Chemical Engineering Department
ChE 427 Bioreaction Engineering
Fall 2018

Elective/Option course, 3 (3+0+0) credits.
Catalogue Description: Kinetics of enzyme-catalyzed reactions. Kinetics of cell cultures. Analysis and correlation of data. Transport phenomena in bioreactors. Introduction to design and analysis of biological reactors. Examples of industrial bioprocesses and biotechnology products.
Prerequisite: ChE 342; consent of instructor for graduate students.

Class schedule: M 14:00-17:00 (KB 428)

Instructor: Zeynep İlsen ÖNSAN, Professor x-6412, e-mail: onsan@boun.edu.tr
Office hours: M. 10:00-12:00 (outside office hours, please e-mail for an appointment)

Textbook and other required material: 1. H. W. Blanch and D. S. Clark, Biochemical Engineering, UC Berkeley, Marcel Dekker, Inc., N.Y. 1997
2. Lecture notes are provided as pdf files.
Web: Students are responsible for information/announcements on ChE 427 course page at ChE web site.
Reference: H. Scott Fogler, Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall, 2006.

Topics covered

1. Introduction (2 lectures) 1.1. Course Objectives 1.2 Biotechnology, Bioprocesses, Bioreactors 2. Kinetics of Enzyme-Catalyzed Reactions (10 lectures) Reading: Chapter 1 & 2 2.1. The Enzyme-Substrate Complex 2.2. The Basic Equations of Enzyme Kinetics 2.3. Effect of Other Parameters on Enzyme Activity 2.4. Enzyme Immobilization 3. Cell Cultivations & Cell Kinetics (10 lectures) Reading: Chapters 3 & 4 3.1. Experimental Kinetic Studies 3.2. Growth Kinetics 3.3. Unstructured/Unsegregated Kinetic Models 3.4. Structured/Segregated Kinetic Models	4. Transport Phenomena in Bioprocess Systems (4 lectures) Reading: Chapter 5 4.1. Mass Transfer in Cellular Systems 4.2. Oxygen Transfer Rates in Bioreactors 4.3. Mass and Heat Transfer Correlations 4.4. Scale-up Principles 5. Modelling and Design of Bioreactors (5 lectures) Reading: Chapter 4 5.1. Idealized Bioreactor Types 5.2. Bioreactor Operation Modes 6. Biotechnology Products (5 lectures) Reading: Chapter 8 **Suggested problems will be separately announced for each section.

Contribution of course to meeting the requirement of criterion 5:
Engineering science (67%), engineering design (33%)

Course Learning Outcomes:

1. To provide principles involved in enzyme kinetics and techniques for analyzing rate data; to formulate rate equations for various types of enzyme-catalyzed reactions.
2. To provide basic concepts in microbial process kinetics; to develop insight into interactions between substrate utilization, cell growth and product formation; to introduce different categories of kinetic models, correlation of rate data and parameter estimation.
3. To identify mass transport effects in cellular systems, with particular emphasis on oxygen transfer rates in aerobic cultures.
4. To integrate kinetic models into bioreactor modelling and macroscopic design.

Grading:

- No make-up exams will be given. 100% attendance is required for classwork sessions.
- Exam type will be problem solving. All exams will be open-book, only the textbook and print-outs of pdf files provided by the instructor will be permitted.
- Bonus points will be given for attendance ≥ 80%.
- Minimum overall attendance required for passing the course is 60%; students with attendance < 60% will not take the final exam or the final make-up exam.
- Attendance to all Project Presentations is compulsory.

Classwork Sessions (Oct 22, Nov 19, Dec 3, 2018)	10%	
Midterm 1 (November 5, 2018)	20 %	(enzyme kinetics)
Midterm 2 (December 10, 2018)	25 %	(cell kinetics & mass transport effects)
Project Report & Presentation (to be announced)	15 %	(bioprocesses & biotechnology products)
Final Examination	30 %	(entire course content)
TOTAL	100 %	

Academic Honesty:
Cheating & plagiarism are violations of academic honesty, and the result is a failing grade.

Prepared by Prof. Zeynep İlsen Önsan **Date: September 2018**