University Requirements (23)
- Writing, Rhetoric and American Cultures (WRA)
- Integrative Studies in Humanities (IAH)
- Integrative Studies in Social Sciences (ISS)
- Bioscience (one of the following):
  - BS 111, MMG 201, PLB 105

College Requirements (29)
- CEM 141 General Chemistry
- CSE 131 Technical Computing and Problem Solving
- MTH 132 Calculus I
- MTH 133 Calculus II
- MTH 234 Multivariable Calculus
- MTH 235 Differential Equations
- PHY 183 Physics for Scientists and Engineers I
- PHY 184 Physics for Scientists and Engineers II

Major Requirements (58)
- BE 130 Engineering Design Fundamentals for Biological Systems
- BE 230 Engineering Analysis of Biological Systems
- BE 332 Engineering Properties of Biological Materials
- BE 333 Biosystems Engineering Laboratory
- BE 350 Heat and Mass Transfer in Biosystems
- BE 351 Environmental Thermodynamics
- BE 431 Bio-resource Optimization
- BE 485 Biosystems Design Techniques
- BE 487 Biosystems Design Project (W)
- BS 110 Organisms and Populations
- CE 221 Statics
- CE 321 Introduction to Fluid Mechanics
- CEM 143 Survey of Organic Chemistry
- CEM 161 Chemistry Laboratory I
- ECE 345 Electronic Instrumentation and Systems
- STT 351 Probability and Statistics for Engineering

Select two of the following courses:
- BE 456 Electric Power and Control
- BE 477 Food Engineering: Fluids
- BE 478 Food Engineering: Solids
- BE 481 Land and Water Conservation Engineering
- BE 482 Non-point Source Pollution Control

Engineering Electives
Complete at least 6 credits in courses selected from a list of approved technical electives available from the Department, Website or Academic Advisor.

Cognates (12)
A cognate consists of carefully selected courses that support a career objective involving the application of engineering skills to challenges with critical biological components. The cognate allows for breadth of interest and depth of learning for a given student. The cognate must include at least one biological science course beyond the university requirements, at least one quantitative/technical course, and must include 300- and 400-level courses to achieve depth in a particular area. Engineering electives cannot simultaneously satisfy the cognate requirement. Courses that are used to satisfy the engineering electives requirement and the cognate requirement must be chosen to form a career objective and be approved by the student’s academic adviser.

A student has three choices for completing the cognate:

1. Complete one of the two cognates developed by the department (described below):
   a. Food Engineering
      (Food Processing Safety)
   b. Ecosystems Engineering
      (Natural Resources and Environmental)

2. Complete a college/university recognized option or Specialization, such as:
   c. Biomedical Engineering
   * Biotechnology

3. Complete a custom-designed cognate, consistent with the BE program objectives. These must be approved in advance by the academic adviser. Examples are:
   * Agricultural Engineering
   * Aquacultural Engineering

a) Food Engineering Cognate
Food engineers develop new and innovative processing and preservation techniques to increase value and ensure the safety of manufactured food products. They study the physics, chemistry, and biology of food materials, in order to apply that knowledge to new and innovative engineering designs. Graduates in this area typically are employed by food manufacturing companies, food equipment companies, pharmaceutical companies, or regulatory agencies (e.g., FDA).

Select at least 1 of the following biological science courses or approved alternatives:
- MMG 201 Fundamentals of Microbiology
- FSC 440 Food Microbiology

Select at least 3 of the following or approved alternatives:
- FSC 211 Principles of Food Science
- FSC 401 Food Chemistry
- FSC 421 Food Laws and Regulations
- FSC 430 Food Processing: Fruits & Vegetables
- FSC 431 Food Processing: Cereals
- FSC 432 Food Processing: Dairy Foods
- FSC 433 Food Processing: Muscle Foods
- FW/FSC 275 Seafood Systems Management
- HRT 403 Handling and Storage of Horticulture Crops

1If PHY 231 is taken in place of PHY 183, PHY 233B must also be completed. If PHY 232 is taken in place of PHY 184, PHY 234B must also be completed.
2Strongly recommended for Food Engineering Cognate.
3Strongly recommended for Ecosystems Engineering Cognate.
b) Ecosystems Engineering Cognate
Ecosystems engineers take a proactive, systems approach to protecting our environment and conserving our natural resources. They apply geographic information systems (GIS) for watershed modeling, design constructed wetlands to manage water quality, develop on-site wastewater treatment systems, and generally apply their engineering skills to problems that involve complex plant and/or animal systems. Graduates in this area typically are employed by environmental consulting firms or regulatory agencies (e.g., Michigan Department of Environmental Quality or the U.S. Natural Resource Conservation Services).

Select at least 1 of the following biological science courses approved alternatives:

- MMG 201 Fundamentals of Microbiology 3
- MMG 425 Microbial Ecology 3
- PLB 203 Biology of Plants 3
- ZOL 355 Ecology 3
- BS 111 Cells and Molecules 3
- PSL 250 Introductory Physiology 4

Plus 9 credits from the following list:

- ATM 431 Irrigation, Drainage & Erosion Control Systems 3
- CSS 210 Fundamentals of Soil Science 3
- CSS 360 Soil Biology 3
- CSS 380 Crop Physiology 3
- CSS 440 Soil Biophysics 3
- CSS 455 Pollutants in the Soil Environment 3
- BME 401 Quantitative Human Biology 3 (spring only)
- BME 490 Independent Study 1-4 (fall, spring or summer)
- BME 491 Selected Topics 1-4 (fall, spring or summer)
- ME 494 Biofluid Mechanics and Heat Transfer 3 (fall only)
- ME 495 Tissue Mechanics 3 (spring only)
- ME 497 Biomechanical Design 3 (spring only)
- MSE 425 Biomaterials and Biocompatibility 3 (spring only)

Other Electives (Variable)

The requirements listed above apply to students admitted to the program beginning Fall 2007. The Department of Biosystems and Agricultural Engineering (BAE) constantly reviews program requirements and reserves the right to make changes as necessary. Consequently, each student is strongly encouraged to consult with his/her adviser to obtain assistance in planning an appropriate schedule of courses. Students who have questions about Biosystems Engineering should contact Elaine Johnson-Hahn (517) 355-6616 ext 1.
**Biosystems Engineering**

**Sample Program**

### Freshman Year

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<th>Fall</th>
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### Senior Year

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### PROGRAM EDUCATIONAL OBJECTIVES

The overall purpose of the MSU biosystems engineering undergraduate program is to prepare graduates who will integrate and apply principles of engineering and biology to a wide variety of socially important problems. To achieve that purpose, the primary objectives of the biosystems engineering program are to prepare graduates to:

- identify and solve problems at the interface of biology and engineering, using modern engineering techniques and the systems approach, and
- analyze, design, and control components, systems, and processes that involve critical biological components.

Additionally, the biosystems engineering program is designed to help graduates succeed in diverse careers by developing a professional foundation that includes vision, adaptability, a practical mindset, effective communication skills, the ability to work in cross-disciplinary teams, an appreciation for global, economic, and societal issues, and a commitment to continuing professional growth and ethical conduct.

(Approved by the Biosystems Engineering faculty, student group, and Industry Advisory Board, April 2004)