Course Code	CP309
Course Title	Biological Process Engineering
No. of Credits	3
Pre-requisites	CP204
Compulsory/Optional	Compulsory

Aim(s): To provide essential knowledge to analyse and design industrial bioprocesses.

Intended Learning Outcomes:

On successful completion of the course, the students should be able to;

ILO 1: Identify biological systems for the production of commercial goods and services.

ILO 2: Explain elementary aspects of biological process engineering systems.

ILO 3: Apply the knowledge of enzyme and cellular kinetics to design bio reactors.

ILO 4: Critically analyse the design and operational aspects of a selected industrial bioprocess.

Topics	**Time Allocation/Hours**			
	L	**T**	**P**	**A**
• **Biological systems for the production of commercial goods and services** Food, drugs, chemicals, fuel, equipment, diagnostics, and waste treatment	02			
• **Biological basics** Primary cell types, microbial diversity, microbial growth (monod model, stoichiometry of cell growth), materials of cell construction (carbohydrates, proteins, lipids, nucleic acids), cell nutrients (carbon, nitrogen, oxygen, hydrogen and other).	04		06	
• **Enzyme kinetics** Simple enzyme kinetics (Michaelis-Menten/ Briggs-Halden approaches), enzyme reactors with simple kinetics (Batch reactor, CSTR, PFR), inhibition of enzyme reactions (competitive/non-competitive/un-competitive inhibition), influences on enzyme activity (pH, temperature, shear), industrial applications of enzymes.	05	02	04	
• **Cellular kinetics and fermenter design** Cell growth kinetics, batch fermenter, PF fermenter, CSTF.	05	02		16
• **Sterilization** Sterilization methods (thermal/chemical/Irradiation etc.), thermal death kinetics (Isothermal/ Non-isothermal), design criterion, batch sterilization, continuous sterilization, other sterilization methods (Air sterilization/filtration).	05	02		
• **Aeration and scale-up** Oxygen transfer in bioreactor systems, scale-up of fermenters.	03			
• **Downstream processing** Intracellular/extracellular products, cell harvesting, cell disruption, cell debris/biomass removal, product extraction and purification.	02			
Total equivalent hours	**26**	**06**	**05**	**08**

Recommended Texts:

- Bisswanger, H., Enzyme Kinetics - Principles and Methods, (3 Ed), John Wiley & Sons, 2017.
- Doran, P. M., Bioprocess Engineering Principles, (2 Ed), Academic Press, 2012.

<table>
<tr><td colspan="3">Ravi, R., Vinu, R., Gummadi, S. N., Coulson and Richardson’s Chemical Engineering- Chemical & Biochemical Reactors and Reaction Engineering, (4 Ed), Butterworth-Heinemann, 2018.
Shuler, M. L., Kargi, F., Bioprocess Engineering - Basic Concepts, (2 Ed), Prentice-Hall of India, 2005.</td></tr>
<tr><td>Assessment</td><td colspan="2">Percentage Mark</td></tr>
<tr><td>In-course
Tutorials/Assignments/Quizzes/Laboratory work</td><td>50</td><td>50</td></tr>
<tr><td>End-semester</td><td></td><td>50</td></tr>
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