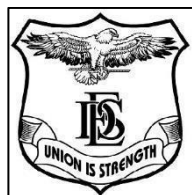


Deccan Education Society's

**Kirti M. Doongursee College of  
Arts, Science and Commerce  
(AUTONOMOUS)**



Affiliated to

**UNIVERSITY OF MUMBAI**

Syllabus for  
Program: Bachelor of Science  
Course: F.Y.Bsc  
Subject: **Biotechnology**

Choice Based Credit System (CBCS)  
with effect from  
Academic Year 2023-2024

## **PROGRAM OUTCOMES**

| <b>PO</b>  | <b>Description</b>  |
|--|---|
| A student completing Bachelor's Degree in <b>Science</b> Program will be able to |   |
| PO1  | Understand scope and applications of Biotechnology and its interdisciplinary approach.  |
| PO2  | Understand Fundamentals of Biotechnology.<br>Acquire and Demonstrate Comprehensive knowledge and good experimental and Laboratory skills in Biotechnology                                 |
| PO3  | Build strong Knowledge and conceptual learning through systematic thinking and self -study.   |
| PO4  | Understand and apply appropriate tools and techniques in Biotechnology<br>Acquire the knowledge of upcoming fields of Biotechnology, make the learner competent to pursue higher studies. |
| PO5  | Acquire an ability to analyse and scientific problems and develop scientific research ability   |
| PO6  | Learn appropriate skills in conduction of Biotechnological experiments<br>learn good oral and written communication skills as well as nurturing creativity                                |
| PO7  | Employe skill and knowledge in environmental management and sustainable development<br>Impart skills and Knowledge in designing entrepreneurial courses in the field of biotechnology.    |

| <b>Semester</b> | <b>Course Code</b>                                | <b>Course Title</b>  | <b>Vertical</b> | <b>Credit</b> |
|-----------------|---|--|-----------------|---------------|
| <b>I</b>        | K23USBTMJ111                                      | Fundamentals of Biotechnology-I                                    | Major           | 2             |
|                 | K23USBTMJ112                                      | Molecular Biology and Genetics -2                                  | Major           | 2             |
|                 | K23USBTOE131                                      | Food Technology  | OE              | 2             |
|                 | K23USBTVC141                                      | Wine Technology  | VSC             | 2             |
|                 | K23USBTSC151                                      | Microbial Culture Techniques                                       | SEC             | 2             |
| <b>II</b>       | K23USBTMJ211                                      | Fundamentals of Biotechnology-2                                    | Major           | 2             |
|                 | K23USBTMJ212                                      | Cell biology Physiology and Immunology                             | Major           | 2             |
|                 | K23USBTMRC221/<br>K23USBTMRM221/<br>K23USBTMRL221 | Chemistry/<br>Microbiology/ Life Science                           | Minor           | 2             |
|                 | K23USBTVC241                                      | Analytical Instrumentation Techniques                              | VSC             | 2             |
|                 | KU23USBTSC251                                     | Crop improvement strategies, Composting and Solid waste management | SEC             | 2             |

|  |   |                       |                           |
|--|---|-----------------------|---------------------------|
| <b>Course Code</b>   | <b>MAJOR-I SEM – I</b>  | <b>Credits</b>        | <b>Lectures/<br/>Week</b> |
| <b>K23USBTMJ111</b>  | <b>Paper I<br/>Fundamentals of biotechnology-1</b>  | <b>2</b>              | <b>2</b>                  |
| <b>Course Outcomes:</b>  |   |                       |                           |
| After successful completion of this course, students would be able to  |   |                       |                           |
| <ul style="list-style-type: none"> <li>• To acquaint students with various fields of Biotechnology and their applications</li> <li>• To Understand the applications of biotechnology in the field of agriculture, health care, Human welfare, fermentation industry and Environment</li> <li>• To analyse Scope of the Biotechnology in different industry.</li> </ul> |   |                       |                           |
|  |   |                       |                           |
| <b>Unit</b>  | <b>Topics</b>   | <b>No of Lectures</b> |                           |
| <b>I</b>   | <p><b>Scope and Introduction to Biotechnology</b></p> <p><b>Biotechnology</b> –an interdisciplinary biological science;<br/> Biotechnology – definition;<br/> History &amp; Introduction to Biotechnology;<br/> Traditional and Modern Biotechnology;<br/> Scope and importance of biotechnology;<br/> World of Biotechnology- Pharmaceutical Biotechnology, Plant Biotechnology, Industrial Biotechnology, Marine Biotechnology, Animal Biotechnology, Medical Biotechnology, Environmental Biotechnology.<br/> Biotechnology in India – bio-business in India, booming biotech market, success story of biotech market, policy initiatives; and global trends;<br/> Biotechnology research in India;<br/> Potential of modern biotechnology<br/> Achievement of biotechnology; Prevention of misuse of biotechnology; Biotechnology Institutions in India (Public and Private Sector); Public Perception of Biotechnology.<br/> Case study: Serum Institute of India and its products</p> | <b>15</b>             |                           |
| <b>II</b>  | <p><b>Applications of Biotechnology and fermentation technology</b></p> <p><b>1.Agriculture –GM fruits</b><br/> GM papaya, GM tomato<br/> Insect resistant transgenic plants – Bt cotton, Bt brinjal<br/> Modifications in nutrient quality – starch, oil, seed protein, golden rice</p>  | <b>15</b>             |                           |

|  |   |  |
|--|---|--|
|  | <p><b>2.Livestock – growth, disease resistance, product quality, pharmaceuticals and nutritional supplements, industrial application</b></p> <p><b>3.Human welfare</b><br/> <b>Cloned genes for production of -Insulin; recombinant vaccine for Hepatitis B virus.</b><br/> Molecular farming<br/> Edible vaccines and their advantages</p> <p><b>4.Environment- pollution abatement through GMOs</b><br/> Bioethics<br/> Biomass: A renewable source of energy</p> <p><b>Case study: Genetically modified microbes for bioremediation of oil spills in marine environment</b></p> <p><b>Introduction: Marine Biotechnology introduction</b></p> <p>Introduction to fermentation processes<br/> Microbial biomass, Microbial enzymes, Microbial metabolites, recombinant products, transformation processes<br/> Development of fermentation Industry<br/> Component Parts of fermentation process</p> <p><b>Screening:</b> Definition<br/> Primary screening and its methods<br/> Secondary screening and its methods</p> <p><b>Fermenter design:</b><br/> Definition of a fermenter<br/> Aerated stirred tank batch fermenter-Typical design<br/> Construction materials used, aeration and agitation<br/> Temperature control<br/> Foam production and control<br/> pH measurement and control<br/> CO<sub>2</sub> and O<sub>2</sub> control</p> <p><b>Fermentation medium:</b><br/> Basic requirements of industrial media<br/> Criteria for use of raw materials in media<br/> Examples of raw materials used<br/> Growth factors<br/> Water<br/> Carbohydrate sources<br/> Protein sources</p> <p><b>Production of Yeast and Yeast Products</b><br/> Introduction<br/> Yeast Production<br/> Yeast derived Products</p> |  |
|--|---|--|

