**ARCH 125 3-D Digital Modeling in Architectural Design and Presentation (1)**

Substantive introduction to the creation of three-dimensional digital models and their output as applicable to architectural design and presentation. 1 seminar.

**ARCH 126 Page Layout and 2-D Vector Graphics in Architectural Design and Presentation (1)**

Substantive introduction to page layout and the creation of two-dimensional vector drawings as applicable to architectural design and presentation. 1 seminar.

**ARCH 127 Web Site Development in Architectural Design and Presentation (1)**

Substantive introduction to the creation of web pages and sites as applicable to architectural design and presentation. 1 seminar. Prerequisite or concurrent: ARCH 124.

**ARCH 131 Design and Visual Communication I (4)**

Principles, concepts, methods and skills pertaining to freehand, drafted and computer construction of drawings employing orthographic, axonometric, oblique, and lineal perspective drawings systems to representative ideas, objects and environments. Basic principles and concepts of two- and three-dimensional visual and architectural design. It is highly recommended that students purchase a computer, software and peripherals to participate in this course. 4 laboratories.

**ARCH 132 Design and Visual Communication II (4)**

Continuation and development of content and issues introduced in ARCH 131 plus the principles, concepts, methods and skills pertaining to freehand, drafted and computer construction of shadows, digital and physical model building, entourage and color theory. It is highly recommended that students purchase a computer, software and peripherals to participate in this course. 4 laboratories. Prerequisite: ARCH 131.

**ARCH 133 Design and Visual Communication III (4)**

Continuation and development of content and issues introduced in ARCH 131 and ARCH 132, plus the principles, concepts, methods and skills pertaining to freehand, drafted and computer visualization and communication of quantitative and qualitative information to support analysis and conceptualization. It is highly recommended that students purchase a computer, software and peripherals to participate in this course. 4 laboratories. Prerequisite: ARCH 132.

**ARCH 202 Creative Problem-Solving (3)**

Techniques for stimulating creative behavior applied to general and environmental problems. Development of problem-solving and decision-making skills and knowledge. 3 lectures.

**ARCH 204 Architectural Theory (3)**

Theories of architectural design. 3 lectures. Prerequisite: EDES 101.

**ARCH 207 Environmental Control Systems I (4)**

Theory and application of climate, energy use and comfort as determinants of architectural form. Emphasis on architectural methods of ventilating, cooling, heating, and lighting for envelope-load dominated buildings. 2 lectures, 2 laboratories. Miscellaneous course fee required–see *Class Schedule*. Prerequisite: PHYS 131, PHYS 132 or PHYS 121, PHYS 122. Concurrent: ARCH 253.

**ARCH 217 History of World Architecture: Prehistory – Middle Ages (4) GE C3**

Architecture and urbanism in the ancient world, from prehistory to the Middle Ages. Social, cultural and physical conditions that influenced the built environment to the Mediterranean basis, plus Europe, Asia, Africa and Pre-Columbian America. 4 lectures.

**ARCH 218 History of World Architecture: Middle Ages – 18th Century (4) GE C3**

World architecture and urbanism from the Middle Ages until the end of the 18th century Baroque. Social, cultural and physical conditions which influenced the built environment of Europe, Asia, and the Pre-Columbian and Colonial Americas. 4 lectures.

**ARCH 219 History of World Architecture: 18th Century – Present (4) GE C3**

Architecture and urbanism of the modern world, from the 18th century to the present. Social, cultural and physical conditions influencing the built environment of Europe, Asia, Africa and the Americas. 4 lectures.

**ARCH 221, 222 Architectural Design Fundamentals (3) (3)**

Development of knowledge and abilities in the theories, processes, and methods of creative problem solving; basic visual and verbal communication; basic two and three-dimensional design and composition and the analysis of the built environment. 3 laboratories. Prerequisite: EDES 101, ARCH 111, EDES 113.

**ARCH 231 Architectural Practice (3)**

Wood construction methods and processes. Construction documents used as communication medium for such methods and processes. 3 laboratories. Prerequisite: ARCH 106 plus ARCH 122 or ARCH 132 or ARCH 111.

**ARCH 240 Additional Architectural Laboratory (1–2)**

Total credit limited to 4 units, with a maximum of 2 units per quarter. 1 or 2 laboratories.

**ARCH 250 Computer Applications (3)**

Introduction to the application of computers in architecture. History of computing and its use in architectural practice, hardware options, operating systems, electronic mail, databases, programming languages, graphics systems, survey and use of selected applications in architecture. Miscellaneous course fee may be required–see *Class Schedule*. 2 lectures, 1 laboratory.

**ARCH 251 Architectural Design Fundamentals I (5)**

Theories, principles, methods and means pertaining to the creation of two- and three-dimensional visual organizations to communicate intended concepts and meanings. 5 laboratories. Prerequisite: ARCH 123 or ARCH 133; prerequisite or concurrent: EDES 101.

**ARCH 252 Architectural Design Fundamentals II (5)**

Continuation of the content and issues introduced in ARCH 251 plus the theories, principles, methods and means pertaining to the creation of architectural form, space and organizations and the incorporation of function and light as issues that shape the built environment and support the communication of intended concepts and meanings. 5 laboratories. Prerequisite: ARCH 251; prerequisite or concurrent: ARCH 124, ARCH 125, ARCH 126, ARCH 127 or ARCH 133.

**ARCH 253 Architectural Design Fundamentals III (5)**

Continuation of the content and issues introduced in ARCH 251 and ARCH 252 plus the theories, principles, methods and means pertaining to the incorporation of context, structure and climate as issues that shape the built environment and support the communication of intended concepts and meanings. 5 laboratories. Prerequisite: ARCH 251, ARCH 252, ARCH 106. Concurrent: ARCH 207.

**ARCH 270 Selected Topics (1–4)**

Directed group study of selected topics. *Class Schedule* will list topic selected. Open to first-, second-, third-year students. Total credit limited to 8 units. 1 to 4 lectures.

**ARCH 302 Principles of Architectural Design (3)**

Basic theory of the art of architecture and its application in architectural design. 3 lectures. Prerequisite: ARCH 204.

**ARCH 303 Human Factors for Environmental Designers (3)**

Integrated approach to development of systematic design programs. Developing and interpreting human factors design criteria, performance and satisfaction as a function of environmental factors, determining and assessing user preferences, methods of field observation and analysis. 3

lectures. Prerequisite: Second-year standing in College of Architecture and Environmental Design or consent of instructor.

**ARCH 307 Environmental Control Systems II (4)**

Theory and application in the integration of environmental control systems and architectural form. Comprehensive techniques for achieving an architecture of the well-tempered environment. Miscellaneous course fee required–see *Class Schedule*. 2 lectures, 2 laboratories. Prerequisite: ARCH 207. Concurrent: ARCH 352.

**ARCH 310 Architectural Design Methods and Theories (4)**

Analysis of design process, methods of analysis, synthesis, and evaluation in design. Relation between methods used and theories of design. 4 lectures. Prerequisite: ARCH 253.

**ARCH 313 Advanced Delineation (2)**

Development of proficiency in architectural presentation. Projects and critiques. 2 laboratories. Prerequisite: ARCH 253.

**ARCH 316 California Architecture and the California Dream (3)**

Development of California Architecture as the symbolic expression of the myth of the California Dream. Focus on tracing California's unique contribution to architecture and urban patterns in the United States. 3 lectures. Prerequisite: ENGL 134.

**ARCH 320 History of Asian Architecture and the Built Environment (4) GE C4**

Architecture and the built environment of Asia from prehistory to the present. Major monuments, urbanism, and common building. Some important historical, geographic, religious and cultural factors that affected the shaping of the built environment. 4 lectures. Prerequisite: GE Area A1 and one of the following Area C3 courses: ARCH 217, 218, 219, or ART 112.

**ARCH 337 Photographic Presentation (2)**

Media presentations in architecture with emphasis on black and white and color print photographic presentations, formats, and techniques applicable to architecture subjects and to design communication. 1 lecture, 1 laboratory. Prerequisite: ARCH 121, ARCH 122, ARCH 123 or ARCH 131, ARCH 132, ARCH 133.

**ARCH 338 Media Presentations in Architecture (2) (CR/NC)**

Media presentations in architecture with emphasis on photographic color slide presentations, formats and techniques applicable to architectural subjects and to design communication. For students in CAED. Credit/No Credit grading only. 1 lecture, 1 laboratory. Prerequisite: ARCH 121, ARCH 122, ARCH 123 or ARCH 131, ARCH 132, ARCH 133.

**ARCH 339 Video Presentations in Architecture (2) (CR/NC)**

Media presentations in architecture with emphasis on video format and creative camera and editing techniques as applicable to subjects in architecture and design communication. Open to students in CAED. Credit/ No Credit grading only. 1 lecture, 1 laboratory. Prerequisite: ARCH 121, ARCH 122, ARCH 123 or ARCH 131, ARCH 132, ARCH 133.

**ARCH 341, 342 Architectural Practice (4) (4)**

Construction systems in masonry, steel, and concrete and combinations of these materials. Preparation of outline specifications. Production of design development drawings. 2 lectures, 2 laboratories. Prerequisite: ARCH 231, ARCH 253. Concurrent enrollment required in ARCH 341: ARCH 351; ARCH 342: ARCH 353.

**ARCH 350 Computer Applications in Architecture (3)**

Applications of computer systems to large-scale data processing, analysis, optimization and evaluation of design program elements. 2 lectures, 1 activity. Prerequisite: Consent of instructor.

**ARCH 351 Architectural Design (5)**

Continuation of ARCH 253. Development and exploration of architectural theories, building systems, and design processes involved in creating appropriate architecture on a sensitive site; implications of the site as building form generator.-Miscellaneous course fee required–see *Class Schedule*. 5 laboratories. Prerequisite: ARCE 226, ARCH 231, ARCH 253. Concurrent: ARCH 341.

**ARCH 352 Architectural Design (5)**

Continuation of ARCH 351. Development and exploration of architectural theories, building systems, and design processes involved in creating appropriate sustainable architecture with an emphasis on ecological and environmental concerns. Miscellaneous course fee required–see *Class Schedule*. 5 laboratories. Prerequisite: ARCE 226, ARCH 231, ARCH 253. Concurrent: ARCH 307.

**ARCH 353 Architectural Design (5)**

Continuation of ARCH 352. Development and exploration of architectural theories, building systems, and design processes involved in creating appropriate architecture with an emphasis on socio-cultural and space planning/life safety concerns. Miscellaneous course fee required–see *Class Schedule*. 5 laboratories. Prerequisite: ARCE 226, ARCH 231, ARCH 253. Concurrent: ARCH 342.

**ARCH 363 Off-Campus Orientation Seminar (2) (CR/NC)**

Preparation for off-campus architectural study programs includes cultural orientation, an introduction to basic language skills, travel and housing protocols as well as academic and financial advising. Credit/No Credit grading only. Total credit limited to 4 units, with a maximum of 2 units per quarter. 2 seminars. Prerequisite: Consent of instructor.

**ARCH 400 Special Problems for Advanced Undergraduates (1–2)**

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

**ARCH 401 Toward a Barrier-Free Environment (3)**

Exploring the interface between the built environment and human behavior. Physical and psychological design determinants. Attitudes towards deviancy, accessible environments and persons with disabilities. Legal, ethical, human factors. 3 lectures. Prerequisite: Junior standing or consent of instructor.

**ARCH 407 Environmental Control Systems III (4)**

Theory and application of mechanical and electrical systems for comfort. Emphasis on internal-load dominated buildings. Consid-eration of artificial lighting, H.V.A.C. systems, acoustics, water and waste systems. Miscellaneous course fee required–see *Class Schedule.* 2 lectures, 2 laboratories. Prerequisite: ARCH 307.

**ARCH 411 Climatic Determinants of Building Design (2)**

Influence of solar radiation and climatic conditions on siting and design of buildings. Architectural principles and energy conservation. 2 lectures. Prerequisite: ARCH 307, PHYS 132 or PHYS 122.

**ARCH 413 The Built Environment: Issues and Education (3)**

Identification of major issues in the design and creation of the built environment. Strategies for developing instructional units related to critical thinking and problem solving in the K-12 school setting. 1 lecture, 2 activities. Prerequisite: Junior standing.

**ARCH 420 Seminar in Architectural History, Theory and Criticism (4)**

Special topics based on the exploration of specific approaches, periods of time, and cultural or geographic areas. *Class Schedule* will list topic selected. Total credit limited to 12 units; repeatable in same term. 4 seminars. Prerequisite: 4th year standing *and* ARCH 217, ARCH 218, and ARCH 219, or consent of instructor.

**ARCH 441 Professional Practice (3)**

The practice of architecture as it relates to the profession, firm organization and management. An introduction to the process and requirements from graduation to licensed professional. 1 lecture, 2 activities. Prerequisite: ARCH 342. Concurrent: ARCH 452.

**ARCH 442 Professional Practice (3)**

Continuation of ARCH 441. The practice of architecture as it relates to the architect's role and responsibilities for building project development, delivery, and construction administration. Introduction to the architect's legal and ethical relationship to owner, contractor and subcontractors before, during and following the building construction process. 1 lecture, 2 activities. Prerequisite: ARCH 441 and ARCH 452. Concurrent: ARCH 453.

**ARCH 445 Urban Design in Architecture (3)**

Design role of the urban architect. Economic, environmental and technological forces impacting on architectural practice in urban areas. 3 lectures. Prerequisite: ENGL 134.

**ARCH 446 The Small Scale Master Builder (4)**

Principles of practice as owner-designer-builder, selling or leasing products. Comparison with traditional practice. Potential income, constraints on design decisions, and ethics. Analysis of factors and methods relevant to such practice, including financing, taxes, accounting, market analysis, and development potential. Starting with little or no capital. 4 lectures. Prerequisite: Fourth-year standing.

**ARCH 447 Design Regulations (4) (Also listed as CRP 447)**

Practical application of fundamental zoning, subdivision, design/development standards, and building codes in the design review process, either in the form of a proposed development project or preparation of ordinances, codes, standards, and/or guidelines to apply to a project. 3 lectures, 1 activity. Prerequisite: Fourth year standing, or consent of instructor.

**ARCH 451 Architectural Design (5)**

Continuation of ARCH 351, 352, 353. Problems of increasing architectural complexity involving the comprehensive integration of architectural theory, design processes, and building systems with emphasis placed on multifunction singular buildings. Miscellaneous course fee required–see *Class Schedule*. 5 laboratories. Prerequisite: ARCH 307, ARCH 341, ARCH 342, ARCH 351, ARCH 352, ARCH 353, ARCE 321, ARCE 322, ARCE 323.

