

# **SHIVAJI UNIVERSITY, KOLHAPUR.**



\*\*\*\*\*

Accredited by NAAC with 'A' Grade  
CHOICE BASED CREDIT SYSTEM

Syllabus For

**B.Sc. Part-I**

**INDUSTRIAL MICROBIOLOGY**

**(Faculty of Science and Technology)**

**SEMESTER I AND II**

**(Syllabus to be implemented from August, 2022 onwards as per NEP 2020)**

## **Revised Syllabus for Bachelor of Science Part - I: Industrial Microbiology**

**1. TITLE:** Industrial Microbiology

**2. YEAR OF IMPLEMENTATION:** Revised Syllabus will be implemented from June, 2021 onwards.

**3. PREAMBLE:** This syllabus is framed to give sound knowledge with understanding of Industrial Microbiology to undergraduate students at third year of three years of B.Sc. degree course. Students learn Industrial Microbiology as a separate subject from B.Sc. I. The goal of the syllabus is to make the study of Industrial Microbiology popular, interesting and encouraging to the students for higher studies including research. The new and updated syllabus is based on a basic and applied approach with vigor and depth. At the same time precaution is taken to make the syllabus comparable to the syllabi of other universities and the needs of industries and research. The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields. The units of the syllabus are well defined, taking into consideration the level and capacity of students.

**4. DURATION:** The course shall be a fulltime course.

**5. PATTERN:** Pattern of Examination will be Semester for theory and annual for practicals.

**6. MEDIUM OF INSTRUCTION:** The medium of instruction shall be English.

### **7. Learning Outcomes or Program Specific Outcomes of Industrial Microbiology:**

After completion of three years Industrial Microbiology program, the students vision insights will broaden into –

1. Application of Basic & Advanced concept of industrial microbiology to diverse areas such as fermentation technology, quality control, government's law and regulations, quality management and environmental monitoring.
2. Competence of a working knowledge of theory, practicals, skills and use of various aspects of industrial microbiology according to the needs of industries.
3. Identifying societal problems and providing innovative remedies with a broader perspective of industrial microbiology.
4. Development of entrepreneur skills.

## Structure of Bachelor of Science with Industrial Microbiology as principle Subject

SEM	Discipline specific Core Course (DSC) (L+T+P) (Credits)	Discipline specific Elective Course (DSE)/ Open Elective (OE) (L+T+P) (Credits)	Ability Enhancement Compulsory Courses (AECC)/ Languages (L+T+P) (Credits)	Skill Enhancement Courses (SEC)		Total Credits
				Skill Based Courses (L+T+P) (Credits) (Non-CGPA)	Value Based Courses (L+T+P) (Credits) (Non-CGPA)	
I	Industrial Microbiology C1 (4+2) Chemistry C1 (4+2) Microbiology C1 (4+2)	Botany C1 / Zoology C1 (4+2)	AECC-1 (2) (Non-CGPA) English for communication	SEC-1 (2) Multidisciplinary	NCC / NSS / Sports / Cultural (1) / SSC (2)	24
II	Industrial Microbiology C2 (4+2) Chemistry C2 (4+2) Microbiology C2 (4+2)	Botany C2 / Zoology C2 (4+2)	AECC-2 (2) (Non-CGPA) English for communication	SEC-2 (2) Multidisciplinary	NCC / NSS / Sports / Cultural (1) / SSC (2)	24
Option 1: Exit with Certificate Course in Science (Industrial Microbiology) (with the completion of courses equal to minimum of 48 credits)						

