Bioprocess Engineering

Course Syllabus

BE 4300 (4 credits)

Class Schedule:

Instructor: Dr. Gerard J. Madlambayan,
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Phone: (248) 370-3585
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Office Hours: W 1:00pm – 3:00pm, others by appointment

COURSE DESCRIPTION

This course will cover material related to the application of biological, biochemical, and engineering fundamentals in the area of bioprocess engineering. Students will review aspects related to molecular biology, cell biology, genetic engineering, biochemistry and microbiology as they pertain to bioprocess engineering concepts. Advanced topics will include bioprocessing kinetics (enzymes, cell growth, substrate utilization, and product formation); bioenergetics; quantification of metabolism; bioreactor design and selection; bioprocess scale-up; product recovery; biosafety and good manufacturing practices; and the role of bioprocess engineering in medicine.

PRE-REQUISITES

BIO 1200 and BIO 3210 or BIO 3500; students may also receive instructor permission to take the course

COURSE OBJECTIVES

At the end of the course student should be able to:

1. Describe applications and solve problems relating to the use of enzymes for industrial bioprocessing (ABET - a, e, l)
2. Model the growth of microorganisms in batch, fed-batch, and continuous flow processes (ABET - a, e, l)
3. Explain and solve problems relating to mass and energy balances in biological reactors (ABET - a, e, l)
4. Describe different types of bioreactors, appropriate conditions for their use, and considerations in reactor scale-up (ABET - a, c, e, h, l)
5. Describe theory and practical applications of product recovery techniques including filtration, centrifugation, liquid-liquid and liquid-solid extractions, and chromatography (ABET - a, e, h, l).
6. Describe differences in use of animal, plant and genetically engineered cells in cell cultures and bioprocess design (ABET - a, c, e, h, l, m, n)
7. Explain how bioprocess engineering is used in the medical field (ABET - a, h, l, m, n)

REQUIRED TEXT AND COURSE MATERIAL

Schuler, M. L., and Kargi, F. 2002. *Bioprocess engineering: Basic concepts.* 2nd ed. Upper Saddle River, NJ: Prentice Hall PTR. ISBN 0-13-081908-5

LECTURE SCHEDULE

DATE		Chapter	Topic
Jan	x	1	What is a bioprocess engineer? (1.1-1.5)
	x	2	Overview of Biological Basics (2.1, 2.4)
	x	3	Enzymes (3.1-3.3)
	x	3	Enzymes (3.4-3.7)
	x	4	How Cells Work (4.1-4.8)
	x	5	Major Metabolic Pathways (5.1-5.6)
	x	5	Major Metabolic Pathways (5.7-5.12)
	x		***Examination 1 (Chapters 1- 5)***
Feb	x	6	How Cells Grow (6.1-6.5)
	x	7	Stoichiometry of Microbial Growth and Product Formation (7.1-7.5)
	x	8	How Cellular Information is Altered (8.1-8.6)
	x	9	Operating Considerations for Bioreactors for suspension and Immobilized Cultures (9.1-9.6)
	x	10	Selection, Scale-Up, Operation and Control of Biopreactors (10.1,10.2)
	x	10	Selection, Scale-Up, Operation and Control of Biopreactors (10.3,10.5)
	x		***Examination 2 (Chapters 6- 10)***
	x		***no class***
March	x		***no class***
	x	11	Recovery and Purification of Products (11.1-11.4)
	x	11	Recovery and Purification of Products (11.4, cont-11.7)
	x	12	Bioprocess Considerations in using Animal Cell Cultures (12.1-12.3)
	x	12	Bioprocess Considerations in using Animal Cell Cultures (12.4-12.5)
	x	13	Bioprocess Considerations in using Plant Cell Cultures (13.1-13.5)
	x	14	Utilizing Genetically Engineering Organisms (14.1-14.10)
	x	15	Medical Applications of Bioprocess Engineering (15.1-15.5)
	x		***Examination 3 (Chapters 11- 15)***
April	x		Student Presentation
	x		Student Presentation
	x		Student Presentation
	x		Student Presentation
	x		Student Presentation

Date/Time To Be Determined: ***Final Examination (cumulative)***

EXAMS

Exams will include all material covered in the required readings and in class. The format of the exams may vary, but will likely include multiple choice, short answer questions and long essay type questions. We will discuss this more prior to the exams. The final exam will be non-cumulative.

Do not miss exams!! If you know that a conflict might cause you to miss an exam, please see me for arrangements to take a make-up exam. I require make-up exams to be taken within two days of when the original exam was taken by the class (if possible).

STUDENT PRESENTATIONS

There will be one student presentation. You will work in groups of two or three (depending on class enrollment size). Groups will be picked by the instructor.

The presentation will cover topics related to bioprocess design. TBD

GRADES

- 3 exams (20% each)
- 1 final exam (15%)
- 1 Student presentation 15% each
- Class participation 10%

  This is an important grading criterion and should not be taken lightly. Failure to participate in class discussion will have a negative impact on your overall grade.

A grade of at least 95% earns a 4.0. Grades between 95% and 50% will be based on a straight scale of percentages from a 4.0 to a 1.0. Final grades less than 50% will earn a 0.0. I may adjust the grade scale to assure equitable grading at the end of the class. However, the scale will not be higher ("worse" or more "difficult") than the straight scale described above.

ACADEMIC CONDUCT POLICY

This course will follow the policy of academic conduct as stated in the most updated Undergraduate Catalog. Any instance of cheating will be reported directly to the Department Chairman and the Dean of Students for consideration before the Academic Conduct Committee of the University Senate.

SPECIAL CONSIDERATIONS

Students with disabilities who may require special considerations should make an appointment with campus Disability Support Services. Students should also bring their needs to the attention of the instructor as soon as possible.

CIVILITY POLICY

Once class has begun silence cell phones. Refrain from side conversations and interpersonal remarks. Address personal and/or other non-course related problems to your professor before or after class or during office hours. Avoid noisy rustling of snack food containers. If you use a laptop in class, please be aware this can be a distraction to people around you, as a courtesy, sit in the back of the class room. Casual comings and goings are not acceptable; if you have a legitimate reason to leave class early, inform your professor in advance. Persistent failure to abide by these and other common sense rules or courtesy may result in corrective action at the discretion of the professor, including removal of disruptive students from the classroom.

ABET STUDENT OUTCOMES

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations), and statistics
(m) solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems
(n) analyzing, modeling, designing and realizing bio/biomedical engineering devices, systems, components, or processes
(o) making measurements on and interpreting data from living systems