"Dissemination of Education for Knowledge, Science and Culture"

-Shikshanmaharshi Dr. Bapuji Salunkhe.

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur

(An Empowered Autonomous Institute)

DEPARTMENT OF MICROBIOLOGY

B. Sc. Part-II

Semester - III & IV

NEP Phase II

SYLLABUS (Draft)

B.Sc.–II (Semester -III and IV) Microbiology

To be implemented from Academic Year 2025-2026

Department of Microbiolgy
Departmental Teaching and Evaluation scheme
Second Year Semester-III &IV

Sr. No.	Course Abbr.	Course code	Course Name	Teaching Scheme Hours/week		Examination Scheme and Marks				Course Credits
				TH	PR	SEE	CIE	PR	Marks	
Semester-III										
Major										
1	DSC-V	2DSC03MIC31	Applied Microbiology	2	-	40	10	-	50	2
2	DSC-VI	2DSC03 MIC32	Microbial Physiology	2	-	40	10	-	50	2
3	VSC-PR-II	2VSC03MIC39	VSC Microbiology Lab-1 (Analytical Microbiology)	-	4	-	-	25	25	2
4	DSC-PR-III	2DSC03MIC39	DSC Microbiology Lab-3	-	8	-	-	50	50	4
Minor										
1	MIN-V	2 MIN03MIC31	Agricultural Microbiology	2	-	40	10	-	50	2
2	MIN-VI	2 MIN03MIC32	Environmental Microbiology	2	-	40	10	-	50	2
3	MIN-PR-III	2MIN03MIC39	MIN Microbiology Lab-1	-	4	-	-	25	25	2
Open Elective										
1	OEC LFS-PR-III	2OEC03LFS34	OEC Microbiology Lab-1 (Milk Microbiology)	-	4	-	-	25	25	2
Semester –III Total				**8**	**20**	**160**	**40**	**125**	**325**	**18**
Semester-IV										
Major										
1	DSC-VII	2DSC03MIC41	Medical Microbiology-I	2	-	40	10	-	50	2
2	DSC-VIII	2DSC03MIC42	Microbial Genetics-I	2	-	40	10	-	50	2
3	VSC-PR-III	2VSC03MIC49	VSC Microbiology Lab-2 (Milk & Water Microbiology)	-	4	-	-	25	25	2
4	DSC-PR-IV	2DSC03MIC49	DSC Microbiology Lab-4	-	8	-	-	50	50	4
Minor										
1	MIN-VII	2 MIN03MIC41	Food Microbiology	2	-	40	10	-	50	2
2	MIN-VIII	2 MIN03MIC42	Industrial Microbiology	2	-	40	10	-	50	2
3	MIN-PR-IV	2MIN03MIC49	MIN Microbiology Lab-2	-	4	-	-	25	25	2
Open Elective										
1	OEC LFS-PR-IV	2OEC03LFS44	OEC Microbiology Lab-2 (Water Microbiology)	-	4	-	-	25	25	2
Semester –IV Total				**8**	**20**	**160**	**40**	**125**	**325**	**18**

Abbreviations:
TH-Theory, PR-Practical, PRO- Project, ESE- End Semester Examination, CIE-Continuous Internal Examination

SEMESTER III

Paper V	2DSC03MIC31: Applied Microbiology - I	No. of Hours per Unit

Course Outcomes: Upon successful completion of course, students are expected to be able to

CO1: Understand the basic understanding of industrial microbiology

CO2: Determine potability of water

CO3: Understand and design sampling methods for microbial examination of air.

CO4: Understand principle and working of various instruments used in laboratory.

Unit I	Industrial and Water Microbiology	7

Industrial Microbiology

A. Basic concepts of fermentation.

1. Definition, concept of primary and secondary metabolites
2. Types of fermentations – Batch, continuous, dual and multiple.
3. Typical Fermenter design – Parts and their functions.
4. Factors affecting fermentation process.

