FOR 2 –YEAR PG PROGRAMME IN INDUSTRIAL MICROBIOLOGY

Scheme B-1 (For Courses of Science & Arts Discipline having Major Practicum Component)

Year / Semester		Course Type				Total Credits
		Course Level	**Core Courses/ Dissertation**	**Practicum Courses**	**Internship/Apprenticeship/Seminar OR VAC** (CHM/EESC)	
First Year	**Sem-I**	400	CC-11 (6 Credits) Cell biology & Biochemistry of Microorganisms	PC-11 (4 Credits) Practical based on- Cell biology & Biochemistry of Microorganisms	Internship/Apprenticeship ***OR*** Seminar (2 Credits)	**22**
		400	CC-12 (6 Credits) Microbial Metabolism & Physiology	PC-12 (4 Credits) Practical based on- Microbial Metabolism & Physiology		
	Sem-II	400	CC-21 (6 Credits) Analytical techniques in Microbiology	PC-21 (4 Credits) Practical based on- Analytical techniques in Microbiology	VAC (CHM/EESC) (2 Credits)	**22**
		400	CC-22 (6 Credits) Fermentation Technology	PC-22 (4 Credits) Practical based on- Fermentation Technology		

Note: Students who exit at the end of 1 " year shall be awarded a postgraduate Diploma.

OPTION- 1: Only Course Work
(Applicable to the UTDs/Colleges)

Year / Semester		Course Level	Core Courses/ Dissertation	Practicum Courses	Internship/Apprenticeship/Seminar OR VAC (CHM/EESC)	Total Credits
Second Year	**Sem-III**	500	CC-31 (6 Credits) Industrial Production processes	PC-31 (4 Credits) Practical based on- Industrial Production processes	Internship/Apprenticeship ***OR*** Seminar (2 Credits)	**22**
		500	CC-32 (6 Credits) Bioprocess technology & Biosafety	PC-32 (4 Credits) Practical based on- Bioprocess technology & Biosafety		
	Sem-IV	500	CC-41 (6 Credits) Microbial Biotechnology	PC-41 (4 Credits) Practical based on- Microbial Biotechnology	VAC (CHM/EESC) (2 Credits)	**22**
		500	CC-42 (6 Credits) Genomics, Bioinformatics & Biostatistics	PC-42 (4 Credits) Practical based on- Genomics, Bioinformatics & Biostatistics		

OPTION- 2: Course Work & Research Work

(Applicable to the UTDs/Colleges having research centers recognized by the University)

Year / Semester		Course Level	Core Courses/ Dissertation	Practicum Courses	Internship/Apprenticeship/Seminar OR VAC (CHM/EESC)	Total Credits
Second Year	Sem-III	500	CC-31 (6 Credits) Industrial Production processes	PC-31 (4 Credits) Practical based on- Industrial Production processes	Seminar (2 Credits)	22
		500	CC-32 (6 Credits) Bioprocess technology & Biosafety	PC-32 (4 Credits) Practical based on- Bioprocess technology & Biosafety		
	Sem-IV	-	-	-	Research thesis/Project/Patent (22 Credits)	22

OPTION- 3: Only Research Work

(Applicable to the UTDs/Colleges having research centers recognized by the University

Second Year	Sem-III	Research thesis/Research Project/Patent (22 Credits)	22
	Sem-IV	Research thesis/Research Project/Patent (22 Credits)	22

Note: (1) UTDs/Colleges with Research Centers have the choice of running all the OPTION mentioned above.

(2) Students having 4 –Year Under Graduate Degree (Honours/Honours with Research) are eligible for entry in the Semester –I of I-year PG Programme.

Syllabus of Theory Paper

Part A Introduction				
Program: 1 year PG diploma/ 2 year PG Programme		Class`: M Sc	Year: First year (Semester-I)	Session: 2025-26
Subject: Industrial Microbiology				
1	Course Code	CC - 11		
2	Course Title	Cell Biology and Biochemistry of Microorganisms		
3	Course Type (Core Course)	Core		
4	Pre-requisite (if any)	To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in three years Undergraduate level degree.		
5	Course Learning outcomes (CLO)	On completion of this course, learners will be able to demonstrate a knowledge and understanding of: • The basic principle of biochemistry including important molecules their economic and scientific importance inside the cell. • biochemical pathways of synthesis and degradation of these molecules and the transport of different metabolites generated with application in industrial processes. • Knowledge of major molecules, carbohydrate, lipids, proteins, amino acids and nucleic acid. • comprehensive knowledge of the cell biology and its functions.		
6	Credit Value	06		
7	Total Marks	Max. Marks: 40+60	Min. Passing Marks:40	

