

# BIORESOURCE & AGRICULTURAL ENGINEERING

BioResource & Agricultural Engineering Bldg. (08), Room 101  
 Phone: 805.756.2378; Fax: 805.756.2626  
<https://brae.calpoly.edu>

Department Head: Peter Livingston

## Academic Programs

Program name	Program type
Agricultural Systems Management	BS
BioResource and Agricultural Engineering	BS

The department offers two programs leading to a Bachelor of Science degree: BioResource and Agricultural Engineering and Agricultural Systems Management.

The BioResource and Agricultural Engineering Department is an engineering-based educational organization consisting of professionals whose mission is the study, teaching, and practice of engineering and systems management support for agriculture. The department is nationally recognized as a leader in this field, and for balancing theory with application and principle with practice.

Department facilities include well-equipped laboratories for hydraulic systems, evaluation and testing of power units, fabrication of agricultural machinery, agricultural electrical systems, design and construction of agricultural structures, photogrammetry, microcomputers and controllers.

Outdoor facilities include a water resources center with multiple pumping systems and operational canals, a field for evaluation of various irrigation systems including an operating linear move and land for experience in the mechanical production of farm products and safe operation of agricultural machinery.

Students are encouraged to participate in the student clubs of the department. The Agricultural Engineering Society is involved in a broad range of activities and services including Open House displays. The student branch of the American Society of Agricultural and Biological Engineers offers professional and co-curricular activities.

## Undergraduate Programs

### BS Agricultural Systems Management

The mission of the Agricultural Systems Management program is to provide a "learn by doing" undergraduate educational experience that prepares students for systems management practice in support of agriculture and related industries throughout the West.

Students receive broad agricultural training with a business and management emphasis in one of the following areas: plant production, livestock production, food and fiber processing, environmental information management, water/irrigation, and processing and manufacturing. Students have the opportunity to develop management expertise through interdisciplinary experiences in agricultural technology and business oriented coursework.

The objectives of the Agricultural Systems Management program are to produce graduates who, in 3-5 years after graduation, are successful as one of the following:

- Individuals that are successful in technical, business, or management positions within agriculture or related industries
- Applying unique engineering problem-solving skills and principles so that they are "industry ready" to undertake technological, business, or management projects and make significant contributions from day one on the job
- Actively pursuing professional development such as a degree in an advanced degree program, professional license, or technical certification

Agricultural Systems Management graduates demonstrate a knowledge and understanding of basic agricultural technologies and agribusiness principles necessary for technical operations and business management careers in agriculture and related industries; an understanding of modern science and practice within a specialized agricultural area of interest; and ability to apply quantitative, analytical processes for developing solutions to technological, business or management problems associated with production, processing, or the distribution of products and support services in agriculture and related industries; an understanding of the interconnected "systems" of agriculture; and ability to safely and properly handle the materials, machines, sensors, tools and techniques of modern agricultural or technical operations; and an ability to communicate and perform as effective agricultural systems management professionals in the solution of problems crossing discipline or cultural boundaries.

Career opportunities are available in the manufacturing, sales, and service of agricultural equipment and machinery; management and production of animals and crops; processing of food and fiber; and management of water/irrigation facilities. The program is recognized by the American Society of Agricultural and Biological Engineers.

### BS BioResource and Agricultural Engineering

The bioresource/agricultural engineer represents the most general type of engineer, adept at utilizing electrical and mechanical energy sources, water resources, and designing structural units. The curriculum features a unique combination of engineering and applied science coursework, with a focus on preparing graduates for practice in professional engineering.

The mission of the BioResource and Agricultural Engineering program is to provide a "learn by doing" undergraduate educational experience that prepares students for engineering practice in support of agriculture and related industries throughout the West.

