

# BIOLOGICAL SYSTEMS ENGINEERING (EBS)

College of Engineering

## EBS 001 – Foundations of Biological Systems Engineering (4 units)

*Course Description:* Introduction to engineering and the engineering design process with examples drawn from the field of biological systems engineering. Introduction to computer-aided design and mechanical fabrication of designs. Quarter-long group design project.

*Learning Activities:* Lecture 2 hour(s), Laboratory 6 hour(s), Project.

*Enrollment Restriction(s):* Open only to students in Biological Systems Engineering.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Oral Skills (OL); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

## EBS 075 – Properties of Materials in Biological Systems (4 units)

*Course Description:* Properties of typical biological materials; composition and structure with emphasis on the effects of physical and biochemical properties on design of engineered systems; interactions of biological materials with typical engineering materials.

*Prerequisite(s):* BIS 002A; PHY 009B (can be concurrent).

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

## EBS 090C – Research Group Conference in Biological Systems Engineering (1 unit)

*Course Description:* Research group conference.

*Prerequisite(s):* Consent of instructor. Lower division standing in Biological Systems Engineering or Food Engineering.

*Learning Activities:* Discussion 1 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

## EBS 092 – Internship in Biological Systems Engineering (1-5 units)

*Course Description:* Supervised work experience in biological systems engineering.

*Prerequisite(s):* Consent of instructor. Lower division standing; project approval prior to period of internship.

*Learning Activities:* Internship.

*Repeat Credit:* May be repeated.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

## EBS 098 – Directed Group Study (1-5 units)

*Course Description:* Group study of selected topics; restricted to lower division students.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

## EBS 099 – Special Study for Lower Division Students (1-5 units)

*Course Description:* Special study for lower division students.

*Learning Activities:* Variable.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

## EBS 103 – Fluid Mechanics Fundamentals (4 units)

This version has ended; see updated course, below.

*Course Description:* Fluid mechanics axioms, fluid statics, kinematics, velocity fields for one-dimensional incompressible flow and boundary layers, turbulent flow time averaging, potential flow, dimensional analysis, and macroscopic balances to solve a range of practical problems.

*Prerequisite(s):* PHY 009B.

*Learning Activities:* Lecture 4 hour(s).

*Cross Listing:* HYD 103N.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Visual Literacy (VL).

## EBS 103 – Fluid Mechanics Fundamentals (4 units)

*Course Description:* Fluid mechanics axioms, fluid statics, kinematics, velocity fields for one-dimensional incompressible flow and boundary layers, turbulent flow time averaging, potential flow, dimensional analysis, and macroscopic balances to solve a range of practical problems.

*Prerequisite(s):* PHY 009B.

*Learning Activities:* Lecture 4 hour(s).

*Cross Listing:* HYD 103N.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

This course version is effective from, and including: Spring Quarter 2026.

## EBS 114 – Principles of Field Machinery Design (3 units)

*Course Description:* Traction and stability of vehicles with wheels or tracks. Operating principles of field machines and basic mechanisms used in their design.

*Prerequisite(s):* ENG 102; (ENG 104 or ENG 104V).

*Learning Activities:* Lecture 2 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Visual Literacy (VL); Writing Experience (WE).

## EBS 115 – Forest Engineering (3 units)

*Course Description:* Applications of engineering principles to problems in forestry including those in forest regeneration, harvesting, residue utilization, and transportation.

*Prerequisite(s):* ENG 104 or ENG 104V.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

**EBS 120 – Power Systems Design (4 units)**

*Course Description:* Design and performance of power devices and systems including combustion engines, electric generators and motors, fluid power systems, fuels, and emerging technologies. Selection of units for power matching and optimum performance.

*Prerequisite(s):* (ENG 017 or ENG 017V); ENG 102; ENG 103; ENG 105.

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

**EBS 125 – Heat Transfer in Biological Systems (4 units)**

*Course Description:* Fundamentals of heat transfer with application to biological systems. Steady and transient heat transfer. Analysis and simulation of heat conduction, convection and radiation. Heat transfer operations.

*Prerequisite(s):* BIS 002A; EBS 075; ENG 103; ENG 105.