B. Fermentation Media:

A. Water, carbon source, nitrogen source, precursors, growth factors, antifoam agents, chelating agents.

B. Use of wastes as Fermentation media – Molasses, sulphite waste liquor & corn steep liquor**.**

C. Screening of industrially important microorganisms.

1. Primary Screening of: Antibiotic producers, Organic acid producers and Amylase producers
2. Secondary screening

Unit II	**Water Microbiology:**	8
	1. Sources of microorganisms in water. **2.** Fecal pollution of water. **3.** Indicators of fecal pollution **4.** Routine Bacteriological analysis of water. **1.** SPC **2.** Tests for Coli forms **A. Qualitative test** a. Detection of coliforms – i. Presumptive test, ii. Confirmed Test, iii. Completed test. b. Differentiation between coliforms i. IMViC test, ii. Eijkman test. c. **Quantitative test –** i. MPN ii. Membrane filter technique **3.** Municipal water purification process and its significance.	
Unit III	**Air Microbiology**	8
	A. Air Microbiology: **1.** Sources of microorganisms in air **2.** Definitions of- a. Infectious dust, b. Droplets, c. Droplet nuclei **3.** Sampling methods for microbial examination of air - a. Solid impaction-Sieve device b. Liquid Impingement–Bead-bubbler device	

UNIT IV	Applied microbiology	7
	A. Bioinstrumentation: Principle, working and application of- **A.** Electrophoresis (Agarose gel, PAGE) **B.** U.V. –visible spectrophotometer. **B. Bioinformatics:** 1. Introduction of basic terminologies-Database, Genomics and Proteomics. 2. Applications of bioinformatics. **C.** Space Microbiology: Introduction & application **D.** Gnotobiology: Introduction	

Reference Book:

1. General Microbiology– Vol. I and Vol. II– Pawar and Daginawala Himalaya publising
2. A Textbook of Microbiology R. Dubey, D. K. Maneshwar S. Chand Co. Ltd. Ramnagar New Delhi 110055
3. Fundamentals of Microbiology– Frobisher et al.

Paper VI	2DSC03 MIC 32: Microbial Physiology	No. of Hours per Units

Course Outcomes- Upon successful completion of course, students are expected to be able to-

CO1: Explain various phases of growth in bacteria and various environmental factors affecting it.

CO2: Explain the microbial physiology, patterns of growth and various methods of bacterial growth measurement.

CO3: Understand metabolic pathways & mode of energy generation.

CO4: Understand nutrient uptake and transport across the cell membrane.

Unit I	Microbial Physiology & Metabolism	8

A. Growth: Growth phases, measurement of growth, continuous growth, synchronous growth and diauxic growth

B. Effect of environmental factors on microbial growth:

1. Temperature:-

a) Mesophiles, psychrophiles, thermophiles and hyperthermophiles.

b) Thermal destruction of bacteria- D, F and Z values, TDP and TDT

2. pH- Neutrophiles, Acidophiles and Alkalophiles.

3. Osmotic pressure – Isotonic, hypotonic and hypertonic Environments, xerophile and halophiles.

4. Heavy metals

5. Radiations-U.V rays

Unit II	**Transport across cell membrane–**	7
	1. Diffusion, 2. active transport 3. Group translocation.	
Unit III	**Microbial Metabolism**	8
	Catabolism of glucose– A. Embden Meyerhof Parnas Pathway (EMP) B. Hexose Monophosphate pathway (HMP) C. Entner-Doudoroff pathway (ED) D. Tricarboxylic Acid cycle (TCA).	
UNIT IV	**Fermentation**	7
	A. Fermentation:- Homolactic & Heterolactic fermentation **B.** Bacterial electron transport chain – Components, flow of electrons & mechanism of ATP generation– **C.** Chemiosmotic hypothesis	

Reference Books:

1. General Microbiology–Vol.I and Vol. II–Pawar and Daginawala, Himalaya Publiactions
2. Leehningers Biochemistry, Fifth Edition, David L. Nelson, Michael Cox, E.H. Freeman and Company
3. Outlines of Biochemistry – Conn and Stumpf, Fifthe edition(2006), Wiley Publication
4. A Textbook of Microbiology–R. Dubey, D.K. Maneshwari, S. Chand Co. Ltd. Ramnagar New Delhi 110055
5. Fundamentals of Microbiology–Frobisher et al, W.B. Saunders Company
6. Introduction to Microbiology–John I. Ingraham, Catherine A. Ingraham A. Ronald M; Second edition (1999), S. Chand and Company Ltd.