**Textbooks:**

- A Textbook of Biotechnology by R Chaubey 4<sup>th</sup> edition

- Advanced Biotechnology by R C Dubey 1<sup>st</sup> edition
- Biotechnology, Expanding Horizons by B D Singh, 4<sup>th</sup> edition
- Microbial Technology Microbial Process Volume I PeplerPeriman second Edition
- Springer Book of Marine Biotechnology

**Additional References:**

- Stanbury and whitaker 3rd ed
- Screening- Casida
- Fermenter Design- Nduka Okafor 1<sup>st</sup>ed

| Course Code   | MAJOR-II SEM – I   | Credits        | Lectures/Week |
|---|--|----------------|---------------|
| K23USBTMJ112  | Paper II Molecular Biology and Genetics  | 2              | 2             |
| <p><b>Course Outcomes:</b></p> <p>After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> <li>• To understand the Composition and structure of DNA and RNAs</li> <li>• To acquaint students with DNA Replication, Repair and Genetic Engineering.</li> <li>• To learn the concepts of Mendelian Genetics.</li> </ul> |  |                |               |
| Unit  | Topics   | No of Lectures |               |
| I   | <p><b>DNA Composition, Chromosome, DNA structure and packing:</b></p> <p><b>The Composition and structure of DNA and RNA:</b><br/> Nucleotide and Nucleoside, Structure of nucleotides.<br/> Structure of DNA.<br/> DNA double helix – Watson and Crick’s Model.<br/> Structure of RNA. Types of RNA.</p> <p><b>Organization of DNA in chromosome:</b><br/> Viral and Prokaryotic Chromosomes.<br/> Eukaryotic Chromosomes.<br/> Histone and Non-histone proteins.<br/> Nucleosome Structure.<br/> Packaging of DNA into chromosomes.<br/> Euchromatin and Heterochromatin.<br/> Centromeres and Telomeres<br/> Chromosome Banding Techniques.</p> | 15             |               |
| II  | <p><b>DNA replication and Mutation and repair and fundamentals of genetics:</b></p> <p>Models of DNA Replication<br/> DNA Replication in Prokaryotes<br/> Evidence of Semi-conservative DNA replication- Meselson and Stahl’s experiment<br/> DNA Polymerases and its role,<br/> E. coli Chromosome Replication,</p>   | 15             |               |

|  |  |  |
|--|--|--|
|  | <p>semi discontinuous replication<br/> Bidirectional Replication of Circular DNA molecules.<br/> Rolling Circle Replication,<br/> DNA Replication in Eukaryotes<br/> Enzymes and proteins involved in DNA replication</p> <p><b>DNA REPAIR</b><br/> Photo reversal, Base Excision Repair,<br/> Nucleotide Excision Repair, Mismatch<br/> Repair, SOS Repair</p> <p><b>Genetics:</b> Transmission genetics, Molecular genetics,<br/> Population genetics and Quantitative genetics.<br/> Basic Terminologies in genetics</p> <p><b>Mendelian Genetics:</b><br/> Monohybrid Crosses and Mendel’s Principle of<br/> Segregation. Representing crosses with a Branch<br/> Diagram.</p> <p>Confirming the principle of Segregation: The use of<br/> Test<br/> crosses.<br/> Dihybrid crosses and Mendel’s Principle of<br/> Independent<br/> Assortment.<br/> Extensions of and Deviations from Mendelian Genetic<br/> Principles: Multiple Alleles - ABO Blood groups<br/> Modifications of Dominance Relationships:<br/> Incomplete<br/> Dominance and Codominance.<br/> Essential Genes and Lethal Alleles. Effects of the<br/> environment on Gene expression.<br/> Gene Interactions and Modified Mendelian Ratios:<br/> Epistatic and non-epistatic interactions.<br/> Mendelian Genetics in Humans: Pedigree Analysis.<br/> Examples of Human Genetic Traits</p> |  |
|--|--|--|

**Textbooks:**

- iGenetics – A molecular approach Peter J Russell 3rd edition
- 2.Biochemistry - U Satyanarayana U.Chakrapani, (2013) 4th edition
- 3.Principles of Genetics. E J Gardner, M J Simmons & D Peter Snustad. 8th edition
- 4. A Textbook of Biotechnology By R.C. Dube



- 5.iGenetics – A molecular approach Peter J Russell 3rd edition.

**Additional References:**

- Cell and Molecular Biology 5th edition by Gerald Karp (John Wiley and sons publications)
- Genetics, (2006) Strickberger MW - (Prentice Hall, India) (recombination repair)

| Course Code          | Practical of Major | Credits  | Lectures/Week |
|----------------------|--------------------|----------|---------------|
| <b>K23USBTMJP111</b> |                    | <b>2</b> | <b>4</b>      |

**Course Outcomes:**

After successful completion of this course, students would be able to

- To learn the concepts and principles of various laboratory and aseptic techniques.
- To acquaint students with various microbial culture techniques.
- To understand the concept of Genetics and to apply it in various analytical techniques.

