BE 230 - Principles of Biosystems Engineering

Course Syllabus

12:40-1:30 pm, 118 FAE, Fall Semester 2001
MWF (section 1); TuWF (section 2)

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Appropriate Program Objectives vs Course Objectives

	Appropriate BE program objectives. Graduates will:		Course objectives. Students will:
a	Apply knowledge of math, science, engineering	5	Solve simultaneous systems of 2 or more linear and non-linear ODE's and interpret the response of connected variables. Translate "word" problems into math expressions.
d	Function on multidisciplinary teams	1	Acquire team skills.
f	Understand professional & ethical responsibility	1	Consider the ethical dilemma of environment versus short-term productivity.
g	Communicate effectively	1	Submit a technical paper on the project. Groups prepare posters and present to a faculty jury.
h	Understand global & societal impacts	1	Understand the sustainability property of biological systems.
i	Prepare for life-long learning	1	Conduct a literature search.
k	Use modern engineering tools, skills	3	Use *Mathematica.*
l	Understand interface between biology & engineering	3	Identify cybernetic and systemic properties of biological systems. Analyze biological systems for stability.
m	Apply systems concepts & develop models	5	Learn systems methodology. Apply concepts to biologically-based case studies. Learn analytical approach to model development. Develop models that represent biological systems.

BE 230 web site: http://www.egr.msu.edu/classes/be230/

Course Catalog Description:

BE 230: Principles of Biosystems Engineering. Concepts of biosystems. Hard and soft systems. Conceptual and computer modeling of components of biosystems. Fall. 3(3-0)

Course Content

1. The Biosystems Engineering

- The **Bio**sphere and Ecosystem - Biosphere, lithosphere, hydrosphere, atmosphere, ecology, ecosystem, food chain, population, biomes, herbivores, carnivores, omnivores, and detrivores.
- **Systems** Concepts - System, controllable input, exogenous input, desired output, undesired byproducts, state variables, system parameters, system boundary, and environment.
- **Engineering** Skills - analysis, design, and control.
- **Biosystems Engineering** Principles - growth and decay, conservation of mass, cybernetics, steady states, stability, and sustainability.

2. Systemic Properties of Biosystems

- Systemic Properties - hierarchy, modularity, network, wholeness, purpose, open system, feedback, stability, growth/reproduction, and stochasticity
- Case studies - "Persistence of the DDT Pesticide in the Yakima River Basin Washington," and "The Quality of Our Nation's Waters: Nutrients and Pesticides."

3. Systems Methodologies

- General systems methodology - Problem definition, goal setting, systems synthesis, systems evaluation, and system selection
- Life cycle assessment - Goal and scope definition, inventory analysis, impact assessment, interpretation, and design for the environment
- Biological modeling - problem statement, purpose of model, system components, system boundary, input and output, topological structure, system processes, model equations, model testing, and model validation. Continuous- and discrete-time models.
- Data analysis - single variable

4. Growth and Feedback in Population Dynamics

- Exponential (Malthusian) growth and decay equations - single population
- Logistic (Verhulst) equation - single population
- Lotka-Voterra's predator-prey equation - competition, host-parasite interaction
- Multispecies extension of Lotka-Volterra model - the dynamics of infection, SIR and SIRS models.
- Feedback analysis - predator-prey with pesticide application, strong and mild competition

- Steady state and isocline analysis - steady states of logistic growth, predator-prey interaction, infection model.

5. Conservation of Mass in Food and Natural Resource Systems

- One-compartment system - lake pollution
- Two-compartment system - pollution of connected lakes with and without tributaries
- Three-compartment system - phosphorus cycling in a lake and circular reaction
- Multiple-compartment system - hydrologic cycle, deforestation, biomagnification of trace substances in the food chain, carbon cycle, atmospheric pollution, and acidification of the atmosphere.

6. Sustainability and Design for the Environment

- Sustainable harvesting - optimum fisheries management, optimum harvesting of two interacting species
- Design for the environment - principles and methodology

Required Materials

1. Alocilja, E.C. 2000. Principles of Biosystems Engineering, Erudition Books, MA. ISBN 15-869-2098-7. To order online, go to http://www.eruditionbooks.com or http://www.custombookstore.com/cbstore/. To order by phone, call toll free number 1-800-228-8637.
2. Wolfram, S. 1996. The Mathematica Book, 3rd ed. Wolfram Media/Cambridge University Press.

Prerequisite: MTH 132 or equivalent

Classroom Mechanics

Teaching Style. Cooperative learning technique will be used in the classroom. Cooperative learning is instruction that involves students working in teams to accomplish a common goal, under conditions that involve both *positive interdependence* (all members must cooperate to complete the task) and *individual accountability* (each member is accountable for the complete final outcome).