SEMESTER III (Minor)

Paper V	2 MIN 03MIC 31: Agricultural Microbiology	No. of Hours per Units
Course Outcomes - Upon successful completion of course, students will be able to – CO1: Understand various plant microbe interactions especially rhizosphere and their applications especially the bio fertilizers and their production techniques CO2: Understand various biogeochemical cycles – C, N, P cycle and microbes involved CO3: Perform isolation of agriculturally important microorganisms and formulate biofertilizers. CO4: Explain role of microorganisms and common symptoms of plant diseases.		
Unit I	**Soil Microbiology**	8
	A. Physical characters. **B.** Chemical characters. **C.** Types of microorganisms in soil and their role in soil fertility. **D.** Microbiological interactions - Symbiosis, Commensalism, Amensalism, Parasitism, Predation.	
Unit II	**Role of microorganisms in elemental cycle**	7
	A. Carbon cycle. **B.** Nitrogen cycle **C.** Phosphorous cycle **D.** Sulfur cycle	
Unit III	**Bio fertilizer, Bio pesticide production**	8
	Types, production, methods of application and uses of - **A.** Bio fertilizers **1.**Nitrogen fixing - *Azotobacter Rhizobium, Azospirillum.* **2.** Phosphate Solubilizing Microorganisms.	

	B. Bio pesticides **1.** *Bacillus thuringiensis* **2.** *Tricoderma spp.*	
UNIT IV	**Plant Pathology**	7
	A. Common symptoms produced by plant pathogens **B.** Modes of transmission of plant diseases. **C.** Plant diseases- **1.** Citrus Canker **2.** Tikka disease of groundnut **3.** Bacterial Blight of Pomegranate. **D.** Control of plant disease caused by bacteria.	

Reference books:

1. Soil Microbiology-An exploratory approach-Mark Coyne, New Edition (1999), Delmer Cengage Learning
2. Agricultural Microbiology- N. Mukherjee and T. Ghosh, Kalyani Publication
3. Introduction to Soil Microbiology-Martin Alexander IInd Edition (1990), Krieger Pub Co.
4. Agricultural Microbiology- Rangaswamy and Bhagyaraj IInd Edition, CBS Publishers and Distribution Pvt. Ltd
5. Plant diseases - R.S. Singh, Sixth Edition (11990), Oxford & IBH Publishing company
6. Diseases of crop plants in India- G. Rangaswamy, Prentice Hall Learning, Pvt Ltd
7. Soils and Soils Fertility-6thedition- Frederick R. Troeh (Blackwell publishing Co.)
8. Soil Microbiology-Singh, Purohit, Parihar. (Agrobios India,2010)

Paper VI	2 MIN 03MIC 32 : Environmental Microbiology	No. of Hours per Units

Course Outcomes - Upon successful completion of course, students will be able to –

CO1: Understand the basic principle of environment microbiology and be able to apply these principles to understanding and solving environmental problems.

CO2: Know the Microorganisms responsible for water pollution and their transmission

CO3: Describe classification of lakes, sources, consequences and control of eutrophication.

CO4: Understand Bioremediation and bioleaching method

Unit I	**General characteristics of waste**	7
	A. Liquid waste - pH, electrical conductivity, COD, BOD, total solids, total dissolved solids, total suspended solids, total volatile solids, chlorides, sulphates, oil & grease. **B.** Solid waste- pH, electrical conductivity, total volatile solids, ash. **C.** Standards as per MPCB	
Unit II	**Sewage Microbiology**	8
	A. Physico-chemical and Biological characteristics **B.** Treatment methods- i. Physical treatment: Screening, Sedimentation ii. Biological treatment: Trickling filter, Activated sludge process, Oxidation ponds, Anaerobic digestion (Biomethanation), Septic tank. **C.** Chemical treatment - Chlorination.	

Unit III	**Eutrophication and EIA**	7
	A. Eutrophication a.Classification of lakes b.Sources c. Consequences. B. **Environmental Impact Assessment**- Concept and brief introduction	
UNIT IV	**Bioremediation and Bioleaching**	8
	A. Bioremediation **1.**Definition **2.**Types **3.**Applications. **B. Bioleaching** **1.**Introduction **2.**Microorganisms involved **3.**Chemistry of Microbial leaching **4.**Laboratory scale and pilot scale leaching **5.**In situ leaching - Slope, heap **6.**Leaching of Copper	

Reference Books:

1. Environmental Pollution by Chemicals- Walker, Second Edition (1975), Hutchinson
2. Biochemistry and Microbiology of Pollution-Higgins and Burns, (1975), Academic Press Inc
3. Environmental Pollution-Laurent Hodge, Hol, New York Publication.
4. Waste Water Treatment– Datta and Rao, Oxford and IBH Publishing company
5. Sewage and waste treatment–Hammer, Seventh Edition (2012), Prentice Hall India Learning Pvt. Ltd