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Oral Skills (OL); Quantitative Literacy (QL); Visual Literacy (VL); Writing Experience (WE).

**EBS 127 – Mass Transfer & Kinetics in Biological Systems (4 units)**

*Course Description:* Fundamentals of mass transfer and kinetics in biological systems. Molecular diffusion and convection.

Thermodynamics and bioenergetics. Biological and chemical rate equations. Heterogeneous kinetics. Batch and continuous reaction processes. Mass transfer operations.

*Prerequisite(s):* EBS 125.

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Visual Literacy (VL); Writing Experience (WE).

**EBS 128 – Biomechanics & Ergonomics (4 units)**

*Course Description:* Anatomical, physiological, and biomechanical bases of physical ergonomics. Human motor capabilities, body mechanics, kinematics and anthropometry. Use of bioinstrumentation, industrial surveillance techniques and the NIOSH lifting guide. Cumulative trauma disorders. Static and dynamic biomechanical modeling. Emphasis on low back, shoulder and hand/wrist biomechanics.

*Prerequisite(s):* STA 100; ENG 102.

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s).

*Enrollment Restriction(s):* Limited enrollment.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

**EBS 130 – Modeling of Dynamic Processes in Biological Systems (4 units)**

*Course Description:* Techniques for modeling processes through mass & energy balance, rate equations, and equations of state. Computer problem solution of models. Example models include package design, evaporation, respiration heating, thermal processing of foods, and plant growth.

*Prerequisite(s):* (ENG 006 or ECS 032A or ECS 032AV ); (MAT 022B C- or better or MAT 027B C- or better); EBS 075.

*Learning Activities:* Lecture 3 hour(s), Discussion 1 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

**EBS 135 – Bioenvironmental Engineering (4 units)**

*Course Description:* Biological responses to environmental conditions. Principles and engineering design of environmental control systems. Overview of environmental pollution problems and legal restrictions for biological systems, introduction of environmental quality assessment techniques, and environmental pollution control technologies.

*Prerequisite(s):* EBS 125; EBS 130.

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

**EBS 144 – Groundwater Hydrology (4 units)**

*Course Description:* Global role of groundwater resources in society; groundwater in the hydrologic cycle; geology of groundwater; global, US, and California geography of groundwater; physical measures of groundwater occurrence and flow; water balance; modeling groundwater flow; principles of well construction; aquifer tests; groundwater quality; contaminant transport and monitoring; groundwater law, water quality regulations, and sustainable management.

*Prerequisite(s):* MAT 012 (can be concurrent) or MAT 021A (can be concurrent) or MAT 019A (can be concurrent) or MAT 016B (can be concurrent); or consent of instructor.

*Learning Activities:* Lecture 3 hour(s), Laboratory 2 hour(s).

*Cross Listing:* HYD 144.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

**EBS 145 – Irrigation & Drainage Systems (4 units)**

*Course Description:* Engineering and scientific principles applied to the design of surface, sprinkle and micro irrigation systems and drainage systems within economic, biological, and environmental constraints. Interaction between irrigation and drainage.

*Prerequisite(s):* EBS 103 or HYD 103N.

*Learning Activities:* Lecture 4 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

## **EBS 147 – Runoff, Erosion & Water Quality Management (3 units)**

*Course Description:* Practical hydrology and runoff water quality management from disturbed watersheds. Development of hillslope and soils restoration concepts and practice, modeling and application.

*Prerequisite(s):* (PHY 007B or PHY 009B); (MAT 016C or MAT 017C or MAT 021C); (ECI 142 or HYD 141 or ESM 100); or equivalent.

*Learning Activities:* Lecture/Lab 3 hour(s), Fieldwork.

*Cross Listing:* HYD 147.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

## **EBS 148 – Evapotranspiration Principles, Measurement & Modeling (4 units)**

*Course Description:* Estimation of evapotranspiration (ET) for irrigation management and water resources planning; including the basic principles and key factors controlling evaporation and ET rates, methods of measuring these factors in the field and remotely, and determination of likely water requirements for crops and various landscape conditions as needed for water resources planning.

*Prerequisite(s):* HYD 124 C or better; consent of instructor.