**ARCH 452 Architectural Design (5)**

Continuation of ARCH 451. Problems of increasing architectural complexity involving the comprehensive integration of architectural theory, design processes, and building systems with emphasis placed on multibuilding, multifunctional projects. Miscellaneous course fee required–see *Class Schedule*. 5 laboratories. Prerequisite: ARCH 407 and ARCH 451. Concurrent: ARCH 441.

**ARCH 453 Architectural Design (5)**

Continuation of ARCH 452. Problems of increasing architectural complexity involving the comprehensive integration of architectural theory, design processes, and building systems with emphasis placed on multifunctional projects in an urban context. Miscellaneous course fee required–see *Class Schedule*. 5 laboratories. Prerequisite: ARCH 441 and ARCH 452. Concurrent: ARCH 442.

**ARCH 455 Human Factors Applications in Architecture (3)**

Human factors applications: human factors taxonomy, standardized information system, ergonomic research methods, evaluation procedures, and application strategies. 3 lectures. Prerequisite: ARCH 303 or consent of instructor.

**ARCH 457 Computer Graphics in Architecture (4)**

Two-dimensional drawing systems in architectural practice with particular emphasis on office productivity in the production side of the design process; includes drawing database administration, local area networks, management and cost issues. 2 lectures, 2 laboratories. Prerequisite: Fourth year standing.

**ARCH 460 Advanced Computer Graphics in Architecture (3)**

Advanced methods in the application of computer graphics and multi-media techniques in architectural design. Miscellaneous course fee required–see *Class Schedule*. 2 lectures, 1 activity. Prerequisite: ARCH 133 or ARCH 124, ARCH 125, ARCH 126, ARCH 127 or consent of instructor.

**ARCH 461 Advanced Computer-Aided Design in Architecture (3)**

Advanced applications of computers in architectural design with emphasis on utilizing intelligent tools in the design process. Miscellaneous course fee required–see *Class* Schedule. 2 lectures, 1 activity. Prerequisite: ARCH 457 or equivalent and consent of instructor.

**ARCH 462 Topics in Architectural Practice (2)**

Directed group study of selected subtitles addressing various aspects of Architectural Practice for advanced students in CAED. Topics may include strategic planning, managing quality, ethics, portfolio preparation, and legal considerations. Open to undergraduate and graduate students. *Class Schedule* will list subtitle selected. Total credit limited to 6 units. 2 activities. Prerequisite: Consent of instructor.

**ARCH 463 Undergraduate Seminar (2) (CR/NC)**

Discussion and lectures on problems of practice in architecture. Professional ethics. Students present organized material on some subject of interest in architecture. 2 seminars. Prerequisite: Fourth-year standing in architecture. Credit/No Credit grading only.

**ARCH 464 Computer Applications in Design (3)**

Exposure to all aspects of two-dimensional computer-aided design. Introduction to three-dimensional CAD through the use of AUTOCAD 12 software. *Class Schedule* will list topic selected. Total credit limited to 12 units. 3 lectures. Prerequisite: Junior standing and current participation in Washington Alexandria Architectural Consortium off-campus program.

**ARCH 465 Design Related Media (3)**

The role of various media of visual communication as tools of documentation, analysis and creation in the design visual environment. Skills in graphics, photography, product design, film, video techniques, and printmaking graphics will be developed in specific relation to environmental design study and presentation. *Class Schedule* will list topic selected. Total credit limited to 12 units. 3 lectures. Prerequisite: Junior standing and current participation in Washington Alexandria Architectural Consortium off-campus program.

**ARCH 466 Topics in Architectural History and Theory (3)**

Design from its beginning with the crafts design period to its expression of industrial design in its present form. Various stages in the evolution of design explored through analyzing the influ-ences and contributions of leading artists. *Class Schedule* will list topic selected. Total credit limited to 12 units. 3 lectures. Prerequisite: Junior standing and current participation in Washington Alexandria Architectural Consortium off-campus program.

**ARCH 467 Undergraduate Research (3)**

Architecture and urban theoretical intentions and results in the context of the Capitol of the United States – Washington, DC. This theoretical and historical study will not occur within the confines of the classroom, but directly within the "laboratory" of the city. *Class Schedule* will list topic selected. Total credit limited to 12 units. 3 lectures. Prerequisite: Junior standing and current participation in Washington Alexandria Architectural Consortium off-campus program.

**ARCH 468 Advanced Environmental Building Systems (3)**

Technologies which provide a "well building" environment by engaging in: weather protection; thermal/moisture control; natural and artificial lighting; and electrical and other "energy source" utility service. 3 lectures. Prerequisite: Junior standing and current participation in Washington Alexandria Consortium off-campus program.

**ARCH 469 Topics in Design Methods (3)**

Relationship of art and architecture addressed to encourage critical debate. Historically, the "art" and the "architecture" were not as polarized as today. Both historical perspective and practical issues

concerning collaboration. *Class Schedule* will list topic selected. Total credit limited to 12 units. 3 lectures. Prerequisite: Junior standing and current participation in the Washington Alexandria Architectural Consortium off-campus program.

**ARCH 470 Selected Advanced Topics (1–4)**

Directed group study of selected topics for advanced students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Consent of instructor.

**ARCH 471 Selected Advanced Laboratory (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories. Prerequisite: Consent of instructor.

**ARCH 472 Housing Design Concepts (3)**

For students preparing for further study or practice relating to housing, urban design and new communities. This course will address design objectives, concepts, and current theories and forms in housing and mixed-use projects. 3 activities. Prerequisite: Third-year standing or consent of instructor.

**ARCH 474 Collaborative Studio: Rendering, Animation and Modeling (4) (Also listed as ART 474/LA 474)**

A collaborative visualization and design studio focusing on rendering, animation and modeling. Modeling and animation software for design conceptualization and expression. Collaboration in teams with students from the College of Architecture and Environmental Design and the Art and Design Department. Total credit limited to 8 units. 2 lectures, 2 activities. Prerequisite: ART 335 or ARCH 350 or LA 310, ARCH 460 or consent of instructor.

**ARCH 480 Special Studies in Architecture (1–12)**

Special issues and problems through research, field trips, design projects, and other forms of investigation and involvement. Course requirements are determined prior to each individual project through a contractual agreement between students and department. The departmental Off Campus Study Guidelines apply except when superseded by guidelines and practices of the London Study Program of the College of Liberal Arts. Total credit limited to 36 units. Prerequisite: Junior standing.

**ARCH 481 Senior Architectural Design Project (5)**

Comprehensive building design and research project in an architectural concentration area. Demonstration of professional competency in integration of architectural theory, principles and practice with creative, organizational and technical abilities in architectural programming, design and design research. Miscellaneous course fee may be required–see *Class Schedule*. Total credit limited to 15 units. 5 laboratories. Prerequisite: ARCH 407, ARCH 441, ARCH 442, ARCH 451, ARCH 452, ARCH 453 and 5th-year standing.

**ARCH 485 Cooperative Education Experience (6) (CR/NC)**

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**ARCH 492 Senior Design Thesis (3)**

Development of the framework and format of a thesis project proposal related to the specific design option. Work to include: research topic, intent, scope, methodology, assumptions, outline of work program and documentation. To be taken concurrently with first quarter of ARCH 481. 3 seminars. Prerequisite: 5th year standing or consent of instructor.

**ARCH 495 Cooperative Education Experience (12) (CR/NC)**

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**ARCH 501 Environmental Control Systems (3)**

Comparative analysis and evaluation of mechanical and electrical building systems in high-rise and special purpose low-rise buildings. 3 seminars. Prerequisite: ARCH 407.

**ARCH 510, 511 Environmental Design Methods (3) (3)**

Application of systematic, step-by-step procedures to rational and intuitive judgmental tasks. Methods for formulation, idea production, evaluation, and testing applied to planning, testing, design information systems, communication between designer and client, user participation in design, and other current topics. 511 focuses on specific problem area among topics and may be repeated up to 9 units. 3 lectures. Prerequisite: Graduate standing.

**ARCH 513 Natural Architectural Lighting (3)**

Perception and awareness of light; natural light as generator of urban spaces and building forms. Principles of design in lighting fundamentals and techniques. 3 lectures. Prerequisite: ARCH 407 or consent of instructor.

**ARCH 519 Theory of Architecture (3)**

Comparative analysis of the major historic influences which have contributed to the development of architectural design theories. *Class Schedule* will list topic selected. Total credit limited to 9 units. 1 lecture, 2 seminars. Prerequisite: ARCH 319 or graduate standing.

**ARCH 521 Graduate Architectural Design Project (5)**

Comprehensive building design and research project in an architectural concentration area. Demonstration of professional competency in integration of architectural theory, principles and practice with creative, organizational and technical abilities in architectural programming, design and design research. Miscellaneous course fee may be required–see *Class Schedule*. Total credit limited to 15 units. 5 laboratories. Prerequisite: ARCH 407, ARCH 441, ARCH 442, ARCH 451, ARCH 452, ARCH 453 and 5th-year standing.

**ARCH 531 Habitability (3)**

Habitability standards and concepts significant for architectural design and practice. Behavioral analysis of habitats, facilities and urban systems. Design and development of structures and systems responsive to human needs. Habitability and environmental specifications, human factors, human engineering, behavioral sciences. 3 seminars. Prerequisite: ARCH 303, ARCH 453, or consent of instructor.

**ARCH 532 Quantitative Methods in Architecture (3)**

Roles of research in environmental design analysis. Approaches to research, hypothesis testing, data banks, and information systems for design. Use of research findings in various decision-making systems. 3 seminars. Prerequisite: Graduate standing.

**ARCH 533 Architectural Programming (3)**

Information management in the design process. Techniques for gathering, analyzing, and transforming data for use as design information. Variety of approaches to pre-design planning. 3 seminars. Prerequisite: ARCH 453.

**ARCH 537 Principles of Development (3)**

Theory and application of the architect's role in real estate development. Topics include financing, corporate structuring, feasibilities, market studies, and proposal presentation. Emphasis on the influence of design on the success of the development process. 3 seminars. Prerequisite: Graduate standing in Architecture, or consent of instructor.

**ARCH 551 Architectural Design (5)**

Professional initiative and responsibility in integrating architectural design theory and practice with fields influencing the total environment. Building types considered as the coordinating factor. Total credit

limited to 15 units with no more than 5 units in any one quarter. 5 laboratories. Prerequisite: Graduate standing.

**ARCH 561 Advanced Design (3)**

Continuation of ARCH 551. Advanced studies integrating architectural design theory and practice with fields influencing the shaping of the total environment. Total credit limited to 9 units. 3 laboratories. Prerequisite: Graduate standing.

**ARCH 563 Professional Seminar (2)**

Problems and topics in the field of the architectural profession. Seminar drawn upon expertise of visiting professionals in addition to topics presented by regular faculty and students. 2 seminars. Prerequisite: Graduate standing.

**ARCH 580 Seminar in Theory of Architecture (3)**

Directed group study of selected topics in the theory of architecture for graduate students. *Class Schedule* will list specific topics selected. Total credit limited to 9 units. 3 seminars. Prerequisite: ARCH 453.

**ARCH 592 Graduate Design Thesis (3)**

Development of the framework and format of a thesis project proposal related to the specific design option. Work to include: research topic, intent, scope, methodology, assumptions, outline of work program and documentation. To be taken concurrently with first quarter of ARCH 521. 3 seminars. Prerequisite: 5th year standing or consent of instructor.

**ARCH 598 Master's Design Project (3–6)**

Completion of a master project demonstrating in-depth research ability at a graduate level. Total credit limited to 9 units. 3 or 6 laboratories. Prerequisite: Consent of graduate adviser.

**ARCH 599 Master's Thesis (3–6)**

Completion of a thesis embodying original research in an area of environmental design. Total credit limited to 9 units. Prerequisite: Consent of graduate adviser.

## ART

**ART 101 Fundamental of Drawing (4) GE C3**

Introduction to the artistic practice and cultural value of drawing from the Renaissance to the 21st Century. Emphasis and expansion of the practical skills of observation, rendering, and understanding the signs of meaning produced in visual art. Development of formal techniques, media experimentation, and content creation through personal expression. Exercises to encourage growth in technical skill, conceptual innovation, critical thinking, and visual communication. 1 lecture, 3 activities.

**ART 111 Introduction to Art (4) GE C3**

Designed to acquaint the non-art major with painting, sculpture, drawing, crafts, architecture and printmaking. Development of vocabulary, analytic skills, and research techniques for the understanding of art objects. 4 lectures.

**ART 112 Survey of Western Art (4) GE C3**

History of major art movements in western civilization from ancient art to the twentieth century. Representative periods of western culture, such as the ancient world, the Middle Ages, the Renaissance, and the modern world. 4 lectures.

**ART 131 2-Dimensional Design Fundamentals (3)**

Basic design theory in black, white and greys covering the visual elements and principles in two dimensions. 1 lecture, 2 activities.

**ART 132 Beginning Color Theory (3)**

Basic design color theory developed through exercises in hue, value and intensity. 1 lecture, 2 activities. Prerequisite: ART 131.

**ART 133 Color and Design (3)**

Advanced color problems in two-dimensional design theory covering compositional, optical and psychological aspects of visual communication. 1 lecture, 2 activities. Prerequisite: ART 131, ART 132.

**ART 134 3-Dimensional Design (3)**

Studio course in research and application of principles, elements and criticism of three-dimensional design concepts. Miscellaneous course fee required–see *Class Schedule*. 1 lecture, 2 laboratories.

**ART 148 Sculpture (4) GE C3**

Exploration of three dimensional form through problems in modeling, casting, carving, and techniques of assembly. Historical and contemporary concepts as applied to the discipline of sculptural styles. Miscellaneous course fee required–see *Class Schedule*. 1 lecture, 3 activities.

**ART 181 Computer Imaging and Design (3)**

Introduction to the Macintosh system to acquaint students with operating procedures. Students will learn QuarkXPress, Adobe Illustrator, Aldus Freehand, and Adobe Photoshop for use in their own creative design or photography. Miscellaneous course fee required–see *Class Schedule.* 2 lectures, 1 laboratory. Prerequisite: ART 133 and CSC 113 or consent of the instructor.

