



**Birla Institute of Technology & Science, Pilani**  
Hyderabad Campus

**FIRST SEMESTER 2023-2024**  
Course Handout Part II

Date: 11.08.2023

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, and transport phenomena in bioprocesses. 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, 2<sup>nd</sup> Edition, Tata McGraw-Hill.

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

**Course Plan:**



Lecture No.	Learning Objectives	Topics to be covered	Chapter in the textbook
1-2	Introduction to biochemical engineering	<ul style="list-style-type: none"> <li>What is biochemical engineering?</li> <li>What is the role of a chemical engineer in the life sciences industry.?</li> </ul>	T2 Ch 1
3 – 5	An overview of biology basics	<ul style="list-style-type: none"> <li>Basics of microbiology</li> <li>Chemicals of life</li> <li>Cell nutrition</li> </ul>	T1 Ch 1-2 T2 Ch 2
6 – 9	Understanding enzyme kinetics & calculating kinetic constants for a given system	<ul style="list-style-type: none"> <li>What are enzymes &amp; why are they important?</li> <li>Mechanism of enzyme activity</li> <li>Enzyme kinetics with one &amp; two substrates using Michaelis-Menten equation</li> <li>Enzyme deactivation</li> </ul>	T1 Ch 3 T2 Ch 3
10-11	Application of enzyme-catalyzed reactions	<ul style="list-style-type: none"> <li>Types of enzymes &amp; their applications</li> <li>Immobilized enzyme technology</li> </ul>	T1 Ch 4 T2 Ch 3
12-14	Product formation and yield	<ul style="list-style-type: none"> <li>Energy &amp; metabolism</li> <li>Stoichiometry of cell growth &amp; product formation</li> </ul>	T1 Ch 5 T2 Ch 7
15-20	Bioreactors for kinetic measurements& biomass production	<ul style="list-style-type: none"> <li>Ideal reactors (batch &amp; CSTR)</li> <li>Biomass growth kinetics</li> <li>Product formation kinetics</li> </ul>	T1 Ch 7 T2 Ch 6
21-26	Design considerations for a bioreactor	<ul style="list-style-type: none"> <li>Design equation for single-stage chemostat, chemostat with recycle &amp; multistage chemostat</li> <li>Fed-batch operation</li> <li>Bioreactor for immobilized cell system</li> <li>Sterilization reactors</li> </ul>	T1 Ch 9 T2 Ch 9
27-31	Transport phenomena in bioprocesses	<ul style="list-style-type: none"> <li>Oxygen transfer rates</li> <li>Power requirement calculations</li> <li>Scale up criteria</li> </ul>	T1 Ch 8
32-34	Recovery & purification of products	<ul style="list-style-type: none"> <li>Separation of insoluble products</li> <li>Separation of soluble products</li> <li>Finishing steps for product purification</li> </ul>	T1 Ch 11 T2 Ch 11
35-40	Application in advanced biological systems	<ul style="list-style-type: none"> <li>Animal vs. plant cell culture</li> <li>Wastewater treatment</li> <li>Medical applications of bioprocess engineering</li> </ul>	T2 Ch 12, 13, 15, 16 T1 Ch 14

**Evaluation Scheme:**

Evaluation Component	Duration	Weightage (%)	Date and Time	Nature of Component
Mid semester test	90 min	30	14/10 - 4.00 - 5.30PM	Closed book
Quiz/Assignment	NA	20 (15% to be completed before mid-test)	To be announced in class	10% Closed book, 10% Open book
Seminar	NA	10	To be announced in class	Open book
Comprehensive Examination	180 min	40	21/12 AN	20% Closed book, 20% Open book

**Chamber Consultation Hour:** Monday 5-6 pm, D-206

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

**Make-up Policy:** Make-up for Mid test or Compre will be granted only for genuine cases with valid justification and only with prior permission of Instructor-in-charge. There will be **no** make-up for assignments, quizzes, and seminar.

**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.



**Dr. Debirupa Mitra**  
**INSTRUCTOR-IN-CHARGE**

