

BIOSYSTEMS ENGINEERING BE

Department of Biosystems and Agricultural Engineering College of Agriculture and Natural Resources

- 130 Engineering Design Fundamentals for Biological Systems**
Fall. 2(1-2) P:M: (MTH 132 or concurrently or MTH 114 or concurrently or MTH 116 or concurrently or LBS 117 or concurrently or LBS 118 or concurrently or MTH 152H)
Professional and fundamental methods of biosystems engineering. Basic engineering methods. Analysis and design. Interdisciplinary design.
- 230 Engineering Analysis of Biological Systems**
Spring. 3(3-0) P:M: (MTH 132 or MTH 152H or LBS 118) and (BS 110 or concurrently)
Biosystems modelling of growth and dynamic interactions. Conservation of mass, and sustainability. Steady-state and stability analysis. Ecological concepts. Life-cycle analysis. Design for environment.
- 232 Food Production and Processing Systems**
Fall. 1(0-2)
Crop and animal production systems. Food processing systems. Field trips required.
- 329 Fundamentals of Food Engineering**
Spring. 3(3-0) Interdepartmental with Food Science. P:M: (FSC 325) and (MTH 126 or LBS 118) and (PHY 231 or LBS 271) RB: (FSC 211) SA: FE 329
Unit operations in food industry: fluid mechanics, heat transfer, rate processes, refrigeration, freezing, and dehydration. Thermal process calculations.
- 332 Engineering Properties of Biological Materials**
Fall. 3(3-0) P:M: (BS 111 or PLB 105 or MMG 201) and (ME 221) C: BE 333 concurrently.
Physical, thermal, and electromagnetic properties of biological materials necessary for the design and analysis of processes and equipment in biosystems.
- 333 Biosystems Engineering Laboratory**
Fall. 1(0-3) P:M: (BS 110 or BS 111 or PLB 105 or ENT 205 or MMG 201 or MMG 301 or PSL 250 or ZOL141) R: Open only to students in the Biosystems Engineering major.
Measurement of physical, chemical, and biological parameters. Properties that characterize engineered biosystems. Data collection and analysis. Experiment design.
- 350 Heat and Mass Transfer in Biosystems**
Spring. 3(3-0) P:M: (MTH 235 or MTH 255H or LBS 220) and (CSE 131) and (CE 321 or concurrently or CHE 311 or concurrently or ME 332 or concurrently) and (CEM 143 or concurrently) R: Open only to students in the College of Engineering. Not open to students with credit in ME 410.
Steady state and transient heat conduction. Radiation and convection heat transfer. Heat exchangers. Mass transfer application problems in biosystems engineering.

- 148H Honors Organismal Biology**
Fall. 3(3-0) Interdepartmental with Lyman Briggs School. Not open to students with credit in BS 110 or LBS 144.

Diversity and basic properties of organisms, with emphasis on genetic principles, ecological interactions, and the evolutionary process. Historical approach to knowledge discovery.

- 149H Honors Cell and Molecular Biology**
Spring. 3(3-0) Interdepartmental with Lyman Briggs School. P:M: (CEM 141 or concurrently or CEM 151 or concurrently or CEM 181H or concurrently or LBS 171 or concurrently) Not open to students with credit in BS 111 or LBS 145.

Exploration of the physicochemical and molecular organization of cells as the unifying framework for genetics, evolution, and the social relevance of biology.

- 158H Honors Organismal Biology Laboratory**
Fall. 2(1-3) Interdepartmental with Lyman Briggs School. Not open to students with credit in BS 110 or LBS 144. C: BS 148H concurrently.

Basic procedures used by organismal biologists, including experimental design and statistical methods. Development and implementation of research projects to test hypotheses in genetics, ecology, and evolution.

- 159H Honors Cell and Molecular Biology Laboratory**
Spring. 2(1-3) Interdepartmental with Lyman Briggs School. Not open to students with credit in BS 111L or LBS 145. C: BS 149H concurrently.

Basic techniques of cellular and molecular biology including experimental design and hypothesis formulation. Student-initiated projects to test hypothesis-driven projects in biochemistry, molecular biology or genetics.

BIOMEDICAL ENGINEERING BME

College of Engineering

- 401 Quantitative Human Biology**
Spring. 3(4-0) Interdepartmental with Materials Science and Engineering; Radiology; Human Anatomy. P:M: (MTH 235 and PHY 184) and (PSL 250 or concurrently or PSL 431 or concurrently) and (CEM 141 or CEM 151) and (ANTR 350 or concurrently) RB: (CSE 131 or concurrently or CSE 231 or concurrently or PSL 410)

Qualitative description and quantitative engineering analysis of selected, tractable human-biological systems. Multi-disciplinary problem-solving among medical and engineering professionals.