The objectives of the BioResource and Agricultural Engineering program are to produce graduates who, in 3-5 years after graduation, are successful as one of the following:

- Engineers in positions of professional responsibility and leadership in a modern multi-disciplinary, system-oriented environment that emphasizes problem solving
- Actively pursuing professional development such as a degree in an advanced degree program, professional license, or technical certification

- Applying unique engineering problem-solving skills and principles within a career outside traditional engineering environments, such as management, teaching, research, or other professional fields

BioResource and Agricultural Engineering graduates demonstrate a knowledge and understanding of the basic mathematics, physical and engineering sciences necessary for modern agricultural engineering practice; the ability to design components, systems or processes to meet specified objectives, including prudent use of resources; an understanding of their professional and ethical responsibilities as agricultural engineers, including the societal impact of engineering solutions and the need to engage in life-long learning; the ability to plan, design, execute and evaluate engineering solutions to problems/projects that are real, practical and of a complexity representative of projects encountered in beginning professional practice; and the ability to communicate and perform as effective engineering professionals in both individual and team-based project environments.

Cal Poly's "learn by doing" philosophy is emphasized by the numerous design-centered laboratories and the senior project. In the senior design project, which is completed in a three-quarter set of capstone courses, students demonstrate their understanding of engineering knowledge and their ability to apply that knowledge creatively to practical problems.

Consistent with program accreditation requirements regarding a graduate's ability to function on multidisciplinary teams, the BioResource and Agricultural Engineering program has adopted an explicit graduation requirement in this area. This provides students an opportunity to practice team skills. Such experience is important for practicing engineers given the ever-increasing diversity of engineering science and applications. Methods to fulfill this requirement include items such as:

- Team design project
- CO-OP or internship employment
- Certain club activities
- Working with faculty on a sponsored project
- Project embedded in curriculum
- Taking certain technical electives
- Service learning project

Career opportunities exist in the design, evaluation and management of systems – water resources, irrigation, drainage, groundwater, pumps, soil conservation; agricultural power and machinery; food processing; energy; and agricultural environments. The program is accredited by the Engineering Accreditation Commission of ABET (<http://www.abet.org>).

## Minors

The department participates in offering interdisciplinary minors in Water Science and Geographic Information Systems. Please see College of Agriculture, Food and Environmental Sciences (<http://catalog.calpoly.edu/collegesandprograms/collegeofagriculturefoodenvironmentalsciences>) section for more information.

## Graduate Program

Cal Poly offers the MS in Agriculture with specializations in BioResource and Agricultural Systems and in Irrigation, and the MS in Engineering with a specialization in Water Engineering. Please see College of Agriculture, Food and Environmental Sciences (<http://catalog.calpoly.edu/collegesandprograms/>

[collegeofagriculturefoodenvironmentalsciences](http://catalog.calpoly.edu/collegesandprograms/collegeofagriculturefoodenvironmentalsciences)) and College of Engineering (<http://catalog.calpoly.edu/collegesandprograms/collegeofengineering/msengineeringsspecializationinwaterengineering>) sections for more information.

## BRAE Courses

### **BRAE 121. Agricultural Mechanics. 2 units**

Term Typically Offered: F, W

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. 1 lecture, 1 laboratory.

### **BRAE 128. Careers in Bioresource and Agricultural Engineering. 2 units**

Term Typically Offered: F

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. 1 lecture, 1 laboratory.

### **BRAE 129. Laboratory Skills and Safety. 1 unit**

Term Typically Offered: F, W, SP

Prerequisite: BRAE and ASM majors only.

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.

### **BRAE 133. Introduction to Engineering Design Graphics. 1 unit**

Term Typically Offered: F, W

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 laboratory.

### **BRAE 141. Agricultural Machinery Safety. 3 units**

Term Typically Offered: F, SP

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 units**

Term Typically Offered: F

Prerequisite: MATH 116 or equivalent.

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.

**BRAE 151. CAD for Agricultural Engineering. 1 unit**

Term Typically Offered: F, W, SP

Prerequisite: BRAE 133 or equivalent.

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.

**BRAE 152. 3-D Solids Modeling. 1 unit**

Term Typically Offered: F, W, SP

Prerequisite: BRAE 133, BRAE 151 or equivalent courses.

Introduction to 3-dimensional solids modeling using state-of-the-art software. Model generation and modification of associative properties, assembly modeling, extrusions and revolutions. 1 laboratory.

**BRAE 200. Special Problems for Undergraduates. 1-4 units**

Term Typically Offered: F, W, SP

Prerequisite: Consent of department head.

Individual investigation, research, studies or surveys of selected problems. Total credit limited to 8 units, with a maximum of 4 units per quarter.

