DEPARTMENT OF BIOLOGICAL AND AGRICULTURAL ENGINEERING

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The **departmental mission** is teaching, research, and extension to produce sustainable solutions for engineering and technological management problems in agriculture, environment, biotechnology, and natural resources through application and integration of the biological, chemical and physical sciences. The department's teaching program includes degree programs in Biological and Agricultural Engineering, which are offered through the College of Engineering, and in Agricultural and Life Sciences – Agricultural Systems Management, offered through the College of Agricultural and Life Sciences. The graduate program in biological and agricultural engineering is offered through the College of Graduate Studies. The educational objectives for the B.S. degree in Biological and Agricultural Engineering are:

1. Learn and Integrate: Graduates will be proficient engineering problem solvers capable of identifying, formulating, and solving engineering problems by applying their knowledge of mathematics, engineering, and appropriate biological, chemical, natural resources and/or agricultural topics.
2. Think and create: Graduates will be effective engineers who can apply their skills to design systems, components, and processes to solve engineering problems for an ever-changing world.
3. Communicate: Graduates will be effective written and verbal communicators, and productive team members.
4. Clarify purpose and perspective: Graduates will have a strong professional identity with a keen awareness of their professional and ethical responsibility, and practice lifelong learning.
5. Practice Citizenship: Graduates will design for advancement and sustainability of their local, national and global communities protecting human health and safety, and practicing environmental stewardship.

The Biological and Agricultural Engineering curriculum is accredited by the Engineering Accreditation Commission of ABET 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, ph. 410-347-7700. Students in this program are eligible to take the Fundamentals of Engineering (FE) Examination prior to graduation and to become registered professional engineers after graduating and completing an experience requirement.

The five engineering options in the Biological and Agricultural Engineering program provide each student the opportunity to pursue a course of study suited to a particular professional engineering career goal.

Agricultural Engineering is the curriculum that bridges between two fields of applied science – engineering and agriculture. It is oriented to the design and control of equipment and systems for production, processing, and transportation of food, feed, natural raw fiber, and forest products and for the effective use of natural resources. Agricultural engineers have the education and interests that make them uniquely capable of developing engineering solutions for agricultural and biological systems.

The agricultural engineering program at the UI is designed to prepare students for a variety of interesting and rewarding careers. Many graduates are employed as design or development engineers by equipment manufacturers, irrigation companies, trade associations, engineering consulting firms, and governmental agencies. Others are self-employed in farm equipment manufacturing, consulting firms, and other engineering-related enterprises.

Bioenergy Engineering prepares students for careers within traditional food processing industries and for emerging careers in bioprocess industries including bioenergy and biofuels such as the ethanol and biodiesel industries. The program is designed to develop engineering expertise in the area of applied biotechnology in such areas as waste treatment, biomass to energy production, industrial biological processes and/or molecular biology as related to engineered applications of biotechnology. The goal is the application of the science to real-world problems through more engineering input.

Graduates are prepared for work with private industry, consulting firms, state and federal agencies on projects related to bioprocess development, energy conservation, testing, evaluation and application of new food, industrial and fuel projects.

BAE has an internationally recognized program in biofuels, especially biodiesel. Faculty play a significant role in biofuel development and demonstration and cooperates regularly with the University of Idaho National Institute for Advanced Transportation Technology. The Food and Bioprocessing program works cooperatively with the Food Science and Toxicology programs at both the University of Idaho and Washington State University.

Biological Systems Engineering is an undergraduate curriculum designed to prepare students to solve technological problems in systems that involve plants, animals, microorganisms, and biological materials. They produce creative and effective solutions to problems in the environment, our food supply, and the interaction of living organisms in a biologically complex, interconnected and changing world. The program can be designed to prepare the student for advanced biomedical or environmental engineering studies.

A broader emphasis in biology and chemistry is made within this curriculum compared to other engineering disciplines. Depending on their electives, graduates in biological systems engineering have opportunities to work with consulting and industrial firms in design, environmental control and monitoring, non-point source pollution abatement, bioremediation, hydrology and water quality control. They may also work with food processing industries in storage, product development and quality control. Other options include governmental agencies in water resources, environmental quality, and environmental protection. This program is often used as a pre-biomedical program to prepare students for graduate studies in the biomedical profession.