**Topics**

1. Sterilization of Laboratory Glassware and Media using Autoclave and Hot air oven
2. Preparation of media- Nutrient broth and Agar, MacConkey Agar, Sabouraud's Agar
3. Fermentative production of Citric acid.
4. Isolation and characterization of food fermenting organism from idli batter (Using Bergey's Manual)
5. Qualitative estimation of Alcohol by Ritter Test.
6. Fermentation of Sugarcane juice by using yeast.
7. Isolation of Yeasts from the natural environment.
8. Study of morphology and colony characteristics of yeasts.
9. Estimation of DNA by DPA method.
10. Estimation of RNA by Orcinol method
11. Qualitative analysis of DNA
12. Identification of types of point mutations from given DNA sequences
13. Study of Watson and Crick model of DNA using micrographs/ Schematic representations.
14. Study of Semi conservative replication of DNA through micrographs/ Schematic representation.
15. Preparation of competent cells and demonstration of Bacterial transformation and mapping
16. Demonstration of Bacterial Conjugation and interrupted mating-based mapping.
17. Study of Blood groups ABO in humans.
18. Construction of Pedigree charts and Analysis of Human Genetic trait using Pedigree analysis.
19. Problems based on Mendelian genetics.
20. Demonstration of transduction and mapping

|  |   |                       |                      |
|--|---|-----------------------|----------------------|
| <b>Course Code</b>   | <b>OPEN ELECTIVE SEM – II Food Technology</b>   | <b>Credits</b>        | <b>Lectures/Week</b> |
| <b>K23USBTOE131</b>  | <b>Paper I Food Technology</b>  | <b>2</b>              | <b>2</b>             |
| <b>Course Outcomes:</b>  |   |                       |                      |
| After successful completion of this course, students would be able to  |   |                       |                      |
| <ul style="list-style-type: none"> <li>• To impart skills about Food technology and Explain the application of biotechnology in the food industry. The learner will be able to understand the role of microbes in fermentation, and to know the important genera of microorganisms associated with food and their characteristics.</li> <li>• To introduce the basics of various food processing and preservation technologies. To study the importance microorganisms in food preservation</li> <li>• The learner will be able to understand Food regulations (national as well as international) Design and implementation of food safety management systems such as ISO series, Emerging concerns.</li> </ul> |   |                       |                      |
|  |   |                       |                      |
| <b>Unit</b>  | <b>Topics</b>   | <b>No of Lectures</b> |                      |
| <b>I</b>   | <b>Introduction To Food Biotechnology, its applications, Fermented Food Products</b><br>History of microorganisms in food science and key developments.<br>Applications of biotechnology in fermented food products - Introduction to Unit Operations and Processes, Food processing & packaging (canning & bottling), Production of cultures.<br>Fermented food products – Bread, Vinegar, Sauerkraut, Single Cell Protein (SCP), Probiotics | <b>15</b>             |                      |
| <b>II</b>  | <b>Food spoilage, Food Preservation, Quality and safety</b><br>Food spoilage, food deterioration and contamination.<br>Methods of food preservation<br>Indicators of Food Microbial Quality & Safety, HACCP, FSSAI & FDA  | <b>15</b>             |                      |

**Textbooks:**

- Food Microbiology, 5 th edition, William C. Frazier, Dennis C. Westhoff, N.M. Vanitha, McGraw Hill Education, India.
- Fundamentals of Food Biotechnology, 2 nd edition, Byong H. Lee, Wiley Blackwell
- Modern Food Microbiology, 7 th edition, James M. Jay, Martin J. Loessner, David A. Golden, Food Science Texts Series
- Prescott's Microbiology, 9 th edition, Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, McGraw-Hill, USA.
- Industrial Microbiology, A. H. Patel

## Additional References:

- <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=15>
- <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=15>
- [https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=15.](https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=15)

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|--|--|---------------------------|---------------------------|
| <b>Course Code</b>   | <b>VOCATIONAL SKILL COURSE<br/>SEM – I - Wine Technology</b>   | <b>Credits</b>            | <b>Lecture<br/>s/Week</b> |
| <b>K23USBTV141</b>   | <b>Paper I Wine Technology</b>   | <b>2</b>                  | <b>2</b>                  |
| <b>Course Outcomes:</b>  |  |                           |                           |
| After successful completion of this course, students would be able to  |  |                           |                           |
| <ul style="list-style-type: none"> <li>• To impart the knowledge of Wine and Fermentation</li> <li>• Categorize Wines and the microorganisms based on various growth conditions.</li> <li>• Differentiate between the Processes of development of Different wines.</li> <li>• To Identify, formulate, and solve complex problems related to viticulture by applying principles of Biotechnology</li> </ul> |  |                           |                           |
|  |  |                           |                           |
| <b>Unit</b>  | <b>Topics</b>  | <b>No of<br/>Lectures</b> |                           |
| <b>1</b>   | <b>Wine fermentation</b><br>Introduction<br>Definition, Size of the Industry, Historical Background<br>Microbiological Aspects<br>Nature of Microbial process, Fermentation and its byproduct, Other compounds formed by Yeast Fermentation, Effects of Temperature on Fermentation, Use of Sulfur Dioxide, Yeast Nutrition, Deacidification of Wines, Fermentation of Flor Sherries, Wine Spoilage Organisms<br>Fermentation Economics<br>Market Potential, Fermentation and Product Recovery Cost, Process appraisal | <b>15</b>                 |                           |
| <b>II</b>  | <b>Processing of Wine</b><br>Processing<br>Yeast selection, Process flow, Processing of Wine<br>Packaging and Distribution<br>Evaluation of Wines<br>Sensory Examination, Microbial Examination<br>Chemical and Physical Analyses<br>Uses Wines  | <b>15</b>                 |                           |

**Textbooks:**

- Microbial Technology Fermentation Technology Second Edition Volume 2  
HJ Peppler D Perlman.

**Additional References:**

- Industrial Microbiology by L.E Casida

|  |  |                           |                           |
|--|--|---------------------------|---------------------------|
| <b>Course Code</b>   | <b>SKILL ENHANCEMENT COURSE<br/>SEM – II - Microbial Culture Techniques</b>  | <b>Credits</b>            | <b>Lecture<br/>s/Week</b> |
| <b>K23USBTSC151</b>  | <b>Paper I Microbial Culture Techniques</b>  | <b>2</b>                  | <b>2</b>                  |
| <b>Course Outcomes:</b>  |  |                           |                           |
| After successful completion of this course, students would be able to  |  |                           |                           |
| <ul style="list-style-type: none"> <li>• To impart the knowledge of growth of microorganisms.</li> <li>• Categorize microorganisms based on various characteristics.</li> <li>• Differentiate between various media used for culturing microorganisms and decide which one is appropriate for the microorganism used in the experiment.</li> </ul> |  |                           |                           |
| <b>Unit</b>  | <b>Topics</b>  | <b>No of<br/>Lectures</b> |                           |
| <b>I</b>   | <b>Cultivation and maintenance of microbial culture</b><br>Introduction to prokaryotic cells structure: size, shape, arrangement<br>Gram positive and gram negative cell wall<br>Microbial nutrients, Nutritional types of microorganisms<br>Culture media, types of media(chemically defined, complex, anaerobic media, selective, differential, enrichment), isolation of pure cultures – spread plate, streak plate, pour plate, colony morphology, Liquid culture media and solid culture media<br>Preserving bacterial cultures | <b>15</b>                 |                           |
| <b>II</b>  | <b>Cultivation and maintenance of microbial culture</b><br>Introduction to prokaryotic cells structure: size, shape, arrangement<br>Gram positive and gram negative cell wall<br>Microbial nutrients, Nutritional types of microorganisms<br>Culture media, types of media(chemically defined, complex, anaerobic media, selective, differential, enrichment), isolation of pure cultures – spread plate, streak plate, pour plate, colony morphology, Liquid culture media and solid culture media<br>Preserving bacterial cultures | <b>15</b>                 |                           |