**ART 200 Special Problems for Undergraduates (1–2)**

Individual investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisite: Consent of instructor.

**ART 201 Intermediate Drawing (3)**

Development of additional drawing techniques with emphasis on form and composition. 3 activities. Prerequisite: ART 101.

**ART 203 Art Theory and Practice (3)**

Contemporary issues in art and design, linking "ideas" in art theory to problem-solving. Emphasis on creative expression through knowledge of contemporary thinking, aesthetics, techniques, and vocabulary. 1 lecture, 2 activities. Prerequisite: ART 101 and ART 148.

**ART 204 Beginning Watercolor (3)**

Transparent watercolor painting. Course emphases: proper use of watercolor paper, brush techniques, pigment mixing, use of color, use of washes, wet-into-wet, indirect methods, composition and presentation. 3 activities. Prerequisite: ART 101.

**ART 209 Beginning Painting (3)**

Introduction to technical and formal problems in painting. Physical characteristics of paint, various tools and substrates. Projects emphasize creative understanding of pictorial space, color and concept. 3 activities. Prerequisite: ART 101 and ART 132 or consent of instructor.

**ART 211 Art History–Ancient to Renaissance (4)**

Development of art from antiquity to the early stages of the Renaissance in Europe. Particular emphasis on European art with appropriate references to sources from antiquity which have been particularly influential on European painting and sculpture. 4 lectures.

**ART 212 Art History–Renaissance through Baroque Eras (4)**

The significant visual expressions of Northern and Southern European art of the Renaissance and Baroque period. Relevant parallel examples of the art of non-European cultures. 4 lectures.

**ART 221 Basic B/W Photography (3)**

Fundamental techniques in black and white photography. Mechanics of cameras and equipment, optics, composition, filters, subject content, developing, printing, and mounting. Understanding photographic principles, producing a quality continuous tone print, and print presentation. 35mm camera with manual adjustment capability required. 2 lectures, 1 laboratory.

**ART 222 35mm Intermediate B/W Photography (3)**

Control of tonal range using 35mm cameras and available daylight illumination. Composition and visual communication. Assignments

range from close-ups to architecture. Emphasis on "photographic seeing" and professional quality enlargements. 2 lectures, 1 laboratory. Prerequisite: ART 221 or equivalent.

**ART 224 Introduction to Artificial Lighting for Photography (3)**

Tungsten and electronic strobe studio lights are used to introduce the student to contemporary professional studio photography. Quality developing and printing skills required. Introduction to current examples of professional studio lighting. Emphasizes photographic communication and expression of ideas through an understanding of controlled lighting. Color transparency materials are introduced in the studio environment. 2 lectures, 1 laboratory. Prerequisite: ART 222.

**ART 232 Beginning Graphic Design (3)**

Basic terminology, studio skills, assembly methods, photographic reproduction processes, and specification for graphic designers. Familiarization with the various services available. 2 lectures, 1 laboratory. Prerequisite: ART 131, ART 132, ART 133.

**ART 240 Introduction to Glassblowing (4)**

Survey of history of glass and introduction to contemporary glass art, presented through visual examples in slide/lecture format. Development of tools and forming processes introduced while student develops 3-dimensional projects. Miscellaneous course fee required–see *Class Schedule*. 3 lectures, 1 activity. Prerequisite: ART 101, ART 148 or ART 203.

**ART 245 Ceramics I (3)**

Studio course in basic clay working with emphasis on design quality, hand building, and use of the potter's wheel. Miscellaneous course fee required–see *Class Schedule*. 1 lecture, 2 laboratories.

**ART 248 Intermediate Sculpture (3)**

Intermediate sculpture course in expressive use of form with modeling, casting, carving, and/or assembly. Miscellaneous course fee required–see *Class Schedule*. 3 activities. Prerequisite: ART 148.

**ART 255 Jewelry Design (3)**

Studio course in nonferrous metal techniques including cutting, forming, soldering, and forging with emphasis on creative design solutions. Miscellaneous course fee required–see *Class Schedule*. 3 activities.

**ART 301 Advanced Drawing (3)**

Development of advanced methods and techniques in the study of form and structure. Emphasis on problem-solving. 3 activities. Prerequisite: ART 131 and ART 201.

**ART 302 Life Drawing I (3)**

Development of methods and techniques in the study of form and structure as it relates to human proportion and anatomy analysis. 3 activities. Prerequisite: ART 201.

**ART 304 Intermediate Watercolor (3)**

Transparent watercolor painting. Design and composition of painting, use of drawing and advanced watercolor techniques. Total credit limited to 6 units. 3 activities. Prerequisite: ART 204.

**ART 309 Intermediate Painting (3)**

Continuation of study of technical and formal problems in painting. Expanded study of physical characteristics of paint, tools, and substrates. Emphasis on the creative process from concept to finished art. Contemporary issues in painting introduced. *Class Schedule* will list topic selected. Total credit limited to 9 units. 3 activities. Prerequisite: ART 209, or consent of instructor.

**ART 310 Art History–American Art (4)**

Major historical periods of American art from the colonial period to the present. Special emphasis will be given to the broader notion of American art as a process of developing an identity of the varied historical and sociological forces that have shaped images in American art. 4 lectures. Prerequisite: ART 111, ART 213, or consent of instructor.

**ART 311 Art History–Nineteenth Century Art (4)**

History of painting and sculpture from the French Revolution to the beginning of the 20th century. Significant movements such as Neo-Classicism, Romanticism, Realism, Impressionism and Post-Impressionism. 4 lectures. Prerequisite: One lower division Art History course, or consent of instructor.

**ART 312 Art History–Twentieth Century Art (4)**

History of major art movements from the beginning of the twentieth century to the present. Major emphasis will be placed on Fauvism, Expressionism, Dada, Surrealism, and the period of Post-World War II art in Europe and the United States. 4 lectures. Prerequisite: ART 211 or ART 212 or consent of instructor.

**ART 313 Design History (4)**

Survey of graphic and product design from the Vienna Secession to the present, including the Russian avant-garde, art deco, streamlining, and development of Modernism. 4 lectures. Prerequisite: Any lower division art history course.

**ART 314 History of Photography (4) GE C4**

In-depth survey of the artistic and cultural achievements in photography from its invention to the present day. Significant photographers, the evolution of aesthetic criteria in the context of other visual arts as well as social/cultural impact. 4 lectures. Prerequisite: Completion of GE Areas A and C3.

**ART 316 Women as Subject and Object in Art History (4) (Also listed as WS 316)**

Exploration of the role of women in the visual arts. Women as artists, women as portrayed in art, and feminist theory as it applies to the study of the visual arts and art history. 4 lectures. Prerequisite: ART 111, ART 112 or consent of instructor.

**ART 317 Asian Art Survey (4)**

Survey of the traditional arts of Asia – primarily India, China and Japan. Emphasis on the connections between the visual arts in Asia and the philosophical, social and cultural environments in which they arose. 4 lectures. Prerequisite: ART 111 or ART 112, or ART 211, or consent of instructor.

**ART 318 Asian Art Topics: National, Religious, and Intellectual Movements (4) GE C4**

In-depth examination of significant art movements in Asia. Each topic will focus on the development of art in Asia within the context of a specific geographical or theoretical framework. Details will vary depending on topic. *Class Schedule* will list topic selected. 4 lectures. Prerequisite: Completion of GE Areas A and C3.

**ART 322 Color Photography (3)**

Fundamental techniques in color photography. Theory of color, visual concepts, exposing color transparencies and negatives, printing from color negatives, finishing and presentation. Studio electronic flash and available light. 2 lectures, 1 laboratory. Prerequisite: ART 222.

**ART 323 Introduction to Digital Image Making (3)**

Digital modification of color photography using transparency materials. Development of consistent control of 35mm color transparency films. Digital photographic vocabulary as well as theory of color in expression and communication. Survey of contemporary color photography and digital image making. Miscellaneous course fee required–see *Class Schedule.* 2 lectures, 1 laboratory. Prerequisite: ART 181, ART 222 or consent of instructor.

**ART 324 Photographic Expression: B/W (4)**

Advanced techniques including multiple exposure, series, high contrast and digital manipulation. Emphasis on personal expression and developing style, introduction to symbology, visual source development

and the work of contemporary creative photographers. 2 lectures, 2 laboratories. Prerequisite: ART 224 and ART 314.

**ART 325 4x5 Camera Techniques (3)**

Basic techniques using 4x5 view cameras. Architecture, landscapes, portraiture, and other outdoor subjects used to help the student master the use of large format cameras. Other topics include exposure techniques, perspective, and sharpness correction, lighting and composition. Sensitometric approach to B/W film development and print quality emphasized. 2 lectures, 1 laboratory. Prerequisite: ART 323.

**ART 326 4x5 Camera/Commercial (3)**

Professional techniques with large format cameras. Outdoor and studio photography presented using B/W film and color transparencies. Topics include studio lighting for glass and metal, copying, interiors, and product photography. 2 lectures, 1 laboratory. Prerequisite: ART 325.

**ART 327 Portraiture (3)**

Studio and environmental portraiture. Emphasis on light ratios/patterns; posing; personality portrayal. Retouching of film and print. 2 lectures, 1 laboratory. Prerequisite: ART 224.

**ART 329 Editorial and Corporate Photography (3)**

Creating, lighting and executing editorial photography. Producing photography for corporate needs, i.e. annual reports, brochures and in-house publications. Emphasis on selecting subject matter, handling lights and color film. 2 lectures, 1 laboratory. Prerequisite: ART 326.

**ART 331 Typographic Design (3)**

Principles of letterforms and how these principles affect the communication of ideas through graphic design. Analysis of type style, structure, and form. Computer applications are required for appropriate problems. 3 activities. Prerequisite: Junior standing. ART 133 or consent of instructor.

**ART 332 Symbology (3)**

Use of symbolism and metaphor in graphic design. Communication of complex or abstract concepts with connotative/denotative imagery. Development of ideas from research, reference materials, and the imagination. Computer applications are required for appropriate problems. 3 activities. Prerequisite: ART 133, ART 331, junior standing.

**ART 333 Corporate Identity (3)**

Design and implementation of corporate logos. Development of a graphic standards manual for use of identity in diverse applications. For Art and Design majors only. Computer applications are required for appropriate problems. 3 activities. Prerequisite: ART 134, ART 332, junior standing.

**ART 335 Digital 3D Modeling and Design (4)**

Development of skills and techniques in the use of three-dimensional design and modeling via digital technology. Capabilities of current software in the design and modeling of three-dimensional form. 2 lectures, 2 activities. Prerequisite: ART 134 and ART 181, or consent of instructor.

**ART 336 Exhibition Design/Museum Studies (3)**

Theory and applied principles of exhibition design for art objects in the museum or gallery setting. Class responsible for planning and installing actual gallery exhibitions. Total credit limited to 9 units. 2 lectures, 1 laboratory. Prerequisite: ART 148, ART 134, or consent of instructor.

**ART 340 Glass Fusing and Forming (4)**

Studio course in the creative processes of fusing, forming, and assembling glass. Introduction to the use of line, color, and texture related to glass as a transparent or opaque material. Miscellaneous course fee required–see *Class Schedule*. Total credit limited to 8 units. 1 lecture, 3 activities. Prerequisite: ART 148 or ART 240 or consent of instructor.

**ART 345 Ceramics II (3)**

Studio course in hand, wheel, mold, extruder, jigger, and press forming skills. Design of single and multiple forms and kiln firing procedures. Miscellaneous course fee required–see *Class Schedule*. Total credit limited to 6 units. 3 activities. Prerequisite: ART 148, or ART 134, or ART 245 or consent of instructor.

**ART 346 Ceramics III (3)**

Studio use of clay, slip, engobe, glaze, stoneware and raku. Contemporary craftmaker's skills are developed through use of historic and industrial techniques. Miscellaneous course fee required–see *Class Schedule*. 1 lecture, 2 activities. Prerequisite: ART 148, or ART 134, or ART 245 or consent of instructor.

**ART 353 Intermedia/Art (4)**

Studio course emphasizing individual and collaborative creative exploration with project content derived from student's experience. Focus on using traditional as well as new genres of artistic expression such as site specific installations, video art, book works, and performance art. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1 lecture, 3 activities. Prerequisite: ART 101, ART 131, and ART 148.

**ART 355 Metalsmithing (3)**

Studio course investigating intermediate fabrication including raising, box construction and masonite dye. Exploration of surface design techniques for nonferrous metals. Emphasis on creative design solutions to problems. Miscellaneous course fee required–see *Class Schedule*. Total credit limited to 9 units. 3 activities. Prerequisite: ART 148 or ART 255, or consent of instructor.

**ART 356 Jewelry Casting (3)**

Introduction to casting for the jeweler with emphasis on creative design solutions to assigned problems. Use of lost wax techniques including design, wax working, casting and finishing. Miscellaneous course fee required–see *Class Schedule*. Total credit limited to 9 units. 3 activities. Prerequisite: ART 148 or ART 255, or consent of instructor.

**ART 400 Special Problems for Advanced Undergraduates (1–2)**

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisite: Senior standing and consent of instructor.

**ART 402 Life Drawing II (3)**

Advanced problems in life drawing. Advanced methods and techniques in the study of the human form as it relates to proportion, anatomy analysis and composition. Total credit limited to 6 units. 3 activities. Prerequisite: ART 302.

**ART 406 Advanced Selected Topics in Painting (3)**

Comparative development of proportion and structure of the human head and figure as it relates to color and value. Mixing of pigment color and its implementation to figure painting. Continued emphasis with figure, its artistic placement in space and pictorial composition. *Class Schedule* will list topic selected. Total credit limited to 6 units. 3 activities. Prerequisite: ART 302, ART 304.

**ART 409 Advanced Painting (3)**

Advanced problems in painting. Emphasis on the creative process from concept to finished art. Investigation of traditional, non-traditional and explorative work. to encourage development of personal approach. *Class Schedule* will list topic selected. Total credit limited to 9 units. 3 activities. Prerequisite: ART 309, or consent of instructor.

**ART 427 Illustration Photography (3)**

Applied principles of design and color to produce a photograph that sells an idea, product, or service. Both traditional and digital applications used. Joint projects with ART 432, Advertising Design. Emphasis on thinking, planning, interpreting, and presenting an idea photographically. 2 lectures, 1 laboratory. Prerequisite: ART 326 and senior standing.