Ecohydrological Engineering is an undergraduate engineering program designed to prepare students to solve technological problems at the farm and watershed scale of practical importance to the western United States. Topics include soil and water engineering, water use, water conservation, watershed engineering, nonpoint source pollution, water quality, soil conservation, stream restoration, riparian buffer design, irrigation and drainage, water management, and soil-plant-water relationships.

The Department of Biological and Agricultural Engineering is a major player in the water issues facing the state of Idaho. Faculty are involved in the Snake River Plain aquifer issues including modeling efforts directed toward the Snake River Aquifer and water use issues. They are involved with research related to water management, irrigation, and crop water response. BAE has an internationally recognized program in remote sensing related to evapotranspiration and crop water response. They have programs related to nanoparticle transport and the mobility of small particles, especially the transport of constituents sorbed onto clay particles or humic acid molecules. The department conducts studies related to watershed management, and hydrologic modeling of small watersheds for erosion prediction. BAE is the home of the Idaho State Climatologist who also does research using remotely sensed surface temperature data and other phenomena related to water and energy exchange between the land surface and the atmosphere for use in weather and climate prediction.

Environmental Engineering focuses on the design and management of systems that use or impact natural resources. Study in this program prepares engineers to work in natural resource conservation and environmental quality enhancement. Environmental Engineers are uniquely prepared to address issues related to surface water hydrology, groundwater hydrology, sediment transport, water quality, chemical rate and transport determination, waste management, reclamation of disturbed lands, site remediation and drainage. Applications include water quality studies of lakes, rivers and groundwater, system design and management, waste treatment, management of air quality inside buildings and outside, remediation of land damaged by construction, mining, or other activity.

Graduates in environmental engineering work with state and federal agencies, consulting firms and private companies on projects related to environmental engineering design, permitting, waste management, pollution abatement, bioremediation, and hydrology. They may also be employed by processing industries in quality control, waste management, and in projects related to other environmental issues.

Agricultural Systems Management emphasizes the use and management of equipment and systems based on an understanding of their design and operation. Agricultural systems management courses are designed to provide students with experience in systems technology and analysis of agricultural equipment and machinery applications, feed and food processing, agricultural electrification, soil and water management, waste management, agricultural systems, and fabrication practices for agricultural and natural resource-based enterprises.

The undergraduate degree program in agricultural systems management (B.S.Ag.L.S.) is designed to prepare students to apply biological, physical, mechanical, and business knowledge to the production, service, sales, application, and management of the equipment and processes used in agriculture. The curriculum stresses courses in agriculture, agricultural systems management, and basic and applied sciences. It also includes a strong background in agricultural economics, accounting, and business. It prepares students for a variety of important and rewarding career opportunities. Many graduates return to farming, while others pursue careers as farm managers or are employed in agricultural and natural resource-oriented businesses, banking firms, educational institutions, or governmental agencies. This curriculum is recognized by the American Society of Agricultural Engineers. The educational objectives in Agricultural Systems Management are:

1. The graduate can communicate in writing and orally to clientele and the public about solutions to agricultural technology and management problems.
2. The graduate has mechanical skills needed to develop, construct, alter and repair agricultural equipment systems.
3. The graduate has knowledge in business, and in physical and biological sciences for application to system and technology development to creatively solve agricultural problems.
4. The graduate has computer skills that can be used in the analysis and development of agricultural systems.
5. The graduate has mathematical skills to quantify physical and biological processes in agriculture.
6. The graduate has a social science and humanities background to provide sensitivity for the concerns of society and appreciate different points of view.

The agricultural systems management courses are also available to nonmajors interested in obtaining an understanding of the technology used in modern agricultural production systems. A minor in agricultural systems management can be used to support degree programs in other departments.