Department of Higher Education

Part B- Content of the Course		
Total No. of Lectures-Tutorials-Practical (90 hours): **L-T-P:**		
Unit	**Topics**	**No. of Lectures (in Hrs)**
I	1.1 Impact of microorganisms in human civilization. Drishya (Visible) and Adrishya (invisible) microorganism description in Atherva Veda. 1.2 Structural organization of intracellular organelles: Cell wall, nucleus, mitochondria, golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast. 1.3 Function of intracellular organelles. 1.4 Structure & function of cytoskeleton and its role in motility. 1.5 Ribosome and protein synthesis: Ribosome, structure of 70s & 80s, polyribosomes. protein synthesis.	**18**
II	2.1 Cell signalling: primary messengers, cell-cell communication, modes of cell signalling, signal transduction pathways, cell junctions. 2.2 Overview of the extracellular signalling, signalling pathways, membrane receptors. 2.3 G-Protein coupled receptors and their effectors. Receptor tyrosine kinases. Ligand gated channels, Integrins, 2.4 Second messengers. cAMP. phospholipids and Calcium, insulin signalling. 2.5 Cell regulation: Cell growth and division. Cell cycle, phases of cell cycle, mitotic events, cell cycle check points, maturation promoting factor (MPF), cyclins and cdk. cell Synchrony	**18**
III	3.1 Carbohydrates: Stereoisomerism, aldose and ketose family of monosaccharides. Structure of oligosachharides and polysaccharide. 3.2 Enzymatic degradation of polysaccharides. 3.3 Amino Acids: Classification, structure and properties of amino acids. 3.4 Non protein amino acids, methods of separation of amino acid mixture. Detection of amio acids. 3.5 Protein degradation and amino acid sequencing. N-terminal and C terminal detection	**18**

Department of Higher Education

23/6/25

IV	4.1 Proteins: The peptide bond, primary secondary , tertiary and quaternary structure. 4.2 Alpha helix, beta plated sheet, beta turn, super secondary structure, motifs. 4.3 Position and number of disulfide bonds. 4.4 Constraints for polypeptide confirmation. Ramachandran plot. 4.5 Isolation and purification of proteins. Criterion of purity.	**18**
V	5.1 Enzymes: Classification and nomenclature. 5.2 Enzyme kinetics and Michaelis-Menton equation. Measurement of enzyme activity, specific activity, turnover number. Kinetics of enzyme inhibition. 5.3 Mechanism of enzyme action. Factors contributing to the catalytic efficiency of enzymes. 5.4 Regulation of enzyme activity: Allosteric enzymes , cumulative and coordinated regulation. Isozymes, covalent modification, zymogen. 5.5 Diagnostic importance of enzymes. Coenzymes.	**18**

Activities:

- *Listing charts of different cell cycles, Biochemical pathways and enzyme related activities.*
- *Industrial visit/ field visit to observe different biochemical pathways*
- *Preparation charts and models related to modules*
- *Registration of Virtual labs for activities related to modules from different web labs.*
-

Keywords/Tags: *Visible, invisible microorganisms, enzymes, proteins, cell signalling*

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Principles of Biochemistry Voet & Voet John Wiley & sons
2. Principles of Biochemistry . Lehninger by Nelson and Cox .
3. Biochemistry Lubert stryer. W.H.freeman .
4. Cell and Molecular Biology. 811' Edition. Eduardo D. P. De Robertis, E. M. F. De Robertis. Lippincott Williams & Wilkins, 2010.
5. The Cell: A Molecular Approach. 6th Edition. Geoffrey M. Cooper, ASM Press 2013
6. Cell and Molecular Biology: Concepts and Experiments. 6lh Edition. Gerald Karp. John Wiley & Sons, Inc. 2010
7. Suggestive digital platforms web links https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Learning for Higher Education

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks : 100

Continuous Comprehensive Evaluation (CCE) : 40marks University Exam (UE) 60 marks

Internal Assessment : Continuous Comprehensive Evaluation (CCE):40	Class Test / Assignment/ Presentation	40
External Assessment : University Exam Section: 60 Time : 03.00 Hours	**Section(A)** : Five Very Short Questions (50 Words Each) **Section (B) :** Five Long Questions (500 Words Each)	02 x 05 = 10 05 x 10 = 50 **Total 60**

Any remarks/ suggestions:

Department of Higher Education

Syllabus of Practicum Course

Part A Introduction			
Program: 1 year PG diploma/ 2 year PG Programme	**Class`: M. Sc.**	**Year: First (Semester-I)**	**Session: 2025-26**
Subject: Industrial Microbiology			

1	**Course Code**	**PC - 11**
2	**Course Title**	**Cell Biology and Biochemistry of Microorganisms**
3	**Course Type (Core Course)**	**Practical course**
4	**Pre-requisite (if any)**	**To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in three years Undergraduate level degree**
5	**Course Learning outcomes (CLO)**	• **Student will be equipped with the knowledge to handle microbes and basic biochemical and cell biology practices used in microbiological laboratory.** • **Various basic techniques to isolate, characterize the microbes morphologically will be known to them.** • **and the knowledge can be applied for advanced research.**
6	**Credit Value**	**04**
7	**Total Marks**	Max. Marks: 40+60 / Min. Passing Marks:40

Part B- Content of the Course

Total No. of Lectures-Tutorials-Practical (120 hours):
L-T-P:

