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| <b>Subject Code: 2SC2010303</b> | <b>Subject Title: Industrial Biotechnology</b> |
| <b>COURSE TYPE: CORE COURSE</b> |                                                |

**Course Objective:** Bioprocess and Biochemical Engineering deals with Microbial Processes that produce the product of interest, i.e. Specialty Products, Enzymes, Vitamins, Antibiotics, Organic Acids, Alcohols, etc. It covers the fundamental aspects of Bioreactor design, Media formulations, Control of factors that affect such bioprocesses and their maintenance.

| Teaching scheme (hours) per week |           | Credit |           |       | Theory Marks    |                  | Practical Marks |                  | Total |
|----------------------------------|-----------|--------|-----------|-------|-----------------|------------------|-----------------|------------------|-------|
| Theory                           | Practical | Theory | Practical | Total | Uni. Assessment | Cont. Assessment | Uni. Assessment | Cont. Assessment |       |
| 4                                | -         | 4      | -         | 4     | 60              | 40               | -               | -                | 100   |

| Unit | Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Lectures | Weightage |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------|
| 1    | Unit 1: Growth kinetics: Batch, fed-batch and continuous culture (chemostat and turbidostat )<br>Isolation, Enrichment & screening (Primary & Secondary)<br>Preservation techniques<br>Strain Improvement: Induced mutants for primary and secondary metabolites, Application of r-DNA technology for strain improvement.<br>Inoculum Development : Inocula development for Bacteria, Yeast and Fungal processes.                                                                                             | 12       | 22%       |
| 2    | Unit 2: Bioreactor Design & Formulation of Media<br>Medium formulations and Raw materials used in fermentation media and criteria for selection.<br>Medium sterilization: Batch & Continuous Sterilization Methods<br>Sterilization of Air<br>Design of an ideal Stirred Tank Reactor & its various auxiliary parts<br>Aseptic operation and Role of contaminants: Techniques for the Achievement and Maintenance of Aseptic condition during Fermentation Processes<br>Basic Design of a Typical Fermenters. | 18       | 28%       |
| 3    | Unit 3: Downstream Processing:<br>Removal of Solid & Microbial Cells and other solid Matter, Foam separation, Precipitation, Filtration and Centrifugation<br>Extraction of intracellular products by cell disruption methods<br>Methods for the Concentration of Extracted products: Liquid-Liquid extraction, Distillation,<br>Purification products: Chromatography, Membrane processes and ultra filtration<br>Drying & Crystallization<br>Quality Assurance-Bioassay                                     | 12       | 22%       |

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| 4 | Unit 4: Typical Fermentation Processes-2:<br>Solid state fermentation: Application of Mushroom cultivation<br>Fermentation processes of Enzyme (Amylase)<br>Fermentation processes of alcohol<br>Fermentation processes of organic acids (Gluconic acid / Citric acid/Acetic Acid)<br>Fermentation processes of amino acids (Lysine), vitamins (Vit. B12)<br>Fermentation processes of antibiotics (penicillin)<br>Fermentation processes of Microbial Biomass ( SCP, SCO) | 18 | 28% |
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**Learning Outcome:** Students will learn the basics of bioprocesses and fermentation technology. They will also learn the fundamental concepts underlying the production & applications of various products produced by industrial fermentations.

**Reference Books:**

1. Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2002.
2. Pauline Doran, Bioprocess engineering principles, 1 Edition, Academic Press, 1995.
3. Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2001.
4. Roger Harrison et al., Bioseparations Science and Engineering, Oxford University Press, 2003.
5. Principles of Fermentation Technology by R.H. Whittaker
6. Mansi, : Fermentative productions of vitamin B 12
7. Fermentation microbiology and Biotechnology, Tylor and Francis.
8. Crueger and Crueger: Biotechnology
9. Peppler: Microbial Technology: Fermentation technology
10. L.E. Casida: Industrial Microbiology
11. Presscott & Dunn: Industrial Microbiology
12. Patel A. H. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
13. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education
14. Biotechnology –The Biological Principles, M.D.Trevaan ,S.Boffey,K H Goulding, P Stanbury Mukhopadhyay, Process Biotechnology Fundamental. Viva book.
- Shuler and Kargi, 1992. Bioprocess engineering, Prentice-Hall.
15. Bialy & Ollis.1986. Biochemical Eng. Fundaments. McGraw-Hill.
- Schugerl. 1987. Bioreaction engineering, J/W.
16. Sikyta. Methods in Industrial microbiology. Ellis Hardwood Ltd.
17. Krysman. Product recovery in bioprocess technology.
18. T.K. Ghose. Bioprocess computation in biotechnology, Ellis Hardwood Ltd.
19. Murry Joh. 1997. Microorganisms and Biotechnology.
20. Demain efal. (ED) 1999. Manual of industrial Microbiology and Biotechnology. Asin Press.
21. Bioprocess Engineering Principles by Doran (D); Academic Press, 1998.
22. Cooney, A.E. Humphrey, Comprehensive Biotechnology : The principles and Regulation of Biotechnology in Industry, Agriculture and Medicine. Vol.2, Pergamon Press, 1985. Edition. Panima Publishing Company, New DelhiWilley JM, Sherwood LM AND Woolverton CJ (2013)