OE PR- I	2 OEC 03MIC 31 Milk Microbiology	No. of Hours per Unit
Course Outcomes: Upon successful completion of course, students are expected to be able to- CO1: Learn about applied microbiology techniques related to milk microbiology CO2: Perform and demonstrate different methods used to determine the quality of milk CO3: Learn about role of microbes in milk CO4: Determine role of microbes in spoilage of milk.		
	1. Enumeration of bacteria from milk by SPC method 2. Direct Microscopic Count (DMC) of Milk 3. Detection of presence of Coliform in milk. 4. Detection of presence of Yeast and Mold in milk. 5. MBRT test. 6. Resazurin Reduction Time Test. 7. Phosphatase test. 8. SPC of buttermilk, cheese. 9. Isolation of bacteria from spoiled milk 10. Isolation of bacteria from spoiled cheese. 11. Isolation of bacteria from spoiled wine. 12. Isolation and identification of Lactic acid bacteria from Curd	30

Reference Books: -

1. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology Metropolitan
2. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.

2VSCII	**2VSC 03 MIC 39 Analytical Microbiology**	**No. of Hours per Unit/Credit**
Course Outcomes: Upon successful completion of course, students are expected to be able to- CO1: Prepare buffer solutions CO2: Use and explain principle and working of spectrophotometer and pH meter CO3: Estimate the various macromolecules likes DNA , RNA & carbohydrates in given sample CO4: Explain various analytical methods used for separations		
	1. Preparation of Molar and Normal Solution of HCL and NaOH **2.** Preparation of Phosphate buffer **3.** Demonstration of analytical instruments- pH meter and Spectrophotometer. **4.** Estimation of protein by Biuret method **5.** Estimation of carbohydrates by Molish methods. **6.** Estimation of RNA by Orcinol method **7.** Estimation of DNA by diphenyl amine method **8.** Estimation of amino acids by Ninhydrine method **9.** Dry weight analysis of bacterial cell mass by indirect method **10.** Paper chromatography method **11.** Thin layer chromatography **12.** Calibration of colorimeter (Verification of Beer's law) **13.** Determination of absorption maxima. **14.** Determination of Molar extinction coefficient.	30

Reference Books: -

1. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
2. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

DSC – PR- III	2 DSC 03 MIC 39 Microbiology Lab - 3	No. of Hours per Unit/Credit
	1. Effect of environmental factor on microorganisms: (i) Temperature (ii) pH (iii) Heavy metals – Copper (iv) Salt (NaCl) (v) Antibiotic (Penicillin & Streptomycin) 2. Primary Screening of- (i) Antibiotic producers–crowded plate technique. (ii) Amylase producers. 3. Determination f growth phases of *E.coli* by Optical density. 4. Study of diauxic growth. 5. Biostatistics – Measures of central tendency: Mean, Median and Mode 6. Micrometry. 7. Stains and staining procedures: i) Spore staining (Dorner's method) ii) Flagella staining (Bailey's method) iii) Nucleus staining (Giemsa's method) using yeast cells.	30

MIN–PR- III (Minor)	2 MIN 03MIC 39 Microbiology Lab - 3	No. of Hours per Unit/Credit
	Major: **1.** Isolation of *Azotobacter* from soil. **2.** Isolation of *Xanthomonas* from infected citrus fruit. **3.** Isolation of *Rhizobium* from root nodules. **4.** Isolation of phosphate solubilizing bacteria from soil. **5.** Determination of BOD of sewage **Minor:** 1. Determination of texture, color, pH of soil. 2. Estimation of Calcium and Magnesium from soil (EDTA method) 3. Determination of organic carbon content of soil (Walkley and Black method) **4.** Determination of COD of sewage.	30

Reference Books:

1. Practical Biochemistry –Plummer, Third Edition (2017), McGraw Hill Educational
2. APHA (American Public Health Association) Handbook
3. Soil, Plant and Water Analysis - P.C. Jaiswal, Third Edition(2018), Kalyani Publishers
4. Practical Microbiology–R.C. Dubey, D.K. Maheshwari, S. Chand & Co. Ltd.