**ART 428 Portfolio Production Photography (1)**

Physical production of final portfolio for the graduating senior in photography concentration. 1 laboratory. Prerequisite: ART 427 and senior standing; concurrent enrollment in ART 462 required.

**ART 430 Advanced Typographic Design (3)**

Advanced principles of letterform design and modification related to the communication of ideas. Continuation of analysis of type characteristics. Emphasis on computer application to the typographic design processes. Miscellaneous course fee required–see *Class Schedule.* 3 activities. Prerequisite: ART 333 and senior standing.

**ART 431 Package Design (3)**

Graphics for food, beverage and related packaging. Positioning of products through research into typography, imagery and color. For Art and Design majors only. Computer applications are required for appropriate problems. 3 activities. Prerequisite: ART 333 and senior standing.

**ART 432 Advertising Design (3)**

Development of print advertising from concept to final presentation. Emphasis on art direction, photo direction and copywriting. For Art and Design majors only. Computer applications are required for appropriate problems. 3 activities. Prerequisite: ART 333 and senior standing.

**ART 433 Editorial Design (3)**

Design of editorial material, printed collateral, magazine layouts and annual reports. For Art and Design majors only. Computer applications are required for appropriate problems. 3 activities. Prerequisite: ART 431 and senior standing.

**ART 435 Illustration (3)**

Development of concept and illustration techniques for use in graphic design and advertising. Total credit limited to 6 units. For Art and Design majors only. 3 activities. Prerequisite: ART 204, ART 302, ART 331.

**ART 440 Advanced Selected Topics in Glass (4)**

Continued exploration into the expressive use of glass as a creative medium. Topics may include glass casting, glass blowing, mold making, and kiln work. Miscellaneous course fee required–see *Class Schedule*. Total credit limited to 12 units. 2 lectures, 2 activities. Prerequisite: ART 240 or ART 340, or consent of instructor.

**ART 448 Advanced Topics in Sculpture (3)**

Studio course specializing in three dimensional form. Materials include clay, plaster, metal, or wood. Course content will be selected from various topics that are representational, abstraction, non-objective, or conceptual. *Class Schedule* will list topic selected. Total credit limited to 6 units; may be in same term. 3 activities. Prerequisite: ART 248 and one of the following: ART 302 or ART 404.

**ART 460 Professional Practices (2)**

Professional practices in the art, photography, and design fields, including legal and ethical issues, taxes, contracts, fees and copyrights. Current job opportunities are researched and a business plan is prepared. Course lectures augmented by visiting professionals. For Art and Design majors only. 2 lectures. Prerequisite: Senior standing.

**ART 461 Senior Project (2)**

Selection and completion of a project under faculty super-vision. Minimum of 90 hours time. Results presented in a formal report. Prerequisite: Senior standing and ART 460.

**ART 462 Senior Portfolio Project (2)**

Preparation of portfolio system for entrance into the professional job market or graduate school. 2 activities. Prerequisite: Senior standing and ART 461.

**ART 463 Undergraduate Seminar (2)**

Analysis of selected problems and topics for undergraduates. 2 seminars. Prerequisite: Senior standing.

**ART 465 Contemporary Photography Seminar (2)**

Survey of significant photographers and developments in the field since 1950. The interaction between photography and the other visual arts as well as its social impact during this period. Student presentations on selected research topics. Total credit limited to 4 units. 2 seminars. Prerequisite: ART 314.

**ART 470 Selected Advanced Topics (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Consent of instructor.

**ART 471 Selected Advanced Laboratory (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories. Prerequisite: Consent of instructor.

**ART 474 Collaborative Studio: Rendering, Animation and Modeling (4) (Also listed as ARCH 474/ LA 474)**

A collaborative visualization and design studio focusing on rendering, animation and modeling. Modeling and animation software for design conceptualization and expression. Collaboration in teams with students from the Art and Design Department and the College of Architecture and Environmental Design. Total credit limited to 8 units. 2 lectures, 2 activities. Prerequisite: ART 335 or ARCH 350 or LA 310, ARCH 460 or consent of instructor.

**ART 483 Video and Multimedia Production (4)**

Video and computer generated multimedia presentation scripting, editing, storyboarding and sound cutting. Emphasis on effective communication using presentation techniques and application software to create high impact applications. 2 lectures, 2 laboratories. Prerequisite: ART 181.

**ART 484 Animation and Interactive Design (3)**

Creation of in-depth animations and interactive presentations. Advanced scripting, storyboarding and interactive communication techniques. 2 lectures, 1 laboratory. Prerequisite: ART 181.

**ART 486 Advanced Digital Image Making (3)**

Expressive possibilities of latest image manipulation software. Advanced capabilities of this software explored with focus on development of conceptual and expressive abilities in the digital medium. Art and Design majors only. Miscellaneous course fee required–see *Class Schedule*. 2 lectures, 1 laboratory. Prerequisite: ART 181 or ART 323 and senior standing.

**ART 487 Web Design (3)**

Planning and implementation of web sites. Focus on site structure, navigation, HTML, animation, and design considerations. Art and Design majors only. 2 lectures, 1 laboratory. Prerequisite: ART 181 or ART 323 and senior standing.

**ART 494 Cooperative Education Experience (6) (CR/NC)**

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**ART 495 Cooperative Education Experience (12) (CR/NC)**

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

# ASCI–ANIMAL SCIENCE

**ASCI 101 Introduction to the Animal Sciences (2) (CR/NC)**

Economic, environmental and societal impact of the livestock, poultry and horse industries. Basic terminology, anatomy, and physical requirements of animals. Career and academic planning. Co-curricular, extra-curricular, and post-graduate opportunities. Required of all first-time students in the Animal Sciences and Industry Department. Credit/No Credit grading only. 2 lectures.

**ASCI 141 Market Beef Production (4)**

Survey of industry characteristics, breeds, market classes, carcass residues, environmental protection and diet/health issues. Application of management skills, health care and behavior. 3 lectures, 1 laboratory.

**ASCI 142 Swine Science (4)**

Role of swine in agriculture, consideration of product quality assurance, diet/health issues and animal welfare concerns. Evaluation of brood stock and progeny product, husbandry systems, management skills, feeding systems and health management. 3 lectures, 1 laboratory.

**ASCI 143 Systems of Sheep Production (4)**

Types of sheep operations and geographic influence on management. The role of sheep in world agriculture. Social concerns including humane care, residues and diet/health issues. Evaluation of products, management skills, health care and behavior. 3 lectures, 1 laboratory.

**ASCI 144 Equine Science (4)**

History, status of the horse industry, breeds. Basic anatomy and physiology, unsoundnesses, diseases. Application of management skills, safety, conformation evaluation, hoof and leg conformation and care. Understanding equine behavior. 3 lectures, 1 laboratory.

**ASCI 200 Special Problems for Undergraduates (2–3)**

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 3 units per quarter. Prerequisite: Consent of instructor.

**ASCI 209 Animal Food Products (3)**

Composition of muscle-based foods in relation to cost, yield, quality, meal preparation and nutritional value. Buying, storing, handling and preservation. Uniform retail and food service identity standards for fresh cuts. Classification and methods of making processed meat products. Credit not allowed for students having completed ASCI/FSN 211. Miscellaneous course fee required--see *Class Schedule.* 2 lectures, 1 laboratory.

**ASCI 211 Meats (3)**

Muscle food processing methods and operations. Meat inspection, grading, composition, curing, preservation and related topics. Carcass beef, pork, and lamb will be processed into consumer ready products. Credit not allowed for students having completed ASCI/FSN 209. Miscellaneous course fee required--see *Class Schedule.* 2 lectures, 1 laboratory.

**ASCI 212 Livestock Show Management (2)**

Principles and procedures in organizing, managing and promoting a livestock show. Emphasis placed on the actual management of operating Cal Poly's Western Bonanza Jr. Livestock Show. Total credit limited to 4 units. 2 activities.

**ASCI 214 Equine Management (2)**

Application of safety, risk reduction, horsemanship skills. Develop a working equine/human relationship. Selection and application of nutrition, equipment, preventive health and farrier program, and equitation skills. Miscellaneous course fee may be required–see *Class Schedule*. 2 laboratories. Prerequisite: Consent of instructor.

**ASCI 216 Meat Grading and Evaluation (2)**

Factors related to carcass quality and yield. USDA meat grading principles and practices. Judging of carcass and wholesale cuts. Field trip to meat packing plants required. 1 lecture, 1 laboratory. Prerequisite: ASCI/FSN 211.

**ASCI 220 Introductory Animal Nutrition and Feeding (4)**

Food nutrients, identification and nutrient quality of feedstuffs and uses for each class of livestock. Ration formulation based on the digestion and utilization of feeds. Economy and least price purchasing based on nutrient content and market value of livestock. 3 lectures and 1 laboratory.

**ASCI 226 Livestock Evaluation (3)**

Utilization of objective and subjective estimation measures in establishing economic worth of domestic animals of the three meat animal species and horses. 1 lecture, 2 laboratories.

**ASCI 231 General Animal Science (3)**

Relationship of animal agriculture to society and the economy and their role for human use and consumption. Discussion of nutrition, reproduction and management of beef cattle, sheep, swine and horses. Credit not allowed for Animal Science majors. 3 lectures.

**ASCI 260 Preparation of Livestock for Shows and Sales (2)**

Techniques, equipment and knowledge necessary in order to properly condition, groom, and present beef cattle or horses for evaluation and merchandising. Total credit limited to 4 units. 2 laboratories.

**ASCI 290 Livestock Management Enterprise (2–4) (CR/NC)**

Management techniques of the livestock enterprise. Providing health, nutritional and physical care to a representative group of animals. Planning, budgeting and marketing. Instructor approval required. Prerequisites may exist for some enterprises. Total degree credit for 290/490 limited to 9 units. Credit/No Credit grading only. Prerequisite: Consent of instructor.

**ASCI 304 Animal Breeding (3)**

Application of genetic principles for livestock improvement. Improving production through a study of selection techniques, mating systems, and performance evaluation using current technology. 3 lectures. Prerequisite: BIO 302 or BIO 303.

**ASCI 311 Commercial Beef Management (3)**

Management practices involved in the commercial beef cattle breeding enterprise. Trends and economic considerations relative to California and the U.S. Principles of selection, basic reproductive physiology, breeding systems, range management, nutrition, health programs and marketing phases of the enterprise. 3 lectures. Prerequisite: ASCI 141.

**ASCI 312 Swine Management (3)**

Management practices involved in commercial and purebred swine enterprises. Methods of production and marketing, performance testing programs and carcass evaluation techniques. Nutritional requirements, rations, feed additives, diseases and parasites, facilities and equipment. 3 lectures. Prerequisite: ASCI 142.

**ASCI 313 Sheep Management (3)**

Management practices of purebred and commercial sheep operations. Techniques, equipment, feeds, health care products and decision making throughout a production cycle from selection to culling. Exposure to emerging technologies and scientific advancements that will affect the sheep industry. 3 lectures. Prerequisite: ASCI 143.

**ASCI 314 Advanced Horse Management (3)**

Management practices relative to the training and conditioning of the horse. Investigation of the nutritional, behavioral and physiological parameters required of the horse in work, sport and recreational events. Miscellaneous course fee required–see *Class Schedule.* 3 lectures. Prerequisite: ASCI 144.

**ASCI 315 Equine Biomechanics (4)**

Anatomy and physiology of the equine hoof and limb. An understanding of the art and science of the farrier's work. Evaluation of proper hoof care, trimming, and shoeing. Foot and leg conformation as it relates to

sound locomotion. 3 lectures, 1 activity. Prerequisite: ASCI 144 or equivalent. Recommended: VS 223.

**ASCI 324 Advanced Equine Evaluation (2)**

Appraising the relative merit of individual horses in halter and performance through the application, development and refinement of deductive and inductive logical processes. Oral and written expression of the selection rationale. 2 laboratories. Prerequisites: ASCI 226 and/or consent of instructor.

**ASCI 326 Advanced Livestock Evaluation (2)**

Application of deductive and inductive logical processes in appraising the relative merit of individual animals within a group sample. Oral expression of the selection rationale. 2 laboratories. Prerequisite: ASCI 226.

**ASCI 329 Principles of Range Management (3)**

Characteristics, history and multiple uses of rangeland. Principles of range plant physiology and ecology in relation to range condition, trend, utilization and improvement practices. Principles of proper grazing practices and nutrition of livestock. 3 lectures. Prerequisite: One course each in soil science, animal science and botany or crop science.

**ASCI 333 Equine Reproduction (5)**

Management of the breeding farm, breeding problems, diseases, study of estrus cycles, servicing the mare, handling stallions. Breeding systems, teasing, embryo transfer, ultrasound pregnancy diagnosis, new developments in breeding technology. Miscellaneous course fee required–see *Class Schedule*. 4 lectures, 1 laboratory. Prerequisite: ASCI 144.

**ASCI 339 Internship in Animal Science (1–12) (CR/NC)**

Selected Animal Science students will spend up to 12 weeks with an approved agricultural firm engaged in production or related business. Time will be spent applying and developing production and managerial skills and abilities. One unit of credit may be allowed for each full week of completed and reported internship. Degree credit limited to 6 units. Credit/No Credit grading only. Prerequisite: Consent of internship instructor.

**ASCI 340 Computer Applications in Ration Formulation (2)**

Development of nutritionally balanced rations for livestock. Balancing of rations using Pearson Square, algebraic methods, linear programming methods, and commercial software. 2 activities. Prerequisites: ASCI 220 or DSCI 101, CSC 110 or consent of instructor.

**ASCI 344 Equine and Human Communication (3)**

Behavior of the horse and its relationship with people. Learning, motivation, social behavior and communication with techniques to improve the safety and understanding between people and horses. 3 laboratories. Prerequisites: ASCI 144 and ASCI 260 or consent of instructor.

**ASCI 345 Equine Behavior Modification (3)**

Advanced principles of equine behavior modification for training young horses under saddle. Identifying differences in individual horse's attitudes, techniques to teach horses to respond to various stimuli, management of young equine athlete. 3 laboratories. Prerequisite: ASCI 344 or consent of instructor.

**ASCI 346 Equine Nutrition (3)**

Equine digestion, diet development considerations and evaluations, nutritional management, and the relationship of respective topics to recommended feeding practices, research data, and nutritional portfolios. Information is based on recent advances in horse nutrition and the National Research Council's Nutrient Requirements for Horses. A distance learning course. 3 lectures. Prerequisite: ASCI 144 and ASCI 220.