Graduate study is offered in biological and agricultural engineering with specialization in irrigation, water and chemical management, hydrology, soil and water conservation, subsurface water and chemical transport modeling, and climate modeling; alternative fuels and lubricants; harvesting and handling food and bioproduct processing of agricultural crops; off-road vehicle development, instrumentation and control; equipment design and development; and bioremediation and organic waste management and treatment. The M.S. and Ph.D. degrees are primarily research degrees. Prospective students should have the equivalent of a B.S. degree in engineering and must have a working knowledge of computers including mainframe and microcomputers, structured programming, and electronic spreadsheets.

Assessment of departmental objectives is accomplished by monitoring performance of students on the Fundamentals of Engineering examination and by student interviews. All graduates are interviewed at the time of graduation by the department to evaluate concerns, opportunities, and effectiveness of its educational programs. The assessment statistics can be obtained from the departmental office.

Courses

See course description section for courses in Agricultural Systems Management (ASM) and Biological and Agricultural Engineering (BAE).

Biological and Agricultural Engineering Undergraduate Curricular Requirements

Agricultural Systems Management (B.S.Ag.L.S.)

Required course work includes the university requirements (see regulation J-3) and:

Agricultural and Life Science Core

AgEd 406	Exploring International Agriculture (3 cr)
Soil 205, Soil 206	The Soil Ecosystem and Lab (4 cr)
Stat 251	Statistical Methods (3 cr)

One of the following (2-3cr):

ASM 305	GPS and Precision Agriculture (3 cr)
ASM 412	Agricultural Safety and Health (2 cr)
PlSc 207	Introduction to Biotechnology (3 cr)

One of the following (4cr):

Chem 101	Introduction to Chemistry I (4 cr)
Chem 111	Principles of Chemistry I (4 cr)

One of the following (3-4cr):

Comm 101	Fundamentals of Public Speaking (2 cr)
Engl 207	Persuasive Writing (3 cr)
Engl 313	Business Writing (3cr)
Engl 316	Environmental Writing (3 cr)
Engl 317	Technical Writing (3 cr)

One of the following (3-4cr):

Math 143	Pre-calculus Algebra and Analytic Geometry (3 cr)
Math 160	Survey of Calculus (4 cr)
Math 170	Analytic Geometry and Calculus I (4 cr)

Agricultural Systems Management Courses

Acct 201	Introduction to Financial Accounting (3 cr)
Acct 202	Introduction to Managerial Accounting (3 cr)
AgEc 278	Farm and Agribusiness Management (4 cr)
AgEc 289	Agricultural Markets and Prices (3 cr)
AgEc 356	Agricultural and Rural Policy (3 cr)
ASM 107	Beginning Welding (2 cr)
ASM 112	Introduction to Agricultural Systems Management (3 cr)
ASM 200	Seminar (1 cr)
ASM 202	Agricultural Shop Practices (2 cr)
ASM 305	GPS and Precision Agriculture (3 cr)
ASM 315	Irrigation Systems and Water Management (3 cr)
ASM 331	Electric Power Systems for Agriculture (3 cr)
ASM 409	Agricultural Tractors, Power Units and Machinery Management (4 cr)
ASM 412	Agricultural Safety and Health (2 cr)
ASM 433	Agricultural Processing Systems (3 cr)
BAE 491	Senior Seminar (1 cr)
Biol 102	Biology and Society (3 cr)
Bus 101	Introduction to Business Enterprises (3 cr)
Bus 190	Integrated Business and Value Creation (3 cr)
BLaw 265	Legal Environment of Business (3 cr)
Econ 202	Principles of Microeconomics (3 cr)
PlSc 102	The Science of Plants in Agriculture (3 cr)

Agricultural and Technical Electives (13 cr)
Life Science Elective (3 cr)

One of the following (2-3 cr):

Engr 105	Engineering Graphics (2 cr)
CTE 267	Computer Aided Drafting/Design (3 cr)

One of the following (4 cr):

Phys 100, Phys 100L	Fundamentals of Physics and Lab (4 cr)
Phys 111, Phys 111L	General Physics I and Lab (4 cr)
Phys 211, Phys 211L	Engineering Physics I and Lab (4 cr)

Three credits from the following (3 cr):

AgEc 411	The World of International Agribusiness (1 cr)
AgEc 413	Management of Human Resources in Agribusiness Firms (1 cr)
AgEc 415	Entrepreneurial Skills in Agribusiness Management (1 cr)

AgEc 418	Developing Negotiation Skills in Agribusiness (1 cr)
AgEc 419	Development and Analysis of Enterprise Budgets (1 cr)

Courses to total 128 credits for this degree

Biological and Agricultural Engineering (B.S.B.A.E.)