Nametags. Knowing each other well is an important factor in successfully accomplishing team projects. To facilitate the process, each student will be requested to wear a nametag (to be provided by the instructor) during the first four weeks of class.

Ad Hoc Teams During the Class Period. Teams of two members each will be organized during any class period on an ad hoc basis. Members of the team may be asked to (1) identify key issues, (2) solve a problem, or (3) interpret results.

Project Teams for the Semester. A team of three students, preferably heterogeneous in composition, will be organized for the semester. You may choose any one of the projects listed in the following website: http://www.werc.net/contest/tasks.htm. For our purpose, we will pretend that you are able to build and demonstrate a prototype of your solution. Proceed on writing the paper and prepare a poster according to the guidelines. For poster and paper preparation guidelines, see Attachments 1 and 2, respectively.

Homework. Homework is due at the end of the class-hour. Work must be submitted on 8 ½x 11 white paper (without lines). Late homework will not be accepted.

Student Portfolio. Each student is **required** to submit a portfolio in the form of a **three-ring binder.** The objective is to develop a course portfolio, leading to a career portfolio, that will demonstrate the student's experiences and strengths in BE 230 in particular and the Biosystems Engineering in general, for use in gaining future employment and implementing a mechanism for continuous quality improvement (CQI) of the course. For content and preparation guidelines, see Attachment 3.

Bonus Points. Bonus points (additional 3%) will be accumulated and used to supplement the final grade according to the instructor's formula.

Class Requirement

Class participation	15% of total grade
Homework	15% of total grade
Exams, quizzes	25% of total grade
Team project/poster	25% of total grade
Laboratory work	15% of total grade
Portfolio	5% of total grade

Grading System

90 - 100%:	4.0	70 - 74%:	2.0
85 - 89%:	3.5	65 - 69%:	1.5
80 - 84%:	3.0	60 - 64%	1.0
75 - 79%:	2.5	0 - 59%	0.0

(The instructor reserves the right to lower the scale, whenever appropriate.)

Important Dates

Office hours: Wednesday, 2-4 p.m., 204 FAE Hall

Computer Lab Schedule:

Monday and Tuesday sections: 12:40-1:30 p.m., 105 FAE

Exam Schedule:

First exam: Friday, September 28

Second exam: Friday, October 26

Third exam: Friday, November 30

Project outline due: Friday, September 14

Project updates due: Every Friday until week before presentation

Poster presentation: Monday, December 3, 7-10 p.m., 118 FAE

Poster and Paper Revisions, SIRS Form: Wednesday, December 5

Faculty interaction on posters: Friday, Dec. 8, 12:40-1:30 p.m., FAE 2nd floor lobby

Student portfolio due: Wednesday, December 12, 1 p.m.

NO FINAL EXAM BUT WILL MEET ON SCHEDULED EXAM PERIOD TO COMPLY WITH POLICY: Wednesday, December 12, 12:45 - 2:45 p.m.

Attachment 1: Poster Preparation Guidelines

I. Poster Preparation

Size: No bigger than 4 ft. wide and 3 ft. high. Use a thick, tri-fold board (available in bookstores; **don't make your own tri-fold; it does not work!**)

Content: Title of poster and team members; summary of technical paper.

Text Fonts: Use serif type, such as "Times," or sans serif type, such as "Helvetica."

Title: Title should be brief, visible, and dominant to catch the viewer's attention. Title should be at least 2 cm high and in bold type style.

Sections: Use 24-point type size and in bold type style. Place headings above the section flush left or centered.

Body Text: Use 18-point type size, black text on white background.

Color: Color is a powerful graphic element to emphasize or highlight information.

Photograph: Photograph can be a positive element in the technical message.

Visual Aid: Any visual aid to convey the purpose of your study will be very helpful.

Judging Criteria: (1) Conciseness and clarity of the poster; (2) Completeness of the poster; (3) Team's knowledge of the subject; and (4) Overall Impression.

II. Oral Poster Presentation

1. Oral presentation is **12 minutes**, followed by questions and answers for at most **3 minutes.**
2. Present **highlights** of the project. Suggested order of presentation: (a) Title Of Project, (b) Team Member Introduction, (c) Problem Definition, (d) Objectives, (e) Proposed Method and Design, (f) Summary.
3. Distribute a one-page Executive Summary to the audience during your presentation.
4. Be professional in your presentation materials. Use overhead transparencies or MS PowerPoint or 35 mm slides, as appropriate. You may bring sample items.
5. Be professional in your attire (at least, don't wear a baseball cap during presentation).
6. When making presentation, be enthusiastic, well prepared, organized, and clear. Visual materials (transparencies, slides, etc.) must be readable by people at the back of the classroom.
7. Every team member must be equally involved during the presentation.