**ASCI 347 Equine Exercise Physiology (3)**

Applied physiology of the exercising horse. Examine different physiological systems: muscular, cardiovascular, respiratory, and nutritional. Gait analysis, lameness, and treatment. The athletic horse: sports medicine, conditioning, drugs, and necropsy evaluation. A distance learning course. 3 lectures. Prerequisite: ASCI 144 and any human/animal physiology class.

**ASCI 350 Applied Nonruminant Nutrition (4)**

Comparison of nonruminant and ruminant digestive systems, nutrient requirements, risk management for ingredients, formulation and nutritional management. Influence of growth and production curves, consumption patterns, and feeding management in commercial poultry and swine industries. Feed manufacturing and governmental regulations. 3 lectures, 1 laboratory. Prerequisite: ASCI 220 or DSCI 101.

**ASCI 384 Processed Meat and Poultry Products (4)**

Physical, chemical and functional characteristics of meat food raw materials. Science and technology of value-added processing including curing, sausage manufacture, low moisture products, and restructuring. Quality assurance and related current industry topics. Miscellaneous course fee may be required–see *Class Schedule*. 3 lectures, 1 laboratory. Prerequisite: ASCI/FSN 209 or ASCI/FSN 211, junior standing.

**ASCI 400 Special Problems for Advanced Undergraduates (2–4)**

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 4 units per quarter. Prerequisite: consent of instructor.

**ASCI 401 Reproductive Physiology (4)**

Reproductive anatomy of male and female farm animals. General endocrinology and systemic physiology. Endocrine system effects on the various aspects of reproduction, such as: gametogenesis, estrus, gestation, parturition, mothering and seasonality. Introduction to reproductive biotechnology and embryo manipulation. 3 lectures, 1 laboratory. Prerequisite: VS 223.

**ASCI 405 Domestic Livestock Endocrinology (4)**

Endocrine system and its role in the homeostasis of the animal. Use of hormones in increasing productivity of domestic animals. Endocrinology of reproduction, growth, metabolism and immunology. Discussions of cost-benefit relationships in the use of hormones. 4 lectures. Prerequisite: VS 223, ASCI 220.

**ASCI 410 Ultrasonography (1)**

Utilization of ultrasound technology for pregnancy diagnosis in sheep, beef cattle, swine and horses and live animal carcass estimation in sheep, beef cattle and swine. 1 laboratory. Prerequisite: FSN 211, ASCI 401, VS 223 and senior standing.

**ASCI 420 Animal Nutrition (3)**

Metabolism of proteins, carbohydrates, lipids, minerals, vitamins and water, and the relationship of nutrient utilization to animal production. 3 lectures. Prerequisite: ASCI 220 and CHEM 212/312 (or CHEM 216/316 and CHEM 217/317).

**ASCI 450 Computer Applications in Animal Science: Spreadsheet Analysis (4)**

Development of spreadsheets relating to livestock production. Integration of database and analytical techniques. Cost-benefit analyses of livestock production systems. 2 lectures, 2 activities. Prerequisite: AG 250, CSC 110, or consent of instructor..

**ASCI 461 Senior Project (2)**

Selection of a project and an ASCI 462 adviser, formulation of an outline and a literature review. Projects selected in the student's expected field of employment. Outline and literature review will be presented as part of the ASCI 462 final report. Minimum 60 hours. 2 seminars. Prerequisite: Senior standing.

**ASCI 462 Senior Project (2)**

Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum 60 hours.

**ASCI 463 Undergraduate Seminar (2)**

Major developments in the chosen field of the student. Discussion of new developments, policies, practices, and procedures. Each individual is responsible for the development and presentation of a topic in the chosen field. 2 seminars.

**ASCI 470 Selected Advanced Topics (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Consent of instructor.

**ASCI 471 Selected Advanced Laboratory (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories. Prerequisite: Consent of instructor.

**ASCI 476 Issues in Animal Agriculture (3)**

Exploration of social, political and environmental forces which will affect livestock production in the future. Roles played by advocacy groups and the media in influencing consumer demands and management practices. 3 seminars. Prerequisite: Upper division standing.

**ASCI 485 Cooperative Education Experience in Animal Science (6) (CR/NC)**

Part-time work experience with an approved Animal Science firm engaged in production or related business, industry or governmental agency. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Degree credit limited to 6 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**ASCI 490 Advanced Livestock Management Enterprise (2–4) (CR/NC)**

Intensified management of specialized livestock enterprises in all species areas. Application of applied research and progressive husbandry practices employed. Industry contact and visitation encouraged. Specified class prerequisites and consent of instructor required. Total degree credit for 290/490 limited to 9 units. Credit/No Credit grading only. Prerequisite: Specified classes and consent of instructor.

**ASCI 495 Cooperative Education Experience in Animal Science (12) (CR/NC)**

Full time work experience with an approved Animal Science firm engaged in production or related business, industry or governmental agency. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Degree credit limited to 6 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**ASCI 500 Individual Study in Animal Science (1–6)**

Advanced independent study planned and completed under the direction of a member of the Animal Science faculty. Total credit limited to 6 units. Prerequisite: Consent of department head, graduate adviser and supervising faculty member.

**ASCI 570 Selected Topics in Animal Science (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 12 units. 1 to 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**ASCI 581 Graduate Seminar in Animal Production (3)**

Current findings and research problems in the field and their application to the industry. 3 seminars.

## ASTR–ASTRONOMY AND ASTROPHYSICS

**ASTR 101 Introduction to the Solar System (4) GE B3**

Descriptive astronomical properties of the Earth, Moon, other planets and their satellites. Comets, asteroids and other members of the Solar System. Theories of the formation of the Solar System. Opportunities for telescope observations of the Moon and planets. Not open to students who have completed or are taking ASTR 301, ASTR 302, or PHYS 132. 4 lectures.

**ASTR 102 Introduction to the Stars and Galaxies (4) GE B3**

Descriptive astronomical properties of the Sun, stars, galaxies and interstellar material. Expanding universe and cosmological models. Opportunities for telescope observations of the stars and constellation identification. Not open to students who have completed or are taking ASTR 301, ASTR 302, or PHYS 132. ASTR 101 is not a prerequisite. 4 lectures.

**ASTR 301 The Solar System (3)**

Quantitative and descriptive properties of the Solar System including the physics of the planets, their satellites, comets and interplanetary media. Possible origins of the Solar System. Not open to students who have completed ASTR 101. 3 lectures. Prerequisite: PHYS 132 or PHYS 123.

**ASTR 302 Stars and Galaxies (3)**

Quantitative and descriptive properties of the stars, galaxies and interstellar media; including stellar structure and evolution, structure and make-up of galaxies and cosmological models. Not open to students who have completed ASTR 102. 3 lectures. Prerequisite: PHYS 132 or PHYS 123. ASTR 301 is not a prerequisite.

**ASTR 326 Relativity and Cosmology (3)**

Introduction to the basic ideas of Einstein's theories of relativity and cosmology. The structure and evolution of the universe. The principle of relativity, the speed of light, gravity and the equivalence principle. Curved spacetime, black holes, the expanding universe, the Big Bang, and nucleosynthesis. 3 lectures. ASTR 302 is not a prerequisite. Prerequisite: PHYS 122 or PHYS 132.

## BIO–BIOLOGY

**BIO 100 Orientation to Biological Sciences (1) (CR/NC)**

Career opportunities in the biological sciences, designing a career goal and a survey of departmental facilities and procedures related to research, study and graduation. Credit/No Credit grading only. 1 lecture.

**BIO 111 General Biology (4) GE B2 & B4**

Principles of cellular biology, heredity, ecology, biological diversity, and evolution, with emphasis on their relationships to human affairs. A Saturday field trip may be required. Not open to students who have completed BIO 115, BIO 151, or BOT 121. 3 lectures, 1 laboratory.

**BIO 112 Environmental Biology and Conservation (4) GE B5**

A biologically centered exploration of our planet focusing on natural resource conservation and contemporary environmental issues. Interactions between components of the biosphere and impacts of human society on interrelationships within ecosystems. Trends in natural resource conservation and biodiversity preservation. 4 lectures. .

**BIO 113 Animal Diversity and Ecology (4) GE B2 & B4**

Animal diversity and ecology in aquatic and terrestrial communities including structural and functional adaptations of animals to their environment. Identification of common invertebrate and vertebrate animals. Field experience in local ecosystems. Saturday field trips. 2 lectures, 2 laboratories.

**BIO 114 Plant Diversity and Ecology (4)** **GE B2 & B4**

Plant diversity and ecology in aquatic and terrestrial plant communities including adaptations of plants to their environment. Identification of common, local native plants and plant communities, uses of native plants by Native Americans, and human impacts on native plant communities. Saturday field trips. 2 lectures, 2 laboratories.

**BIO 115 Animal/Human Structure and Function (4)** **GE B2 & B4**

Survey of the structure and function of animal cells, tissues, organs, and organ systems, with examples drawn from vertebrates and invertebrates; emphasis will be on vertebrates, especially the human. Not open to students who have completed BIO 153. 3 lectures, 1 laboratory. Recommended prerequisite: a course in chemistry.

**BIO 151 Introduction to Biology (5)** **GE B2 & B4**

Fundamental principles of biology with emphasis on the physical and chemical basis of life; cytology; bioenergetics; storage; processing and expression of genetic information; ecology; evolution. 3 lectures, 2 laboratories. Recommended prerequisite: Concurrent or previous enrollment in college chemistry course.

**BIO 152 Biology of Plants and Fungi (5)**

Structure, ecology, reproduction, and evolution of fungi, cyanobacteria, algae, and plants. 3 lectures, 2 laboratories. Prerequisite: BIO 151.

**BIO 153 Biology of Animals (5)**

Survey of the protist and animal kingdoms; fundamentals of animal form and function. 3 lectures, 2 laboratories. Prerequisite: BIO 151.

**BIO 207 Resource Survey (3)**

Introduction to survey and analysis methods used in locating and assessing biological resources. Map reading, compass and level surveys, map construction, descriptive statistics, and animal, plant, and social surveys. 2 lectures, 1 laboratory. Prerequisite: MATH 120.

**BIO 213 Life Science for Engineers (2)** **GE B2**

Fundamentals of life sciences: energetics, cell biology, molecular and classical genetics, microbiology, organismal biology, and ecology. For engineering students only. 2 lectures. Prerequisite: MATH 142 and CHEM 124. Co-requisite: ENGR/BRAE 213.

**BIO 227 Wildlife Conservati on Biology (4)** **GE B2**

Historical development of wildlife biology and philosophies. Basic principles of ecology and evolution. Practices applied to wildlife. Current problems involving people-wildlife interactions with special reference to world biodiversity. 4 lectures.

**BIO 228 Wildlife Biology Laboratory (1)**

Recognition of important wildlife resources and presentation of life histories. Emphasis towards those forms that have been historically managed as game species and those currently considered endangered. Investigation of habitats common to various wildlife. 1 laboratory. Prerequisite: Concurrent or previous enrollment in BIO 227.

**BIO 253 Orientation to the Health Professions (1) (CR/NC)**

Participation in hospital activities and mental health services. Intended for medically oriented students. Total credit limited to 6 units with a maximum of 1 unit per quarter. Credit/No Credit grading only. 1 activity. Prerequisite: Instructor's consent and one quarter of college chemistry and BIO 115 or BIO 153.

**BIO 300 Biology of Cancer (2)**

Molecular, cellular and immunological aspects of cancer. Types of cancer and modes of treatment. Environmental, psychological and sociological implications. Cancer research. Not for Biology credit for Biological Sciences majors. 2 lectures.

**BIO 301 Conservation and Environmental Biology (4)**

Introduction to natural processes regulating renewable and non-renewable physical, chemical, and biological resources. Human population ecology and the influence and interactions of human populations on/with physical, chemical, and non-human biological resources. Principles of management, environmental science, and conservation biology that lead to equilibrium or self-sustaining conditions. 4 lectures. Prerequisite: One course in college biology.

**BIO 302 Human Genetics (4)** **GE B5**

Basic principles of human inheritance, including the transmission of genetic traits, chromosomal abnormalities and their effects, gene structure and function, mutations and mutagenic agents, cancer genetics, population genetics, and principles of genetic counseling. 4 lectures. Prerequisite: one course from GE Area B1 (Recommended: STAT 217 or STAT 218), and one course from GE Area B2.

**BIO 303 Survey of Genetics (3)**

Principles of heredity and variation. 3 lectures. Prerequisite: One quarter of college biology and one quarter of college mathematics. Recommended: College level course in statistics.

**BIO 306 Applications of Biological Concepts (4)**

Applications of basic biological concepts with special reference to how these concepts can be presented and developed in elementary schools. Emphasis is on hands-on activities, problem solving and computer assisted instruction modules in biology. 3 lectures, 1 laboratory. Prerequisite: Two of the following: BIO 113, BIO 114, BIO 115.

**BIO 311 Radiation Biology (3)**

Review of production and characteristics of non-ionizing and ionizing radiation; interaction and effect of radiation on living cells, tissues, organs, and organisms; introduction to use of radioisotopes; radiation protection and dosimetry; impact of nuclear energy on the biological world. 3 lectures. Prerequisite: CHEM 111 or CHEM 128 and one of the following: BIO 111, BIO 115, BIO 151, BOT 121.

**BIO 322 Introduction to Electron Microscopy (2)**

Introduction to principles and theory of scanning and transmission electron microscopy including instruments utilized in study of biological and nonbiological specimens. 1 lecture, 1 activity. Prerequisite: BIO 115 or BIO 151, BOT 121 or consent of instructor.

**BIO 323 Scanning Electron Microscopy Laboratory (1)**

Techniques of using the scanning electron microscope including preparing, examining and interpreting biological and nonbiological materials. 1 laboratory. Concurrent or previous enrollment in BIO 322.

**BIO 324 Transmission Electron Microscopy Laboratory (2)**

Applications of transmission electron microscopy including in-depth training in specimen preparation and use of the microscope. Design of experiments and interpretation of results will be included in laboratory. 2 laboratories. Concurrent or previous enrollment in BIO 322.

**BIO 325 General Ecology (4)**

Interactions between living organisms and their environment in terrestrial and aquatic habitats. 3 lectures, 1 laboratory. Prerequisite: BIO 152 and BIO 153.

**BIO 327 Wildlife Biology Methods (5)**

Methods for gathering information for management of wildlife. Use of the literature, inventory of plants and animal populations, use of maps, sexing and aging, trapping, handling, and marking techniques, physiological indices, and radio telemetry. 3 lectures, 2 laboratories. Prerequisite: BIO 227 and BIO 228.