SEMESTER IV

Paper VII	**2 DSC03 MIC 41: Medical Microbiology -**	**No. of Hours per Units**
Course Outcomes: Upon successful completion of course, students are expected to be able to- CO1: Understand basic principles of medical microbiology& infectious disease. CO2: Explain various ways of prevention and control of microbial diseases. CO3: Understand the silent features of Ag-Ab reaction & its uses. CO4: Describe the types of organs involved in immune system.		
Unit I	**Medical Microbiology**	7
	A. Definitions– Host, Parasite, Saprophytes, Commensal, Infection, Etiological agent, Disease, Pathogen, Opportunistic pathogen, True pathogen, Virulence, Pathogenicity, Fomite, Incubation period, Carriers, Morbidity rate, Mortality rate, epidemiology, etiology, Prophylaxis, Antigen, Antibody, Hapten, Vaccine, Immunity. **B. Virulence factors**- Production of endotoxins, exotoxins, enzymes, Ability to escape from phagocytosis. **C. Types of infections–** Chronic, acute, primary, secondary, reinfection, Iatrogenic, congenital, local, generalized, Covert, Overt, Simple, Mixed, Endogenous, Exogenous, Latent, Pyogenic, Nosocomial. **D. Types of diseases–** i) Epidemic–e.g. Influenza, Cholera ii) Endemic–E.g. Common cold, Typhoid iii) Pandemic–E.g. SARS, Corona iv) Sporadic–E.g. Polio	

Unit II	**Transmission and preventions of diseases**	8
	A. Modes of transmission of diseases 1. Air-borne transmission, 2. Vehicle transmission 3. Contact transmission 4. Vector borne transmission **B.** General principles of prevention and control of microbial diseases. **C.** Normal flora of human body& its significance -(Flora of skin, throat, GI tract & Urogenital tract). 1. Beneficial and harmful aspects of normal flora 2. Concept of antibiosis.	
Unit III	**Immunology**	7
	A. Immunity: 1. Definition 2. Innate Immunity-types, factors influencing innate immunity 3. Acquired Immunity– Active & passive **B.** Non Specific defense mechanisms of the vertebrate body 1. First line of defense 2. Second line of defense **C.** Organs of Immune system-Types of Primary and secondary lymphoid organs	
UNIT IV	**Antigen And Antibodies**	8
	A. Antigen-Chemical nature, types of antigens, factors affecting antigenicity. **B.** Antibody-Structure, properties and functions, types of antibodies. **C.** Theories of antibody production. **D.** Mechanism of antigen–antibody reaction–Lattice hypothesis. **E.** Types of antigen antibody reaction-Agglutination & Precipitation. **F.** Immune Response: Primary and secondary immune responses.	

Reference Books:

1. Foundation in Microbiology–by Kathleen Park talaro, Arther Talaro(2017), McGraw-Hill Co
2. Zinsser's Microbiology–by Wolfaging K. Joklik(1995), McGraw-Hill Co.
3. Microbiology–Pelczar, Reid and Chan, Fifth Edition (1986), McGraw Hill Inc.
4. Fundamentals of Microbiology–Frobisher et al, Thomson Learning
5. Fundamental principles of Bacteriology–A. G. Salle, Dodo Press (2017)
6. Textbook of Microbiology–Ananthnarayan and Pannikar, Nineth Edition (2013), Universities Press

Paper VIII	2 DSC03 MIC 42 :Microbial Genetics - I	No. of Hours per Units

Course Outcomes: Upon successful completion of course, students are expected to be able to-

CO1: Understand basic concepts of gene, mutation and DNA repair and recombination.

CO2: Describe the importance of genetic code &discuss molecular mechanism underlying mutation.

CO3: Understand & explain the various gene transfer mechanisms in bacteria.

CO4: Understand Natural and artificial plasmids

Unit I	Microbial Genetics	7
	A. Basic concepts of genetics– **1.** Basic terminologies–Gene, genome, genotype, phenotype, mutagen, recon, muton, cistron, split genes. **2.** Forms of DNA **3.** Genetic code–definition and properties of genetic code. **4.** Organization of Chromosomal DNA in *E.coli.*	
Unit II	**Mutation**	8
	Mutation: - **A.** Basic Concepts of Mutation: Base pair substitutions, Frame shift, missense, nonsense, neutral, silent, pleiotropic and suppressor mutations. **B.**Spontaneous mutation–Definition and basic concepts. **C.**Induced mutations–Definition and mechanism of mutagenesis by– 1. Base analogues: 5-Bromouracil and 2-amino purines 2. Mutagens modifying nitrogen bases- Nitrous acid, Hydroxyl amine, Alkylating agents 3. Mutagens that distort DNA– Acridine dyes and UV light.	