Practical	Topics	Hrs
Part A- Cell Biology:	1. Observing cheek cells morphology under microscope 2. observing onion epidermis cells morphology under microscope 3. Observing cell division stages in growing onion tips. 4. Isolation of chloroplast from spinach leaves. 5.Counting of RBC and WBC in Neubars chamber 6. Differential leukocyte count using Leishman stain. 7. Whole genomic DNA isolation from blood. 8. Agarose gel electrophoresis of DNA. 9. Estimation of purity of DNA spectrophotometerically. 10.Isolation of Lymphocytes by Histopaque	**120**

Department of Higher Education

Part B Biochemistry	1. Estimation of protein by spectrophotometery at 280 nm. 2. Estimation of protein by Lowery method, 3. estimation of protein by Biuret method. 4. Recording the absorption spectra of Tryophan, tyrosine, Phnylalanine 5. Recording the absorption spctra of protein and determining lamda max. 6. Estimation of carbohydrate by DNS method 7.Estimation of carbohydrate by Dubois method. 8.Estimation of DNA by DPA method. 9. Estimation of RNA by orcinol method. 10. Estimation of Starch by iodine KI method. 11. Estimation of activity of salivary amylase by using iodine KI method 12. Study of effect of pH on salivary amylase activity 13. Study of effect of temperature on Amylase activity. 14. Determination of km and V max of salivary amylase. 15. Preparation of different buffers and finding their buffering capacity. 16.Demonstration of SDS PAGE. 17. Demonstration of western blotting. 18. Isolation of casein from milk and its quantitation. 19. Demonstration of gel filtration using kit. 20. demonstration of NATIVE PAGE using casein. 21. Perform modules related virtual lab experiment from different web labs.	
Keywords/Tags: *Absorption spectra, protein, carbohydrate*		

Department of Higher Education

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. "Laboratory Manual in Biochemistry" by J. Jayaraman
2. "Practical Biochemistry" by R. N. Sawhney&Randhir Singh
3. "Principles and Techniques of Biochemistry and Molecular Biology" by Keith Wilson & John Walker
4. Microbial Metabolism & Biotechnology: E-Book http://www.twinamasiko.com/IOBB/Eublications/Biotechnology Lc Book.pdf
5. Physiology and Biochemistry of Prokaryotes: David White Bacterial Physiology and Metabolism: BH Kim and GM Gadd
6. Bacterial Metabolism: Gerhard Gottschalk
7. Bacterial Metabolism: HW Doelie
8. Micro rial Energetics: EA Dawe
9. Analytical techniques: Holme and Peck
10. Analytical Instrumentation handbook: Jack Gazes, CRC press
11. Analytical techniques in Biochemistry and Molecular biology: R Katoch
12. Biological Instrumentation and methodology: PK Bajpai

2. Suggestive digital platforms web links

Suggestive digital platforms web links https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Internal Assessment	Marks	External Assessment	Marks
Class Interaction /Quiz	10	Viva Voce on Practical	10
Attendance	10	Practical Record File	10
Assignments (Charts/ Model Seminar / Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey / Industrial visit)	20	Table work / Experiments	40
TOTAL	40		60

Any remarks/ suggestions:

Department of Higher Education

Syllabus of Theory Paper

Part A Introduction				
Program: 1 year PG diploma/ 2 year PG Programme		Class`: M Sc	Year: First year (Semester-I)	Session: 2025-26
Subject: Industrial Microbiology				
1	Course Code	CC - 12		
2	Course Title	Microbial Metabolism and Physiology		
3	Course Type (Core Course)	Core		
4	Pre-requisite (if any)	To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in three years Undergraduate level degree programme.		
5	Course Learning outcomes (CLO)	On completion of this course, learners will be able to demonstrate a knowledge and understanding of: • Microbial growth and its nutrients requirements. • Concept of Nitrogen cycle and its applications and • Concept of bioenergetics and transport across membrane. • Provides a clear understanding about the biosynthesis and degradation pathways involved. • Addresses the fixation of molecular nitrogen into usable form by microorganism		
6	Credit Value	06		
7	Total Marks	Max. Marks: 40+60	Min. Passing Marks:40	