**Textbooks:**

- Liquid culture media and solid culture media Bacterial culture through selective and non-selective conditions: the evolution of culture media in clinical microbiology, M. Bonnet,<sup>1</sup> J.C. Lagier,<sup>1,2</sup> D. Raoult,<sup>1,2</sup> and S. Khelaifia<sup>1,2,\*</sup> *New Microbes New Infect.* 2020 Mar; 34: 100622. Published online 2019 Nov 30. doi: 10.1016/j.nmni.2019.100622
- Microbiology, 5th Edition, Prescott, Harley. Klein.
- Prescott's Microbiology, 10<sup>th</sup> edition, Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton

**Additional References:**

- Microbiology an Introduction by Tortora, Funke, and Case. 13<sup>th</sup> edition.



# **Semester II**

| <b>Course Code</b>   | <b>MAJOR I SEM – II</b>   | <b>Credits</b>        | <b>Lectures/Week</b> |
|--|---|-----------------------|----------------------|
| <b>K23USBTMJ211</b>  | <b>Paper I Fundamentals of Biotechnology-2</b>  | <b>2</b>              | <b>2</b>             |
| <p><b>Course Outcomes:</b><br/>           After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> <li>• The learner will be able to impart skills about Food and Medical Biotechnology</li> <li>• Explain the application of biotechnology in the food industry</li> <li>• Demonstrate the role of vaccines in medical biotechnology.</li> <li>• Describe the concept of genetic engineering and state various components of it.</li> </ul> |   |                       |                      |
| <b>Unit</b>  | <b>Topics</b>   | <b>No of Lectures</b> |                      |
| <b>I</b>   | <b>Medical biotechnology and Immunotechnology</b><br>Introduction to Medical Biotechnology<br>Vaccines<br>Types of vaccines<br>General vaccine production<br>Large scale production of vaccine<br>Trends in Vaccines Research<br>Issues related to vaccine research<br>Synthetic peptides as vaccine<br>Antibody Production<br>Gene therapy<br>Organ transplant cloning<br>Stem cells -Sources and applications | <b>15</b>             |                      |

|                  |  |                  |
|------------------|--|------------------|
| <p><b>II</b></p> | <p><b>Genetic engineering</b></p> <p>rDNA technology –Definitionanddevelopments<br/> What is genetic engineering?<br/> What is gene cloning?<br/> Strategy for cloning – How to clone a gene?<br/> How to construct rDNA?<br/> Source DNA [insert]<br/> Isolation of DNA from bacterial cell<br/> <b>Enzymes in rDNA –</b><br/> 1. restriction endonuclease;<br/> 2. DNA ligase;<br/> . Enzymes to modify ends of DNA molecules -<br/> exonuclease;endonuclease; S1 nuclease;<br/> alkaline phosphatase; polynucleotide kinase;<br/> DNA polymerase and klenow fragment; reverse<br/> transcriptase; terminal deoxynucleotidyl<br/> transferase<br/> <b>Vectors</b> – Role as agents of transfer<br/> Features of plasmid vectors<br/> Plasmid vectors - pBR322<br/> pUC<br/> BAC<br/> Plant virus vectors and Animal virus vectors<br/> Shuttle vector; Expression vector<br/> Introducing insert into cloning vector<br/> Host cells – E. coli; Bacillus subtilis;<br/> Saccharomyces cerevisiae; Xenopus oocytes;<br/> Mammalian fertilized egg cell<br/> Introducing vector into host –<br/> Prokaryote<br/> Eukaryote<br/> Identification of recombinant clones</p> | <p><b>15</b></p> |
|------------------|--|------------------|

**Textbooks:**

- Food Microbiology, 5<sup>th</sup> edition, William C. Frazier, Dennis C. Westhoff, N.M. Vanitha, McGraw Hill Education, India
- Fundamentals of Food Biotechnology, 2<sup>nd</sup> edition, Byong H. Lee, Wiley Blackwell
- Prescott's Microbiology, 9<sup>th</sup> edition, Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, McGraw-Hill, USA

**Additional References:**

- Industrial Microbiology, A. H. Patel
- Biotechnology Fundamentals by Dr. FirdosAlam Khan
- Medical Biotechnology Glick 1st edition