Unit III	**Molecular Biology**	8
	Gene transfer in bacteria. 1. Fate of exogenote in recipient cell. 2. Modes of gene transfer– a) Transformation. b) Conjugation c) Transduction	
UNIT IV	**DNA and Plasmid**	7
	A. DNA repair: 1. Photo reactivation 2. Dark repair mechanism (Excision repair) **B.** Plasmids– 1. Natural–Properties, types, structure & applications 2. Artificial -p BR 322- structure and applications	

Reference Book:

1. Microbial Genetics–by Stanley R. Maloy , David Freifelder and John E. Cronan, Second Edition (1994), Jones and Bartlett Publishers Inc
2. Molecular Genetics of Bacteria–by Larry Snyder, Wendy Champnes, Third Edition (2007), American Society for Microbiology.
3. General Microbiology–Vol. I and Vol. II– Pawar and Daginawala, Himalaya Publication
4. Lehningers Biochemistry, David L. Nelson, Michael Cox, Fifth Edition, W.H. Freeman
5. A Text book of Microbiology – R. Dubey, D. K. Maneshwari, S. Chand Co. Ltd. Ramnagar New Delhi 110055.

SEMESTER IV (MINOR)

Paper VII	**2 MIN 03MIC 41: Food Microbiology**	**No. of Hours per Units**
Course Outcomes: Upon successful completion of course, students are expected to be able to- CO1: Understand the cause of spoilage of food. CO2: Explain various principles and methods of preservation of food. CO3: Understand the Role of microorganisms in food borne diseases. CO4: Apply their knowledge for production of probiotic and fermented products.		
Unit I	**Food Microbiology**	8
	A. Food as a substrate for microorganisms. **B.** Principles of microbial spoilage of food: 1. Spoilage of fruits 2. Spoilage of breads 3. Spoilage of meat	
Unit II	**General principles and methods of food preservation**	7
	1. Asepsis 2. Removal of microorganism – trimming , filtration ,centrifugation 3. Dehydration method 4. Irradiation 5. Anaerobiosis 6. Chemical preservatives	
Unit III	**Food borne diseases**	7
	Food borne diseases – Role of microorganisms in food borne diseases **A.** Food poisoning – i) Staphylococcal ii) Fungal (aflatoxin) **B.** Food infections –Salmonellosis	
Unit IV	**Industrial Production Of Fermented Foods**	8
	Industrial Production, Spoilage Of Fermented Foods And Its Preservation **A. Probiotics**- Concept, Production by using *Lactobacillus* and applications	

	B. Fermented vegetables -sauerkraut fermentation. **C. Alcoholic Beverages:** Wine: a) Red Table Wine b) Sparkling Wine- Champagne	

Reference Books:

1. Food Science (1996) , Fifth Edition by Norman and Potter
2. Food Microbiology Frazier, McGraw Hill Educational
3. Dairy Microbiology by J.S.Yadav, S. Grover, and V.K. Batish, (1993), Metropolitan

Paper VIII	2 MIN 03MIC 42 :Industrial Microbiology -	No. of Hours per Unit/ Credit

Course Outcomes: Upon successful completion of course, students are expected to be able to-

CO1: Understand basic concepts of fermentation.

CO2: Understand the importance of fermentation media and inoculum preparation.

CO3: List the industrially important microorganisms using screening technique.

CO4: Know methods used for industrial production of various products using microorganisms

Unit I	**Fermentation Microbiology**	7
	Basic concepts of fermentation. **A.** Definition, concept of primary and secondary metabolites **B.** Types of fermentations – Batch, continuous, dual and multiple. **C.** Typical Fermenter design – Parts and their functions. **D.** Factors affecting fermentation process.	
Unit II	**Fermentation media and Inoculum preparation**	8
	A. Water, carbon source, nitrogen source, precursors, growth factors, antifoam agents, chelating agents. **B.** Use of wastes as Fermentation media – Molasses, sulphite waste liquor & corn steep liquor**.** **C. Production strains** **1.** Concept **2.** Preparation of inoculum **3.** Strain improvement	
Unit III	**Screening of industrially important microorganisms**	7
	A. Primary Screening of : 1. Antibiotic producers 2. Organic acid producers 3. Amylase producers	