Required course work includes the university requirements (see regulation J-3) and:

BAE 142	Engineering for Living Systems (2 cr)
BAE 242	Engineering Analysis and Design (2 cr)
BAE 441	Instrumentation and Measurements (3 cr)
BAE 478	Engineering Design I (3 cr)
BAE 479	Engineering Design II (3 cr)
BAE 491	Senior Seminar (1 cr)
Biol 115	Cells and the Evolution of Life (4 cr)
Chem 111	Principles of Chemistry I (4 cr)
Chem 112	Principles of Chemistry II (5 cr)
Engr 105	Engineering Graphics (2 cr)
Engr 210	Engineering Statics (3 cr)
Engr 240	Introduction to Electrical Circuits (3 cr)
Engr 320	Engineering Thermodynamics and Heat Transfer (3 cr)
Engr 335	Engineering Fluid Mechanics (3 cr)
Engr 350	Engineering Mechanics of Material (3 cr)
Engr 360	Engineering Economy (2 cr)
Math 170	Analytic Geometry and Calculus I (4 cr)
Math 175	Analytic Geometry and Calculus II (4 cr)
Math 275	Analytic Geometry and Calculus III (3 cr)
Math 310	Ordinary Differential Equations (3 cr)
Phys 211, Phys 211L	Engineering Physics I and Lab (4 cr)
Phys 212	Engineering Physics II (3 cr)
Stat 301	Probability and Statistics (3 cr)

And one of the following options:

A. Agricultural Engineering Option

BAE 355	Fundamentals of Hydrologic Engineering (3 cr)
BAE 459	Irrigation System Design (3 cr)
BAE 461	Bioprocess Engineering (3 cr)
BAE 462	Electric Power and Controls (3 cr)
CE 211	Engineering Surveying (3 cr)
CE 322	Hydraulics (3 cr)
CE 342	Theory of Structures (3 cr)
Engr 220	Engineering Dynamics (3 cr)
Soil 205	The Soil Ecosystem (3 cr)

Technical Electives (9 cr)

Courses to total 128 credits for this degree

B. Biological Systems Engineering Option

BAE 461	Bioprocess Engineering (3 cr)
BAE 462	Electric Power and Controls (3 cr)
Biol 250, Biol 255	General Microbiology and Lab (5 cr)
Biol 380	Biochemistry I (4 cr)
Chem 277	Organic Chemistry I (3 cr)
Chem 278	Organic Chemistry I: Lab (1 cr)

Biological Science Electives (3 cr)

Technical Electives (15 cr)

Courses to total 128 credits for this degree

C. Environmental Engineering Option

BAE 355	Fundamentals of Hydrologic Engineering (3 cr)
BAE 461	Bioprocess Engineering (3 cr)
BAE 462	Electric Power and Controls (3 cr)
Biol 250, Biol 255	General Microbiology and Lab (5 cr)
Biol 380	Biochemistry I (4 cr)
Chem 277	Organic Chemistry I (3 cr)
Chem 278	Organic Chemistry I: Lab (1 cr)
CE 330	Fundamentals of Environmental Engineering (3 cr)
Soil 205	The Soil Ecosystem (3 cr)

Technical Electives (9 cr)

Courses to total 128 credits for this degree

D. Bioenergy Engineering Option

BAE 461	Bioprocess Engineering (3 cr)
BAE 462	Electric Power and Controls (3 cr)
BAE 485	Fundamentals of Bioenergy and Bioproducts (3 cr)
BAE 492	Biofuels (3 cr)
BAE 494	Thermochemical Technologies for Biomass Conversion (3 cr)
Biol 250, Biol 255	General Microbiology and Lab (5 cr)
Biol 380	Biochemistry I (4 cr)
Chem 277	Organic Chemistry I (3 cr)
Chem 278	Organic Chemistry I: Lab (1 cr)