Department of Higher Education

Part B- Content of the Course		
Total No. of Lectures-Tutorials-Practical (90 hours): **L-T-P:**		
Unit	**Topics**	**No. of Lectures (in Hrs)**
I	1.1 Contribution of Indian sages in development of ancient Microbiology. Significance of microorganisms under Bhartiya Gyan Parampara. 1.2 Growth of Bacteria - Phases of Growth. Growth Kinetics Batch Culture, Continuous Culture and Synchronous Culture. 1.3 Factors Affecting Growth - Nutrition, Aeration, Temperature and pH. 1.4 Nutritional Types - Autotrophy, Heterotrophy, Chemotrophy, Phototrophy, Lithotophy and Organotropy. Nutrition - Essentiality of Major and Minor Elements. 1.5 Chemotrophism and their Importance, Chemoheterotrophism - Acetogens, Methanogens, Methanogenenesis and its Importance.	**18**
II	2.1 Bacterial Photosynthesis - General Types of Microbial Photosynthesis, Oxygenic and Anoxygenic. 2.2 Structure of Photosynthetic Pigments - Chlorophylls, Bacteriochlorophyll, Carotenoids and Phycobilins. Green Sulphur and Purple. 2.3 Mechanism of Photosynthesis Non-Cyclic and Cyclic. 2.4 ElectronTransport, Photo Phosphorylation. 2.5 Microbial Stress Responses - Osmotic Stress and Osmoregulation, Aerobic to Anaerobic Transitions, Oxidative Stress, pH Stress	**18**
III	3.1 Aerobic Respiration - TCA Cycle - Intracellular Location and Reactions, Amphibolic Reactions. Glyoxalate Cycle. 3.2 Mechanisms of Substrate - Level Phosphorylation. 3.3 Respiratory Electron Transport in Mitochondria and Bacteria. 3.4 Mechanism of Oxidative Phosphorylation. 3.5 Anaerobic Respirations - Sulphate, Nitrate, Carbonate Respirations and their Ecological Significance.	**18**
IV	4.1 Nitrogen Metabolism - Nitrogen Cycle. 4.2 Ammonification, Nitrification, Denitrification and Nitrogen Fixation. 4.3 Nitrogenase Enzyme, 4.4 Physiology of Nitrogen Fixation in Symbiotic and free Living Bacteria. 4.5 Protein metabolism.	

Department of Higher Education

V	5.1 Bioenergetics - Entropy, Enthalpy, Electron Carriers. 5.2 Artificial Electron Donars, Inhibitors, Uncouplers, Energy Bond and Phosphorylation. 5.3 Transport Across Membrane - Diffusion, Osmosis, Active Transport and Group Translocation. 5.4 Types of transport systems, PEP system of transport, ABC super family of transporters, OMPs, Ionophore antibiotics 5.5 Quorum Sensing - Mechanism and Signaling Molecules.	**18**

Activities:

- *Listing charts of different atmospheric cycles.*
- *Industrial visit/ field visit to observe mass scale production of microbial culture*
- *Preparation of charts and models related to modules*
- *Registration of Virtual labs for activities related to modules from different web labs.*

Keywords/Tags: *Visible, invisible microorganisms, enzymes, proteins, cell signalling*

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Microbial Metabolism & Biotechnology: E-Book http://www.twinamasiko.com/IOBB/Eu blications/B iotechnolo gyL_cB ook.pdf
2. Physiology and Biochemistry of Prokaryotes: David White Bacter ial Physiology and Metabolism: BH Kim and GM Gadd
3. Bacter ial Metabolism: Gerhard Gottschalk
4. Bacter ial Metabolism: HW Doelie
5. Microbial Energetics: EA Dawes
6. Biochemistry by Geoffrey L. Zubay. Fourth Edition Addison-Wesley educational publishers Inc.,2008.
7. Lehninger Principles of Biochemistry by David L. Nelson and Michael l,f. Cox. Fifth Edition, W.H. Freeman and Compary, 2008

2. Suggestive digital platforms web links https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks : 100

Continuous Comprehensive Evaluation (CCE) : 40marks University Exam (UE) 60 marks

Internal Assessment : Continuous Comprehensive Evaluation (CCE):40	Class Test / Assignment/ Presentation	40
External Assessment : University Exam Section: 60 Time : 03.00 Hours	**Section(A)** : Five Very Short Questions (50 Words Each) **Section (B) :** Five Long Questions (500 Words Each)	02 x 05 = 10 05 x 10 = 50 **Total 60**

Any remarks/ suggestions:

Document of Higher Education

Syllabus of Practicum Course

Part A Introduction				
Program: 1 year PG diploma/ 2 year PG Programme		Class`: M. Sc.	Year: First (Semester-I)	Session: 2025-26
Subject: Industrial Microbiology				
1	Course Code	PC - 12		
2	Course Title	Microbial Metabolism and Physiology		
3	Course Type (Core Course)	Practical course		
4	Pre-requisite (if any)	To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in three years Undergraduate level degree		
5	Course Learning outcomes (CLO)	• Student will be equipped with the knowledge to handle microbes and basic instrumentation used in microbiological laboratory. • Concept of Nitrogen cycle and its applications and • Concept of bioenergetics and transport across membrane. • Provides a clear understanding about the biosynthesis and degradation pathways involved. • Addresses the fixation of molecular nitrogen into usable form by microorganism		
6	Credit Value	04		
7	Total Marks	Max. Marks: 40+60	Min. Passing Marks:40	