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s).

*Cross Listing:* ESM 118; HYD 118.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

## **EBS 161 – Kinetics & Bioreactor Design (4 units)**

*Course Description:* Provide the basic principles of reactor design for bioprocess applications. Emphasizes the following topics: 1) kinetics and reactor engineering principles; 2) bio-reaction kinetics; and 3) bioreactor design.

*Prerequisite(s):* EBS 127.

*Learning Activities:* Lecture 3 hour(s), Discussion 1 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Visual Literacy (VL).

## **EBS 165 – Bioinstrumentation & Control (4 units)**

*Course Description:* Instrumentation and control for biological production systems. Measurement system concepts, instrumentation and transducers for sensing physical and biological parameters, data acquisition and control.

*Prerequisite(s):* ENG 100.

*Learning Activities:* Lecture 3 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

## **EBS 170A – Engineering Design & Professional Responsibilities (3 units)**

*Course Description:* Engineering design including professional responsibilities. Emphasis on project selection, data sources, specifications, human factors, biological materials, safety systems, and professionalism. Detailed design proposals developed for EBS 170B and EBS 170BL.

*Prerequisite(s):* EBS 001; ENG 102; (ENG 104 or ENG 104V).

*Learning Activities:* Lecture 2 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Oral Skills (OL); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

## **EBS 170B – Engineering Projects: Design (2 units)**

*Course Description:* Individual or group projects involving the design of devices, structures, or systems to solve specific engineering problems in biological systems. Project for study is jointly selected by student and instructor.

*Prerequisite(s):* EBS 170A; EBS 170BL (can be concurrent); EBS 170BL required concurrently.

*Learning Activities:* Discussion 2 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Oral Skills (OL); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

## **EBS 170BL – Engineering Projects: Design Laboratory (1 unit)**

*Course Description:* Individual or group projects involving the design of devices, structures, or systems to solve specific engineering problems in biological systems.

*Prerequisite(s):* EBS 170B (can be concurrent); EBS 170B required concurrently.

*Learning Activities:* Laboratory 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Oral Skills (OL); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

## **EBS 170C – Engineering Projects: Design Evaluation (1 unit)**

*Course Description:* Individual or group projects involving the fabrication, assembly and testing of components, devices, structures, or systems designed to solve specific engineering problems in biological systems. Project for study previously selected by student and instructor in EBS 170B.

*Prerequisite(s):* EBS 170B; EBS 170CL (can be concurrent); EBS 170CL required concurrently.

*Learning Activities:* Discussion 1 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Oral Skills (OL); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

## **EBS 170CL – Engineering Projects: Design Evaluation (2 units)**

*Course Description:* Individual or group projects involving the fabrication, assembly and testing of components, devices, structures, or systems designed to solve specific engineering problems in biological systems.

*Prerequisite(s):* EBS 170C (can be concurrent); EBS 170C required concurrently.

*Learning Activities:* Laboratory 6 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Oral Skills (OL); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

**EBS 175 – Rheology of Biological Materials (3 units)**

*Course Description:* Fluid and solid rheology, viscoelastic behavior of foods and other biological materials, and application of rheological properties to food and biological systems (i.e., pipeline design, extrusion, mixing, coating).

*Prerequisite(s):* EBS 103 or ENG 103.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE); Quantitative Literacy (QL); Visual Literacy (VL).

**EBS 189A – Special Topics in Biological Systems Engineering: Agricultural Engineering (1-5 units)**

*Course Description:* Special topics in Agricultural Engineering.

*Prerequisite(s):* Consent of instructor; upper division standing in Engineering.

*Learning Activities:* Variable 3-15 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**EBS 189B – Special Topics in Biological Systems Engineering: Aquacultural Engineering (1-5 units)**

*Course Description:* Special topics in Aquacultural Engineering.

*Prerequisite(s):* Consent of instructor; upper division standing in Engineering.

*Learning Activities:* Variable 3-15 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**EBS 189C – Special Topics in Biological Systems Engineering: Biomedical Engineering (1-5 units)**

*Course Description:* Special topics in Biomedical Engineering.

*Prerequisite(s):* Consent of instructor; upper division standing in Engineering.