Science Elective (3 cr)

Technical Electives (6 cr)

Courses to total 128 credits for this degree

E. Eco-Hydrological Engineering Option

BAE 355	Fundamentals of Hydrologic Engineering (3 cr)
BAE 451	Engineering Hydrology (3 cr)
BAE 452	Environmental Water Quality (3 cr)
BAE 458	Open Channel Hydraulics (3 cr)
CE 211	Engineering Surveying (3 cr)
CE 322	Hydraulics (3 cr)
Engr 220	Engineering Dynamics (3 cr)
Soil 205	The Soil Ecosystem (3 cr)

Technical Electives (11 cr)

One of the following (3 cr):

CS 112	Introduction to Problem Solving and Programming (3 cr)
CS 130	Programming with Visual Basic (3 cr)

Courses to total 128 credits for this degree

A grade of C or better is required in each of the following courses before registration is permitted in upper-division engineering courses: BAE 242, Chem 111, Engr 210, Math 275, and Phys 211.

To graduate in this program, a grade of C or better is required in each of the following courses: BAE 242, Chem 111, Engr 210, Math 275, and Phys 211.

Students are required to submit a course plan and a statement of how the humanistic and social course requirements complement the technical content of the curriculum and are consistent with the program and institution objectives.

Biological and Agricultural Engineering Academic Minor Requirements

Agricultural Systems Management Minor

ASM 202	Agricultural Shop Practices (2 cr)
ASM 305	GPS and Precision Agriculture (3 cr)
ASM 315	Irrigation Systems and Water Management (3 cr)
ASM 409	Agricultural Tractors, Power Units and Machinery Management (4 cr)
ASM 412	Agricultural Safety and Health (2 cr)

At least four credits from the following skill courses:

ASM 107	Beginning Welding (2 cr)
ASM 112	Introduction to Agricultural Systems Management (3 cr)
ASM 210	Small Engines (2 cr)
CTE 267	Computer Aided Drafting/Design (3 cr)

Courses to total 20 credits for this minor

The minimum number of credits for a minor in agricultural systems management courses is 20.

Biological and Agricultural Engineering Graduate Degree Programs

Candidates must fulfill the requirements of the College of Graduate Studies and of the Department of Biological and Agricultural Engineering. See the College of Graduate Studies section for the general requirements applicable to each degree.

Master of Science. General M.S. requirements apply. Study and research programs are available in all of the areas listed above.

Master of Engineering. General M.Engr. requirements apply.

Doctor of Philosophy. Admission to this program is based on the student's interest being compatible with faculty interest, funds, and facilities. Admission is given only after a thorough review of the student's academic background, research interests, and potential. Individual programs normally consist of three years' work beyond the bachelor's degree. The department does not have a mandatory foreign language requirement. Students are required, however, to broaden their education in

an area outside the normal engineering and science curricula. This can be done by taking courses in the humanities and social sciences, demonstrating an in-depth proficiency in a foreign language, or participating in an equivalent broadening educational experience.

AGRICULTURAL SYSTEMS MANAGEMENT COURSES

Tom Hess, Interim Dept. Head, Dept. of Biological and Agricultural Engineering (421 Engineering/Physics Bldg. 83844-0904; phone 208/885-6182; fax 208/885-7908; baengr@uidaho.edu).

ASM 105 Survey of Agricultural Mechanics (1-3 cr, max 3)
This course is designed to introduce the student to the principles of technology in agriculture. It includes the development of knowledge and skills pertaining to agricultural mechanics, welding, power technology, electricity, and structures. It will provide introductory learning experiences for students in the areas of agricultural systems management.

ASM 107 Beginning Welding (2 cr)
Principles of operation, use, and care of arc and acetylene welding equipment. One lec, one 2-hr lab, and two hrs of individual practice a wk. Enrollment limited to 12 per section. Cooperative: open to WSU degree-seeking students.

ASM 112 Introduction to Agricultural Systems Management (3 cr)
Application of basic engineering principles to solving problems dealing with farm machinery, buildings, processing, irrigation, and energy use. Recommended Preparation: high school algebra.

