

# Department of Biosystems Engineering

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Biosystems engineers ensure that we have the necessities of life: healthy food to eat, clean water to drink, renewable fuel and energy sources, and a healthy environment in which to live. The mission of the Department of Biosystems Engineering at Auburn University is to develop and disseminate engineering knowledge to solve problems in biological systems, natural resources, and the environment. It meets the resident instruction portion of that mission through the offering of a degree program which leads to a Bachelor of Biosystems Engineering, and another degree that leads to Bachelor of Science in Biological and Agricultural Technology Management. The four pathways to the BSEN degree program (biosystems engineering pathway, bioprocess engineering option, ecological engineering option, and forest engineering option), and the biological and agricultural technology management degree program are described below:

## Biosystems Engineering

The Department of Biosystems Engineering offers the only accredited degree in biosystems engineering in Alabama. It is committed to preparing students for productive professional careers in the biosystems industries and related natural resource and environmental systems sectors.

The biosystems engineering program curriculum pathway is coordinated by the Samuel Ginn College of Engineering. Students should apply for admission to the Samuel Ginn College of Engineering and complete the pre-biosystems engineering program.

## Bioprocess Engineering Option

The focus of the bioprocess engineering option is to produce engineers that seamlessly combine engineering and natural sciences to designing and developing systems, processes and equipment that convert biological and agricultural materials to value-added products such as food, nutraceuticals, polymers and pharmaceuticals. Bioprocess engineers provide a bridge between the research lab and the economic, large-scale implementation of technologies used to convert these biological materials to value-added products. The bioprocess engineering option is coordinated by the Samuel Ginn College of Engineering. Students should apply for admission to the Samuel Ginn College of Engineering and complete the bioprocess engineering option portion of the pre-biosystems engineering program.

## Ecological Engineering Option

The Department of Biosystems Engineering offers an option in ecological engineering as part of the Bachelor of Biosystems Engineering degree. This option prepares students to solve environmental problems by applying engineering knowledge to natural ecological and biological systems. Ecological engineering combines basic and applied science from engineering, ecology, economics, and natural sciences to design, construct, and manage sustainable ecosystems that have value to both humans and the natural environment. The ecological engineering option is coordinated by the Samuel Ginn College of Engineering. Students should apply for admission to the Samuel Ginn College of Engineering and complete the ecological engineering option portion of the pre-biosystems engineering program.

## Forest Engineering Option

The Department of Biosystems Engineering (in conjunction with the Samuel Ginn College of Engineering and College of Forestry, Wildlife and Environment) offers an option in forest engineering as part of the Bachelor of Biosystems Engineering degree.

This forest engineering option involves preparing graduates to be able to apply of engineering principles and techniques for sustainable management and maintenance of trees, soil, water and other natural resources with the forest ecosystem. Forest engineering is therefore a hybrid of engineering, forest and management that is focused on efficient, cost-effective and environmentally friendly utilization of these resources. Therefore, this option prepares students for productive professional careers in the forest products industry and related natural resource and environmental systems sector.

The forest engineering option is coordinated by the Samuel Ginn College of Engineering and the College of Forestry, Wildlife and Environment, and is administered by the Department of Biosystems Engineering. Students can become registered foresters upon completion of a minor in forest resources. Beginning students should apply to the Samuel Ginn College of Engineering and complete the forest engineering option portion of the pre-biosystems engineering program. Students pursuing the forest engineering option must meet College of Forestry, Wildlife and Environment requirements for admission to the Forestry Summer Field Practicum.

## Biological and Agricultural Technology Management

Students enrolled in the biological and agricultural technology management (BATM) major take a variety of courses in technology, science and management that will enable them to be practical problem solvers and be able to manage and develop solutions to the

technological challenges of the increasingly complex agricultural and biological systems of the 21<sup>st</sup> century. The curriculum is also designed such that students can simultaneously obtain a minor in an area that is of interest to the student such as minor in agronomy and soils, stewardship-based agriculture, agribusiness, poultry science, information systems management, business analytics, technical and professional communication, or sustainability. The BATM curriculum is coordinated by the College of Agriculture.

