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**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:**

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| --- | --- | --- | --- |
| **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 | * Basics of microbiology * Chemicals of life * Cell nutrition | T1 Ch 1-2  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:**

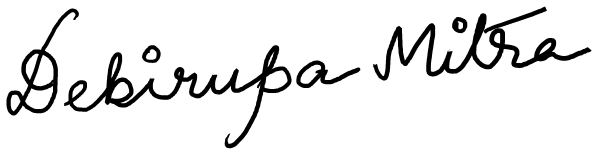
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| **Evaluation Component** | **Duration** | **Weightage (%)** | **Date and Time** | **Nature of Component** |
| Mid semester test | 90 min | 30 | 23/10/2021 9.00 - 10.30AM | Open book |
| Assignment-1 | NA | 5 | TBA |
| Assignment-2 | NA | 10 | TBA |
| 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.

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**Dr. Debirupa Mitra**

**INSTRUCTOR-IN-CHARGE**