**BIO 328 Marine Biology (5)**

Introduction to the functional biology of marine plants and animals and the processes that underlie their distribution and abundance in open oceans, coastal regions, estuaries, and wetlands. 3 lectures, 2 laboratories. Several field trips. Prerequisite: BIO 152 and BIO 153.

**BIO 342 Computer Applications in Biology (3)**

Applications of computers and data processing technology to the understanding and solving of specific problems in biology. 2 lectures, 1 laboratory. Prerequisite: One college level course in biological science and one course in computer science.

**BIO 343 Principles of Systematic Biology (4)**

Introduction to the concepts, methods and data used to define and recognize the units of biological diversity, including a survey of various types of molecular and morphological data and computer programs used in their analysis. 3 lectures, 1 laboratory. Prerequisite: Completion of BIO 150 series, BIO 303 or BIO 351, and STAT 218 or equivalent.

**BIO 348 Bioinformatics (4) GE Area F**
**(Also listed as CHEM/CPE/CSC 348)**

Introduction to problems in molecular biology and the use of computers to address them. The computational perspectives on problems involving nucleic acid and protein analysis, and the algorithmic and database approaches to their solution. The ethical and societal challenges of genetic manipulation. 3 lectures, 1 laboratory. Prerequisite: Consent of instructor, or the following: CSC 103, completion of GE Area B, and junior standing.

**BIO 351 Classical and Molecular Genetics (5)**

Introduction to transmission genetics and to the structure, function and regulation of proteins and nucleic acids. 5 lectures. Prerequisite: BIO 151, BIO 152, BIO 153, and CHEM 212/312 or CHEM 217/317. Recommended: Biochemistry.

**BIO 375 Molecular Biology Laboratory (2)**
**(Also listed as CHEM 375)**

Techniques used in molecular biology and biotechnology, plasmid DNA extraction, agarose gel electrophoresis, restriction endonuclease mapping, transduction, transformation, and gene cloning. 2 laboratories. Prerequisite: MCRO 221 or MCRO 224, and BIO 351 or CHEM 373.

**BIO 400 Special Problems for Advanced Undergraduates (1–2)**

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. 1-2 laboratories. Prerequisite: Consent of department chair.

**BIO 414 Evolution (4)**

Scientific evaluation of the theories, mechanisms, and evidences concerning biological evolution. 3 lectures, 1 activity. Prerequisite: BIO 303 or BIO 351.

**BIO 415 Biogeography (4)**

Plant and animal distribution patterns in relation to past and present physical and biotic factors; survey of major biomes with major emphasis on North and South America. 4 lectures. Prerequisite: BIO 325.

**BIO 418 Limnology (4)**

Biological, physical, and chemical dynamics of aquatic systems surrounded by land. 3 lectures, 1 laboratory. Prerequisite: BIO 325. Recommended: One college level course in chemistry.

**BIO 419 Quantitative Methods in Ecology (4)**

Introduction to quantitative methods used in ecology with an emphasis on the design and analysis of field studies. Population estimates, sampling design and analysis, and the determination of community structure. 4 lectures. Prerequisite: STAT 218 or equivalent. and one course in upper division ecology. Recommended: (BIO 325, BOT 326, or BIO 418) and STAT 313.

**BIO 424 Organizing and Teaching Biological Sciences (3)**

Objectives, content, techniques, material, and recent trends of successful instruction in secondary school biology. 3 lectures. Prerequisite: Consent of instructor.

**BIO 427 Wildlife Management (4)**

Important habitats, such as riparian, wetlands, etc. and habitat features important to wildlife, such as vegetation types and snags. Basic concepts of wildlife management. Emphasis on planning and designing habitats to meet the needs of wildlife. 3 lectures, 1 laboratory. Prerequisite: BIO 325.

**BIO 431 General and Cellular Physiology (4)**

Physiological processes in cells and organisms, including membrane phenomena, metabolism, enzyme kinetics, and cellular events associated with excitable cells and tissues. Current theories of biochemical, cellular, and organ system control mechanisms. Classical and current experimental techniques. 2 lectures, 2 laboratories. Prerequisite: BIO 152 or BIO 153, and CHEM 212/312. Recommended: STAT 218.

**BIO 432 Vertebrate Systems Physiology (4)**

Physiological mechanisms associated with several of the organ systems of vertebrates, including respiration and metabolism, circulation, digestion, water/ion regulation, and excretion. Various functional aspects, including cellular mechanisms, and how the mechanisms are integrated into the organism as a whole. 3 lectures, 1 laboratory. Prerequisite: BIO 431.

**BIO 433 Endocrinology and Reproductive Physiology (4)**

Introduction to the endocrine and reproductive systems of vertebrate animals. Topics include classical actions of hormones, mechanisms of hormone action, relationship between nervous and endocrine systems, assays of hormones, and selected clinical aspects of endocrinology. 3 lectures, 1 laboratory. Prerequisite: BIO 431.

**BIO 434 Environmental Physiology (4)**

Comparative physiological mechanisms involved in the regulation of oxygen uptake, water and ion balance, and temperature regulation in animals. Emphasis is placed on physiological adaptations which maintain or restore homeostasis in animals which are subjected to environmental changes. 3 lectures, 1 laboratory. Prerequisite: BIO 153, CHEM 212/312. Recommended: BIO 325 and BIO 431.

**BIO 435 Plant Physiology (4)**

Consideration of the principal physiological and biochemical processes of plants with emphasis on water relations, mineral nutrition, photosynthesis, and the physiology of plant development. 3 lectures, 1 laboratory. Prerequisite: BOT 121 or BIO 152, CHEM 212/312.

**BIO 437 Marine Resources (4)**

Biology of historical, current and potential marine resources including both technical means used to harvest and biological factors important in achieving a sustainable yield. Identification, life histories, ecology, culture and economics of pertinent organisms. 3 lectures, 1 laboratory. Prerequisite: BIO 152, BIO 153.

**BIO 438 Aquaculture (4)**

Propagation and rearing of fishes, invertebrates and algae from marine, freshwater and estuarine habitats. Current methodologies and general life histories. Global perspective including aquacultural development in developed and developing countries. 3 lectures, 1 laboratory. Prerequisite: BIO 153, ZOO 322, ZOO 336 or consent of instructor.

**BIO 442 Biometry (4)**

Design of biological experiments with emphasis on sampling methods, data collection, mensuration, and analysis of field and laboratory data. 3 lectures, 1 recitation. Prerequisite: One year of biology, STAT 218 or STAT 321.

**BIO 444 Population Ecology (3)**

Growth, fluctuations, balance, and natural mechanisms controlling terrestrial wildlife populations. 3 lectures. Prerequisite: BIO 325 or one course in ecology.

**BIO 450 Undergraduate Laboratory Assistantship (1–4) (CR/NC)**

Assisting the instructor in teaching and supervising undergraduate laboratories in the Biological Sciences Department. Total credit limited to 8 units, with a maximum of 4 units per quarter. Credit/No Credit grading only. Prerequisite: Consent of instructor and department chair.

**BIO 452 Cell Biology (4)**

Introduction to cell structure and function, energy conversions, protein sorting, signaling, cytoskeleton, cell adhesion and the cell cycle. 3

lectures, 1 laboratory. Prerequisite: BIO 351 or CHEM 373 and CHEM 212/312 or CHEM 217/317. Recommended: Course in biochemistry.

**BIO 453 Advanced Cell Biology Laboratory (2)**

Techniques used in biotechnology, including plant and animal cell culture, prokaryotic and eukaryotic transformation, restriction digests, cloning, expression vectors, genomic and plasmid DNA extraction. Southern blots, and PCR. 2 laboratories. Prerequisite: BIO 351.

**BIO 461, 462 Senior Project (3) (2)**

Projects are selected from typical problems which graduates may meet in areas of their future employment. Results are presented in written reports. BIO 461: 3 laboratories. BIO 462: 2 laboratories.

**BIO 465 Communicating Biology (4)**

Intensive approach designed to improve communication skills in biology. A combination of writing assignments and oral presentations to target a range of audiences and scientific sub-disciplines. 2 lectures, 2 activities. Prerequisite: completion of GE Area A, junior standing in biology and consent of instructor.

**BIO 470 Selected Advanced Topics (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Consent of instructor.

**BIO 471 Selected Advanced Laboratory (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topics selected. Total credit limited to 8 units. 1 to 4 laboratories. Prerequisite: Consent of instructor.

**BIO 475 Tissue Culture Techniques (4) (Also listed as CHEM 475)**

Introduction to the principles and methods of tissue culture with emphasis on the manipulation and study of animal cells. 2 lectures, 2 laboratories. Prerequisite: MCRO 221 or MCRO 224, BIO 303 or BIO 351 and CHEM 313 or CHEM 371.

**BIO 485 Cooperative Education Experience (6) (CR/NC)**

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**BIO 495 Cooperative Education Experience (12) (CR/NC)**

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**BIO 500 Individual Study (1–3)**

Advanced study planned and completed with the approval of and under the direction of a member of the department faculty. A written scholarly presentation of the results of each BIO 500 project must be included in the graduate student's departmental file. Not open for credit to students in the thesis program. Total credit limited to 3 units. 1-3 laboratories. Prerequisite: Graduate standing and consent of instructor.

**BIO 501 Cellular Biology (4)**

Consideration of recent studies on energetics, synthesis, regulation, genetics, transport, movements, reproduction, and differentiation of cells. 3 lectures, 1 laboratory. Prerequisite: Graduate standing or consent of instructor.

**BIO 502 Biology of Organisms (4)**

Genes and proteins that regulate the development and evolution of animals and plants. Role of homeotic and nonhomeotic genes. Importance of signal transduction pathways and regulation of the cell cycle. Role of oncogenes and mutant tumor suppressor genes in the development of cancer. 3 lectures, 1 laboratory. Prerequisite: Graduate standing or consent of instructor; BIO 501, BIO 351, or CHEM 373.

**BIO 503 Population Biology (4)**

Considerations of theory and practice in population ecology, evolutionary biology and biosystematics. 3 lectures, 1 laboratory. Prerequisite: Graduate standing or consent of instructor.

**BIO 515 History of Biology (3)**

Analysis of historical attempts to solve biological problems. 3 seminars. Prerequisite: Graduate standing or consent of instructor.

**BIO 524 Developmental Biology (4)**

Consideration of developmental phenomena and principles with an emphasis on the underlying cellular and molecular mechanisms. Focus on animals, both vertebrate and invertebrate. Topics include fertilization, gastrulation, axis determination, cell differentiation and organ formation. 3 seminars, 1 activity. Prerequisite: Graduate standing or consent of instructor. Recommended: BIO 501 and BIO 502.

**BIO 531 Theory and Prediction in Ecology (3)**

Directed group study and lectures on selected topics in ecology. Emphasis on an in-depth study of a restricted topic. 3 seminars. Prerequisite: Graduate standing or consent of instructor.

**BIO 542 Multivariate Biometry (4)**

Studies in continuous multivariate statistics, including the multivariate linear model, principal components and factor analysis, discriminant analysis, clustering, and canonical correlation. Use of MINTAB and SAS throughout. 4 lectures. Prerequisite: Two courses in statistics or consent of instructor.

**BIO 570 Selected Topics in Biology (1–4)**

Directed group study of selected topics for graduate students. *Class Schedule* will list topics for selection. Total credit limited to 12 units. 1 to 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**BIO 575 College Teaching Practicum (4) (CR/NC)**

Part-time teaching assignment in an undergraduate college classroom. Includes teaching and related activities under the supervision of a professor in Biological Science. Total credit limited to 8 units. Credit/No Credit grading only. 4 activities. Prerequisite: Graduate standing and evidence of satisfactory preparation in biology. Department chair and graduate coordinator's approval required.

**BIO 585 Cooperative Education Experience (6) (CR/NC)**

Advanced study, analysis and part-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Total credit limited to 9 units. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

**BIO 590 Seminar in Biology (1)**

Problems and topics in advanced biology selected according to the interest and needs of the students enrolled. Total credit limited to 5 units. 1 two-hour seminar. Prerequisite: Graduate standing or consent of instructor.

**BIO 595 Cooperative Education Experience (12) (CR/NC)**

Advanced study, analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Total credit limited to 9 units. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

**BIO 599 Thesis (3)**

Individual research under the general supervision of the faculty, leading to a graduate thesis of suitable quality. Total credit limited to 9 units. 3 laboratories. Prerequisite: Graduate standing, consent of instructor, and consent of thesis committee.

## BOT–BOTANY

**BOT 121 General Botany (4)** **GE B2 & B4**

The anatomy, physiology, reproduction, and importance of seed plants. 2 lectures, 2 laboratories.

**BOT 221 Native Plants for Landscape Architects (3) (Also listed as LA 221)**

Introduction to the horticultural characteristics and landscape design potential of California native plants. Includes experiences in field identification, basic planting design, installation and maintenance techniques. Required field trips. 2 lectures, 1 laboratory. Prerequisite: BIO 114 or BOT 121 or consent of instructor.

**BOT 223 Introductory Plant Taxonomy (4)**

Introduction to the principles and practices of vascular plant taxonomy. Emphasis on the basic terminology used in plant descriptions, classification and recognition of major plant families, and gaining proficiency in using taxonomic keys. Transfer equivalent to BOT 313. Not open to students with credit in BOT 313. 2 lectures, 2 laboratories. Prerequisite: BIO 152 or BOT 121.

**BOT 238 Native Plant Materials (3)**

Classification, identification, and associations of native plants. Factors which affect plant growth in natural environments. Miscellaneous course fee required–see *Class Schedule*. 2 lectures, 1 laboratory. Prerequisite: BOT 121.

**BOT 313 Taxonomy of Vascular Plants (4)**

Introduction to classification and identification of vascular plants, emphasizing major plant families; field and herbarium techniques. Miscellaneous course fee may be required–see *Class Schedule*. 2 lectures, 2 laboratories. Prerequisite: BIO 152 or BOT 121.

**BOT 323 Plant Pathology (4)**

Comprehensive study of the causes and effects of disease in plants. Designed to lead to an understanding of the science and modern control methods. 2 lectures, 2 laboratories. Prerequisite: BIO 152 or BOT 121.