Judging Criteria: (1) Overall quality, completeness, level of research; and discussion of results. (2) Justification and advantages of the proposed project Process Flow sheet, material balance, and safety discussion; (3) Realism of cost estimates; (4) Ability to answer questions; and (5) Delivery and effectiveness of presentation.

Attachment 2: Paper Preparation Guidelines

The technical write-up should be no more than 15 pages on 8.5 x 11 white paper, submitted electronically. It must include:

1. A report cover identifying the task, team members, and course (not counted in the page limit)
2. Title page and Table of Contents (count as first page)
3. An Executive Summary (maximum of two pages) highlighting your proposed solution.
4. Body of the paper: nature of task, design of proposed solution, details of your design, waste to be generated, and a technical evaluation
5. References
6. Audits - You are required to have a separate audit to address each of the following: economics, health, and legal issues. The audits should be made by professionals involved in the specific field. These audits will not be counted as part of your page limit. The audits can be made by faculty members, industrial representatives, experts, doctoral students, etc.

Paper Specifications – Use ASAE's Journal Template.doc (www.asae.org/pubs/authguide.html)

Judging Criteria: (1) Overall Quality, thoroughness, technical depth and clarity; (2) Quality and clarity of Executive summary; (3) Engineering and scientific basis; (4) Equipment and process selection; (5) Discussion of legal, health, worker safety; (6) Discussion of process monitoring; (7) Economic analysis, if available; (8) Public involvement, if appropriate; (9) Professional audits.

Note: Keep in mind the following issues:

1. Grammar and spell check your work.
2. Legibility and neatness will be considered.

Attachment 3: Portfolio Preparation Guidelines

Objective: To develop a course portfolio, leading to a career portfolio, that demonstrates the student's experiences and strengths in BE 230 in particular and the Biosystems Engineering in general, for use in gaining future employment and implementing a mechanism for continuous quality improvement (CQI) of the course.

Contents:

Page 1: Cover letter introducing yourself and your career goal (that is, what you hope to become.)

Page 2. Professional resume

Pages 3: Project paper

Page ff: Personal comments about the project: what you learned from the project, from the team effort, and how to improve it.

Page ff: Student evaluation: One-page summary of what you learned in class, areas you have difficulty, and areas to improve.

Page ff: Course evaluation learning matrix.

BE 230 Course Evaluation Learning Matrix

ABET Criteria	BE 230 Course Objectives	Level of Learning			
		#1	#2	#3	#4
Apply knowledge of math, science, engineering	Solve simultaneous systems of 2 or more linear and non-linear ODE's and interpret the response of connected variables. Translate "word" problems into math expressions. (Weighted 5/21)				
Function on multidisciplinary teams	Acquire team skills. (1/21)				
Understand professional & ethical responsibility	Consider the ethical dilemma of environment versus short-term productivity. (1/21)				
Communicate effectively	Submit a technical report in ASAE format. Groups prepare posters and present to a faculty jury. (1/21)				
Understand global & societal impacts	Understand the sustainability property of biological systems. (1/21)				
Prepare for life-long learning	Conduct a literature search. (1/21)				
Use modern engineering tools, skills	Use *Mathematica*. (3/21)				
Understand interface between biology & engineering	Identify systemic properties of biological systems. Analyze biological systems for stability. (3/21)				
Apply systems concepts & develop models	Learn systems methodologies. Apply concepts to biologically-based case studies. Learn analytical approach to model development. Develop models that represent biological systems. (5/21)				

Guidelines in filling up the course evaluation learning matrix:

Learning is not a binary operation ("yes, I know it" or "no, I don't know it") but rather progressive and dynamic. Therefore, the course matrix is divided into four different levels of learning defined as follows:

Level #1 - Information: Learner shall be able to define, repeat, list, name, label, memorize, recall, and/or relate that information.

Level #2 - Knowledge: Learner shows an understanding and comprehension of the information gained in Level #1, and shall be able to describe, explain, compare/contrast, identify, discuss, and/or summarize it.

Level #3 - Application/Analysis: Learner shall be able to solve problems by applying knowledge in new situations, and can critically distinguish the logical components of other applications of that knowledge.

Level #4 - Wisdom: Learner shall be able to display professional judgment and the ability to synthesize, design, organize, plan, manage, teach, and/or evaluate.