**BRAE 203. Agricultural Systems Analysis. 4 units**

Term Typically Offered: W

Prerequisite: MATH 118 or equivalent.

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, 2 activities.

**BRAE 213. Bioengineering Fundamentals. 2 units**

GE Area B2

Term Typically Offered: F, W, SP

Prerequisite: MATH 142; for engineering students only. Corequisite: BIO 213. Recommended: CHEM 124.

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. Course may be offered in classroom-based or online format. 2 lectures. Crosslisted as BMED/BRAE 213. Fulfills GE B2.

**BRAE 216. Fundamentals of Electricity. 4 units**

Term Typically Offered: F

Prerequisite: BRAE 129, MATH 142, PHYS 131.

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.

**BRAE 232. Agricultural Structures Planning. 4 units**

Term Typically Offered: SP

Prerequisite: BRAE 151, PHYS 132.

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.

**BRAE 234. Introduction to Mechanical Systems in Agriculture. 4 units**

Term Typically Offered: SP

Prerequisite: PHYS 131.

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.

**BRAE 236. Principles of Irrigation. 4 units**

Term Typically Offered: F

Prerequisite: MATH 141, SS 121.

Land grading design, operation, management, and evaluation of irrigation methods. 3 lectures, 1 laboratory.

**BRAE 237. Introduction to Engineering Surveying. 2 units**

Term Typically Offered: F, W, SP

Prerequisite: MATH 119 or equivalent.

An introduction to basic field note keeping as well as the use of steel tapes, automatic levels, total stations and survey tools. Training in the procedures for differential and profile leveling; angle measurement and traversing. Hands-on experience with the use of GPS for surveying. An understanding in computations to determine direction, elevations, and earthwork volumes. Practice in map reading and building layout. 1 lecture, 1 laboratory.

**BRAE 239. Engineering Surveying. 4 units**

Term Typically Offered: F, W, SP

Prerequisite: MATH 119 or equivalent.

Development of proper field note taking and procedures for measuring using automatic levels, total stations and GPS systems. Understanding in the procedures and computations for differential leveling, profiles, traversing, triangulation and topographic surveys. Computations in traverse adjustment, contour mapping, earthwork volumes, curve alignments and building layout. Understanding in map reading, the use of datums, photogrammetry, CAD design and boundary law. 2 lectures, 2 laboratories.

**BRAE 240. Agricultural Engineering Laboratory. 1 unit**

Term Typically Offered: F, W, SP

Prerequisite: Consent of instructor.

Individual projects. Total credit limited to 4 units. 1 laboratory.

**BRAE 244. Precision Farming. 4 units**

Term Typically Offered: W

Prerequisite: AEPS 133 or AEPS 190 or AEPS 260 or BRAE 237 or BRAE 239.

Precision agriculture applications. Integrating GIS, GPS, and remote sensing technologies with site-specific farming practices to optimize agricultural productivity. Field trip required. 3 lectures, 1 laboratory. Crosslisted as AEPS/BRAE 244.

**BRAE 247. Forest Surveying. 2 units**

Term Typically Offered: F, W, SP

Prerequisite: NR 215.

Use and care of tapes, staff compass, abney levels, total stations, and GPS receivers. Keeping field notes, measurements by tape. Closed and open traverse by compass and total stations. Turning angles and determining directions of lines. Map reading and public land description. GPS measurements. Weekend field trips required. 1 lecture, 1 laboratory. Crosslisted as BRAE/NR 247.

**BRAE 270. Selected Topics. 1-4 units**

Term Typically Offered: TBD

Prerequisite: Open to undergraduate students and consent of instructor.

Directed group study of selected topics. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1 to 4 lectures.

**BRAE 301. Hydraulic and Mechanical Power Systems. 4 units**

Term Typically Offered: SP

Prerequisite: PHYS 121 or PHYS 141.

Selection, application and use of hydraulic components and mechanical power transmission equipment. Use of standardized circuit design procedures. 3 lectures, 1 laboratory.

**BRAE 302. Servo Hydraulics. 4 units**

Term Typically Offered: W

Prerequisite: BRAE 216 or BRAE 324 and BRAE 234 or BRAE 301.

Application of microcomputers and programmable logic controllers to hydraulic, pneumatic and mechanical systems. Theory, instrumentation and sensors used in process and control systems used in agricultural equipment. 3 lectures, 1 laboratory.