- 425 Biomaterials and Biocompatibility**
Spring. 3(3-0) Interdepartmental with Materials Science and Engineering. Administered by Department of Chemical Engineering and Materials Science. P:M: (PSL 250 or concurrently and MSE 250) SA: MSM 424, BME 424, BME 324, MSE 324

Materials science of human implants. Design requirements imposed by the human body, and need for bodily protection.

- 490 Independent Study**
Fall, Spring. 3 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Approval of department.

Individualized reading and research in biomedical engineering or bioengineering.

- 490A Independent Study in Clinical Biomechanics**
Fall. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department.

Individualized reading and research in the application of biomechanics to clinical cases.

- 490B Independent Study in Biomaterials**
Spring. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department.

Individualized reading and research in the application of biomaterials.

- 491 Special Topics**
Fall, Spring. 3 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course.

Special topics in biomedical engineering or bioengineering.

- 495 Tissue Mechanics**
Spring. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Department of Mechanical Engineering. P:M: (ME 222) R: Open only to students in the College of Engineering. SA: MSM 441

Application of solid mechanics to understanding mechanical responses of biological tissues. Microstructure and biological function for soft and hard connective tissues and muscle.

- 496 Biodynamics**
Fall. 3(2-2) Interdepartmental with Mechanical Engineering. Administered by Department of Mechanical Engineering. P:M: (ME 361) R: Open only to students in the Engineering Mechanics major.

Fundamentals of motion analysis of human movement and its application to the study of function and dysfunction of the musculoskeletal system. Solution methods of the inverse dynamics problem.

- 497 Biomechanical Design**
Spring. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Department of Mechanical Engineering. R: Open only to juniors or seniors in the College of Engineering. SA: BME 491A, MSM 445

Biomechanical product design with application to people or animals. Synthesis, prototyping, and analysis of designs. Project management. Market research.