	B. Secondary screening	
UNIT IV	**Industrial production**	8
	Industrial production – Organisms used Inoculum preparation, Fermentation media, Fermentation conditions, Extraction and Recovery. **A. Primary metabolite:** **i) Amino acids**: Lysine **&** Glutamic acid **ii) Organic acid** : Citric acid **&**Lactic acid **B. Secondary metabolite** **i) Antibiotics:** **a.** Penicillin & semi-synthetic penicillin **ii) Alcoholic Beverages:** Wine: a) Red Table Wine b) Sparkling Wine- Champagne	

Reference:

1. Bailey J.E and Ollis D.F. (1986) Biochemical Engineering Fundamentals 2nd ed.McGraw Hill Book Company, N. Delhi.
2. Stanbury P.F., Whitaker A, and Hall S.J. (1997) Principles of Fermentation Technology 2
3. Stainer R. Y. Ingrahm J. L., Wheelis M. L. and Painter P. R. (1987) General Microbiology 5th Edition, Macmillan Press Ltd. London

2 OE PR-II	2 OEC 03MIC 41 Water Microbiology	No. of Hours per Unit/Credit
Course Outcomes: Upon successful completion of course, students are expected to be able to- CO1: Learn about applied microbiology techniques related to water microbiology CO2: Perform and demonstrate different methods used to determine the quality of water CO3: Learn about role of microbes in water CO4: Determine potability of water.		
	1. Enumeration of bacteria from water by SPC method 2. MPN of water 3. Enumeration of bacteria from water by SPC method. 4. Enrichment of coliform from water by MacConkeys broth. 5. Presumptive test for coliform. 6. Total viable count of microorganisms present in water by membrane filter techniques 7. IMViC 8. Determination of dissolved oxygen concentration of water 9. Determination of residual free chlorine in water. 10. Determination of COD of sewage. 11. Determination of BOD of sewage. 12. Eijkman's test	30

Reference Books: -

1. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology Metropolitan
2. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

VSC II	**2 VSC 03 MIC 39 Water and Milk Microbiology**	**No. of Hours per Unit**
Course Outcomes: Upon successful completion of course, students are expected to be able to- CO1: Learn about applied microbiology techniques related to milk & water microbiology CO2: Perform and demonstrate different methods used to determine the quality of milk CO3: Learn about role of microbes in milk & water CO4: Describe methods used to determine the quality of water.		
	1. Enumeration of bacteria from milk by SPC method **2.** Direct Microscopic Count (DMC) of Milk **3.** Detection of presence of Coliform in milk. **4.** Detection of presence of Yeast and Mold in milk. **5.** MBRT test. **6.** Phosphatase test. **7.** Resazurin Reduction Time Test **8.** Enumeration of bacteria from water by SPC method **9.** MPN **10.** Qualitative test of water: **11.** IMViC	30

Reference Books: -

1. Environmental Pollution by Chemicals- Walker, Second Edition(1975), Hutchinson
2. Biochemistry and Microbiology of Pollution-Higgins and Burns,(1975), Academic Press Inc
3. Environmental Pollution-Laurent Hodge, Hol, New York Publication.
4. Waste Water Treatment– Datta and Rao, Oxford and IBH Publishing company
5. Sewage and waste treatment–Hammer, Seventh Edition (2012), Prentice Hall India Learning Pvt.Ltd

DSC – PR- III	2 DSC 03 MIC 49 Microbiology Lab - 4	No. of Hours per Unit/Credit
	1. Preparation of media: Tripal sugar iron agar, Gelatin agar, Amino acid decarboxylation medium, Amino acid deamination medium, Arginine broth, Christensen's medium, Peptone nitrate broth, Hugh and Leifson's medium, Egg-Yolk agar, Mannitol salt agar. **2. Biochemical tests**: (i) Gelatin hydrolysis test. (ii) Amino acid decarboxylation test (iii) Amino acid deamination test (iv) Arginine hydrolysis test (v) Urea hydrolysis test (vi) Nitrate reduction test (vii) Hugh and Leifson's test (viii) Oxidase test (ix) Lecithinase test (x) Coagulase test **3. Isolation and identification of pathogenic microorganisms from clinical sample**. (a)*Salmonella species* (b) ***S.aureus*** (c)*Proteus species* **4.** Serological tests-Widal test–qualitative slide test.	30