**BRAE 312. Hydraulics. 4 units**

Term Typically Offered: F

Prerequisite: PHYS 132, ME 211.

Static and dynamic characteristics of liquids, flow in open and closed channels, uniform and nonuniform flow, flow measurement, pumps. 3 lectures, 1 laboratory.

**BRAE 320. Principles of Bioresource Engineering. 4 units**

Term Typically Offered: SP

Prerequisite: BRAE 232, BRAE 236, PHYS 132.

Theory and applications of bioprocess technology in biological and agricultural systems. Engineering properties of biological materials and organisms. Basic unit operations, fluid mechanics and heat/mass transfer as applied to bioprocess technology. Special requirements of agricultural and biological processes. 3 lectures, 1 laboratory.

**BRAE 321. Agricultural Safety. 3 units**

Term Typically Offered: W

Prerequisite: Junior standing.

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.

**BRAE 324. Principles of Agricultural Electrification. 4 units**

Term Typically Offered: W

Prerequisite: MATH 119, PHYS 121.

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.

**BRAE 328. Measurements and Computer Interfacing. 4 units**

Term Typically Offered: SP

Prerequisite: EE 321; EE 361; and CSC 231 or CSC 232 or CSC 234.

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.

**BRAE 331. Irrigation Theory. 3 units**

Term Typically Offered: W

Prerequisite: BRAE 236, or BRAE 340.

Plant-water-soil relations using evapo-transpiration, plant stress, soil moisture deficiency, frequency and depth of irrigation, salinity, infiltration, drainage and climate control. 3 lectures.

**BRAE 335. Internal Combustion Engines. 4 units**

Term Typically Offered: W

Prerequisite: Junior standing.

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.

**BRAE 337. Landscape Irrigation. 4 units**

Term Typically Offered: W

Prerequisite: MATH 118.

Design of sprinkler and drip irrigation systems including: site characteristics, soil variables affecting water storage and infiltration rate, plant selection and hydrozones, hydraulics, nozzle spacing, selection of system components, back flow prevention, plumbing codes and cost estimating. Irrigation system evaluation and audit irrigation scheduling, and water budget. 3 lectures, 1 laboratory.

**BRAE 339. Internship in Bioresource and Agricultural Engineering. 1-12 units**

CR/NC

Term Typically Offered: F, W, SP

Prerequisite: Consent of internship instructor.

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.

**BRAE 340. Irrigation Water Management. 4 units**

GE Area F

Term Typically Offered: F, W, SP

Prerequisite: Junior standing, completion of GE Area B, and Math 118 or higher.

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. Fulfills GE Area F.

**BRAE 342. Agricultural Materials. 4 units**

Term Typically Offered: F

Prerequisite: PHYS 121, SS 121, MATH 119.

Physical properties of agricultural materials and their measurement. Strength of materials, material flow and transport, material deformation, shape and size classification, moisture relationships and biological interactions. Interactions between agricultural materials, the environment and equipment used to handle them. 3 lectures, 1 laboratory.

**BRAE 343. Mechanical Systems Analysis. 4 units**

Term Typically Offered: W

Prerequisite: BRAE 342.

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.

**BRAE 344. Fabrication Systems. 4 units**

Term Typically Offered: SP

Prerequisite: BRAE 343.

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.

**BRAE 345. Aerial Photogrammetry and Remote Sensing. 3 units**

Term Typically Offered: F, W

Prerequisite: MATH 118.

Object recognition, three-dimensional equipment, and interpretation 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.

**BRAE 348. Energy for a Sustainable Society. 4 units**

GE Area F

Term Typically Offered: F, W, SP

Prerequisite: Junior standing and completion of GE Area B.

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. Fulfills GE Area F.

**BRAE 400. Special Problems. 1-4 units**

Term Typically Offered: F, W, SP

Prerequisite: Consent of department head.

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.

**BRAE 403. Agricultural Systems Engineering. 4 units**

Term Typically Offered: SP

Prerequisite: MATH 242 or MATH 244.

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.

**BRAE 405. Chemigation. 1 unit**

Term Typically Offered: SP

Prerequisite: BRAE 236 or BRAE 340; or graduate standing.