Biosystems Engineering—BE

- 351 Environmental Thermodynamics**
Fall. 3(3-0) P:M: (MTH 235 or MTH 255H or MTH 340 or LBS 220) and (BS 111 or MMG 201 or PLB 105) Not open to students with credit in CHE 321 or ME 201.
First and Second Laws of Thermodynamics with applications in food, biosystems, and environmental engineering. Refrigeration cycles. Entropy. Thermodynamic aspects of fluid flow. Psychrometrics.
- 402 Agricultural Climatology**
Fall of even years. 3(3-0) Interdepartmental with Geography. Administered by Department of Geography. P:M: (MTH 104 or MTH 110 or MTH 116) R: Not open to freshmen or sophomores. SA: AE 402
Relationships between climate and agriculture in resource assessment, water budget analysis, meteorological hazards, pests, crop-yield modeling, and impacts of global climate change.
- 418 Comprehensive Nutrient Management Planning**
Fall. 3(2-2) Interdepartmental with Animal Science. Administered by Department of Animal Science. P:M: (CSS 210)
Comprehensive nutrient management plans (CNMP) for animal feeding operations. Trends in animal production, environmental issues, and diet formulation and their impact on manure production. Development of CNMP for a specific animal feeding operation.
- 419 Applications of Geographic Information Systems to Natural Resources Management**
Spring. 4(2-4) Interdepartmental with Fisheries and Wildlife; Forestry; Geography; Community, Agriculture, Recreation and Resource Studies. Administered by Department of Fisheries and Wildlife. RB: (GEO 221) Not open to students with credit in GEO 425.
Application of geographic information systems, remote sensing, and global positioning systems to integrated planning and management for fish, wildlife, and related resources.
- 431 Bio-resource Optimization**
Fall. 3(2-2) P:M: (BE 230) and (MTH 235 or MTH 255H or LBS 220) Not open to students with credit in BE 831.
Optimal engineering solutions to problems with conflicting objectives and biological constraints. Linear and goal programming, problem formulation, project management, risk and uncertainty.
- 443 Restoration Ecology**
Spring. 3(2-2) Interdepartmental with Fisheries and Wildlife; Zoology. Administered by Department of Fisheries and Wildlife. RB: (CSS 210 or BE 230) and (FOR 404 or FW 364 or ZOL 355)
Principles of ecological restoration of disturbed or damaged ecosystems. Design, implementation, and presentation of restoration plans. Field trips required.
- 452 Watershed Concepts**
Fall, Spring, Summer. 3(3-0) Interdepartmental with Resource Development; Crop and Soil Sciences; Forestry; Fisheries and Wildlife. Administered by Department of Community, Agriculture, Recreation and Resource Studies. P:M: (RD 324 and ZOL 355) RB: organic chemistry
Watershed hydrology and management. The hydrologic cycle, water quality, aquatic ecosystems and social systems. Laws and institutions for managing water resources.
- 456 Electric Power and Control**
Spring. 3(2-2) P:M: (ECE 201 or ECE 345) SA: AE 356
Alternating current circuits, power distribution, electrical machines, protection, and programmable motor controllers. Design project related to food and agricultural industries.
- 460 Natural Resource Economics**
Spring. 3(3-0) Interdepartmental with Resource Development; Environmental Economics and Policy; Park, Recreation and Tourism Resources. Administered by Department of Community, Agriculture, Recreation and Resource Studies. P:M: (EC 201) and (RD 302 or EEP 255)
Economic framework for analyzing natural resource management decisions. Spatial and inter-temporal allocation of renewable and nonrenewable resources. Special emphasis on institutions, externalities, and public interests in resource management.
- 477 Food Engineering: Fluids**
Fall. 3(2-2) Interdepartmental with Food Science. P:M: (BE 350 and BE 351) RB: (CE321 or CHE311 or ME332) SA: FE 465
Unit operations, process engineering, equipment, and industrial practices of the food industry. Manufactured dairy products: thermal processing, pipeline design, heat exchange, evaporation, dehydration, aseptic processing, membrane separation, cleaning, and sanitation.
- 478 Food Engineering: Solids**
Spring. 3(2-2) P:M: (BE 350) and (BE 351)
Analysis and design of unit operations and complete systems for handling, processing, and manufacturing bulk, granular, and solid food products. Material variability and microbial, chemical, and physical hazards.
- 481 Land and Water Conservation Engineering**
Fall. 3(2-2) P:M: (CSE 131) and (CE 321 or CHE 311) and (BE 351 or concurrently) SA: AE 481
Hydrology of small watersheds. Flood routing. Quantifying runoff, infiltration, evapotranspiration. Drainage design. Global Positioning Systems. Geographic Information Systems and applications in engineering projects. Irrigation efficiency.
- 482 Non-point Source Pollution Control**
Spring. 3(2-2) P:M: (BE 481 or CE 421) and (BE 350)
Identification, estimation, and control of non-point source pollution from agricultural and urban sources. Geographic Information Systems (GIS) based computer models of watersheds. Engineering design of practices and structures to control non-point source pollution. Development of watershed management plans.
- 485 Biosystems Design Techniques**
Fall. 3(2-2) P:M: (BE 130 and BE 333) and (BE 331 or BE 350 or BE 351) and (BE 431 or concurrently) SA: BE 486
Engineering design process. Problem identification, analysis, design, modeling, materials, cost estimation, and final specifications. Safety, environmental, and ethical considerations.
- 487 Biosystems Design Project (W)**
Spring. 3(0-6) P:M: (BE 485) and completion of Tier I writing requirement. R: Open only to seniors in the College of Engineering. SA: AE 488
Individual or team design project selected in BE 486. Information expansion, development of alternatives, and evaluation, selection, and completion of a design project.
- 490 Independent Study**
Fall, Spring, Summer. 1 to 5 credits. A student may earn a maximum of 5 credits in all enrollments for this course. P:M: (BE 230 or BE 350) R: Approval of department; application required. SA: AE 490
Supervised individual student research and study in biosystems engineering.
- 491 Special Topics in Biosystems Engineering**
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:M: (BE 230 or BE 331 or BE 350) R: Approval of department. SA: AE 491
Special topics in biosystems engineering.
- 815 Instrumentation for Biosystems Engineering**
Fall. 3(3-0) R: Open only to graduate students in the College of Engineering. SA: AE 815
Theory and techniques of measuring temperature, pressure, flow, humidity, and moisture in biological materials.
- 818 Comprehensive Nutrient Management Planning**
Fall. 3(2-2) Interdepartmental with Animal Science. Administered by Department of Animal Science.
Development of comprehensive nutrient management plans (CNMP) for animal feeding operations. Trends in animal production, environmental issues, and diet formulation and their impact on manure production. Development of CNMP for a specific animal feeding operation.
- 820 Research Methods in Biosystems Engineering**
Fall. 1(1-0) R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Engineering. SA: AE 820
Procedures and methods for designing and executing research projects.
- 832 Network Design and Optimization of Biological Systems**
Spring. 3(2-2) RB: (BE 431 or BE 831)
Techniques of process network theory and multi-criteria optimization for designing environmentally sound and economically beneficial biosystems.
- 850 Dimensional Analysis and Theory of Models**
Fall of odd years. 3(2-2) R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Engineering. SA: AE 850
Dimensional concepts, systems of measurements and transformation of units, and formation of dimensionless groups. Development of prediction equations, concepts of similarity, and scaling laws. Distortion.

