Course Code	Course Name	L-T-P-Credits	Year of Introduction
BT203	Concepts in Biochemical Engineering	4-0-0-4	2016

Prerequisite : Nil

Course Objectives

To introduce contemporary Chemical engineering principles associated with biological processing in order to develop a conceptual understanding of industrial bioprocessing.

Syllabus

Introduction to Biological concepts, structure and functions of various types of cells, cell polymeric chemicals and their building blocks, biochemical aspects of cell growth and product synthesis, enzymes as biological catalysts, bioreactors and modes of bioreactor operation, monitoring bioprocesses.

Expected outcome

On successful completion of this course, students will be able to:

- Appreciate the use of microorganisms and enzymes in biological processing.
- Know different types of metabolites and how they are formed.
- Understand the principles behind batch, fed batch and continuous systems.
- Understand different types of bioreactors and their working.
- Understand common bioprocess parameters and monitor them.

Reference Books

1. James E Bailey, David F Ollis, *Biochemical Engineering Fundamentals*, 2/e, McGraw-Hill Chemical Engineering Series, 1986.
2. Michael L Shuler, Fikret Kargi, *Bioprocess Engineering Basic Concepts*, Second Edition, Prentice Hall International PTR, 2002.
3. Pauline M Doran, *Bioprocess Engineering Principles*, Academic Press, 1995.
4. D G Rao, *Introduction to Biochemical Engineering*, Tata McGraw-Hill Education, 2005.
5. Mukesh Doble, Sathyanarayanan N Gummadi, *Biochemical Engineering*, PHI Learning Pvt. Ltd., 2007.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Biological concepts** - Microbial world, important cell types, animal and plant cells, structure of cells, cell fractionation, cycles of life, Cell polymeric chemicals, their structure and their functions, repetitive and non-repetitive biological polymers, hybrid biochemicals such as cell envelopes, antibody and other glycoproteins, the hierarchy of cellular organisation.	8	15%
II	**Cell growth and product synthesis** - Nutritional requirements, metabolism and bioenergetics, batch growth, growth patterns and kinetics in batch culture, effect of environmental conditions on cell growth and product synthesis, Carbon catabolism - EMP pathway and other biochemical reaction networks, Respiration - TCA Cycle, Respiratory chain, Photosynthesis-light harvesting, End	10	15%

	products of metabolism, Substrate and product inhibition on cell growth and product formation, Maintenance, Patterns of substrate flow in cells synthesising products.		
FIRST INTERNAL EXAM			
III	**Enzymes as biocatalysts** – similarities and differences between enzyme biocatalysts and chemical catalysts, Nomenclature and classification of enzymes. Chemical nature and properties of enzymes. Theory of enzyme action, Co-factors and co-enzymes. Substrate activation and inhibition, enzyme deactivation, Simple enzyme kinetics, Applications of enzymes in industrial, pharmaceutical and analytical sectors with examples, advantages and disadvantages of enzyme-based production processes. Enzyme immobilisation.	09	15%
IV	**Bioprocessing basics** - intracellular and extracellular products, growth associated and non-growth associated products, yield coefficient and maintenance coefficient, Bioprocessing using animal and plant cells, Modes of bioreactor operation - batch bioreactor, simple batch data analysis, Disadvantages of batch bioreactor, Continuous bioreactor, advantages of continuous bioreactor, Fed-batch, continuous with cell recycle, perfusion culture, Photobioreactors, applications.	10	15%
SECOND INTERNAL EXAM			
V	**Bioreactors** - Basic functions of a bioreactor, Bioreactors vs chemical reactors, Basic bioreactor configurations, keys to bioreactor selection, Component parts of a fermenter and their functions, Basic design aspects of a stirred tank fermenter, Aerobic fermentation processes, Oxygen demand in fermentations, factors affecting oxygen demand, Oxygen supply, Balance between oxygen demand and supply, role of aeration and mixing in oxygen transfer, mechanism of mixing, radial and axial flow impellers, flow patterns in an unbaffled stirred tank, flow patterns for radial flow and axial flow impellers in baffled stirred tanks, impeller selection.	10	20%
VI	**Bioprocesses monitoring** - common bioprocess parameters monitored or controlled, measurement of inlet gas flow rates, agitation rates, temperature, pH/redox, dissolved O_2 and CO_2, reactor head space pressure, measurement of cell mass and common metabolites, metabolic state variables of the cells, respiratory quotient, on-line and off-line measurements, ion-specific sensors, biosensors - Enzyme and Microbial Electrodes.	09	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 hours

The question paper consists of Part A, Part B and Part C.

Part A consists of three questions of 15 marks each uniformly covering Modules I and II. The student has to answer two questions (15×2=30 marks).

Part B consists of three questions of 15 marks each uniformly covering Modules III and IV. The student has to answer two questions (15×2=30 marks).

Part C consists of three questions of 20 marks each uniformly covering Modules V and VI. The student has to answer two questions (20×2=40 marks).

Note : Each question can have a maximum of 4 subparts, if needed..