|  |  |                           |                           |
|--|--|---------------------------|---------------------------|
| <b>Course Code</b>   | <b>MAJOR II SEM – II</b>   | <b>Credits</b>            | <b>Lecture<br/>s/Week</b> |
| <b>K23USBTMJ212</b>  | <b>Paper II Cell Biology Physiology and<br/>Immunology</b>   | <b>2</b>                  | <b>2</b>                  |
| <b>Course Outcomes:</b><br>After successful completion of this course, students would be able to                     |  |                           |                           |
| <ul style="list-style-type: none"> <li>To impart the knowledge of Physiology and Immunological Techniques</li> </ul> |  |                           |                           |
| <b>Unit</b>  | <b>Topics</b>  | <b>No of<br/>Lectures</b> |                           |
| <b>I</b>   | <p><b>Ultrastructure of Prokaryotic and eukaryotic cells and physiology</b></p> <p><b>Ultrastructure of Prokaryotic Cell:</b><br/>Concept of Cell shape, size, and arrangement<br/>Bacterial structures external to cell wall - Flagella, Pilli, Fimbriae, Capsule, Slime Layer, Sheath<br/>Cell Wall(Gram Positive and Negative);<br/>Structures internal to cell wall - Cell Membrane, nucleoid, Cytoplasm, and cytoplasmic inclusion bodies and vacuoles, Genetic Material spores and cysts</p> <p><b>Ultrastructure of Eukaryotic Cell:</b><br/>Cell wall; Plasma membrane, Cytoplasmic Matrix, Nucleus –Nuclear Structure, nuclear envelope, nucleoplasm, Nucleolus; cytoplasmic structures – cytoplasmic inclusions, cytoplasmic organelles - Endoplasmic Reticulum; Golgi Apparatus; Mitochondria; Chloroplasts; Ribosomes; Lysosome - Endocytosis, Phagocytosis, Autophagy; Peroxisomes. Microfilaments, Intermediate Filaments, and Microtubules<br/>External Cell Coverings: Cilia And Flagella</p> <p><b>Comparison of Prokaryotic And Eukaryotic Cells</b><br/>Photosynthesis.<br/>Hill's Reaction and its Significance,<br/>Light Reactions, Cyclic and Non-Cyclic Photo induced Electron Flow,<br/>Energetics of Photosynthesis,</p> <p><b>Introduction to physiology.</b> Concept of Homeostasis</p> <p><b>Respiratory system:</b> Phases of Respiration, Principle of gaseous exchange</p> <p><b>Excretion</b> – Organs of excretion. Types of excretory products.</p> | <b>15</b>                 |                           |

|  |  |           |
|--|--|-----------|
| <b>II</b>  | <p><b>Immunology</b><br/> <b>Introduction to Immunology:</b><br/> Overview of Immune Systems,<br/> Innate Immunity, Mechanisms of innate immunity,<br/> Acquired Immunity,<br/> Local and Herd Immunity,<br/> Humoral and Cellular Immunity - Factors Influencing<br/> and<br/> Mechanisms of each.<br/> Introduction to Immunotechnology<br/> Antigens:<br/> Immunogenicity Versus Antigenicity, Factors That<br/> Influence Immunogenicity, Epitopes, Haptens,<br/> Superantigens<br/> Antibodies:<br/> Basic Structure of Antibodies, Antibody-Mediated<br/> Effector Functions, Antibody Classes and Biological<br/> Activities, Antigenic Determinants on<br/> Immunoglobulins.</p> | <b>15</b> |
| <p><b>Textbooks:</b></p> <ul style="list-style-type: none"> <li>● Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by Verma and Agarwal</li> <li>● Cell and Molecular Biology by Karp, 6<sup>th</sup> Ed</li> <li>● The Cell by Cooper and Hausman, 4<sup>th</sup> Ed</li> <li>● 4. Leininger Principles of Biochemistry, 5th Edition- Nelson D. L., and Cox M. M. (2008) W H Freeman and Company</li> <li>● 5. A textbook of plant physiology and biochemistry by S K. Verma ( S Chand publications) part 1- physiology- ( photosynthesis)</li> <li>● 6. Plant Physiology: Theory and Applications, 2e- S. L. Kochhar and Sukhbir Kaur Gujral , Cambridge University<br/> Advanced Biotechnology By R C Dube</li> </ul> <p><b>Additional References:</b></p> <ul style="list-style-type: none"> <li>● Microbiology Stanier 5th ed</li> <li>● Pelczar Ried and Chan</li> </ul> |  |           |

| Course Code   | MAJOR SEM – II – Practicals | Credits | Lectures/Week |
|---|-----------------------------|---------|---------------|
| K23USBTMJ211  |                             | 2       | 4             |
| <p><b>Course Outcomes:</b></p> <p>After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> <li>• To impart the knowledge of Physiology and Immunological Techniques.</li> <li>• To learn about different analytical techniques and apply that knowledge to different concepts.</li> <li>• To understand various separation techniques such as Chromatography.</li> </ul>  |                             |         |               |
| <p><b>Topics</b></p>  |                             |         |               |
| <ol style="list-style-type: none"> <li>1. Sterility Checking of Vaccines.</li> <li>2. Enumeration by Breed's count</li> <li>3. Isolation and Enumeration of microorganisms- Serial dilution, Surface spread method.</li> <li>4. Isolation and Enumeration of microorganisms- Serial dilution, Pour plate method.</li> <li>5. Problems on Restriction digestion.</li> <li>6. Study of Microscope.</li> <li>7. Monochrome staining, Differential Staining, Special and Fungal Staining.</li> <li>8. Study of growth curve of <i>E.coli</i>.</li> <li>9. Isolation techniques: T-streak, polygon method</li> <li>10. Colony Characteristics of Microorganisms.</li> <li>11. Study of Hill's reaction.</li> <li>12. To measure the rate of photosynthesis by Winkler's method</li> <li>13. Effect of PGRs on seed germination</li> <li>14. Solvent extraction of plant pigments and study the absorption spectra of pigments</li> <li>15. Separation of Carotenoids by thin layer chromatography</li> <li>16. Study of human blood count (RBC and WBC) using Haemocytometer</li> <li>17. Isolation and characterization of organisms causing Food Spoilage (Using Bergey's Manual).</li> <li>18. Study of Antigen antibody interaction by Ouchterlony method</li> <li>19. Microbial examination of food and detection of Pathogenic Bacteria from Food Samples</li> <li>20. Isolation and enumeration of bacteriophages (PFU) from water/sewage samples using double agar layer technique.</li> </ol> |                             |         |               |

# **Minor Papers**



|  |   |                           |                           |
|--|---|---------------------------|---------------------------|
| <b>Course Code</b>   | <b>Minor SEM II - Chemistry</b>                     | <b>Credits</b>            | <b>Lecture<br/>s/Week</b> |
| <b>K23USBTMR22<br/>1</b>   | <b>Paper III Basic Chemistry and Biomolecules-1</b> | <b>2</b>                  | <b>2</b>                  |
| <p><b>Course Outcome:</b><br/> After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> <li>• To impart knowledge of Titrimetric and Volumetric Estimations and handling of basic Analytical Techniques like Chromatography and Colorimetry</li> <li>• Identify isomers of molecules.</li> <li>• Explain the types of chemical bonds.</li> <li>• Interpret the results based on the understanding of titration end points.</li> <li>• To impart hands-on skills in preparation of Buffers and Solutions</li> <li>• To impart the knowledge of Classification, Structure and Characterization of Biomolecules</li> <li>• Use the acquired knowledge in preparation of buffers and solutions.</li> <li>• Differentiate between various types of carbohydrates and lipids.</li> <li>• Explain the characteristics and functions of carbohydrates and lipids.</li> </ul> |   |                           |                           |
| <b>Unit</b>  | <b>Topics</b>                                       | <b>No of<br/>Lectures</b> |                           |