**B. Sc. I (Industrial Microbiology)**  
**Semester I**

<p><b>Paper I</b></p>	<p><b>DSC –27A: Introduction to Industrial Microbiology (CREDITS: 02)</b></p>	<p><b>No. of Hours</b></p>
	<p><b>OBJECTIVES :</b></p> <ol style="list-style-type: none"> <li>1. To get acquainted with the contribution made by prominent scientist in the field of industrial microbiology.</li> <li>2. To study industrially important products</li> <li>3. To understand the basic concept of fermentation and technique used for isolation of industrially useful microorganisms.</li> <li>4. To study the characteristics and industrial importance of microorganisms</li> </ol>	
<p><b>Credit I</b></p>	<p><b>History and Basic Concepts of Industrial Microbiology</b></p>	
	<p><b>A. Historical developments of industrial microbiology</b></p> <ol style="list-style-type: none"> <li>1. Definition and scope of Industrial Microbiology.</li> <li>2. Contributions of various scientists to Industrial Microbiology.             <ol style="list-style-type: none"> <li>a) Louis Pasteur</li> <li>b) Antony Van Leeuwenhoek</li> <li>c) Alexander Fleming</li> <li>d) Selman Waksman</li> <li>e) Edward Jenner</li> </ol> </li> <li>3. Introduction to Industrially important products             <ol style="list-style-type: none"> <li>a) Pharmaceutical products –                 <ol style="list-style-type: none"> <li>i) Vitamins – Vit B12</li> <li>ii) Antibiotics–Penicillin</li> <li>iii) Vaccine – Types with examples</li> </ol> </li> <li>b) Agricultural products –                 <ol style="list-style-type: none"> <li>i) Biofertilizers – Azotobacter</li> <li>ii) Biopesticides – Bacillus thuringiensis.</li> </ol> </li> <li>c) Food products –                 <ol style="list-style-type: none"> <li>i) Fermented milk products – Curd, Yogurt</li> <li>ii) Pickles – Sauerkraut</li> </ol> </li> <li>d) Other Industrial products –                 <ol style="list-style-type: none"> <li>i) Enzymes – Amylase</li> <li>ii) Organic acid -Citric acid</li> </ol> </li> </ol> </li> </ol> <p><b>B. Concepts of Fermentation</b></p> <ol style="list-style-type: none"> <li>1. Fermentation – Definition</li> <li>2. Primary and secondary metabolites</li> <li>3. Types of fermentation -             <ol style="list-style-type: none"> <li>a) Batch and continuous fermentations</li> <li>b) Dual and multiple fermentation</li> <li>c) Solid state and liquid state fermentation</li> </ol> </li> </ol>	<p style="text-align: center;"><b>15</b></p>

<b>Credit II</b>	<b>Isolation &amp; Study of industrially important microorganisms</b>	
	<p><b>A. Screening of industrially important microorganisms</b></p> <p>1. Primary Screening of -</p> <ul style="list-style-type: none"> <li>a) Antibiotic producers</li> <li>b) Organic acid producers</li> <li>c) Amylase producers</li> <li>d) Amino acid producers</li> </ul> <p>2. Secondary screening -</p> <ul style="list-style-type: none"> <li>i) Detail information of microorganism used.</li> <li>ii) Detail information of products produced.</li> <li>iii) Qualitative &amp; quantitative study of products</li> </ul> <p><b>B Study of Industrially Important Microorganisms</b></p> <p>1. General characteristics and industrial importance of:</p> <ul style="list-style-type: none"> <li>a) Bacteria including actinomycetes</li> <li>b) Fungi (yeasts and molds)</li> <li>c) Algae</li> </ul>	<b>15</b>
<b>Paper II</b>	<b>DSC –28 A - Basics of Fermentations (CREDITS: 02)</b>	<b>No. of Hours</b>
	<p><b>OBJECTIVES :</b></p> <ul style="list-style-type: none"> <li>1. To study the formulation of fermentation media.</li> <li>2. To understand the use of agricultural and industrial waste as fermentation media</li> <li>3. To understand the principles of sterilization of equipment, culture media, air in industries and validation of sterilization process.</li> </ul>	
<b>Credit I</b>	<b>Fermentation media and Waste as fermentation media</b>	
	<p><b>A. Components of Fermentation media</b></p> <p>1. Basic components</p> <ul style="list-style-type: none"> <li>a) water,</li> <li>b) Sources of: carbon, nitrogen, minerals</li> </ul> <p>2. Special ingredients –</p> <ul style="list-style-type: none"> <li>a) growth factors</li> <li>b) buffers</li> <li>c) precursors, inhibitors, inducers,</li> <li>d) antifoam agents</li> <li>e) redox potential</li> </ul> <p>3. Types of media used</p> <ul style="list-style-type: none"> <li>a) synthetic, semisynthetic</li> <li>b) crude</li> </ul> <p><b>B. Types of Waste and Use of Wastes:</b></p> <p>1. Concept of Pretreatment and addition of supplements.</p> <p>2. a) Industrial waste -</p> <ul style="list-style-type: none"> <li>i) Molasses</li> <li>ii) Corn steep liquor</li> <li>iii) SWL</li> </ul> <p>b) Agricultural wastes</p> <ul style="list-style-type: none"> <li>i) Wheat bran</li> <li>ii) Rice husk</li> </ul>	<b>15</b>

