Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2021-2022

Course Handout Part II

Date: August 20, 2021

In addition to Part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : **CHE F421**
Course Title : **Biochemical Engineering**
Instructor-in-Charge : **Dr. Debirupa Mitra**

Scope and Objective of the Course:

This course will focus on the application of chemical engineering principles to design, develop and analyze bioprocesses. Students will be introduced to enzyme kinetics, applications of enzyme catalysis, bioreactor design considerations, transport phenomena in bioprocesses and bioprocess scale-up. In the end, students will be given a flavor of application of biochemical engineering in some advanced biological systems.

Learning Outcomes

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

- Appreciate the role of a chemical engineer in a biochemical manufacturing processes
- Solve mathematical problems dealing with stoichiometry, microbial growth kinetics, enzyme kinetics
- Differentiate between batch, fed-batch and continuous modes of operation of bioreactors
- Solve mathematical problems related to the design of bioreactors
- Describe the transport phenomena involved in bioprocesses
- Describe the basic principles involved in recovery and purification of products

Textbooks:

T1. Biochemical Engineering Fundamentals, James E. Bailey and David F. Ollis, 2nd Edition, Tata McGraw-Hill.

T2. Bioprocess Engineering Basic Concepts, Michael L. Shuler and Fikret Kargi, 2nd Edition, Pearson Education International.

Course Plan:

Lecture No.	Learning Objectives	Topics to be covered	Chapter in the textbook
1	Introduction to biochemical engineering	• What is biochemical engineering? • What is the role of a chemical engineer in the life sciences industry.?	T2 Ch 1
2 – 4	An overview of biology	• Basics of microbiology	T1 Ch 1-2

	basics	• Chemicals of life • Cell nutrition	T2 Ch 2
5 – 9	Understanding enzyme kinetics & calculating kinetic constants for a given system	• What are enzymes & why are they important? • Mechanism of enzyme activity • Enzyme kinetics with one & two substrates using Michaelis-Menten equation • Enzyme deactivation	T1 Ch 3
10-12	Application of enzyme-catalyzed reactions	• Types of enzymes & their applications • Immobilized enzyme technology	T1 Ch 4
13-16	Understanding product formation through cell metabolism & calculation of product yield	• Thermodynamic principles • Major metabolic pathways • Stoichiometry of cell growth & product formation • Problem solving related to stoichiometry & yield	T1 Ch 5 T2 Ch 7
17-21	Bioreactors for kinetic measurements& biomass production	• Ideal reactors (batch & CSTR) • Biomass growth kinetics • Product formation kinetics	T1 Ch 7
22-25	Transport phenomena in bioprocesses	• Mass transfer in cellular systems • Oxygen transfer rates • Heat transfer	T1 Ch 8
26-31	Design considerations for a bioreactor	• Design equation for single-stage chemostat, chemostat with recycle & multistage chemostat • Fed-batch operation • Bioreactor for immobilized cell system • Sterilization reactors • Scale-up & control of bioreactors	T1 Ch 9 T2 Ch 9-10
32-34	Recovery & purification of products	• Separation of insoluble products • Separation of soluble products • Finishing steps for product purification	T1 Ch 11 T2 Ch 11
35-38	Application in advanced biological systems	• Products of animal cell culture • Using genetically-engineered organisms • Using mixed cultures for waste and wastewater treatment • Medical applications of bioprocess engineering	T2 Ch 12, 14-16
39-40	Concluding remarks	• Challenges in bioprocess development • Recent advances & future prospects	Handout

Evaluation Scheme:

Evaluation Component	Duration	Weightage (%)	Date and Time	Nature of Component
Mid semester test	90 min	30	23/10/2021 9.00 - 10.30AM	Open book
Assignment-1	NA	5	TBA	
Assignment-2	NA	10	TBA	
Assignment-3	NA	5	TBA	
Term Paper	NA	10	TBA	
Comprehensive Examination	120 min	40	27/12 AN	

Chamber Consultation Hour: To be announced

Notices: Course-related notices will be uploaded on the CMS website

Make-up Policy: Make-up will be granted only for genuine cases with valid justification and only with prior permission of Instructor-in-charge.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Debirupa Mitra

Dr. Debirupa Mitra
INSTRUCTOR-IN-CHARGE