## Majors

- Biosystems Engineering ([http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofbiosystemsengineering/biosystemsengineering\\_major/](http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofbiosystemsengineering/biosystemsengineering_major/))
- Biosystems Engineering — Bioprocess Engineering Option ([http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofbiosystemsengineering/biosystemsengineeringbioprocessengr\\_obtion/](http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofbiosystemsengineering/biosystemsengineeringbioprocessengr_obtion/))
- Biosystems Engineering — Ecological Engineering Option ([http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofbiosystemsengineering/ecologicalengineeringoption\\_major/](http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofbiosystemsengineering/ecologicalengineeringoption_major/))
- Biosystems Engineering — Forest Engineering Option ([http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofbiosystemsengineering/forestengineering\\_major/](http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofbiosystemsengineering/forestengineering_major/))
- Biological and Agricultural Technology Management ([http://bulletin.auburn.edu/undergraduate/collegeofagriculture/biosystemsengineeringbsen/BioTech\\_major/](http://bulletin.auburn.edu/undergraduate/collegeofagriculture/biosystemsengineeringbsen/BioTech_major/))

## Bio Ag Technology Management Courses

**BATM 1110 INTRODUCTION TO TECHNOLOGY DESIGN (3)** LEC. 2. LAB. 3. Introduction to the design process, 2D and 3D parametric solid modeling, and both manual and automated fabrication processes.

**BATM 2110 DIGITAL ANALYTICS IN AGRICULTURE AND TECHNOLOGY (3)** LEC. 2. LAB. 1. Pr. BATM 1110 or BIOP 2120. An introduction to creative and analytical methods to solve technological problems. Define the problem, explore strategies, select and implement solutions, and evaluate results.

**BATM 3100 COMPUTER AIDED DESIGN TECHNOLOGY (3)** LEC. 2. LAB. 1. Introductory course in computer aided design (CAD) and land mapping. Students gain competence in CAD operations used to fabricate parts and to develop field- and watershed-scale maps. Class and project topics include drawing for mechanical part fabrication and scale mapping for construction site development and agricultural field management. Must be in Junior standing Course may be repeated for a maximum of 6 credit hours.

**BATM 3110 AG TECHNOLOGY GEOSPATIAL APPLICATIONS (3)** LEC. 2. LAB. 3. Pr. PHYS 1500 or PHYS 1600. Geospatial applications for agricultural land resource management. Course introduces equipment and practices used in conventional land surveying and geospatial mapping as they interface with global positioning systems (GPS), geographic information systems (GIS), and computer-aided design (CAD).

**BATM 3500 NATURAL RESOURCE SYSTEMS CONSERVATION (3)** LLB. Pr. (MATH 1130 or MATH 1133 or MATH 1150 or MATH 1610 or MATH 1680) and (PHYS 1500 or PHYS 1600). Natural resource conservation technologies including rainfall-runoff relationships, sediment transport capacity, runoff control structures, water supply development, surveying techniques including GPS methods.

**BATM 3510 AGRICULTURAL POWER AND MACHINERY FUNDAMENTALS (3)** LLB. Pr. (MATH 1130 or MATH 1133 or MATH 1150 or MATH 1610 or MATH 1680) and (PHYS 1500 or PHYS 1600). Power unit fundamentals with emphasis on diesel and small gasoline engines; mechanics of operation, safety, use, and adjustment of machines used for horticultural and agronomic crop production; and precision agriculturr principles and technology.

**BATM 3530 AGRICULTURAL PRODUCTION AND PROCESSING FACILITY TECHNOLOGY (3)** LEC. 3. Pr. MATH 1130 or MATH 1133 or MATH 1150 or MATH 1610 or MATH 1680. Fundamental requirements for the design and operation of agricultural production and processing facilities.