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| <b>I</b> | <p><b>Nomenclature and Chemical bonds Titrimetry</b><br/> Classification and Systematic Nomenclature of organic compounds.</p> <p>Chemical Bonds: Types and transition between the main types of bonding.</p> <p>Ionic Bond: Nature of Ionic Bond, factors influencing the formation of Ionic Bond. Structure of NaCl and CsCl.<br/> Covalent Bond: Nature of Covalent Bond, Types of covalent bond (Polar and Coordinate covalent bonds). Structure of CH<sub>4</sub>, NH<sub>3</sub>, H<sub>2</sub>O, Shapes of BeCl<sub>2</sub>, BF<sub>3</sub>.<br/> Hydrogen Bond: Theory of Hydrogen Bonding and Types of Hydrogen Bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides).<br/> Titrimetric Analysis: Titration, Titrant, Titrand, End Point, Equivalence Point, Titration Error, Indicator, Primary and Secondary Standards, Characteristics, and examples.<br/> Types of Titrations – Acid –Base, Redox. Precipitation, Complexometric Titration. Acid – Base Titration - Strong Acid Vs Strong Base. Theoretical aspects of Titration Curve and End Point Evaluation.<br/> Theory of Acid –Base Indicators, Choice, and Suitability of Indicators.</p> | <b>15</b> |
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| <b>II</b> | <p><b>Water, Standard solutions and Buffers, Basics of Carbohydrate Chemistry</b></p> <p>Structure, Properties, and functions of water</p> <p>Preparation of standard Solutions:</p> <p>Concept and significance of Chemical and Biological solutions.</p> <p>Normality, Molarity, Molality, Mole fraction, Mole concept, Solubility, Weight ratio, Volume ratio, Weight to Volume ratio, ppb, ppm, millimoles, milliequivalents (Numerical expected).</p> <p>Primary and Secondary Standards:</p> <p>Preparation of Standard Solutions</p> <p>Principle of Volumetric Analysis.</p> <p>Acids and Bases:</p> <p>Lowry-Bronsted and Lewis Concepts. Strong and Weak Acids and Bases - Ionic Product of Water - pH, pKa, pKb. Hydrolysis of Salts.</p> <p>Do one revision lec on Concept of pH</p> <p>Buffer solutions –Concept of Buffers, Derivation of Henderson Hasselbalch equation for Acidic and Basic buffers</p> <p>Buffering capacity</p> <p>Biological buffers:</p> <p>Significance of biological buffers.</p> <p>pH of body fluids like blood and saliva.</p> <p>Blood buffer systems:</p> <p>Eg : Carbonate, Acetate and Phosphate buffers. ( components, eg of buffers at various pH of cellular significance ; explain using Numericals)</p> <p>protein buffers -Introduction</p> <p>Significance of TRIS buffers – Introduction</p><br><p>Carbohydrates: Introduction definition and general formula.</p> <p>Classification of carbohydrates -</p> <p>Monosaccharides - Two Families of Monosaccharides. Aldo series and keto series; ( Triose - Glyceraldehyde and Dihydroxyacetone, Tetrose- Erythrose and Erythrulose,</p><br><p>Pentose- Xylose, Xylulose, Ribose, Ribulose, Hexose- Glucose, Galactose, Mannose, Heptose- sedoheptose</p><br><p>and Sedoheptulose structures to be taught )</p> <p>Concept of Enantiomers, Mutarotation, Anomeric carbon</p> | <b>15</b> |
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|   | <p>and Epimers of glucose.</p> <p>Biologically important Derivatives of Hexoses :<br/>         Glucosamine, Gluconic acid, uronic acid, NAGA, NAMA<br/>         (structures not to be expected in exams)<br/>         Chemical reactions of monosaccharides<br/>         Concept of glycosidic bond.</p> |  |
| <p><b>Textbooks:</b></p> <ul style="list-style-type: none"> <li>● A Textbook of Organic Chemistry, 15<sup>th</sup> edition, Arun Bahl, B S Bahl, S. Chand</li> <li>● Vogel's Textbook of Quantitative Analysis, Fifth Edition</li> <li>● Organic Chemistry, by Solomon and Fryhle</li> <li>● Robert Murray, Daryl G., Peter M., Victor R.; Harper's Illustrated Biochemistry.</li> <li>● Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3<sup>rd</sup> Edition. Books and Allied (P) Ltd.</li> <li>● Lehninger PRINCIPLES OF BIOCHEMISTRY by Nelson and Cox Fifth Edition</li> </ul> <p><b>Additional References:</b></p> <ul style="list-style-type: none"> <li>● Fundamentals of Biochemistry. 3<sup>rd</sup> Edition (2008), Donald Voet &amp; Judith Voet, John Wiley and Sons, I. USA</li> </ul> |  |  |

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| <b>Course Code</b>  | <b>Minor SEM II - Paper I-Microbiology-1</b>  | <b>Credits</b>        | <b>Lectures/Week</b> |
| <b>K23USBTMR222</b>   | <b>Paper I-Microbiology-1</b>   | <b>2</b>              | <b>2</b>             |
| <b>Course Outcomes:</b>   |   |                       |                      |
| After successful completion of this course, students would be able to   |   |                       |                      |
| <ul style="list-style-type: none"> <li>● To impart the knowledge of growth of microorganisms.</li> <li>● Categorize microorganisms based on various characteristics.</li> <li>● Experiment with different sterilization techniques.</li> <li>● Differentiate between various staining techniques and decide the appropriate one as per requirement in planned experiments.</li> </ul> |   |                       |                      |
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| <b>Unit</b>   | <b>Topics</b>   | <b>No of Lectures</b> |                      |
| <b>I</b>  | <p><b>Introduction to microbiology</b><br/> <b>Fundamentals, History and Evolution of Microbiology.</b><br/> Discovery of Microorganisms, Conflict over spontaneous generation. Role of microorganisms in disease</p> <p><b>Classification:</b><br/> The place of Microorganisms in the living world<br/> Classification whittaker's five kingdom classification<br/> Introduction to Bergey's Manual<br/> Groups of Microorganisms<br/> Applications of microbiology in various fields</p> <p><b>Cultivation and Maintenance of microorganisms, Nutritional categories of microorganisms,</b><br/> methods of isolation.</p> <p><b>Definition and Scope of Industrial Microbiology</b></p> | <b>15</b>             |                      |