**BOT 324 Ornamental and Forest Pathology (4)**

Causes and effects of diseases of important ornamental and forest plants, disease agents (life cycle, host range, environmental relationships), and modern approach to control. 2 lectures, 2 laboratories. Prerequisite: BIO 152 or BOT 121.

**BOT 325 Plant Nematology (4)**

Plant parasitic nematodes, their morphology, classification, and the damage they cause plants, alone or in combination with other pathogens. 2 lectures, 2 laboratories. Prerequisite: BOT 323 or BOT 324.

**BOT 326 Plant Ecology (4)**

Plant communities, population dynamics, and effects of the following environmental factors on plant growth and development: soil, water, temperature, light, atmosphere, topography, organisms, and fire. 3 lectures, 1 laboratory. Prerequisite: BIO 114, BIO 151, or BOT 121.

**BOT 333 Field Botany (4)**

Plant communities of California. Field identification of native and introduced plants in nature. Factors affecting plant distribution and relationships. Emphasis on local species. Several field trips. Miscellaneous course fee required–see *Class Schedule*. 2 lectures, 2 laboratories. Prerequisite: BOT 223/313.

**BOT 334 Morphology of Vascular Plants (4)**

Phylogenetic relationships of the plant kingdom as illustrated by comparative morphology of the vascular plants including living and fossil forms. 2 lectures, 2 laboratories. Prerequisite: BIO 152 and BOT 223/313.

**BOT 335 Plant Anatomy (4)**

Microscopic study of vascular plants dealing with the origin, development and structure of cells, tissues and organs. 2 lectures, 2 laboratories. Prerequisite: BIO 152 or BOT 121.

**BOT 425 Plant Virology (4)**

Plant pathogenic viruses, their plant, insect, nematode and fungal host-pathogen relationships, symptom recognition, isolation and identification methods. 2 lectures, 2 laboratories. Prerequisite: BOT 323 or BOT 324.

**BOT 426 Mycology (4)**

Comparative morphology and nuclear behavior of the fungi. Summary of the science with special attention given to forms important in agriculture, medicine and industry. 2 lectures, 2 laboratories. Prerequisite: BIO 152 or BOT 121.

**BOT 431 Advanced Plant Pathology (4)**

Methods, instruments, and materials used in diagnosis of plant diseases and in plant disease research. 2 lectures, 2 laboratories. Prerequisite: BOT 323 or BOT 324.

**BOT 437 Phycology (4)**

Comprehensive examination of the ecology, life histories, functional morphology, physiology and taxonomy of marine and freshwater algae. Laboratories emphasize species endemic to the central coast of California. 2 lectures, 2 laboratories. Prerequisite: BIO 152.

**BOT 443 Systematic Botany (4)**

Current theory of and approaches to botanical systematics, including use of morphological, cytological, biochemical, ecological and evolutionary data in classification. Literature of systematic botany and rules of botanical nomenclature. 3 lectures, 1 laboratory. Prerequisite: BOT 223/313.

**BOT 450 Plant Biotechnology (5)**

Principles and methods of plant tissue culture and transformation; current topics and applications, such as plant defense and genomics, and applications of DNA technology. 3 lectures, 2 laboratories. Prerequisite: BIO 435.

## BRAE–BIORESOURCE and AGRICULTURAL ENGINEERING

**BRAE 121 Agricultural Mechanics (2)**

Identification and use of tools and materials; shop safety; tool sharpening and care; concrete mixes and materials; simple electric wiring; metal work; pipe fitting; basic woodworking; estimating quantities and costs. Students are required to meet safety regulations in laboratory work. Miscellaneous course fee required–see *Class Schedule*. 1 lecture, 1 laboratory.

**BRAE 124 Small Engines (2)**

Operating principles of the small internal combustion engine. Maintenance and trouble-shooting applications of small power units to all types of engine applications. Repair procedures related to economic justifications. 1 lecture, 1 activity.

**BRAE 128 Careers in Bioresource and Agricultural Engineering (2)**

Introduction to careers associated with BioResource and Agricultural Engineering, and Agricultural Systems Management. Professional engineering registration process. Engineering problem solution and report format. Design procedures. Engineering fundamentals. Laboratory includes visits to facilities relating to career opportunities.

Miscellaneous course fee required–see *Class Schedule*. 1 lecture, 1 laboratory.

**BRAE 129 Laboratory Skills and Safety (1)**

Introduction to fabrication and construction materials used in the field of Agricultural Engineering. Fabrication skills in the development of wood, metal, concrete projects, and creative design. Strength tests of wood, fasteners, concrete, and student design projects. 1 laboratory. Prerequisite: BRAE and ASM majors only.

**BRAE 133 Engineering Design Graphics (3)**

Visual communication in engineering design and problem solving. Principles of freehand sketching, engineering graphics, and computer-aided-drafting. Perspective and orthographic sketching, orthographic drawing with instruments and computer, applied descriptive geometry. 1 lecture, 2 laboratories.

**BRAE 141 Agricultural Machinery Safety (3)**

Evaluation of safe tractor and equipment operation. Supervised field operation emphasizing the safe and efficient performance of modern farm and utility-industrial equipment. 2 lectures, 1 laboratory.

**BRAE 142 Agricultural Power and Machinery Management (4)**

Evaluation of agricultural machinery and tractor power performance. Equipment studied includes primary and secondary tillage tools, grain drills, row crop planters, sprayers, grain and forage harvesters, and specialty crop harvesters. Emphasis on management, selection, cost analysis using computers and efficient operation of agricultural machinery. 3 lectures, 1 laboratory. Prerequisite: MATH 116 or equivalent.

**BRAE 143 Power and Machinery (4)**

Performance of tractors and machinery. Evaluation of tillage, planting, and harvesting operations. Analysis and development of optimum mechanical systems. Use of microcomputers for evaluation, analysis, and report presentation. Miscellaneous course fee required–see *Class Schedule*. 3 lectures, 1 laboratory. Prerequisite: BRAE 128, MATH 119 or equivalent.

**BRAE 151 CAD for Agricultural Engineering (1)**

Computer aided drafting on a desktop personal computer using Autocad software. Drawing setup. 2-D projections including automatic dimensioning and hatching. Isometric construction, drawing layers, library symbols. Use of 3-D drawing software. 1 laboratory. Prerequisite: BRAE 133 or equivalent.

**BRAE 200 Special Problems for Undergraduates (1–4)**

Individual investigation, research, studies or surveys of selected problems. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of department head.

**BRAE 201 Enterprise Project (1-4) (CR/NC)**

Introductory experience in a bioresource/agricultural engineering or agricultural systems management project. Project participation is subject to approval by the department head and the Cal Poly Foundation. Credit/No Credit grading only. Prerequisite: BRAE 129 or consent of instructor.

**BRAE 203 Agricultural Systems Analysis (3)**

Agricultural Systems Analysis investigates the interrelationships between sub-components in an overall system. Problem solving algorithms, network analysis, project planning techniques, and optimization. 2 lectures, 1 laboratory. Prerequisite: MATH 118 or equivalent.

**BRAE 213 Bioengineering Fundamentals (2) GE B2**
**(Also listed as ENGR 213)**

Treatment of the engineering applications of biology. Genetic engineering and the industrial application of microbiology. Systems physiology with engineering applications. Structure and function relationships in biological systems. The impact of life on its environment. 2 lectures. For engineering students only. Prerequisite: MATH 142, CHEM 124. Co-requisite: BIO 213.

**BRAE 216 Fundamentals of Electricity (4)**

Application of electricity in BioResource and Agricultural Engineering, including basic electric circuits. Will include wiring materials, code regulations, electrical measurements, R-L-C circuit fundamentals, system planning, motors, basic electronics, and an introduction to computer usage. 3 lectures, 1 laboratory. Prerequisite: BRAE 128, BRAE 129, MATH 142, PHYS 131.

**BRAE 226 Introduction to Principles of Bioresource Engineering (4)**

Introduction to principles of engineering as applied to biological and agricultural systems as found in industry. Engineering properties of conventional and biological materials. Introduction to basic unit processes in industrial, agricultural, and biological systems. Special requirements of agricultural and biological processes. 3 lectures, 1 laboratory. Prerequisite: BRAE 128, BRAE 129, PHYS 131.

**BRAE 231 Agricultural Building Construction (3)**

Development of practical skills in carpentry and light construction. Selection of materials. Agricultural buildings repaired, constructed, or modified during laboratory periods. 1 lecture, 2 laboratories. Prerequisite: BRAE 129 or consent of instructor.

**BRAE 232 Agricultural Structures Planning (4)**

Planning of facilities required in production systems. Materials and processes used in construction of agricultural structures. Environmental factors affecting crop storage structures and animal housing. Design of structural environments to meet the needs of commodities, animals, and plants. 3 lectures, 1 laboratory. Prerequisite: BRAE 151, PHYS 132.

**BRAE 234 Introduction to Mechanical Systems in Agriculture (4)**

Introduction to elements used in the mechanical transmission of power and force in agricultural systems. Power transmission using v-belts. roller chain, gear and shaft drives, hydraulic actuators. Linear and nonlinear actuation devices including linkages, cams, and hydraulic/pneumatic cylinders. 3 lectures, 1 laboratory. Prerequisite: BRAE 128, BRAE 129, PHYS 131.

**BRAE 236 Principles of Irrigation (4)**

Land grading design, operation, management, and evaluation of irrigation methods. Miscellaneous course fee required–see *Class Schedule*. 3 lectures, 1 laboratory. Prerequisite: MATH 141, BRAE 237, SS 121, a computer programming course.

**BRAE 237 Engineering Surveying I (2)**

Use and care of tapes, levels, theodolites and Global Positioning System (GPS) receivers. Keeping field notes, measurements by tape. Differential leveling. Turning angles and determining directions of lines. GPS measurements. Map reading. Introduction to electronic distance measurement (EDM), photogrammetry, and land modeling. 1 lecture, 1 laboratory. Prerequisite: MATH 119 or an understanding of trigonometric functions.

**BRAE 238 Engineering Surveying II (2)**

Traverses by theodolite. Adjustments, coordinates, and area calculations. Earthwork and landgrading. Topographic mapping. Triangulation and trilateration using electronic distance measurement. Horizontal and vertical curve layout. 1 lecture, 1 laboratory. Prerequisite: BRAE 237.

**BRAE 239 Engineering Surveying (4)**

Use and care of tapes, levels, theodolites, Global Positioning system (GPS) receivers, Electronic Distance Measurement instruments (EDM) and electronic field books. Traverses, triangulation, trilateration, earthwork and associated calculations. Topographic mapping, photogrammetry, map reading and land descriptions. 2 lectures, 2 laboratories. Prerequisite: MATH 119 or equivalent.

**BRAE 240 Agricultural Engineering Laboratory (1)**
Individual projects. Total credit limited to 4 units. 1 laboratory. Prerequisite: Consent of instructor.

**BRAE 247 Forest Surveying (2) (Also listed as FNR 247)**
Use and care of tapes, staff compass, abney levels, theodolites, and GPS receivers. Keeping field notes, measurements by tape. Closed and open traverse by compass and theodolite. Turning angles and determining directions of lines. Map reading and public land description. GPS measurements. 1 lecture, 1 laboratory. Prerequisite: MATH 119.

**BRAE 301 Hydraulic and Mechanical Power Systems (4)**
Selection, application and use of hydraulic components and mechanical power transmission equipment. Use of standardized circuit design procedures. 3 lectures, 1 laboratory. Prerequisite: PHYS 121.

**BRAE 312 Hydraulics (4)**
Static and dynamic characteristics of liquids, flow in open and closed channels, uniform and nonuniform flow, flow measurement, pumps. 3 lectures, 1 laboratory. Prerequisite: PHYS 132, ME 211.

**BRAE 321 Agricultural Safety (3)**
Principles of agricultural safety. Accident causation and prevention, hazard identification and abatement, laws and regulations. Machinery, electrical, chemical, livestock, shop and fire safety. Safety program development. 2 lectures, 1 activity. Prerequisite: Junior standing.

**BRAE 324 Principles of Agricultural Electrification (4)**
Applications of DC/AC electricity in agriculture. National Electric Code regulations. The wiring of agricultural structures and electrical distribution. Series, parallel and series-parallel circuits, R-L-C circuits, electric motors, electronics. 3 lectures, 1 laboratory. Prerequisite: MATH 119 or MATH 120, PHYS 121.

**BRAE 325 Agricultural Energy Systems (3)**
Use of energy systems in modern agriculture with a focus on the economic and moral dilemmas facing our technological society. 2 lectures, 1 laboratory. Prerequisite: PHYS 121, BRAE 142.

**BRAE 326 Energy Systems for Agriculture (3)**
Theory and application of energy sources and systems. Covering such sources as heat systems, biomass, direct energy conversion, and power application to the soil. 2 lectures, 1 laboratory. Prerequisite: BRAE 143, ME 211, ME 302. ME 302 may be taken concurrently.

**BRAE 328 Measurements and Computer Interfacing (4)**
Transducers and engineering measurements in agricultural engineering. Covering transducer characteristics, signal processors and controllers, instrumentation techniques, and the use of the computer in the measurement and control of typical engineering problems. 3 lectures, 1 laboratory. Prerequisite: PHYS 206, PHYS 256, a computer programming course.

**BRAE 331 Irrigation Theory (3)**
Plant-water-soil relations using evapo-transpiration, plant stress, soil moisture deficiency, frequency and depth of irrigation, salinity, infiltration, drainage and climate control. Miscellaneous course fee required–see *Class Schedule*. 3 lectures. Prerequisite: BRAE 236, or BRAE 340.

**BRAE 335 Internal Combustion Engines (4)**
Principles of operation of internal combustion engines. Theory of operation and diagnosis evaluation and repair of small engines, gasoline and diesel engines and economics of operation, use and repair. Power analysis and application. 3 lectures, 1 laboratory. Prerequisite: Junior standing.

**BRAE 337 Landscape Irrigation (3)**
Design of landscape irrigation systems including soil factors, hydraulics, site information, selection of system components, back flow prevention, plumbing codes and cost estimating. 2 lectures, 1 laboratory. Prerequisite: SS 121 or consent of instructor.

**BRAE 339 Internship in BioResource and Agricultural Engineering (1–12) (CR/NC)**
Students will spend up to 12 weeks with an approved agricultural firm engaged in production or related business. Time will be spent applying and developing production and managerial skills and abilities. One unit of credit may be allowed for each full week of completed and reported internship. Degree credit limited to 6 units. Credit/No Credit grading only. Prerequisite: Consent of internship instructor.