**BATM 3560 TURF SYSTEMS IRRIGATION DESIGN (3)** LEC. 3. Pr. MATH 1120 or MATH 1130 or MATH 1133 or MATH 1150 or MATH 1610 or MATH 1680. Irrigation system design for turf-based systems including residential lawns, commercial properties, athletic fields, and golf courses. Irrigation scheduling and water demand are presented to provide management capabilities.

**BATM 4100 PROFESSIONAL PRACTICE IN TECHNOLOGY MANAGEMENT (2)** LEC. 1. LAB. 3. Pr. BATM 5110. First in the two-course capstone experience. This course focuses on professional topics that prepare students for technical careers; teamwork, communication, standards and codes, economics, project and time management. Teams initiate the capstone design project.

**BATM 4110 TECHNOLOGY CAPSTONE (3)** LEC. 1. LAB. 6. Pr. BATM 4100. Development and evaluation of a team-based capstone project using tools from the technology curriculum; emphasizing communication, critical thinking, and technical and economic analyses.

**BATM 5110 AGRI-INDUSTRIAL ELECTRICAL APPLICATIONS (3)** LEC. 2. LAB. 3. Pr. BATM 2110 and (PHYS 1500 or PHYS 1600). An introduction to the fundamentals of electricity and electrical systems used in agricultural and industrial applications. Electricity basics include safety, AC (single and three phase) and DC power. Selecting and sizing components include wiring conductors, safety devices, motors, other loads.

**BATM 5120 AGRI-INDUSTRIAL ELECTRONICS AND CONTROLS (3)** LEC. 2. LAB. 3. Pr. BATM 5110. An introduction to the fundamentals of electronic control systems used in agricultural and industrial production and processing applications. Electronic control system components include programmable logic controllers (PLCs), switches, relays, sensors, and ladder logic.

**BATM 5130 PRECISION AG TECHNOLOGY (3)** LEC. 2. LAB. 3. Pr. BATM 3510. An overview of the principles of precision agriculture with focus on prescriptive agriculture and the ability to effectively execute input management plans using today's technologies. Course material and discussions will include how technologies such as GPS, agricultural GIS, sensors for qualitative and quantitative measurement of soil and plant variables, variable-rate technology are being implement with data informing sub-field level management and subsequent farm business decisions.

**BATM 5140 COMMERCIAL POULTRY & LIVESTOCK HOUSING (3)** LEC. 2. LAB. 3. Pr. STAT 2510. An introduction to the basic design, operation, and maintenance of modern commercial animal housing systems. Emphasis will be placed on poultry and swine systems with elements of dairy and beef when applicable.

**BATM 5550 PRINCIPLES OF FOOD ENGINEERING TECHNOLOGY (4)** LEC. 3. LAB. 3. Pr. (MATH 1130 or MATH 1133 or MATH 1150 or MATH 1153 or MATH 1610 or MATH 1613 or MATH 1617) and (PHYS 1000 or PHYS 1003 or PHYS 1007 or PHYS 1500 or PHYS 1600 or PHYS 1607). Engineering concepts and unit operations used in processing food products. Fall.

**BATM 6110 AGRI-INDUSTRIAL ELECTRICAL APPLICATIONS (3)** LEC. 2. LAB. 3. Departmental approval. An introduction to the fundamentals of electricity and electrical systems used in agricultural and industrial applications. Electricity basics include safety, AC (single and three phase) and DC power. Selecting and sizing components include wiring conductors, safety devices, motors, other loads.

**BATM 6120 AGRI-INDUSTRIAL ELECTRONICS AND CONTROLS (3)** LEC. 2. LAB. 3. Pr. BATM 6110. An introduction to the fundamentals of electronic control systems used in agricultural and industrial production and processing applications. Electronic control system components include programmable logic controllers (PLCs), switches, relays, sensors, and ladder logic.

**BATM 6130 PRECISION AG TECHNOLOGY (3)** LEC. 2. LAB. 3. An overview of the principles of precision agriculture with focus on prescriptive agriculture and the ability to effectively execute input management plans using today's technologies. Course material and discussions will include how technologies such as GPS, agricultural GIS, sensors for qualitative and quantitative measurement of soil and plant variables, variable-rate technology are being implement with data informing sub-field level management and subsequent farm business decisions.