*Learning Activities:* Variable 3-15 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**EBS 189D – Special Topics in Biological Systems Engineering: Biotechnical Engineering (1-5 units)**

*Course Description:* Special topics in Biotechnical Engineering.

*Prerequisite(s):* Consent of instructor; upper division standing in Engineering.

*Learning Activities:* Variable 3-15 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**EBS 189E – Special Topics in Biological Systems Engineering: Ecological Systems Engineering (1-5 units)**

*Course Description:* Special topics in Ecological Systems Engineering.

*Prerequisite(s):* Consent of instructor; upper division standing in Engineering.

*Learning Activities:* Variable 3-15 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**EBS 189F – Special Topics in Biological Systems Engineering: Food Engineering (1-5 units)**

*Course Description:* Special topics in Food Engineering.

*Prerequisite(s):* Consent of instructor; upper division standing in Engineering.

*Learning Activities:* Variable 3-15 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**EBS 189G – Special Topics in Biological Systems Engineering: Forest Engineering (1-5 units)**

*Course Description:* Special topics in Forest Engineering.

*Prerequisite(s):* Consent of instructor; upper division standing in Engineering.

*Learning Activities:* Variable 3-15 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

*General Education:* Science & Engineering (SE).

**EBS 190C – Research Group Conference in Biological Systems Engineering (1 unit)**

*Course Description:* Research group conference.

*Prerequisite(s):* Consent of instructor; upper division standing in Biological Systems Engineering or Food Engineering.

*Learning Activities:* Discussion 1 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

**EBS 192 – Internship in Biological Systems Engineering (1-5 units)**

*Course Description:* Supervised work experience in biological systems engineering.

*Prerequisite(s):* Consent of instructor; upper division standing; approval of project prior to period of internship.

*Learning Activities:* Internship.

*Repeat Credit:* May be repeated.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

**EBS 197T – Tutoring in Biological Systems Engineering (1-5 units)**

*Course Description:* Tutoring individual students, leading small voluntary discussion groups, or assisting the instructor in laboratories affiliated with one of the department's regular courses.

*Prerequisite(s):* Consent of instructor; upper division standing.

*Learning Activities:* Tutorial 3-15 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

**EBS 198 – Directed Group Study (1-5 units)**

*Course Description:* Directed group study.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

## **EBS 199 – Special Study for Advanced Undergraduates (1-5 units)**

*Course Description:* Special study for advanced undergraduates.

*Learning Activities:* Variable.

*Grade Mode:* Pass/No Pass only.

*General Education:* Science & Engineering (SE).

## **EBS 200 – Research Methods in Biological Systems Engineering (2 units)**

*Course Description:* Planning, execution and reporting of research projects. Literature review techniques and proposal preparation. Record keeping and patents. Uncertainty analysis in experiments and computations. Graphic analysis. Oral and written presentation of research results, manuscript preparation, submission and review.

*Prerequisite(s):* Graduate standing.

*Learning Activities:* Lecture 2 hour(s).

*Grade Mode:* Letter.

## **EBS 216 – Energy Systems (4 units)**

*Course Description:* Theory and application of energy systems. Systems analysis, energy conversion technologies, environmental considerations, economics and system optimization.

*Prerequisite(s):* ENG 105; or equivalent.

*Learning Activities:* Lecture/Discussion 4 hour(s).

*Grade Mode:* Letter.

## **EBS 221 – Agricultural Robotics (4 units)**

*Course Description:* Agricultural operations and precision farming. Requirements and challenges for agricultural robots. Mobile platforms, path planning, optimal field coverage, and automated path tracking. Sensing for agricultural robots and environment representation. Occupancy grids, and sensor-based navigation amongst obstacles. Probabilistic state estimation and mapping. The Robot Operating System. Case studies in agricultural robotics applications.

*Prerequisite(s):* Graduate standing or consent of instructor.

*Learning Activities:* Lecture/Lab 4 hour(s).

*Grade Mode:* Letter.

## **EBS 228 – Occupational Musculoskeletal Disorders (3 units)**

*Course Description:* Epidemiology and etiology of occupational musculoskeletal disorders (MSDs) with focus on low back and upper extremities disorders; anatomical and biomechanical functions of lower back and upper extremities; MSDs risk factors assessment and control; research opportunities related to MSDs.