Fertilizer and chemical injection through irrigation systems. Hardware, fertilizer compounds, and distribution uniformity. Matching chemicals and equipment to specific irrigation methods. Safety. 1 laboratory.

**BRAE 414. Irrigation Engineering. 4 units**

Term Typically Offered: SP

Prerequisite: BRAE 331 or BRAE 340; BRAE 312 with a grade of C or better; or graduate standing.

Design of on-farm irrigation systems; micro, surface, and sprinkler irrigation systems; canals and pumps; economic and strategies of pipe design; pipeline protection. 3 lectures, 1 laboratory.

**BRAE 418. Agricultural Systems Management I. 4 units**

Term Typically Offered: F

Prerequisite: BRAE 203; AGB 301; AGB 310; and completion of GE Area A3 with a grade of C- or better; or graduate standing.

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. 3 lectures, 1 laboratory.

**BRAE 419. Agricultural Systems Management II. 4 units**

Term Typically Offered: W

Prerequisite: BRAE 418.

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. 2 lectures, 2 laboratories.

**BRAE 421. Equipment Engineering. 3 units**

Term Typically Offered: F

Prerequisite: BRAE 152; CE 204; and ME 212.

Design and construction of specialized agricultural components and equipment. 2 lectures, 1 laboratory.

**BRAE 422. Equipment Engineering. 4 units**

Term Typically Offered: W

Prerequisite: BRAE 421.

Design and construction of specialized agricultural components and equipment. 2 lectures, 2 laboratories.

**BRAE 425. Computer Controls for Agriculture. 3 units**

Term Typically Offered: SP

Prerequisite: BRAE 324.

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.

**BRAE 428. Agricultural Robotics and Automation. 4 units**

Term Typically Offered: W

Prerequisite: BRAE 328.

Agricultural applications of signal processing, control theories, machine vision and robot basics for agricultural production and processing. Approaches and constraints related to agricultural automation and the use of robotics in field applications. Engineering approach to problem-solving and experimental data analysis. Field trip required. 3 lectures, 1 laboratory.

**BRAE 432. Agricultural Buildings. 4 units**

Term Typically Offered: SP

Prerequisite: PHYS 121, BRAE 342, BRAE 343.

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.

**BRAE 433. Agricultural Structures Design. 4 units**

Term Typically Offered: F

Prerequisite: BRAE 232, CE 204.

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.

**BRAE 434. Automotive Engineering for a Sustainable Future. 4 units**

Term Typically Offered: W

Prerequisite: Junior standing in any engineering or physical science major.

Multidisciplinary investigation of automotive renewable fuels and electric/hybrid vehicles. Analyze and design related technologies and systems. Methods for complete-cycle energy and GHG analysis. Comparative emissions, efficiency, power output, and infrastructure requirements. Laboratory projects converting engines and vehicles to operate on alternative fuels or electric propulsion. 3 lectures, 1 laboratory. Crosslisted as BRAE/EE 434.

**BRAE 435. Drainage. 4 units**

Term Typically Offered: W

Prerequisite: BRAE 312 or BRAE 340; or graduate standing.

Relevant principles of hydrology and porous media flow. Flow nets, wells and ground water, design of simple surface and sub-surface drains. 3 lectures, 1 laboratory.

**BRAE 438. Drip/Micro Irrigation. 4 units**

Term Typically Offered: W

Prerequisite: BRAE 236 or BRAE 340; or graduate standing.

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.

**BRAE 440. Agricultural Irrigation Systems. 4 units**

Term Typically Offered: SP

Prerequisite: BRAE 340 or graduate standing.

On-farm irrigation system evaluation and management. Drip, micro-spray, furrow, border strip, sprinkler systems. Irrigation efficiency and uniformity. Pumping costs. For non-BRAE majors only. 3 lectures, 1 laboratory.

**BRAE 447. Advanced Surveying with GIS Applications. 4 units**

Term Typically Offered: SP

Prerequisite: BRAE 239.

Collecting field data; processing the data; generating graphical representation of the data; design based on the data and laying out the design in the field; and available record resources for use in GIS systems and their accuracy. 2 lectures, 2 laboratories.

**BRAE 448. Bioconversion. 4 units**

Term Typically Offered: F

Prerequisite: MATH 118 or equivalent.