**BATM 6140 COMMERCIAL POULTRY AND LIVESTOCK HOUSING (3)** LEC. 2. LAB. 1. An introduction to the basic design, operation, and maintenance of modern commercial animal housing systems. Emphasis will be placed on poultry and swine systems with elements of dairy and beef when applicable.

**BATM 6550 PRINCIPLES OF FOOD ENGINEERING TECHNOLOGY (4)** LEC. 3. LAB. 3. Pr. (MATH 1130 or MATH 1133) and (PHYS 1000 or PHYS 1003 or PHYS 1007). Engineering concepts and unit operations used in processing food products. Fall.

## Biosystems Engineering Courses

**BSEN 2210 ENGINEERING METHODS FOR BIOLOGICAL SYSTEMS (2)** LEC. 1. LAB. 3. Pr. (ENGR 1110 or ENGR 1113) and (PHYS 1600 or PHYS 1607) or Departmental approval. Introduction to experimental design methodology, basic engineering design and problem solving methodology for Biological Engineering. Visualization skills, computer-aided 3-D solid modeling of parts, 3-D assembly of solid part geometries, computation of mass properties, 2-D engineering drawings, engineering design process, safety, tools and fabrication processes and design, and hands-on shop fabrication of semester project.

**BSEN 2240 BIOLOGICAL AND BIOENVIRONMENTAL HEAT AND MASS TRANSFER (3)** LEC. 3. Pr. (MATH 2630 or MATH 2637) and (PHYS 1600 or PHYS 1607) and P/C ENGR 2010. Basic principles of heat and mass transfer with special applications to biological and environmental systems. Introduction to steady state and transient heat conduction. Convection, radiation, diffusion, simultaneous heat and mass transfer, and generation and depletion of heat and mass in biological systems.

**BSEN 3210 MECHANICAL POWER FOR BIOSYSTEMS (3)** LEC. 2. LAB. 3. Pr. ENGR 2010 and MATH 2650 and P/C ENGR 2350. Basic engineering analysis, synthesis, and design concepts applied to power sources, mobile equipment, and machinery applications for agricultural, forestry, and natural resource systems.

**BSEN 3230 NATURAL RESOURCE CONSERVATION ENGINEERING (3)** LEC. 2. LAB. 3. Pr. BSEN 3310. Departmental approval. Engineering analysis applied to natural resource systems. Design principles and practices in rainfall-runoff relationships, soil erosion and its prediction and control, hydraulic structures, and open channel hydraulics.

**BSEN 3240 PROCESS ENGINEERING IN BIOSYSTEMS (3)** LEC. 2. LAB. 3. Pr. BSEN 2240. Departmental approval. Theory and application of process operations in biological, food and agricultural systems. Heat transfer, fluid flow, thermal processing, evaporation, psychrometrics, refrigeration, drying freezing.

**BSEN 3260 ENGINEERING FOR PRECISION AGRICULTURE AND FORESTRY (3)** LEC. 2. LAB. 3. Pr. ELEC 3810 and MATH 2650. Departmental approval. Engineering aspects of spatial technologies applied to agricultural and forest production. Data collection in the field using GPS and use of field data in site specific applications. Fall.

**BSEN 3310 HYDRAULIC TRANSPORT IN BIOLOGICAL SYSTEMS (4)** LEC. 3. LAB. 3. Pr. (ENGR 2050 or ENGR 2053) and MATH 2650 or Departmental approval. Fluid properties, Non-Newtonian fluids and biological systems, Fluid statics, Energy equation, mass and momentum balance, pipe flow for Newtonian and Non-Newtonian fluids, dimensional analysis, compressible flows.