*Prerequisite(s):* Consent of instructor. Graduate standing.

*Learning Activities:* Lecture 2 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

## **EBS 240 – Infiltration & Drainage (3 units)**

*Course Description:* Aspects of multi-phase flow in soils and their application to infiltration and immiscible displacement problems. Gas phase transport and entrapment during infiltration, and oil-water-gas displacement will be considered.

*Prerequisite(s):* SSC 107; ENG 103.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

## **EBS 241 – Precision Irrigation Systems & Management (3 units)**

*Course Description:* Advanced irrigation science and engineering for agricultural, horticultural, engineering, and hydrology graduate students. Precision irrigation techniques for application of water to meet specific requirements of individual plants or management units and maximum economic benefits of crop production.

*Prerequisite(s):* EBS 145; SSC 100; ABT 110; HYD 110.

*Learning Activities:* Lecture 3 hour(s).

*Cross Listing:* HYD 241.

*Grade Mode:* Letter.

## **EBS 242 – Hydrology & Sustainability of Irrigated Lands (3 units)**

*Course Description:* Impact of irrigated agricultural on groundwater depletion, surface water and groundwater quality, soil salinization, downstream ecosystems, and seawater intrusion. Exploration of efficient resource use, and policies adopted in California to enhance sustainability of irrigated crop production.

*Prerequisite(s):* ABT 110 or ESM 110 or HYD 110 or EBS 145.

*Learning Activities:* Lecture 3 hour(s).

*Cross Listing:* HYD 242.

*Grade Mode:* Letter.

## **EBS 243 – Water Resource Planning & Management (3 units)**

*Course Description:* Applications of deterministic and stochastic mathematical programming techniques to water resource planning, analysis, design, and management. Water allocation, capacity expansion, and reservoir operation. Conjunctive use of surface water and groundwater. Water quality management. Irrigation planning and operation models.

*Prerequisite(s):* HYD 141; or equivalent.

*Learning Activities:* Lecture 3 hour(s).

*Cross Listing:* HYD 243.

*Grade Mode:* Letter.

## **EBS 245 – Waste Management for Biological Production Systems (3 units)**

*Course Description:* Characterization of solid and liquid wastes from animal, crop, and food production systems. Study of methods and system design for handling, treatment, and disposal/utilization of these materials.

*Prerequisite(s):* Graduate standing or consent of instructor.

*Learning Activities:* Lecture 3 hour(s).

*Grade Mode:* Letter.

## **EBS 265 – Design & Analysis of Engineering Experiments (5 units)**

*Course Description:* Simple linear, multiple, and polynomial regression, correlation, residuals, model selection, one-way ANOVA, fixed and random effect models, sample size, multiple comparisons, randomized block, repeated measures, and Latin square designs, factorial experiments, nested design and subsampling, split-plot design, statistical software packages.

*Prerequisite(s):* STA 100; ASE 120; or an introductory course in statistics.

*Learning Activities:* Lecture 3 hour(s), Lecture/Discussion 2 hour(s).

*Grade Mode:* Letter.

## **EBS 268 – Polysaccharides Surface Interactions (3 units)**

*Course Description:* Study of fundamental surface science theories as applied to physical and chemical interactions of carbohydrates and polysaccharides.

*Prerequisite(s):* Graduate students in science or engineering.

*Learning Activities:* Lecture 3 hour(s).

*Cross Listing:* ECH 268.

*Grade Mode:* Letter.

## **EBS 270 – Modeling & Analysis of Physical and Biological Processes & Systems (4 units)**

*Course Description:* Mathematical modeling of biological systems: model development; analytical and numerical solutions. Case studies from various specializations within Biological & Agricultural Engineering.

*Prerequisite(s):* MAT 022B or EBS 130; Familiarity with a programming language.

*Learning Activities:* Lecture 3 hour(s), Discussion 1 hour(s).

*Grade Mode:* Letter.