Department of Higher Education

Part B- Content of the Course		
Total No. of Lectures-Tutorials-Practical (120 hours): L-T-P:		
Practical	**Topics**	**Hrs**
Metabolism and Physiology	1. Biochemical Test 2. Qualitative and quantitative estimation of Carbohydrates 3. Qualitative and quantitative estimation of Proteins 4. Qualitative and quantitative estimation of Lipids 5. Perform Iron Agar Test 6. Perform Nitrogen reductase Test 7. Perform Urease Test 8. Perform Catalase Test. 9. Observe Culture Characteristics of Microorganism 10. Quantitative estimation of any one enzyme 11. Isolation and Identification of Symbiotic nitrogen Fixer (*Rhizobium*) from root nodules 12. To study catalase activity of given microbial culture. 13. To study oxidase activity of given microbial culture. 14. To study ability of microorganisms to hydrolyse casein 15. To demonstrate phenylalanine deaminase activity of given bacterial culture. 16. To demonstrate L-lysine decarboxlylase activity of bacterial culture. 17. To demonstrate carbohydrate metabolism (oxidation and fermentation of Glucose) microorganisms . 18. To demonstrate Fat hydrolysis (lipase activity) by bacteria 19. To study ability of microorganisms to hydrolyze gelatin. 20. To demonstrate degradation of sulphur containing amino acids by bacteria 21. Perform modules related virtual lab experiments from different web labs.	**120**
Keywords/Tags: *Absorption spectra, protein, carbohydrate*		

Department of Higher Education

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. "Laboratory Manual in Biochemistry" by J. Jayaraman
2. "Practical Biochemistry" by R. N. Sawhney&Randhir Singh
3. "Principles and Techniques of Biochemistry and Molecular Biology" by Keith Wilson & John Walker
4. Microbial Metabolism & Biotechnology: E-Book http://www.twinamasiko.com/IOBB/Eublications/Biotechnology Lc Book.pdf
5. Physiology and Biochemistry of Prokaryotes: David White Bacterial Physiology and Metabolism: BH Kim and GM Gadd
6. Bacterial Metabolism: Gerhard Gottschalk
7. Bacterial Metabolism: HW Doelie
8. Micro rial Energetics: EA Dawe
9. Analytical techniques: Holme and Peck
10. Analytical Instrumentation handbook: Jack Gazes, CRC press
11. Analytical techniques in Biochemistry and Molecular biology: R Katoch
12. Biological Instrumentation and methodology: PK Bajpai

2. Suggestive digital platforms web links

Suggestive digital platforms web links https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Internal Assessment	Marks	External Assessment	Marks
Class Interaction /Quiz	10	Viva Voce on Practical	10
Attendance	10	Practical Record File	10
Assignments (Charts/ Model Seminar / Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey / Industrial visit)	20	Table work / Experiments	40
TOTAL	40		60

Any remarks/ suggestions:

Department of Higher Education

Syllabus of Theory Paper

Part A Introduction				
Program: 1 year PG diploma/ 2 year PG Programme		Class`: M Sc	Year: First year (Semester-II)	Session: 2025-26
Subject: Industrial Microbiology				
1	Course Code	CC - 21		
2	Course Title	Analytical techniques in Microbiology		
3	Course Type (Core Course)	Core		
4	Pre-requisite (if any)	To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in three years Undergraduate level degree.		
5	Course Learning outcomes (CLO)	On completion of this course, learners will be able to demonstrate a knowledge and understanding of: • Application of microbial techniques in various industries like pharmaceutical, chemical, food, dairy, beverage and agriculture. • History, types and applications of different types of Microscopy. • Separation techniques of chromatography, electrophoresis, centrifugation etc.		
6	Credit Value	06		
7	Total Marks	Max. Marks: 40+60	Min. Passing Marks:40	

Department of Higher Education

Part B- Content of the Course		
Total No. of Lectures-Tutorials-Practical (90 hours): **L-T-P:**		
Unit	**Topics**	**No. of Lectures (in Hrs)**
I	1.1 Microbiological scenario as depicted in the Ancient Sanskrit texts. 1.2 Cell disruption techniques: Homogenization, Mechanical and non Mechanical methods of cell disruption 1.3 Separation techniques: different gel electrophoresis techniques, principle and applications. 1.4 Centrifugation: basic principle, types, applications, components, preparative centrifugation: differential velocity and density gradient centrifugation. 1.5 Case Study: Analyze a research paper where cell disruption is a key step.	**18**
II	2.1 Basic principle and applications of Chromatography. 2.2 Different Paper, thin layer and column chromatography. 2.3 Adsorption chromatography, High performance chromatography. 2.4 HPLC, GLC, Ion-exchange chromatography, Affinity chromatography. 2.5 Data Interpretation Task: Give students results from differential centrifugation	**18**
III	3.1 Concept of Spectroscopy: Beer-Lambert Law. 3.2 Principle, types, components and applications of different types of spectrophotometer. 3.3 Spectrofluorimeter, IR spectrophotometry and their working principles, design and applications. 3.4 Working principle, design and applications of Atomic absorption spectrometer, Mass spectroscopy. 3.5 Spectro-Scavenger Hunt: Give clues to identify unknown samples based on their UV-Vis absorption data	**18**
IV	4.1 Basic principle, types components and applications of ESR. 4.2 Basic principle, types, componenets and applications of NMR spectroscopy 4.3 Advances in ESR and NMR spectroscopy and significance in advance research. 4.4 Radioisotopes: Basic principle and applications in Biology 4.5 Timeline Activity: Create a timeline of key discoveries in radioisotope applications in biology (e.g., radioactive tracers, cancer treatment).	**18**