MIN–PR- III (Minor)	2 MIN 03MIC 39 Microbiology Lab - 3	No. of Hours per Unit/Credit
	Major: **1.** Primary Screening of Antibiotic procedures – crowded plate technique. **2.** Primary Screening of Amylase procedures. **3.** Primary Screening of Organic procedures. **4.** Sauerkraut production **5.** Probiotic production **Minor:** 1. Citric acid fermentation, recovery and estimation by titration. 2. Amylase production by using *Bacillus* species. 3. Isolation of lactic acid bacteria from fermented food. 4. Estimation of lactic acid by titration method.	30

Practical Examination

(A) The practical examination will be conducted on two consecutive days for six hours per day per batch of the practical examination.

(B) Each candidate must produce a certificate from the Head of the Department in her/his 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.

(C) Candidates have to visit at least one place of microbiological interest (pharmaceutical/ industry/dairy/research institute etc.) and submit the report of their visit

EVALUATION PATTERN

Scheme of Marking: Theory

Sem.	Core Course	Marks	Evaluation	Answer Books	Standard of passing
III	2 DSC- 03 MIC31	40	Semester wise	As per Instruction	35% (14 marks)
III	2DSC- 03 MIC32	40	Semester wise	As per Instruction	35% (14 marks)
III	2MIN 03 MIC 31	40	Semester wise	As per Instruction	35% (14 marks)
III	2MIN 03 MIC 32	40	Semester wise	As per Instruction	35% (14 marks)
IV	2DSC- 03 MIC41	40	Semester wise	As per Instruction	35% (14 marks)
IV	2DSC- 03 MIC42	40	Semester wise	As per Instruction	35% (14 marks)
IV	2MIN 03 MIC 41	40	Semester wise	As per Instruction	35% (14 marks)
IV	2MIN 03 MIC 42	40	Semester wise	As per Instruction	35% (14 marks)

SCHEME OF MARKING (CIE) Continuous Internal Evaluation

Sem.	Core Course	Marks	Evaluation	Answer Books	Standard of passing
III	2 DSC- 03 MIC31	10	Semester wise	As per Instruction	35% (4 marks)
	2 DSC- 03 MIC32	10	Semester wise	As per Instruction	35% (4 marks)
	2MIN 03 MIC 31	10	Semester wise	As per Instruction	35% (4 marks)
	2MIN 03 MIC 32	10	Semester wise	As per Instruction	35% (4 marks)
IV	2 DSC- 03 MIC41	10	Semester wise	As per Instruction	35% (4 marks)
	2 DSC- 03 MIC42	10	Semester wise	As per Instruction	35% (4 marks)
	2MIN 03 MIC 41	10	Semester wise	As per Instruction	35% (4 marks)
	2MIN 03 MIC 42	10	Semester wise	As per Instruction	35% (4 marks)

SCHEME OF MARKING (PRACTICAL)

Sem.	Course Code	Marks	Evaluation	Sections	Standard of Passing
III and IV	2 DSC 03 MIC 39	**50**	Semester wise	As per Instruction	40%
	2 DSC 03 MIC49	50			

Sem.	Course Code	Marks	Evaluation	Sections	Standard of Passing
III and IV	2 MIN 03 MIC 39	**50**	Semester wise	As per Instruction	40%
	2 MIN 03 MIC 49	50			

***A separate passing is mandatory**

Nature of Question Paper

Instructions:

1. All the questions are **compulsory**.
2. Figures to the right indicate **full** marks.
3. Draw neat labeled diagrams **wherever** necessary.
4. Use of calculator is allowed.

Time: 2 hours ***Total Marks: 40***

Section A/Section B

Q.1 MCQ **8 Marks**

i)

a. b. c. d.

ii)

a. b. c. d.

iii)

a. b. c. d.

iv)

a. b. c. d.

v)

a. b. c. d.

vi)

a. b. c. d.

vii)

a. b. c. d.

viii)

a. b. c. d.

Q. 2 Attempt any two 16 marks

i)

ii)

Q. 3 Attempt any four 16 marks

i)

ii)

iii)

iv)

v)

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Instruction to paper setters: Equal weight age should be given to all units

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For Continuous Internal Examination: (20 marks)

Mandatory 1) Presently -----**(5 marks)**

***Select any one for B. Sc. II----- (10 marks)**

1) Unit test

2) Home assignment

3) Project

4) Seminar

*Yet it is not finalized