ASM 200 (s) Seminar (cr arr)

ASM 202 Agricultural Shop Practices (2 cr)
Primarily for agricultural mechanization and agricultural education students. Operation, use, and care of shop tools and equipment. One lec and one 3-hr lab a wk.

ASM 204 (s) Special Topics (cr arr)

ASM 210 Small Engines (2 cr)
Principles of engine operation, tune-up, and maintenance; repair and overhaul of small engines. One lec, one 2-hr lab, and two hrs of individual practice a wk. Enrollment limited to 12 per section.

ASM 240 Computer Applications in Biological Systems (3 cr)
Application of computers in production agriculture; microcomputer principles and operation, disk operating systems; word processing; spreadsheets, database management and other application programs; introduction to one program language. Two lec and one 2-hr lab a wk. Recommended Preparation: three credits of college math.

ASM 299 (s) Directed Study (cr arr)

ASM 304 Agricultural Fluid Power Systems (2 cr)
Fundamentals of hydraulic power and control as applied to agricultural machines and processing equipment; component function and sizing; schematic diagrams. One 3-hr lab a wk.
Prereq: *Math 108, 143, or 160*

ASM 305 GPS and Precision Agriculture (3 cr)
This course will cover the fundamentals of global positioning, yield monitors, and variable rate applications. Instrumentation used in agriculture, environmental science, and industry will be discussed. Two Lec. and one 3-hr lab a wk. Cooperative: open to WSU degree-seeking students.

ASM 315 Irrigation Systems and Water Management (3 cr)
Irrigation methods, irrigation management, water rights, conveyance and measurement, pumps, soil-water-plant relationships, and drainage. Two lec and one 3-hr lab a wk. Cooperative: open to WSU degree-seeking students.
Prereq: *Soil 205, Math 108, 143, 160 or 170 or Permission*

ASM 331 Electric Power Systems for Agriculture (3 cr)
Basic circuits; wiring and the code; motors and controls; heating, lighting, and power. Two lec and one 3-hr lab a wk. Cooperative: open to WSU degree-seeking students.

ASM 398 Internship (1-6 cr, max 6)
Graded P/F.
Prereq: *Permission*

ASM 400 (s) Seminar (cr arr)

ASM 404 (s) Special Topics (cr arr)

ASM 407 Advanced Welding (1 cr)
This course provides the student an opportunity to learn various advanced welding theories, practices and applications for ferrous and non-ferrous metals, which include Gas Metal Arc Welding (GMAW), Flux Cored Arc Welding (FCAW), Gas Tungsten Arc Welding (GTAW) and Plasma Arc Cutting (PAC). These are only introduced in ASM 107, Beginning Welding, and will be covered in depth in this course. This course will also provide the student with a technical understanding of calculating material and use of proper procedures for the completion of project manufactured in the lab. Student presentations and demonstrations are required. This course will introduce emerging technologies in welding and fabrication industries.
Prereq: *ASM 107 and Permission*

ASM 409 Agricultural Tractors, Power Units and Machinery Management (4 cr)
This course focuses on the selection, operation, adjustment, and servicing of farm tractors and power units. Fuels, lubrication, cooling, and electrical systems will also be covered. Machinery operation, power transmission systems, hitching, traction, and safety are also discussed. The course will conclude with discussions on depreciation and machinery replacement. Three 1-hr lec and one 3-hr lab a week.

ASM 412 Agricultural Safety and Health (2 cr)
Covers a broad variety of items related to agricultural safety and health: identification of safety and health hazards, maximizing capabilities of farmers and ranchers with disabilities, grain and livestock handling, chemical and gases handling, and fire safety; corrective measures to eliminate hazards and application of information learned to student's own situation. (Alt/yrs)

ASM 433 Agricultural Processing Systems (3 cr)
Grain cleaning, mixing, and drying; materials handling, heat transfer, pumps, fans, refrigeration, and instrumentation. Two lec and one 3-hr lab a wk; one 1-day field trip. Recommended Preparation: Math 160.