Department of Higher Education

V	5.1 Microscopy: Basic principle, components, types and applications. 5.2 Principle, design and applications of Light and Dark field microscopy, Fluorescent and UV Microscopy. 5.3 Principle, design and applications of Phase contrast and Confocal microscopy, live cell imaging. 5.4 Principle, design and application of Electron microscope, Transmission and Scanning Electron microscopy. 5.5 Digital Image Interpretation: Provide a set of micrographs (light, TEM, SEM, confocal), and ask students to match them with correct techniques and organisms.	**18**

Activities:

- *Listing charts of different types of microscopy.*
- *Visit to Scientific laboratories to observe different advanced equipments*
- *Preparation charts and models related to modules*
- *Registration of Virtual labs for activities related to modules from different web labs.*

Keywords/Tags: *Ancient Sanskrit texts, chromatography, spectroscopy, Microscopy*

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Analytical techniques: Holme and Peck
2. Analytical Instrumentation handbook: Jack Gazes, CRC press
3. Analytical techniques in Biochemistry and Molecular biology: R Katoch
4. Principles of Instrumental Analysis, Skoog and West.
5. Biological Spectroscopy, Campbell and Dwek
6. Biological Instrumentation and methodology: PK Bajpai

2. Suggestive digital platforms web links https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks : 100

Continuous Comprehensive Evaluation (CCE) : 40marks University Exam (UE) 60 marks

Internal Assessment : Continuous Comprehensive Evaluation (CCE):40	Class Test / Assignment/ Presentation	40
External Assessment : University Exam Section: 60 Time : 03.00 Hours	**Section(A)** : Five Very Short Questions (50 Words Each) **Section (B) :** Five Long Questions (500 Words Each)	02 x 05 = 10 05 x 10 = 50 **Total 60**

Any remarks/ suggestions:

National Council of Higher Education

Syllabus of Practicum Course

Part A Introduction			
Program: 1 year PG diploma/ 2 year PG Programme	**Class`: M. Sc.**	**Year: First (Semester-II)**	**Session: 2025-26**
Subject: Industrial Microbiology			

1	**Course Code**	**PC - 21**	
2	**Course Title**	**Analytical techniques in Microbiology**	
3	**Course Type (Core Course)**	**Practical course**	
4	**Pre-requisite (if any)**	**To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in three years Undergraduate level degree**	
5	**Course Learning outcomes (CLO)**	**On completion of this course, learners will be able to demonstrate a knowledge and understanding of:** • **Application of microbial techniques in various industries like pharmaceutical, chemical, food, dairy, beverage and agriculture.** • **History, types and applications of different types of Microscopy.** • **Separation techniques of chromatography, electrophoresis, centrifugation etc.**	
6	**Credit Value**	**04**	
7	**Total Marks**	Max. Marks: 40+60	Min. Passing Marks:40

Department of Higher Education

Part B- Content of the Course

Total No. of Lectures-Tutorials-Practical (120 hours):
L-T-P:

Practical	Topics	Hrs	
Analytical Techniques	1. Demonstration of cell disruption using homogenization (e.g., spinach chloroplasts or yeast cells). 2. Mechanical disruption using sonication or bead beating for bacterial/fungal cells. 3. Non-mechanical method: osmotic shock or enzymatic lysis (e.g., lysozyme treatment for *E. coli*). 4. Operation and components of a laboratory centrifuge: identification and understanding of different rotors. 5. Differential centrifugation to fractionate cellular components (e.g., nuclei, mitochondria). 6. Density gradient centrifugation using sucrose gradient to separate organelles or macromolecules. 7. Thin Layer Chromatography (TLC) for separation of lipids or dyes. 8. Column chromatography using silica or resin to separate colored compounds. 9. Ion-exchange chromatography demonstration using protein or amino acid separation (simulation or simple system). 10. Affinity chromatography concept using agarose-based media (if accessible). 11. HPLC/GLC demonstration (through videos, software simulation, or in a centralized lab if available). 12. Beer-Lambert Law: Prepare a standard curve for a colored compound (e.g., KMnO□, CoCl□). 13. Use of UV-Vis spectrophotometer to determine concentration of DNA/protein. 14. Spectro fluorimeter demonstration using fluorescent dyes like fluorescent. 15. Demonstration of Atomic Absorption Spectrophotometer (if available or via video). 16. Use and calibration of compound light microscope. 17. Observation of live and stained cells under light microscope. 18. Phase contrast and fluorescence microscopy (demonstration or live imaging of fluorescent-stained cells). 19. Electron microscopy: demonstration of TEM and SEM images, components (video or virtual lab). 20. Confocal microscopy and live-cell imaging: visualization via videos or software simulations. 21. Perform modules related virtual lab experiments from different web labs.	**120**	**22. 25 Hrs**

Keywords/Tags: *lysozyme, centrifugation, spectrophotometer, microscope.*

Department of Higher Education

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. "Practical Biochemistry" by R. N. Sawhney&Randhir Singh
2. Analytical techniques: Holme and Peck
3. Analytical Instrumentation handbook: Jack Gazes, CRC press
4. Analytical techniques in Biochemistry and Molecular biology: R Katoch
5. Biological Instrumentation and methodology: PK Bajpai