**BSEN 3610 INSTRUMENTATION AND CONTROLS FOR BIOLOGICAL SYSTEMS (3)** LEC. 2. LAB. 3. Pr. MATH 2650 and BSEN 2210. Departmental approval. Understanding of fundamentals of electrical circuits, sensing and sensors, simple digital electronics, analog measurement circuits, introductory digital signal processing, computer data acquisition.

**BSEN 4200 POLYMERS FROM RENEWABLE RESOURCES (2)** LEC. 2. Fundamental aspects of natural, biodegradable polymers, including fibers, adhesives, films and coatings, their synthesis, their structure/properties relationships, and the microbiology of their degradation.

**BSEN 4210 IRRIGATION SYSTEM DESIGN (3)** LEC. 2. LAB. 3. Pr. BSEN 3230. Departmental approval. Theory and design of irrigation systems for the application of water and wastewater including surveying techniques for system design. Systems include solid-set, traveler, center-pivot, and trickle. Fall.

**BSEN 4240 BULK BIOLOGICAL SOLIDS BEHAVIOR AND PROCESSING (3)** LEC. 3. Pr. BSEN 3310. The course is designed to enable students to develop fundamental understanding of the properties of bulk biological solids and how these properties influence the behavior and processability of bulk solids.

**BSEN 4250 HYDRAULIC CONTROL SYSTEMS DESIGN (3)** LEC. 2. LAB. 3. Pr. BSEN 3310 or Departmental approval. Principles of energy transfer by means of fluid power. Design of hydraulic control systems using prime movers, valves, actuators, and accessories. Spring.

**BSEN 4300 PROFESSIONAL PRACTICE IN BIOSYSTEMS ENGINEERING (2)** LEC. 1. LAB. 3. Pr. ENGR 2070 and (BSEN 4240 or BSEN 3230). This course focuses on issues related to the professional practice of biological engineering including preparing students for transition to careers as professional engineers.

**BSEN 4310 ENGINEERING DESIGN FOR BIOSYSTEMS (3)** LEC. 1. LAB. 6. Pr. BSEN 4300. Departmental approval. Capstone design course in biosystems engineering emphasizing teamwork, communication, safety engineering, and economic analysis to complete an engineering design project. Spring.

**BSEN 4960 SPECIAL PROBLEMS IN BIOSYSTEMS ENGINEERING (1-4)** AAB/IND. Departmental approval. Faculty supervision of individual student investigations of specialized problems in biosystems engineering. May be repeated with change in problem. Course may be repeated with change in topics.

**BSEN 4970 SPECIAL TOPICS IN BIOSYSTEMS ENGINEERING (1-4)** DSL. Departmental approval. Individual or small group study of a specialized area in biosystems engineering. Course may be repeated for a maximum of 12 credit hours.

**BSEN 4980 UNDERGRADUATE RESEARCH (2-4)** IND. Departmental approval. Directed research in the area of specialty within the department. Course may be repeated for a maximum of 4 credit hours.

**BSEN 5220 GEOSPATIAL TECHNOLOGIES IN BIOSYSTEMS (3)** LEC. 2. LAB. 3. Pr. STAT 2510 or STAT 2513 or STAT 2610 or STAT 3010 or Departmental approval. Geospatial technologies including GPS, GIS, and remote sensing systems applied to biosystems. Collecting, managing, and analyzing spatial data for agricultural and forest systems. Spring.

**BSEN 5230 WASTE MANAGEMENT AND UTILIZATION FOR BIOSYSTEMS (3)** LEC. 2. LAB. 3. Pr. (CHEM 1040 or CHEM 1120) and BIOL 3200 and (BSEN 3230 or BSEN 4240). Introduction to animal waste management problems of confined production systems, and characterization of animal waste types. Design of biological treatment and processing systems. Departmental approval. May count either BSEN 5230 or BSEN 6230.

**BSEN 5250 DETERMINISTIC MODELING FOR BIOSYSTEMS (3)** LEC. 3. LAB. 2. Pr. MATH 2650. Modeling of biosystems, methods to deal with complexity, and validation tools.