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| <p style="text-align: center;"><b>II</b></p> | <p><b>Sterilization techniques</b><br/> <b>Microscopy and stains Definition :</b><br/> Sterilization and Disinfection.<br/> Types and Applications<br/> Dry Heat, Steam under pressure Gasses,<br/> Radiation and Filtration<br/> Chemical Agents and their Mode of Action -<br/> Aldehydes, Halogens, Quaternary Ammonium<br/> Compounds, Phenol and Phenolic Compounds,<br/> Heavy Metals, Alcohol, Dyes, and Detergents<br/> Ideal Disinfectant. Examples of Disinfectants and<br/> Evaluation of Disinfectant<br/> <b>Case Study Sterilization Procedures During<br/> Pandemic</b><br/> <b>Microscope</b>- Simple and Compound: General<br/> principles of optics; various parts and their functions<br/> - objectives – numerical aperture, resolving power,<br/> depth of focus, working distance, aberrations;<br/> oculars; condensers.<br/> Dark Field Microscope; Phase Contrast Microscope<br/> and Fluorescent Microscope, TEM, SEM<br/> Maintenance of Microscopes<br/> <b>Applications of microscopes</b><br/> <br/> <b>Stains and Staining Solutions</b><br/> <br/> Definition of Dye and Chromogen; acidic and basic<br/> dyes; functions and types of chromophore and<br/> auxochrome groups.<br/> Theories to explain staining.<br/> Definition and function of stain; mordant, intensifiers<br/> and fixative.<br/> <br/> Natural and Synthetic Dyes.<br/> <br/> Simple Staining, Differential Staining – Gram<br/> staining and Acid Fast Staining with specific<br/> examples</p> | <p style="text-align: center;"><b>15</b></p> |
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**Textbooks:**

- Microbiology by Prescott 5th edition
- Microbiology by Pelczar, Reid and Chan 5th Edition
- Textbook of Microbiology by Ananthanarayan

**Additional References:**

- Fundamental Principles of Bacteriology A J Salle 7th
- Microbiology by Pelczar, Chan and Krieg, 5th Ed

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| <b>Course Code</b>   | <b>Minor Sem II Life Science-</b>   | <b>Credits</b>            | <b>Lecture<br/>s/Week</b> |
| <b>K23USBTMRP2<br/>23</b>  | <b>Paper I Life Science-I</b>   | <b>2</b>                  | <b>2</b>                  |
| <b>Course Outcomes:</b>  |   |                           |                           |
| After successful completion of this course, students would be able to  |   |                           |                           |
| <ul style="list-style-type: none"> <li>● To impart skills in Techniques in Genetic Analysis and Population Genetics</li> <li>● Explain types of genetic mapping in bacteria.</li> <li>● Describe the fundamentals in genetics based on mendelian principles.</li> <li>● Apply the principles learned in genetics in identifying and demonstrating hereditary genetic traits in one's family. (LO apply and analyse)</li> </ul> |   |                           |                           |
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| <b>Unit</b>  | <b>Topics</b>   | <b>No of<br/>Lectures</b> |                           |
| <b>I</b>   | <p><b>Microbial genetics and Molecular Biology</b></p> <p><b>Genetic analysis in Bacteria:</b><br/>Prototrophs, Auxotrophs.</p> <p><b>Genetic Mapping in Bacteria by Conjugation:</b><br/>Discovery of Conjugation in E.coli. The sex factor F, High-Frequency Recombination Strains of E.coli. F' Factors. Using conjugation to map bacterial genes- Interrupted-mating</p> <p><b>Genetic mapping in bacteria by Transformation.</b></p> <p><b>Genetic mapping in Bacteria by Transduction:</b><br/>Bacteriophages - Lytic and Lysogenic pathway.<br/>Transduction Mapping of Bacterial Chromosomes - Generalized Transduction and Specialized Transduction</p> <p><b>Karyotype and Idiogram</b><br/>Parameters used in Karyotype preparation- Human Karyotype (Normal) - Male and Female.<br/>Definition of Mutations-<br/>Classification of mutations<br/>Types of Point Mutations,<br/>Types of Spontaneous and induced mutations<br/>Mutagenesis and types of Mutagens.<br/>(Examples of Physical, Chemical and Biological Mutagens)</p> | <b>15</b>                 |                           |



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| <p style="text-align: center;"><b>II</b></p>  | <p><b>Population genetics</b></p> <p><b>Genetic Structure of Populations –</b><br/> Genetic structure of populations-Genotypic Frequencies<br/> and Allelic Frequencies, allele frequency at X linked locus<br/> Hardy- Weinberg Law and its Assumptions<br/> Extension of Hardy weinberg law to loci with more than two alleles<br/> Genetic Variations in Populations,<br/> Forces responsible for change in gene frequencies in population- Natural Selection.<br/> Genetic Drift<br/> migration<br/> Speciation<br/> Role of Population Genetics in Conservation Biology<br/> Genetic Polymorphism</p> | <p style="text-align: center;"><b>15</b></p> |
| <p><b>Textbooks:</b></p> <ul style="list-style-type: none"> <li>● iGenetics – A molecular approach Peter J Russell 3rd edition.</li> <li>● Biochemistry - U Satyanarayana U.Chakrapani, (2013) 4th edition</li> <li>● Principles of Genetics. E J Gardner, M J Simmons &amp; D Peter Snustad. 8th edition</li> <li>● A Textbook of Biotechnology By R.C. Dube</li> </ul> <p><b>Additional References:</b></p> <ul style="list-style-type: none"> <li>● Cell and Molecular Biology 5th edition by Gerald Karp (John Wiley and sons publications)</li> <li>● Genetics, (2006) Strickberger MW - (Prentice Hall, India)</li> </ul> |  |  |