2. Suggestive digital platforms web links

Suggestive digital platforms web links https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Internal Assessment	Marks	External Assessment	Marks
Class Interaction /Quiz	10	Viva Voce on Practical	10
Attendance	10	Practical Record File	10
Assignments (Charts/ Model Seminar / Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey / Industrial visit)	20	Table work / Experiments	40
TOTAL	40		60

Any remarks/ suggestions:

Department of Higher Education

Syllabus of Theory Paper

Part A Introduction				
Program: 1 year PG diploma/ 2 year PG Programme		Class`: M Sc	Year: First year (Semester-II)	Session: 2025-26
Subject: Industrial Microbiology				
1	Course Code	CC - 22		
2	Course Title	Fermentation Technology		
3	Course Type (Core Course)	Core		
4	Pre-requisite (if any)	To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in three years Undergraduate level degree.		
5	Course Learning outcomes (CLO)	On successfully completing the module, students will be able to demonstrate a knowledge and understanding of: • Basic fermentations processes, design of various fermenters and their types. • Different separation techniques and application of fermentation in waste treatment. • Students will be able to select industrially important microbes for economical use including protein products. • Finally students will learn the economics of the fermentation for the total cost of production.		
6	Credit Value	06		
7	Total Marks	Max. Marks: 40+60	Min. Passing Marks:40	

Department of Higher Education

Part B- Content of the Course		
Total No. of Lectures-Tutorials-Practical (90 hours): **L-T-P:**		
Unit	**Topics**	**No. of Lectures (in Hrs)**
I	1.1 Fermentation microbiology exists within Indian culture. Ethnic fermented foods and beverages of India. 1.2 Basics of fermentation. Design of a fermentor, Aseptic operation and containment, Fermentor body construction. 1.3 Design aspects of stirred tank reactors. Working volume, use of baffles and impellers. Configuration of impellers. Fermentor for microbial and animal cell culture, micropropagation of plants. 1.4 Alternative vessel design, common measurements and control systems. Design batch, fed batch and continuous enzymatic bioreactors. 1.5 Immobilized cell reactors and air□lift reactors. Sensors – solutions to common problems in fermentation.	**18**
II	2.1 Typical medium, water, energy sources, carbon sources, nitrogen sources, C/N ratio (importance in biomass and metabolite production), 2.2 Minerals, growth factors, nutrient recycle, buffers, addition of precursors and metabolic regulators to media, oxygen requirement. 2.3 Determination of the oxygen consumption rates during fermentation and evaluation of the oxygen solubility and transfer rates. 2.4 Determination of KLa values, Fluid rheology. Balance between scale up and down. 2.5 Methods of measuring variables in fermentation (aeration, agitation, valves, flow of fluids, pH, temperature, foam, pressure, redox)	**18**
III	3.1 Types of Media for industrial fermentations – media formulation. 3.2 Development of inoculum for industrial fermentations. Seed inoculum and growth library parameters. 3.3 Fermentation modeling-simulation microbial growth and metabolism. Microbial growth kinetics. 3.4 Structured and unstructured kinetic growth models. Monod's Growth kinetics, Specific growth rate, growth yield, production yield. 3.5 Yg, Yo2, Yatp, Saturation constant, maintenance energy.	**18**

Department of Higher Education

IV	4.1 Fermented food and its importance. 4.2 Fermented Food: Definition, types, advantages and health benefits. 4.3 Preparation of inoculums, types of microorganism and production processes. 4.4 Milk Dairy based fermented Food: Traditional and modern Dairy starter. 4.5 Cultured fermented dairy products, dry milk and condensed milk product, feud cultured butter milk, yoghurt, butter and cheese. kumises, Kefir.	**18**
V	5.1 Pre and Probiotic Food. 5.2 Grain based fermented foods as soya sauce, tempeh, bread ,Idly and Dosa , Dhokla, 5.3 Probiotics and other Indian fermented food (microorganism and products) 5.4 Vegetable based fermented foods: pickles, and sauerkraut (Microorganism and production processes). 5.5 Fermented fish and Meat: Types of microorganism involved in reduction processing or fermentation.	**18**

Activities:

- *Commercial uses and role of probiotics in human welfare*
- *Industrial visit/ field visit to observe mass scale production of microbial culture*
- *Preparation of fermented food.*
- *Demonstration of fermentation process for making daily food products*
- *Registration of Virtual labs for activities related to modules from different web labs.*

Keywords/Tags: *Fermentor, immobilization, probiotics, fermented food.*

Department of Higher Education

25/6/25

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Shuler, M. L., &Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
3. Blanch, H. W., & Clark, D. S. (1997). Biochemical Engineering.New York: M. Dekker.
4. Bailey, J. E., &Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.