**BSEN 5260 RENEWABLE ENERGY IN BIOSYSTEMS PROCESS OPERATIONS (3)** LEC. 2. LAB. 3. Pr. BSEN 3310. Application and use of renewable energy in biological, food, forest and agricultural systems including bioenergy, solar energy, wind power and geothermal. Departmental approval. May count either BSEN 5260 or BSEN 6260.

**BSEN 5270 METABOLIC ENGINEERING FOR BIOPROCESS (3)** LEC. 3. Pr. BIOL 3200 and (CHEM 1040 or CHEM 1120). Or with the consent of the instructor. Introduction of basic principles of bioprocess engineering and metabolic engineering, to prepare engineers and scientists for biotechnology and bioeconomy industries.

**BSEN 5280 LIFE-CYCLE ASSESSMENT FOR BIOLOGICAL SYSTEMS (3)** LEC. 2. LAB. 1. Pr. BSEN 2240 and BSEN 3310. Introduces the concept of life cycle assessment (LCA) in in the context of biological engineering. Examples will include LCA applications to engineered biological systems and other engineering processes and products.

**BSEN 5510 ECOLOGICAL ENGINEERING (3)** LEC. 3. Pr. BSEN 3230. Ecological engineering non-point source transport of nutrients, sediment, pesticides, pathogens, and chemicals from agricultural, forestry, and urban activities. Departmental approval. May count either BSEN 5510 or BSEN 6510.

**BSEN 5520 WATERSHED MODELING (3)** LEC. 3. Pr. BSEN 3230. Modeling of non-point source pollution at watershed scale using Soil and Water Assessment Tool model including underlying processes that control movement of pollutants. Departmental approval. May count either BSEN 5520 or BSEN 6520.

**BSEN 5540 BIOMASS AND BIOFUELS ENGINEERING (3)** LEC. 2. LAB. 3. Pr. (CHEM 1040 or CHEM 1120) and MATH 2650 and BSEN 3310. This course introduces the various processes and engineering principles in converting biomass into biofuels and chemicals. The focus will be on thermochemical and biochemical conversion platforms. May count either BSEN 5540 or BSEN 6540.

**BSEN 5560 SITE DESIGN FOR BIOSYSTEMS (3)** LEC. 2. LAB. 3. Pr. BSEN 3230 or (CIVL 3110 and CIVL 3010). Development of student skills in computer-aided site design and restoration by using rural and urban best management practices to reduce environmental impacts. Departmental approval. May count either BSEN 5560 or BSEN 6560.

**BSEN 6220 GEOSPATIAL TECHNOLOGIES IN BIOSYSTEMS (3)** LEC. 2. LAB. 3. Departmental approval. Geospatial technologies including GPS, GIS, and remote sensing systems applied to biosystems. Collecting, managing, and analyzing spatial data for agricultural and forest systems. Spring.

**BSEN 6230 WASTE MANAGEMENT AND UTILIZATION FOR BIOSYSTEMS (3)** LEC. 2. LAB. 3. Departmental approval. Coreq. BSEN 3230. Introduction to the animal waste management problems of confined production systems and characterization of animal waste types. Design of biological treatment and processing systems.

**BSEN 6250 DETERMINISTIC MODELING FOR BIOSYSTEMS (3)** LEC. 2. LAB. 3. Pr. MATH 2650. Modeling of biosystems, methods to deal with complexity, and validation tools.

**BSEN 6260 RENEWABLE ENERGY IN BIOSYSTEMS PROCESS OPERATIONS (3)** LEC. 2. LAB. 3. Pr. BSEN 3310. Departmental approval. Application and use of renewable energy in biological, food forest and agricultural systems including biomass and bioenergy, solar energy, wind power and geothermal.

**BSEN 6270 METABOLIC ENGINEERING FOR BIOPROCESS (3)** LEC. 3. Department/instructor approval. An introduction of basic principles of bioprocess engineering and metabolic engineering, to prepare engineers and scientists for biotechnology and bioeconomy industries. May count either BSEN 5270 or BSE 6270.