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| <b>Course Code</b>  | <b>VOCATIONAL SKILL COURSE<br/>SEM – II - Analytical Instrumentation<br/>Techniques</b>   | <b>Credits</b>            | <b>Lecture<br/>s/Week</b> |
| <b>K23USBTV241</b>  | <b>Paper I Analytical Instrumentation<br/>Techniques</b>  | <b>2</b>                  | <b>2</b>                  |
| <b>Course Outcomes:</b>   |   |                           |                           |
| After successful completion of this course, students would be able to   |   |                           |                           |
| <ul style="list-style-type: none"> <li>• To gain knowledge of the many categories of analytical instruments.</li> <li>• Demonstrate an understanding of the fundamental theoretical concepts and underlying techniques of microscopy, spectroscopy analysis and chromatography.</li> <li>• Comply with procedures and prepare samples for chromatographic, electrophoretic, spectroscopic, and microscopy examination.</li> <li>• Use a variety of analytical instruments while being closely supervised.</li> <li>• Analyse analytical data to provide quantitative outcomes.</li> </ul> |   |                           |                           |
| <b>Unit</b>   | <b>Topics</b>   | <b>No of<br/>Lectures</b> |                           |
| <b>I</b>  | <p><b>Basic Analytical techniques</b>Basics of Analytical techniques</p> <p>Microscopy: Types of Microscopy; Electron Optics; Electron Microscopy- Preparation of Specimen, Fluorescence Microscopy</p> <p>Spectroscopy - Colorimetry: Electromagnetic spectrum of light; simple theory of light absorption by biomolecules, Properties of electromagnetic radiation, interaction with matter, lasers.</p> <p>Colorimetric assays - Principle, Beer-Lambert's Law, transmittance; extinction coefficient; light sources; monochromators; types of detectors.</p> <p>Working principle and applications of visible, UV spectrophotometry. Filter Selection Examples of colorimetric and UV absorption assay.</p> | <b>15</b>                 |                           |

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| <b>II</b>  | <p><b>Chromatography and Electrophoresis</b><br/> Chromatography: Definition, Principles, parameters, Chromatographic performance.<br/> Types: Paper Chromatography, Thin Layer Chromatography, Column Chromatography (Principle and Applications).<br/> Electrophoresis: General principles, Factors affecting electrophoresis, Types of support media used, Types of electrophoresis (Agarose gel electrophoresis AGE, PAGE).<br/> Isolation and analysis of molecules from gel and recovery of molecules from paper/gels. Applications of electrophoresis.</p> | <b>15</b> |
| <p><b>Textbooks:</b></p> <ul style="list-style-type: none"> <li>● Practical Biochemistry: Principles and Techniques 1995, 4th ed. by K. Wilson and J. Walker, Cambridge University Press</li> <li>● Introduction to Practical Biochemistry. 2000. by S.K. Sawhney and Randhir Singh (eds.)</li> <li>● Textbook of Basic Principles in Analytical Chemistry (Sem. III &amp; IV), Seth Publication.<b>Additional References:</b></li> <li>● Industrial Microbiology by L.E Casida</li> </ul> |   |           |

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| <b>Course Code</b>  | <b>SKILL ENHANCEMENT COURSE<br/>SEM – II</b>  | <b>Credits</b>            | <b>Lecture<br/>s/Week</b> |
| <b>K23USBTSC25<br/>1</b>  | <b>Paper I Crop Improvement Strategies,<br/>omposting and Solid waste management</b>  | <b>2</b>                  | <b>2</b>                  |
| <b>Course Outcomes:</b>   |   |                           |                           |
| After successful completion of this course, students would be able to   |   |                           |                           |
| <ul style="list-style-type: none"> <li>• Understand basic concepts of Plant Breeding.</li> <li>• To acquire knowledge about High yielding hybrid crops.</li> <li>• To discuss different solid waste management techniques</li> <li>• To understand different Composting methods.</li> </ul> |   |                           |                           |
| <b>Unit</b>   | <b>Topics</b>   | <b>No of<br/>Lectures</b> |                           |
| <b>I</b>  | <b>Crop improvement strategies</b><br><b>Plant Breeding</b><br>Introduction: Objectives and procedure including conventional and modern innovative approaches for development of hybrid and varieties of crops<br>Breeding for resistance to Diseases, Insects and Pests<br>Breeding for resistance to abiotic stresses.<br>Important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops.<br>High yielding hybrid crop varieties: Wheat ,Rice, Sugarcane, Sorghum, Millets, Roses | <b>15</b>                 |                           |
| <b>II</b>   | <b>Composting and solid waste management</b><br>Composting<br>Introduction: Principles of composting, Objectives and Benefits of composting<br>Bangalore and Indore methods of composting<br>Factors affecting the Composting process<br>Types and sources of solid waste<br>Methods of solid waste management :<br>Landfill, Incineration, Pyrolysis and Gasification  | <b>15</b>                 |                           |

**Textbooks:**

- Crop improvement: New approaches and modern Techniques - Hakeem; P Ahmad ,Springer publications
- Handbook of solid waste management (Second Edition)-George Tchobanoglous and Frank Kreith
- Principles of crops Improvement: Arun Kumar,R.B.Dubey
- Plant breeding by Usha sinha

## **Evaluation Scheme for First Year (UG) under NEP (2 credits)**

### **I. Internal Evaluation for Theory Courses – 40 Marks**

**1) Continuous Internal Assessment(CIA)Assignment** - Tutorial/ Project / Presentations/ Group Discussion / Ind. Visit. – 20 marks

**2) Continuous Internal Assessment(CIA)** ONLINE Unit Test – 20 marks

### **II. External Examination for Theory Courses – 60 Marks**

Duration: 2 Hours

Theory question paper pattern: All questions are compulsory.

| <b>Question</b> | <b>Based on</b> | <b>Marks</b> |
|-----------------|-----------------|--------------|
| Q.1             | Unit I and II   | 15           |
| Q.2             | Unit I          | 15           |
| Q.3             | Unit II         | 15           |
| Q.4             | Unit I and II   | 15           |

- All questions shall be compulsory with internal choice within the questions.
- Each Question may be sub-divided into sub questions as a, b, c, d, etc. & the allocation of Marks depends on the weight age of the topic.

### **III. Practical Examination**

- Each core subject carries 50 Marks.( 30 marks external+20 marks internal)
- Duration: 2 Hours for each practical course.
- Minimum 80% practical from each core subjects are required to be completed.
- Certified Journal is compulsory for appearing at the time of Practical Exam

**NOTE: To pass the examination, attendance is compulsory in both Internal & External (Theory + Practical) Examinations.**