## **EBS 275 – Physical Properties of Biological Materials (3 units)**

*Course Description:* Selected topics on physical properties, such as mechanical, optical, rheological, and aerodynamic properties, as related to the design of harvesting, handling, sorting, and processing equipment. Techniques for measuring and recording physical properties of biological materials.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Lecture 2 hour(s), Laboratory 3 hour(s).

*Grade Mode:* Letter.

## **EBS 289A – Selected Topics in Biological Systems Engineering: Animal Systems Engineering (1-5 units)**

*Course Description:* Special topics in Animal Systems Engineering.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable 1-5 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

## **EBS 289B – Selected Topics in Biological Systems Engineering: Aquacultural Engineering (1-5 units)**

*Course Description:* Special topics in Aquacultural Engineering.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable 1-5 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

## **EBS 289C – Selected Topics in Biological Systems Engineering: Biological Engineering (1-5 units)**

*Course Description:* Special topics in Biological Engineering.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable 1-5 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

## **EBS 289D – Selected Topics in Biological Systems Engineering: Energy Systems (1-5 units)**

*Course Description:* Special topics in Energy Systems.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable 1-5 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

## **EBS 289E – Selected Topics in Biological Systems Engineering: Environmental Quality (1-5 units)**

*Course Description:* Special topic in Environmental Quality.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable 1-5 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

## **EBS 289F – Selected Topics in Biological Systems Engineering: Food Engineering (1-5 units)**

*Course Description:* Special topics in Food Engineering.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable 1-5 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

## **EBS 289G – Selected Topics in Biological Systems Engineering: Forest Engineering (1-5 units)**

*Course Description:* Special topics in Forest Engineering.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable 1-5 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

## **EBS 289H – Selected Topics in Biological Systems Engineering: Irrigation & Drainage (1-5 units)**

*Course Description:* Special topics in Irrigation & Drainage.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable 1-5 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

## **EBS 289I – Selected Topics in Biological Systems Engineering: Plant Production & Harvest (1-5 units)**

*Course Description:* Special topics in Plant Production & Harvest.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable 1-5 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

## **EBS 289J – Selected Topics in Biological Systems Engineering: Postharvest Engineering (1-5 units)**

*Course Description:* Special topics in Postharvest Engineering.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable 1-5 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

## **EBS 289K – Selected Topics in Biological Systems Engineering: Sensors & Actuators (1-5 units)**

*Course Description:* Special topics in Sensors & Actuators.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Variable 1-5 hour(s).

*Repeat Credit:* May be repeated when topic differs.

*Grade Mode:* Letter.

## **EBS 290 – Seminar (1 unit)**

*Course Description:* Weekly seminars on recent advances and selected topics in biological systems engineering. Theme changes from quarter to quarter.

*Prerequisite(s):* Graduate standing.

*Learning Activities:* Seminar 1 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Satisfactory/Unsatisfactory only.

## **EBS 290C – Graduate Research Conference (1 unit)**

*Course Description:* Research problems, progress and techniques in biological systems engineering.

*Prerequisite(s):* Consent of instructor.

*Learning Activities:* Discussion 1 hour(s).

*Repeat Credit:* May be repeated.

*Grade Mode:* Satisfactory/Unsatisfactory only.

## **EBS 298 – Group Study (1-5 units)**

*Course Description:* Group study.

*Learning Activities:* Variable.

*Grade Mode:* Satisfactory/Unsatisfactory only.

## **EBS 299 – Research (1-12 units)**

*Course Description:* Research.

*Learning Activities:* Variable.

*Grade Mode:* Satisfactory/Unsatisfactory only.

## **EBS 390 – Supervised Teaching in Biological & Agricultural Engineering (1-3 units)**

*Course Description:* Tutoring and teaching students in undergraduate courses offered in the Department of Biological and Agricultural Engineering. Weekly conferences with instructor; evaluation of teaching. Preparing for and conducting demonstrations, laboratories and discussions. Preparing and grading exams.

*Prerequisite(s):* Consent of instructor. Graduate standing.

*Learning Activities:* Laboratory 3 hour(s), Tutorial 3-9 hour(s).

*Repeat Credit:* May be repeated 6 unit(s).

*Grade Mode:* Satisfactory/Unsatisfactory only.