Biological, thermal and physical techniques for converting biomass into useful energy forms for agriculture and industry. Laboratory exercises include experiments with anaerobic digestion of animal wastes into methane, ethanol fermentation of grains and composting of agricultural residues. Technical and economic feasibility of biofuels. 3 lectures, 1 laboratory.

**BRAE 450. Solar Photovoltaic System Engineering. 4 units**

Term Typically Offered: W

Prerequisite: PHYS 104 or PHYS 118 or PHYS 121 or PHYS 141; and junior standing.

Engineering principles, design, and installation of solar photovoltaic power systems including grid-tie and off-grid systems. Photonic energy conversion, solar module engineering, solar power electronics, photovoltaic site planning, mechanical and structural considerations, permit processes, government incentives, and analysis of financial and investment issues. Field trips required. 3 lectures, 1 laboratory. Crosslisted as BRAE/HNRS 450.

**BRAE 460. Senior Project Organization. 1 unit**

Term Typically Offered: F, W, SP

Prerequisite: Completion of GE Area A3 with a grade of C- or better.

Selection and organization of senior project. Involves time management, research techniques, budgeting and project presentation. Documentation of multidisciplinary team experience. 1 lecture.

**BRAE 461. Senior Project I. 2 units**

Term Typically Offered: F, W, SP

Prerequisite: BRAE 460.

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.

**BRAE 462. Senior Project II. 2 units**

Term Typically Offered: F, W, SP

Prerequisite: BRAE 461.

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.

**BRAE 470. Selected Advanced Topics. 1-4 units**

Term Typically Offered: TBD

Prerequisite: Consent of instructor.

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.

**BRAE 471. Selected Advanced Laboratory. 1-4 units**

Term Typically Offered: TBD

Prerequisite: Consent of instructor.

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.

**BRAE 481. Advanced Agricultural Mechanics. 2 units**

Term Typically Offered: W

Prerequisite: Agricultural teacher candidates starting/returning from student teaching, senior or graduate standing or consent of instructor.

Advanced shop skills. Carpentry, electricity, plumbing, surveying, power mechanics, tractor equipment operation and maintenance. 1 lecture, 1 laboratory.

**BRAE 485. Cooperative Education Experience in BioResource and Agricultural Engineering. 6 units**

CR/NC

Term Typically Offered: SP

Prerequisite: Sophomore standing and consent of instructor.

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. Major credit limited to 4 units; total credit limited to 12 units. Credit/No Credit grading only.

**BRAE 495. Cooperative Education Experience in BioResource and Agricultural Engineering. 12 units**

CR/NC

Term Typically Offered: TBD

Prerequisite: Sophomore standing and consent of instructor.

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. Major credit limited to 4 units; total credit limited to 12 units. Credit/No Credit grading only.

**BRAE 500. Individual Study. 1-3 units**

Term Typically Offered: F, W, SP

Prerequisite: Consent of instructor.

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 6 units, repeatable in same term.

**BRAE 532. Water Wells and Pumps. 4 units**

Term Typically Offered: SP

Prerequisite: BRAE 312 or BRAE 340 or CE 336 or ME 341.

Water well drilling, design, and development. Pump characteristics and system head. Series and parallel operation. Design of pump intakes. Variable speed electric drives and engines. Pump testing. 3 lectures, 1 laboratory.

**BRAE 533. Irrigation Project Design. 4 units**

Term Typically Offered: W

Prerequisite: BRAE 340 or BRAE 312 or equivalent (hydraulics/fluid mechanics course).

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. 3 lectures, 1 laboratory.

**BRAE 570. Selected Advanced Topics in BioResource and Agricultural Engineering. 1-4 units**

Term Typically Offered: TBD

Prerequisite: Graduate standing or consent of instructor.

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Schedule of Classes will list topic selected. Total credit limited to 12 units. 1 to 4 seminars.

**BRAE 571. Selected Advanced Laboratory in Bioresources and Agricultural Engineering. 1-4 units**

Term Typically Offered: TBD

Prerequisite: Consent of instructor.

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.

**BRAE 599. Thesis in BioResource and Agricultural Engineering. 1-9 units**

Term Typically Offered: F, W, SP

Prerequisite: Graduate standing and consent of instructor.

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.