Programme	Biotechnology	Course Code	BT. 306	Credit Hours	2+1
Course Title	**Principles of Biochemical Engineering**				

Course Introduction

This course provides an introduction to the Principles of Biochemical Engineering, designed for undergraduate students majoring in Biotechnology. The curriculum covers fundamentals Biochemical Engineering and their applications in biotechnology

Practical:

Unstructured microbial growth with application of Monod model; inhibition kinetics and nutrient uptake rate; methods of immobilization via binding and physical retention; yield coefficient and stoichiometry; production of enzymes by structured and segregated models; bioreactor design and analysis (batch, fedbatch and continuous); enzyme catalysis in the CSTR; packed bed and plug flow bioreactor; rheology of fermentation broth; mixing and gas-liquid mass transfer, heat transfer, media and bioreactor sterilization techniques; techno-economic analysis of a typical bioprocess.

Learning Outcomes

On the completion of the course, the students will:

- Understand the principles of biochemical engineering and their role in biotechnology.
- Explain the kinetics of enzyme-catalyzed reactions and cell growth.
- Design bioreactors and optimize bioprocess parameters for industrial applications

Course Content

Theory Unit-I

- Introduction to microorganisms and biological molecules
- Principles of enzyme catalysis
- Methods of enzyme and cell immobilization
- Enzyme kinetics
- Internal mass transfer effect on immobilized growth
- Stoichiometry models of microbial growth
- Structured model of microbial growth
- Bioreactors - continuous stirred tank bioreactors
- Plug-flow and packed bed bioreactors
- Imperfect mixing
- Fed batch bioreactors
- Gas liquid mass transfer in bioreactors
- Power requirement for bioreactor
- Sterilization and heat transfer in bioreactors
- Introduction to bioproduct recovery
- Biological product manufacturing
- Economic analysis of bioprocesses; case study: penicillin

Practical Unit-I

- Unstructured microbial growth
- Unstructured microbial growth with application of Monod model

- Inhibition kinetics and nutrient uptake rate
- Methods of immobilization via binding and physical retention
- Yield coefficient
- Stoichiometry
- Production of enzymes by structured models
- Production of enzymes by segregated models
- Bioreactor design and batch analysis
- Bioreactor design and fedbatch analysis
- Bioreactor design and continuous analysis
- Enzyme catalysis in the CSTR
- Packed bed and plug flow bioreactor
- Rheology of fermentation broth; mixing and gas-liquid mass transfer
- Rheology of fermentation broth; mixing and gas-liquid heat transfer,
- Media and bioreactor sterilization techniques; techno-economic analysis of a typical bioprocess.

Textbooks and Reading Material

- Douglas SC and Blanch HW, 1997. Biochemical Engineering. 2nd Edition; CRC Publishers.33
- Bailey et al., 1986. Biochemical Engineering Fundamentals. 2nd Edition; McGraw-Hill
- Aiba et al., 1973. Biochemical Engineering. 2nd Edition; Academic Press.
- Katoh S and Yoshida F, 2009. Biochemical Engineering, a textbook for engineers, chemists and biologist**s**. Wiley VCH
- Clark DS and Blanch HW, 1997. Biochemical Engineering, 2nd Edition (Chemical Industries). 2nd Edition; CRC Press.

Teaching Learning Strategies

- Lectures
- Assignments and Presentations
- Group discussions
- Interactive sessions

Assignments: Types and Number with Calendar

- Quiz in 4th week of 5 marks
- Assignments in 8th week of 10 marks
- Presentation in 12th week of 10 marks

Assessment

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.

2	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.