<b>Credit II</b>	<b>Sterilization Techniques in Fermentation Industry</b>	<b>15</b>
	<b>A. Sterilization Technique:</b> 1. Principles of Sterilization 2. Sterilization of Equipment 3. Sterilization of production media with respect to Acid Alkali Buffer, Antifoam agent and precursors 4. Sterilization of air. <b>B. Validation of sterilization processes</b>	

## B. Sc. I Industrial Microbiology Semester II

<b>Paper III:</b>	<b>DSC –27B: Introduction to Fermentation Technology (CREDITS: 02)</b>	<b>No. of Hours</b>
	<b>OBJECTIVES :</b> 1. To study the fermenter design and to understand different types of fermenter. 2. To study the temperature, pH, pressure and foam control systems and their importance. 3. To understand the concepts of inoculums preparation, strain improvement, stock culture maintenance and culture collection centers. 4. To study the various factors affecting fermentation process.	
<b>Credit I</b>	<b>Design of Fermenter&amp; working system</b>	<b>15</b>
	<b>A. Basic Fermenter design:</b> 1. Parts and their functions of Conventional Stirred tank fermenter. 2. Fermenter Types - a) Airlift Fermenter b) Fluidized bed fermenter c) Packed bed fermenter d) Bubble cap fermenter <b>B. Fermenter control system:</b> 1. Introduction & Importance of control systems 2. Designs, principles and working of systems for control of – a) temperature b) pressure c) foam d) pH. e) Contamination	
<b>Credit II</b>	<b>Production strains and Factors affecting fermentation process</b>	<b>15</b>
	<b>A. Production strains</b> 1. Concept 2. Concept of strain improvement 3. Stock culture maintenance 4. Culture collection centers <b>B. Preparation of inoculum</b> <b>C. Factors Affecting fermentation process</b> 1. Temperature	

	<ul style="list-style-type: none"> <li>2. pH</li> <li>3. Aeration</li> <li>4. Agitation</li> <li>5. Foam</li> <li>6. Media composition</li> </ul>	
<b>Paper IV:</b>	<b>DSC- 28 B: Microbial Fermentations and Economics (CREDITS: 02)</b>	<b>No. of Hours</b>
	<p><b>OBJECTIVE :</b></p> <ul style="list-style-type: none"> <li>1. To study industrial production of penicillin, semisynthetic penicillin and Vit B12</li> <li>2. To study microbiological assay of vitamins and antibiotics.</li> <li>3. To understand various downstream processes.</li> <li>4. To study economic protection of fermentation product.</li> </ul>	
<b>Credit I</b>	<b>Microbial fermentations and microbial assay</b>	
	<p><b>A. Antibiotics:</b></p> <ul style="list-style-type: none"> <li>1. Production of antibiotics -: Penicillin &amp; semi-synthetic penicillins.</li> <li>2. Production of Vitamin -: Vitamin B12</li> </ul> <p><b>B. Assay of fermentation products</b></p> <ul style="list-style-type: none"> <li>1. Microbiological assay of Vitamins and Antibiotics.</li> <li>2. Chemical assays of Penicillin.</li> </ul>	<b>15</b>
<b>Credit II</b>	<b>Purification and economics of fermentation products</b>	
	<p><b>A. Downstream processes</b></p> <ul style="list-style-type: none"> <li>1. Cell harvesting</li> <li>2. Precipitation, filtration and centrifugation</li> <li>3. Cell disruption</li> <li>4. Liquid-liquid extraction</li> <li>5. Chromatography – adsorption, ion exchange, gel, affinity</li> <li>6. Distillation</li> <li>7. Crystallization</li> </ul> <p><b>B. Fermentation economics</b></p> <ul style="list-style-type: none"> <li>1. Raw material</li> <li>2. Process</li> <li>3. Recovery process</li> <li>4. Storage and Transport</li> <li>5. Product economics</li> <li>6. Waste management</li> </ul>	<b>15</b>