2. Suggestive digital platforms web links https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks : 100

Continuous Comprehensive Evaluation (CCE) : 40marks University Exam (UE) 60 marks

Internal Assessment : Continuous Comprehensive Evaluation (CCE):40	Class Test / Assignment/ Presentation	40
External Assessment : University Exam Section: 60 Time : 03.00 Hours	**Section(A)** : Five Very Short Questions (50 Words Each) **Section (B) :** Five Long Questions (500 Words Each)	02 x 05 = 10 05 x 10 = 50 **Total 60**

Any remarks/ suggestions:

Department of Higher Education

Syllabus of Practicum Course

Part A Introduction			
Program: 1 year PG diploma/ 2 year PG Programme	**Class`: M. Sc.**	**Year: First (Semester-II)**	**Session: 2025-26**
Subject: Industrial Microbiology			

1	**Course Code**	**PC - 22**	
2	**Course Title**	**Fermentation Technology**	
3	**Course Type (Core Course)**	**Practical course**	
4	**Pre-requisite (if any)**	**To study this course, a student must have had the subject Microbiology/ Industrial Microbiology in three years Undergraduate level degree**	
5	**Course Learning outcomes (CLO)**	**On successfully completing the module, students will be able to demonstrate a knowledge and understanding of:** • **Application of microbial techniques in various industries like phannaceutical, chemical, food, dairy, beverage and agriculture.** • **To explore and create innovative ideas for research and development processes among the students, and find solutions to the existing problems.** • **Industrially important microbes for economical use including pharma products.**	
6	**Credit Value**	**04**	
7	**Total Marks**	Max. Marks: 40+60	Min. Passing Marks:40

Department of Higher Education

Part B- Content of the Course		
Total No. of Lectures-Tutorials-Practical (120 hours): **L-T-P:**		
Practical	**Topics**	**Hrs**
Fermentation Technology	1. Assemblage and materials of fermentor 2. Demonstration of working of various fermentors 3. Carry out stoichiometric calculations and specify models of bacterial growth 4. Problems related to microbial growth kinetics 5. Problems related to Monod kinetics 6. Give an account of design, operations and sterilization of various fermenters; 7. Calculation of substrate and yield in biological production process and interpretation of data 8. Carbon, nitrogen calculations of batch and fed batch fermentation process 9. Calculate the need for oxygen and oxygen transfer 10. Critically analyze any bioprocess from market point of view 11. Measurement of different variables and calculations in fermentation process. 12. To study antibiotic resistance in bacteria 13. Determination of thermal death point (TDP) and thermal death time (TDT)of an Organism 14. To demonstrate strain improvement of industrially important bacteria or yeast by mutagenesis and selection of improved strains. 15. Isolation of amylase producing microorganisms from Soil 16. Isolation of cellulase and pectinase producing microorganisms from vegetable and fruit waste. 17. Isolation of lipase producing microorganisms from butter. 18. To isolate antibiotic producing microorganisms from soil 19. To isolate Penicillium species producing penicillin and production of penicillin and to evaluate it activity. 20. Production of wine from grapes. 21. Perform modules related virtual lab experiments from different web labs.	**120**
Keywords/Tags: *Fermenter, bioprocess, strain improvement, penicillin.*		

Department of Higher Education

Part C-Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

1. Principle of Fermentation Technology-AllenWhite
2. Fermentation Microbiology Biotech-EMT El Mansi, Jens Nielsen
3. Industrial Microbiology-Neil Morgan PavidMousdale etc.
4. Manual industrial Microbiology and Biotechnology-Richard H Baltz, Arnold Demain and Jullian Edward.
5. Principles of Fermentation Technology- Peter F Stan bury, AlenWhitaker and Stephen J hall.
6. Introduction to Industrial Microbiology by k Sukesh.
7. Principle and Application of Fermentation Technology- Aridam Kula &Vinay Sharma.
8. Analytical techniques: Holme and Peck
9. Analytical Instrumentation handbook: Jack Gazes, CRC press
10. Analytical techniques in Biochemistry and Molecular biology: R Katoch
11. Biological Instrumentation and methodology: PK Bajpai
12. Principles of Fermentation Technoiogy by Stanbury, P.F., Whitak$ A. and Hall. 1995. Butterworth Heinernann
13. Biotechnology - A Text Book of Industrial Microbiology by Cmger.
14. Fermentation Biotechnology: Industrial perspectives by-Chand.
15. Biochemical Engineering Fundamentals by Bailey andonis, Tata Mccraw Hilr, N.y.
16. Biotechnology. Volume 3. Edited by H. J. Rehm and G. Reed. Veriag Chemie. i993.

2. Suggestive digital platforms web links

Suggestive digital platforms web links https://about.labxchange.org/types/virtual-lab-simulations

Suggested equivalent online courses: https://www.mooc.org, https://swayam.gov.in, https://nptel.ac.in

Part D-Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Internal Assessment	Marks	External Assessment	Marks
Class Interaction /Quiz	10	Viva Voce on Practical	10
Attendance	10	Practical Record File	10
Assignments (Charts/ Model Seminar / Rural Service/ Technology Dissemination/ Report of Excursion/ Lab Visits/ Survey / Industrial visit)	20	Table work / Experiments	40
TOTAL	40		60

Any remarks/ suggestions:

Department of Higher Education