**BSEN 6280 LIFE-CYCLE ASSESSMENT FOR BIOLOGICAL SYSTEMS (3)** LEC. 2. LAB. 3. Pr. BSEN 2240. This course introduces the concept of life cycle assessment (LCA) in in the context of biological engineering. Examples will include LCA applications to engineered biological systems and other engineering processes and products.



**BSEN 6510 ECOLOGICAL ENGINEERING (3)** LEC. 3. Pr. BSEN 3230. Departmental approval. The course introduces students to ecological engineering non-point source transport of nutrients, sediment, pesticides, pathogens, and chemicals from agricultural, forestry, and urban activities.

**BSEN 6520 WATERSHED MODELING (3)** LEC. 3. Departmental approval. The course covers modeling of non-point source pollution at the watershed scale using Soil and Water Assessment Tool model including underlying processes that control movement of pollutants.

**BSEN 6540 BIOMASS AND BIOFUELS ENGINEERING (3)** LEC. 2. LAB. 3. This course introduces the various processes and engineering principles in converting biomass into biofuels and chemicals. The focus will be on thermochemical and biochemical conversion platforms. May count either BSEN 5540 or BSEN 6540.

**BSEN 6560 SITE DESIGN FOR BIOSYSTEMS (3)** LEC. 2. LAB. 3. Pr. BSEN 3230. Departmental approval. The course is designed to develop student skills in computer-aided site design and restoration by using rural and urban best management practices to reduce environmental impacts.

**BSEN 7110 FUNDAMENTALS OF INSTRUMENTATION FOR BIOLOGICAL SYSTEMS (3)** LEC. 2. LAB. 3. Departmental approval. Students will gain an understanding of the fundamentals of sensing and sensors, simple digital electronics and measurement circuits, introductory digital signal processing, and computer data acquisition. They will be required to build and test instrumentation to collect data on biological systems that might include fluid flow, pressure, force, or other transducers.

**BSEN 7140 ALGAE SYSTEMS ENGINEERING (3)** LEC. 2. LAB. 1. This course is a study of engineered systems for cultivating algae for various uses in society. To develop an understanding of engineering principles applied to growing, cultivating, and producing algal biomass for a number of applications, study into the biology, physiology, and ecology of algae and similar species will be a major part of the course. Departmental Approval.

**BSEN 7240 BULK SOLIDS STORAGE, HANDLING AND TRANSPORTATION (3)** LEC. 3. Sampling of particulate materials, bulk solids characterization, flow properties, particle and bulk solid flow, dynamics of fluid/solids systems, hydraulic and pneumatic conveyor design, storage bin and hopper design and geometry, safety issues.

**BSEN 7510 INTRODUCTION TO LAND AND WATER ENGINEERING (3)** LEC. 3. This course aims at equipping students with the engineering tools and knowledge needed for advanced courses in land and water engineering.

**BSEN 7520 INTRODUCTION TO FLUVIAL GEOMORPHOLOGY (3)** LEC. 3. Pr. BSEN 3230. This course provides an overview of stream geomorphology as it relates to natural stream physical processes.

**BSEN 7900 SPECIAL PROBLEMS IN BIOSYSTEMS ENGINEERING (1-4)** IND. Departmental approval. Faculty supervision of individual student investigations of advanced specialized problems in biosystems engineering at the graduate level. Pr., Course may be repeated with change in topics.

**BSEN 7950 SEMINAR (1)** SEM. SU. Reviews and discussions of research techniques, current scientific literature, and recent developments in biosystems engineering. Course may be repeated for a maximum of 12 credit hours.

**BSEN 7970 SPECIAL TOPICS IN BIOSYSTEMS ENGINEERING (1-4)** IND. Departmental approval. Individual or small group study of an advanced specialized area in biosystems engineering at the graduate level. Course may be repeated with change in topics.

**BSEN 7990 RESEARCH AND THESIS (1-10)** MST. Course may be repeated with change in topic.

**BSEN 8990 RESEARCH AND DISSERTATION (1-12)** DSR.