## Practical Course (Annual Pattern)

Paper I & Paper II	Practical Course I: Introduction to Industrial Microbiology and Basics of Fermentations (CREDITS: 02)	No. of Hours
	<p><b>OBJECTIVES :</b></p> <ol style="list-style-type: none"> <li>1. To understand and practice various biosafety techniques used in microbiology laboratory.</li> <li>2. To study working, principles, handling and use of microscope as well as various instruments used in microbiology laboratory.</li> <li>3. To prepare liquid, solid media and to study the working principles of sterilization and disinfection of culture media and glassware.</li> <li>4. To understand the basic laboratory technique used to isolate and cultivate bacteria, yeast, molds and actinomycetes</li> </ol>	
<b>Credit I</b>	<b>Introduction to Industrial Microbial Techniques</b>	
	<p><b>1. Biosafety in Microbiology Laboratory</b></p> <ol style="list-style-type: none"> <li>a) Aseptic techniques :               <ol style="list-style-type: none"> <li>i)Table disinfection</li> <li>ii)Hand wash,</li> <li>iii) Use of aprons</li> </ol> </li> <li>b) Proper disposal of used material</li> <li>c) Cleaning and sterilization of glassware</li> </ol> <p>2. Studying parts of Light compound microscope and its use and care.</p> <p>3. Study of the principle and applications of instruments used in the microbiology laboratory:</p> <ol style="list-style-type: none"> <li>a) Biological safety cabinets</li> <li>b) Autoclave</li> <li>c) Incubator</li> <li>d) Hot air oven</li> <li>e) Seitz filter</li> <li>f) Centrifuge</li> <li>g) pH meter</li> <li>h) Spectrophotometer</li> <li>i) Distillation Unit</li> </ol>	<b>15</b>
	<b>Preparation of Media for the Study of Microorganism in Fermentation</b>	
	<ol style="list-style-type: none"> <li>1. Preparation of liquid and solid culture media and their sterilization.           <ol style="list-style-type: none"> <li>a) Preparation of - agar plates, butts and slants.</li> </ol> </li> <li>2. Preparation of media suitable for the growth of:           <ol style="list-style-type: none"> <li>a) Bacteria – i. Nutrient broth               <ol style="list-style-type: none"> <li>ii. Nutrient agar</li> <li>iii. Soil extract agar</li> </ol> </li> <li>b) Molds – i. Potato Dextrose Agar               <ol style="list-style-type: none"> <li>ii. Czapek Dox agar</li> </ol> </li> <li>c) Yeasts –               <ol style="list-style-type: none"> <li>i. Glucose Yeast Extract Agar</li> <li>ii. Sabouraud’s agar</li> </ol> </li> <li>d) Actinomycetes – i. Glycerol Asparagine Agar</li> </ol> </li> <li>3. Sterilization of culture medium using Autoclave and assessment for sterility.</li> <li>4. Sterilization of glassware using Hot Air Oven and assessment for sterility</li> </ol>	<b>15</b>



Paper III & Paper IV	Practical Course II: Introduction to Fermentation Technology and Microbial Fermentations and Economics (CREDITS: 02)	No. of Hours
	<p><b>OBJECTIVES</b></p> <ol style="list-style-type: none"> <li>1. To study morphological and cultural characteristics of bacteria, fungi and actinomycetes</li> <li>2. To study giant colony techniques of actinomycetes.</li> <li>3. To study screening techniques for amylase, organic acid, antibiotics and amino acids producers.</li> <li>4. Detection and identification of sugars and amino acid by paper chromatography</li> <li>5. Chemical assay of penicillin.</li> </ol>	
Credit II	<b>Study of Industrially Important Microorganism</b>	
	<ol style="list-style-type: none"> <li>1. Isolation and study of microorganisms:               <ol style="list-style-type: none"> <li>a. Bacteria – Isolation, colony characters, Gram staining &amp; motility.</li> <li>b. Fungi – Aspergillus and Penicillium mounting &amp; identification.</li> <li>c. Yeasts – Saccharomyces cerevisiae, monochrome staining.</li> <li>d. Actinomycetes – cultivation using coverslip technique and direct microscopic observation</li> </ol> </li> <li>2. Sub culturing of Microorganism by using solid media</li> <li>3. Demonstration of antimicrobial activity of actinomycetes by the Giant Colony Technique.</li> </ol>	<b>15</b>
	<b>Microbial Fermentations</b>	
	<ol style="list-style-type: none"> <li>1. Primary screening of –               <ol style="list-style-type: none"> <li>a) Amylase producers</li> <li>b) Organic acid producers</li> <li>c) Antibiotic Producers</li> <li>d) Amino Acid Producers</li> </ol> </li> <li>2. Chemical assay of Penicillin</li> <li>3. Separation of amino acids by paper chromatography.</li> <li>4. Separation of sugars by paper chromatography.</li> <li>5. Demonstration of lab Fermenter</li> </ol>	<b>15</b>