**BRAE 340 Irrigation Water Management (4) GE Area F**
Soil-plant-water relationships; evapotranspiration; irrigation schedules; salinity and drainage; irrigation efficiency. Water measurement; soil moisture measurement; irrigation systems and practical constraints affecting scheduling. California water supply and budget; water rights; local, state and federal water institutions; California water issues. 3 lectures, 1 laboratory. Prerequisite: Junior standing, completion of GE Area A1, A3, and Area B, including Math 118 or better.

**BRAE 343 Engineering Analysis (4)**
Use of statics and dynamics to make original calculations, plans, sketches, graphics, drawings, schemes and layouts for the fabrication and construction of machines. 3 lectures, 1 laboratory. Prerequisite: MATH 119, BRAE 203, BRAE 301 or concurrent. Junior standing.

**BRAE 344 Fabrication Systems (4)**
Fabrication systems including cutting, sawing, shearing, bending, welding, grinding, cleaning, painting and proper safety procedures. Experimental projects to include team design and construction, presentation, organization, and evaluation. 2 lectures, 2 laboratories. Prerequisite: BRAE 343.

**BRAE 345 Aerial Photogrammetry and Remote Sensing (3)**
Object recognition, three-dimensional equipment, and interpreta-tion of aerial photographs. Print alignment, stereoscopic viewing, scales, elevation determination, and application. Orthophotos and their relationship to Geographic Information Systems (GIS). Application of aerial photos to regional studies. 2 lectures, 1 laboratory. Prerequisite: MATH 119.

**BRAE 348 Energy for a Sustainable Society (4) GE Area F**
Study of how the transition can be made from fossil fuels to renewable energy sources including hydro, biomass, solar, wind, and energy conservation. Environmental, economic, and political consequences of a renewable energy-based sustainable society. 3 lectures, 1 activity. Prerequisite: Completion of GE Area B and junior standing.

**BRAE 400 Special Problems for Advanced Undergraduates (1–4)**
Individual investigation, research, studies, or surveys of selected problems in agriculture. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of department head.

**BRAE 401 Enterprise Project Management (1-4) (CR/NC)**
Advanced experience in a bioresource/agricultural engineering or agricultural systems management project. Project leadership and management are stressed. Project participation is subject to approval by the department head and the Cal Poly Foundation. Credit/No Credit grading only. Prerequisite: BRAE 201 or consent of instructor.

**BRAE 402 Agricultural Materials (3)**
Introduction to the physical aspects and properties of a wide variety of materials encountered in the field of agriculture. Physical interactions between agricultural commodities and the machines used in handling. 2 lectures, 1 laboratory. Prerequisite: BRAE 325.

**BRAE 403 Agricultural Systems Engineering (4)**
Engineering and economic principles combined with mathematical optimization techniques to evaluate parameters in agricultural production and processing systems. Project planning techniques, linear and nonlinear modeling, response surface methodology. Professional responsibilities in Agricultural Engineering including ethics, patents,

copyrights, liability. 3 lectures, 1 laboratory. Prerequisite: ECON 201/211, MATH 242.

**BRAE 405 Chemigation (1)**

Fertilizer and chemical injection through irrigation systems. Hardware, fertilizer compounds, and distribution uniformity. Matching chemicals and equipment to specific irrigation methods. Safety. Miscellaneous course fee required–see *Class Schedule*. 1 laboratory. Prerequisite: BRAE 236 or BRAE 340.

**BRAE 414 Irrigation Engineering (4)**

Design of on-farm irrigation systems; micro, surface, and sprinkler irrigation systems; canals and pumps; economic and strategies of pipe design; pipeline protection. Miscellaneous course fee required–see *Class Schedule*. 3 lectures, 1 laboratory. Prerequisite: BRAE 331 or BRAE 340; hydraulics.

**BRAE 415 Hydrology (3)**

Collection, organization and use of precipitation and runoff data, flood frequency and economics of structures, stream gauging and use of hydrograph, principles of groundwater management and flood routing. 3 lectures. Prerequisite: Junior standing and MATH 141 or consent of instructor.

**BRAE 418, 419 Agricultural Systems Management I, II (4) (4)**

Project management of agricultural systems. Emphasis placed on a team approach to problem solution. Case studies and student projects used to explore the following topics: project leadership, project organization, communication, needs assessment, feasibility studies, cost analysis, decision making, solution implementation, and evaluation. BRAE 418: 3 lectures, 1 laboratory. BRAE 419: 2 lectures, 2 laboratories. Prerequisite: BRAE 203, AGB 301, AGB 310 and ENGL 148. For BRAE 419: BRAE 418.

**BRAE 421 Equipment Engineering (3)**

Design and construction of specialized agricultural components and equipment. 2 lectures, 1 laboratory. Prerequisite: BRAE 328, CE 205, ME 212.

**BRAE 422 Equipment Engineering (4)**

Design and construction of specialized agricultural components and equipment. 2 lectures, 2 laboratories. Prerequisite: BRAE 421.

**BRAE 425 Computer Controls for Agriculture (3)**

Computer activated controls as applied to agricultural machinery, agricultural structures, processing and irrigation industries. Encompassing control logic to evaluate stability behavior of systems of computer interfacing, data input and control output. 2 lectures, 1 laboratory. Prerequisite: BRAE 324, CSC 110 or CSC 119 or AG 250.

**BRAE 427 Agricultural Process Engineering (3)**

Agricultural engineering principles applied to air, water, air-water mixtures, drying, heating, refrigeration, fluid flow, size reduction, fan laws and materials handling. 2 lectures, 1 laboratory. Prerequisite: BRAE 312, BRAE 430, ME 302.

**BRAE 430 Finite Element Analysis (3)**

Introduction to the theory of finite element analysis and its application to drainage, pipe flow, fruit and vegetable damage predictions, structural strength, heat transfer, and other agricultural engineering applications. 2 lectures, 1 laboratory. Prerequisite: CE 204, MATH 242, ME 302.

**BRAE 432 Agricultural Buildings (4)**

Selection of buildings, storage units, and related equipment for production agriculture. Economics and functionality of various designs and construction materials. Environmental factors affecting crop storage and animal housing. 3 lectures, 1 laboratory. Prerequisite: PHYS 121, BRAE 402.

**BRAE 433 Agricultural Structures Design (4)**

Structural analysis and design of agricultural service and processing buildings. Emphasis on use of wood, metals, and reinforced concrete in light construction. 3 lectures, 1 laboratory. Prerequisite: BRAE 232, CE 205.

**BRAE 435 Drainage (3)**

Flow of water in porous media. Intrinsic permeability and hydraulic conductivity. Flow nets, wells and ground water, design of sub-surface drains. 2 lectures, 1 laboratory. Prerequisite: BRAE 312, BRAE 331, or BRAE 340 or SS 432 and consent of instructor.

**BRAE 437 Conservation Engineering (3)**

Engineering solutions of soil and water conservation problems. Applications of engineering fundamentals of hydraulics, hydrology, and soils used in the design and construction of soil and water conservation structures. 2 lectures, 1 laboratory. Prerequisite: BRAE 312, BRAE 415, SS 121, or consent of instructor.

**BRAE 438 Drip/Micro Irrigation (4)**

Drip/micro irrigation hardware and management. Emphasizes agricultural drip/micro irrigation with some landscape application. Filtration, emitters, chemical injection, agronomic constraints, and scheduling. Field trip(s) included. 3 lectures, 1 laboratory. Prerequisite: BRAE 236 or BRAE 340.

**BRAE 440 Agricultural Irrigation Systems (4)**

On-farm irrigation system evaluation and management. Drip, micro-spray, furrow, border strip, sprinkler systems. Irrigation efficiency and uniformity. Pumping costs. For non-AE majors only. Miscellaneous course fee required–see *Class Schedule*. 3 lectures, 1 laboratory. Prerequisite: SS 121 or consent of instructor.

**BRAE 446 CAD Software for Land Modeling (2)**

Techniques for preparing data for geographic information systems using TERRAMODEL. Digital data from surveying, orthophotography, and government data sources will be entered, displayed, edited and translated for use in other software packages. Transformation of coordinate systems. Earthwork and hydrologic examples. 1 lecture, 1 laboratory. Prerequisite: BRAE 237 or BRAE 247.

**BRAE 448 Bioconversion (3)**

Thermal mechanics and physical techniques for converting biomass into useful energy forms for agriculture and industry. Laboratory exercises include experiments with methane and alcohol production and combustion of agricultural residue. Miscellaneous course fee required–see *Class Schedule*. 2 lectures, 1 laboratory. Prerequisite: MATH 117 or equivalent, or consent of instructor.

**BRAE 452 Legal Aspects/Data Accuracy for GIS (3)**

Research of boundary descriptions, record maps, and existing survey data. Value and implications of the data. Local and state requirements and restrictions on use of data. Procedures for incorporation of data into Arc/Info. 2 lectures, 1 laboratory. Prerequisite: BRAE 237 or BRAE 239.

**BRAE 460 Senior Project Organization (1)**

Selection and organization of senior project. Involves time management, research techniques, budgeting and project presentation. 1 lecture. Prerequisite: ENGL 148, junior standing.

**BRAE 461, 462 Senior Project (2) (2)**

Solution of an engineering or systems management problem in agriculture. May involve research methodology, problem statement, analysis, synthesis, project design, construction, and evaluation. Project requires 150 hours with a minimum of faculty supervision. Prerequisite: BRAE 460.

**BRAE 463 Undergraduate Seminar (1)**

Group discussion of current agricultural engineering topics presented by individual members of the class and visitors. Placement opportunities and requirements. 1 seminar.

**BRAE 464 Professional Practice (3)**

Contracts, specifications, and legal aspects of agricultural engineering. Safety and human factors. Engineering ethics and professional registration. 3 lectures. Prerequisite: Senior standing.

**BRAE 470 Selected Advanced Topics (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1–4 lectures. Prerequisite: Consent of instructor.

**BRAE 471 Selected Advanced Laboratory (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1–4 laboratories. Prerequisite: Consent of instructor.

**BRAE 481 Advanced Agricultural Mechanics (2)**

Advanced shop skills. Carpentry, electricity, plumbing, surveying, power mechanics, tractor equipment operation and maintenance. 2 lectures, 2 laboratories weekly for five weeks per session–two sessions per quarter. Prerequisite: Agricultural teacher candidates starting/returning from student teaching, senior or graduate standing or consent of instructor.

**BRAE 485 Cooperative Education Experience in BioResource and Agricultural Engineering (6) (CR/NC)**

Part-time work experience with an approved BioResource and Agricultural Engineering firm engaged in production or related business, industry or governmental agency. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Degree credit limited to 6 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**BRAE 492 Pumps and Pump Drivers (3)**

Pump characteristics and system head. Net positive suction head. Series and parallel operation. Pump contracts and protection. Selection of pumping systems for different water sources. Design of pump intakes for surface water supplies. Driver selection. Servicing motors and engines. Hand pumps and wind mills. 2 lectures, 1 laboratory. Prerequisite: Senior standing.

**BRAE 495 Cooperative Education Experience in BioResource and Agricultural Engineering (12) (CR/NC)**

Full time work experience with an approved BioResource and Agricultural Engineering firm engaged in production or related business, industry or governmental agency. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Degree credit limited to 6 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**BRAE 500 Individual Study (1–3)**

Advanced study planned and completed under the direction of a member of the department faculty. Open only to graduate students who have demonstrated ability to do independent work. Enrollment by petition. Prerequisite: Consent of instructor.

**BRAE 521 Systems Analysis of Agricultural Systems (4)**

Principles and methods of creative problem solving and systems analysis as applied to the design of agricultural systems. Problem solving using the engineering design process to analyze the need, establish boundaries, and generate creative alternative solutions. Examples worked through in feasibility analysis, transportation and network problems, linear programming, project planning, human factors and ergonomics, and system analysis with an emphasis on optimum system operation. 3 lectures, 1 laboratory. Prerequisite: Consent of instructor.

**BRAE 522 Instrumentation Control/Microprocessors (4)**

Engineering input/output instrumentation for sensing and controlling functions through data acquisition, analysis and response to agricultural processing. Miscellaneous course fee required–see *Class Schedule*. 3 lectures, 1 laboratory. Prerequisite: BASIC language programming or consent of instructor.

**BRAE 529 Small Farm Mechanization (3)**

Principles of farm machinery used for tillage, seeding, weeding, harvesting and transport of agricultural crops. Small-scale equipment, suitable for subsistence farming in developing countries. Small tractors, hand tools, animal power, and fuel from renewable sources. Miscellaneous course fee required–see *Class Schedule*. 2 lectures, 1 laboratory. Prerequisite: BRAE 143 or equivalent, graduate standing, or consent of instructor.

**BRAE 531 Water Wells (3)**

Groundwater resources drilling methods and development of wells. Water well design for pollution prevention. Well rehabilitation. Destruction of abandoned wells. Design of domestic water systems. Water quality standards and water conditioning for different applications. 2 lectures, 1 laboratory. Prerequisite: Graduate standing.

**BRAE 533 Irrigation Project Design (4)**

Engineering solutions and social aspects of improved water delivery to farms and canal automation. Flow measurement. Water user associations. Unsteady canal and pipeline controls. PID controls and modeling. Miscellaneous course fee required–see *Class Schedule*. 3 lectures, 1 laboratory. Prerequisite: BRAE 340, hydraulics/fluid mechanics.

**BRAE 570 Selected Topics in BioResource and Agricultural Engineering (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 12 units. 1 to 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**BRAE 571 Selected Advanced Laboratory in BioResource and Agricultural Engineering (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. *Class Schedule* will list topic selected. Total credit limited to 8 units. 1–4 laboratories. Prerequisite: Consent of instructor.

**BRAE 581 Graduate Seminar in BioResource and Agricultural Engineering (3)**

Group study of current problems of the bioresource and agricultural engineering industry; current experimental and research findings as applied to field of bioresource and agricultural engineering. *Class Schedule* will list topic selected. Total credit limited to 9 units. 3 seminars. Prerequisite: Graduate standing or consent of instructor.

**BRAE 599 Thesis in BioResource and Agricultural Engineering (1–9)**

Systematic research of a significant problem in bioresource and agricultural engineering. Thesis will include problem identification, significance, methods, data analysis, and conclusion. Students must enroll every quarter in which facilities are used or advisement is received. Degree credit limited to 6 units. Prerequisite: Graduate standing and consent of instructor.