ASM 498 (s) Internship (1-6 cr, max 6)
Graded P/F.
Prereq: *Permission*

ASM 499 (s) Directed Study (cr arr)

BIOLOGICAL AND AGRICULTURAL ENGINEERING COURSES

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BAE 142 Engineering for Living Systems (2 cr)
Introduction to engineering principles used to solve agricultural and biological systems problems, including use of computers. One lec and one 3-hr lab a wk; two half-day field trips.

BAE 242 Engineering Analysis and Design (2 cr)
Methods of analyzing and solving engineering problems and introduction to elements of design; use of computers in engineering problem solving. Recommended Preparation: computer science elective in a programming language.
Prereq: *Math 170*
Coreq: *Math 175*

BAE 299 (s) Directed Study (cr arr)

BAE 355 Fundamentals of Hydrologic Engineering (3 cr)
See CE 325.

BAE 398 (s) Engineering Cooperative Internship (cr arr)
Supervised internship in professional engineering settings, integrating academic study with work experience; details of the co-op to be arranged with supervising professor before the start of the co-op; requires written report. Graded P/F. Cannot be used for technical elective.
Prereq: *Permission*

BAE 404 (s) Special Topics (cr arr)

BAE J433/J533 Bioremediation (3 cr)
Theory and practice of bioremediation as applied to toxic and hazardous wastes, including reaction kinetics, reaction stoichiometry, microbiology, and design of ex- and in-situ processes. Graduate credit requires additional design project. One-two field trips.
Prereq: *Biol 115 and Math 170, or Permission*

BAE J441/J541 Instrumentation and Measurements (3 cr)
Sensing elements, signal conditioning, data output and control. Additional projects/assignments reqd for grad cr. Two lec and one 3-hr lab a wk. Recommended Preparation: BAE 462. Cooperative: open to WSU degree-seeking students.

BAE 450 Environmental Hydrology (3 cr)
Carries no credit after BAE 355 or CE 325. The objective of this course is to provide a comprehensive understanding of the hydrologic processes associated with the environmental processes. Includes components of the hydrologic cycle, analysis of precipitation and run off, evapotranspiration, routing, peak flow, infiltration, soil and water relationships, snowmelt, and frequency analysis. (Spring only)
Prereq: *Math 170*

BAE ID451 Engineering Hydrology (3 cr) WSU BSysE 451
See CE 421.

BAE J452/J552 Environmental Water Quality (3 cr)
Engineering design to monitor, evaluate, and minimize non-point pollution from agriculture, environmentally acceptable disposal of wastes, bioremediation. Graduate credit requires an additional project and report. Two lec and one 3-hr lab a wk.
Prereq: *Chem 112 and Soil 205 or Biol 250, and BAE 355 or BAE 450*

BAE 458 Open Channel Hydraulics (3 cr)
See CE 428.

BAE 459 Irrigation System Design (3 cr)
Crop water requirements, irrigation scheduling and water management, selection and design of irrigation systems, pump selection. Two lec and one 3-hr lab a wk; one 1-day field trip.
Prereq: *Engr 335*

BAE 461 Bioprocess Engineering (3 cr)
Carries 2 credits after ME 345. Processing principles and transport processes applied to the analysis and design of handling, processing, and producing of biomaterials and bioprocesses. Two lec and one 3-hr lab a wk. (Spring only, alt/yrs)
Prereq: *Math 310, Engr 320 and 335, or Permission*

BAE 462 Electric Power and Controls (3 cr)
Design, selection, and use of electrical equipment and electric power systems for application to biological systems; design and use of electrical, electronic, and other feedback control systems for use with biological systems. Two lec and one 3-hr lab a wk.
Prereq: *Engr 240*
Coreq: *Math 310*

BAE 478 Engineering Design I (3 cr)
The capstone design sequence for biological and agricultural engineering majors. Course topics include research, design, experimental methods, specifications, prototyping, and verification; report writing, documentation and oral presentations. Topics, from industrial sponsorship, are considered in the context of a major design project involving a team of students. Projects incorporate realistic engineering constraints including environmental concerns, sustainability, ethical, safety, manufacturability, social and political considerations.
Prereq: *BAE 242, Engr 320, Engr 335, and Engr 350*