### **Books Recommended for Theory**

1. General Microbiology – R. Y. Stanier and others. Macmillan Press Ltd.
2. Principles of Fermentation Technology – Stanbury and Whitaker. Pergamon Press.
3. Industrial Microbiology – L. E. Casida Jr. John Wiley and Sons.
4. Microbial Technology, Volumes I & II – H. J. Peppler. Academic Press
5. Microbiology by Pelczar, Reid & Chan
6. Isolation Methods for Microbiologists, Volumes I & II – Gibbs and Shapton. Academic Press
7. Quantitative Bioassay – D. Hancroft, T. Hector and F. Rowell. John Wiley & Sons
8. Industrial Microbiology by A.H.Patel
9. Industrial Microbiology – Prescott & Dunn.
10. Industrial Microbiology – Agarwal & Parihar.
11. Principles & Techniques of Biochemistry and Molecular Biology – Wilson & Walker.
12. Industrial Microbiology – Prescott & Dunn.
13. Principles of Bacteriology – A.G. Salle
14. Biofertilizers – Arun Sharma.

15. Fundamentals of Microbiology – Frobisher et al.

### **Books Recommended for Practical**

1. Experimental Microbiology – R. J. Patel and K. R. Patel, Aditya Publishers, Ahmedabad
2. Laboratory Fundamentals of Microbiology – Alcamo I.E
3. Stains and Staining Procedures – Desai & Desai
4. Introduction to Practical Biochemistry – D. Plummer, J. Willey and sons
5. Introduction to Microbial Techniques – Gunsekaran.

### **List of Minimum Equipments**

- 1) Hot air oven - 1
- 2) Incubator - 1
- 3) Autoclave – 1
- 4) Refrigerator - 1
- 5) Medical microscopes - 10 nos. for one batch
- 6) Chemical balance - 1
- 7) pH meter - 1
- 8) Seitz filter - 1
- 9) Centrifuge - 1
- 10) Spectrophotometer - 1
- 11) Distilled Water Plant - 1
- 12) Colony counter.- 1
- 13) Water bath.- 1
- 14) Computer - 1
- 15) One separate sterilization room attach to the laboratory (10' x 15')
- 16) At least one wash basin for a group of five students
- 17) Arrangements for gas supply and fitting of two burners per table
- 18) One working table of 6' x 2.' for two students
- 19) One separate instrument room attached to lab (10' x 15')
- 20) One laboratory for one batch including working tables (6' x 2.') per two students for one batch
- 21) Store room (10' x 15').

### **Theory Examination**

#### **Nature of Question paper**

- |  |          |
|--|----------|
| Q.1 Multiple choice questions (10- Questions) ----   | 10 marks |
| Q.2 Attempt <b>any two</b> of the following.<br><br>(Essay type/Broad answer questions) ---- | 20 marks |
| Q.3 Write short notes ( <b>any four</b> ) ----   | 20 marks |

## **PRACTICAL EXAMINATION**

- A) The practical examination will be conducted on two consecutive days for not less than three hours and fifteen minutes on each day of practical examination.
- B) Each candidate must produce a certificate from the Head of the Department in his/her college, stating that he/she has completed in a satisfactory manner the practical course on lines laid down from time to time by Academic council on the recommendations of Board of Studies and that the journal has been properly maintained. Every candidate must have recorded his/her observations in the laboratory journal and have written a report on each exercise performed. Every journal is to be checked and signed periodically by a member of teaching staff and certified by the Head of the Department at the end of the year. Candidates must produce their journals at the time of practical examinations.

\*\*\*\*\*