- 852 Systems Modeling and Simulation**
Fall of even years. 3(3-0) Interdepartmental with Fisheries and Wildlife; Forestry; Resource Development. Administered by Department of Fisheries and Wildlife. RB: (STT 422 or STT 442 or STT 464 or GEO 463)

General systems theory and concepts. Modeling and simulation methods. Applications of systems approach and techniques to natural resource management, and to ecological and agricultural research.

- 853 Applied Systems Modeling and Simulation for Natural Resource Management**

Spring of odd years. 3(2-2) Interdepartmental with Fisheries and Wildlife; Forestry; Resource Development; Zoology. Administered by Department of Fisheries and Wildlife. RB: (FW 820 or BE 486 or ZOL 851) or approval of department. R: Open only to seniors and graduate students

Mathematical models for evaluating resource management strategies. Stochastic and deterministic simulation for optimization. System control structures. Team modelling approach.

- 882 Irrigation and Water Management Engineering**

Spring of even years. 3(3-0) RB: (BE 481 and CE 321) SA: AE 882

Design and management of systems for supplemental irrigation. Water supply and transport. Economic and engineering optimization of irrigation design.

- 890 Special Problems**

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department; application required. SA: AE 890

Individual study in biosystems engineering.

- 891 Advanced Topics in Biosystems Engineering**

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to graduate students in the College of Engineering. Approval of department. SA: AE 891

Biosystems engineering topics not covered in regular courses.

- 892 Biosystems Engineering Seminar**

Spring. 1(1-0) R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Engineering. SA: AE 892

Current topics in biosystems engineering.

- 899 Master's Thesis Research**

Fall, Spring, Summer. 1 to 10 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to master's students in the Biosystems Engineering major. SA: AE 899

Master's thesis research.

- 999 Doctoral Dissertation Research**

Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to doctoral students in the Biosystems Engineering major. SA: AE 999

Doctoral dissertation research.

BUILDING CONSTRUCTION MANAGEMENT BCM

Department of Agricultural Engineering College of Agriculture and Natural Resources

- 810 Construction Systems**

Fall, Spring. 1(0-2) R: Open only to graduate students in Building Construction Management, Civil Engineering, and Interior Design and Facilities Management majors. Not open to students with credit in BCM 124 or BCM 210.

Construction materials and methods in the U.S. Steel and wood construction.

- 811 Advanced Project Scheduling**

Fall. 3(2-2)

Critical path analysis for effective and logical scheduling of construction projects. Identification of project activities and their relationships. Schedule development, analysis, and updating. Relationship of project costs and resources to the schedule. Effective communication of schedule information.

- 817 Construction Management Information Systems**

Spring. 3(2-2) R: Open only to graduate students in Building Construction Management, Civil Engineering, and Interior Design and Facilities Management majors.

Information generation and utilization for the management of construction projects. Integration of construction management software, conceptual modeling and knowledge-based models.

- 822 Legal Issues in Construction**

Spring. 3(3-0) RB: A degree or experience in construction management, civil engineering, human environment and design, interior design, architecture, urban planning, landscape architecture or law.

Application of Michigan and Federal case law to construction and development claims and litigation.

- 823 Advanced Construction Project Management**

Fall, Spring. 3(3-0) RB: (BCM 411 and BCM 415) R: Open only to graduate students in Building Construction Management.

Project management issues, services and documentation. Bidding, cost accounting, scheduling. Project planning and controlling.

- 890 Special Problems**

Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course. R: Open only to graduate students in College of Agriculture and Natural Resources. Approval of department; application required.

Individual study in land acquisition and development, design, construction, management, finance, marketing, and structural analysis.

- 891 Advanced Topics in Building Construction Management**

Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open only to graduate students in College of Agriculture and Natural Resources. Approval of department.

Advanced topics in building construction management.

- 892 Construction Management Research Seminar**

Fall. 2(2-0) R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Engineering, or College of Human Ecology.

Current areas and topics of research in construction management. Resources of research results, analysis of existing research and development of preliminary proposal.

- 898 Master's Research**

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to master's students in the Building Construction Management major.

Master's degree research paper.

- 899 Master's Thesis Research**

Fall, Spring, Summer. 1 to 10 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to master's students in Building Construction Management.

Master's thesis research.

CELL AND MOLECULAR BIOLOGY CMB

College of Natural Science

- 800 Cell and Molecular Biology Seminar**

Fall, Spring. 1(1-0) A student may earn a maximum of 5 credits in all enrollments for this course. R: Open only to students in the Cell and Molecular Biology major.

Current literature in such areas of cell and molecular biology as gene expression, intracellular transport, cell signalling, regulation of cell growth and cell structure.

- 880 Laboratory Rotation**

Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Open only to students in the Cell and Molecular Biology major.

Participation in research projects in laboratories of Cell and Molecular Biology faculty.

- 890 Independent Study**

Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 8 credits in all enrollments for this course.

Non-thesis research for Plan B master's students.