BAE 479 Engineering Design II (3 cr)
Continuation of the capstone design sequence for biological and agricultural engineering majors. Course topics include research, design, experimental methods, specifications, prototyping, and verification; report writing, documentation and oral presentations. Topics, from industrial sponsorship, are considered in the context of a major design project involving a team of students. Projects incorporate realistic engineering constraints including environmental concerns, sustainability, ethical, safety, manufacturability, social and political considerations
Prereq: *BAE 478*

BAE J485/J585 Fundamentals of Bioenergy and Bioproducts (3 cr)
Review of current technology for producing energy and products from biological materials. Discussion of economic, social, and political aspects and future prospects for petroleum displacement. Additional projects/assignments required for graduate credit. Recommended Preparation: Organic Chemistry.
Prereq: *Chem 111*
Coreq: *Engr 320 or Permission*

BAE 491 Senior Seminar (1 cr)
Professional aspects of the field, employment opportunities and preparation of occupational inventories. Graded P/F.
Prereq: *Senior standing.*

BAE J492/J592 Biofuels (3 cr)
Basic principles for the production and utilization of biobased fuels; processing techniques and chemistry; fuel properties and utilization. Additional projects/assignments required for graduate credit. Recommended Preparation: Organic Chemistry.
Prereq: *Chem 111*
Coreq: *Engr 320 or Permission*

BAE J494/J594 Thermochemical Technologies for Biomass Conversion (3 cr)
Introduce the fundamentals of biomass conversion technologies for biofuels and bioenergy. Specific topics include biomass preparation / pretreatment, pyrolysis, gasification, direct liquefaction, and economic factors in thermochemical conversion of biomass. Advances of the technologies will be brought to current through literature reviews. A semester long course project is required if taken as a graduate level course. Recommended Preparation: Organic Chemistry, Chemical Reaction Engineering, Engineering Thermodynamics. (Fall, odd numbered/years)
Prereq: *Chem 277 and Chem 278*
Coreq: *Engr 320 or Permission*

BAE 499 (s) Directed Study (cr arr)

BAE 500 Master's Research and Thesis (cr arr)

BAE 501 (s) Seminar (cr arr)
Graded P/F.
Prereq: *Permission*

BAE 502 (s) Directed Study (cr arr)

BAE 504 (s) Special Topics (cr arr)

BAE 533 Bioremediation (3 cr)
See BAE J433/J533.

BAE 534 Applied Bioremediation (3 cr)
Application of theory and design learned in prerequisite BAE 433/533 including conducting treatability studies, transportation and fate modeling in the subsurface, and hydrologic testing. Students required to complete laboratory, numerical modeling, and field-testing modules in addition to a subsurface modeling project.
Prereq: *BAE 433/533*

BAE 541 Instrumentation and Measurements (3 cr)
See BAE J441/J541.

BAE 551 Advanced Hydrology (3 cr)
Principles of the hydrologic cycle including precipitation, lower atmosphere, evaporation, fluid mechanics of free surface flow, overland flow, stream flow routing, water transport in porous media, infiltration, groundwater outflow and base flow, stream flow generation, and elements of frequency analysis in hydrology.
Prereq: *BAE 450 and Math 310; or Permission*

BAE 552 Environmental Water Quality (3 cr)
See BAE J452/J552.

BAE 558 Fluid Mechanics of Porous Materials (3 cr)
Statics and dynamics of multiflow systems in porous materials; properties of porous materials; steady and unsteady flow. Cooperative: open to WSU degree-seeking students.

BAE 585 Fundamentals of Bioenergy and Bioproducts (3 cr)
See BAE J485/J585.

BAE 592 Biofuels (3 cr)
See BAE J492/J592.

BAE J494/J594 Thermochemical Technologies for Biomass Conversion (3 cr)
See BAE J494/J594.

BAE 599 (s) Non-thesis Master's Research (cr arr)
Research not directly related to a thesis or dissertation.
Prereq: *Permission*

BAE 600 Doctoral Research and Dissertation (cr arr)

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