"Dissemination of Education for Knowledge, Science and Culture"
- Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Empowered Autonomous)

DEPARTMENT OF MICROBIOLOGY

M.Sc. Part - II
Semester-III & IV

SYLLABUS

NEP 2020

Academic Year 2024-25

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

1. **Title**: M. Sc. Microbiology, Vivekanand College, Kolhapur (Empowered Autonomous)
2. **Faculty**: Faculty of Science and Technology.
3. **Year of Implementation**: 2024-25
4. **Programme Outcomes (POs):** After completing the M. Sc. Programme, the students will be able to:

PO1: Demonstrate and apply the fundamental knowledge of the basic principles of sciences in various fields.

PO2: Create awareness and a sense of responsibility towards the environment and society to solve the issues related to environmental pollution.

PO3: Apply their professional, social, and personal knowledge.

PO3: Competent to pursue research or pursue a career in the subject.

PO4: Apply knowledge to build up small-scale industries for developing endogenous products.

PO5: Communicate scientific information in a clear and concise manner both orally and in writing.

PO6: Inculcate logical thinking to address a problem and become result oriented with a positive attitude.

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Programme Specific Outcomes

1) To acquaint the students with the basic as well as advanced concepts in Microbiology.
2) To make aware the students about the importance of the subject in daily life.
3) To improve the laboratory skills of the students.
4) To prepare students for further studies helping in their bright career in the subject
5) To make students knowledgeable with industrial processes
6) To encourage the students to think the application of the subject studies for progression of mankind.

Department of Microbiology
Departmental Teaching and Evaluation Scheme
2024-25
Microbiology
M. Sc. II Semester III & IV

Sr. No.	Course Abbr.	Course code	Course Name	Teaching Scheme Hours/week		Examination Scheme and Marks				Course Credits
				TH	PR	ESE	CIE	PR	Marks	
Semester-III										
1	DSC-V	DSC20MIC31	Agricultural Microbiology and Phytopathology	4	-	80	20	-	100	4
2	DSC-VI	DSC20MIC32	Enzymology And Enzyme Technology	4	-	80	20	-	100	4
3	DSE-III	DSE20MIC31	Quality Control Microbiology I	4	-	80	20	-	100	4
		DSE20MIC32	Fermentation Technology							
		DSE20MIC33	Biostatistics, Bioinformatics And Scientific Writing							
4	DSC-PR-III	DSE20MIC39	Microbiology Lab-III	-	12	-	-	150	150	6
5	RPR-I	RPR20MIC31	Research Project	-	4	-	-	100	100	4
Semester-III Total				12	16	240	60	250	550	22
Semester-IV										
1	DSC-VII	DSC20MIC41	Food And Dairy Microbiology	4	-	80	20	-	100	4
2	DSC-VIII	DSC20MIC42	Industrial Waste Management	4	-	80	20	-	100	4
3	DSE-IV	DSE20MIC41	Recombinant DNA Technology	4	-	80	20	-	100	4
		DSE20MIC42	Quality Control Microbiology II							
		DSE20MIC43	Environmental Microbiology							
4	DSC-PR-IV	DSC20MIC49	Microbiology Lab-IV	-	8	-	-	100	100	4
5	RPR-II	RPR20MIC41	Research Project	-	6	-	-	150	150	6
Semester-IV Total				12	14	240	60	250	550	22
Total (Semester III & IV)				24	30	480	120	500	1100	44

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

Note:

1. Passing percentage will be 40%
2. Separate passing for each Head - ESE, CIE and Practicals

VIVEKANAND COLLEGE KOLHAPUR (An Autonomous) ESTD JUNE 1964

SEMESTER-III

DSC20MIC31	AGRICULTURAL MICROBIOLOGY AND PHYTOPATHOLOGY Theory: 60 Hours (Credits - 4)	No. of Hours per unit/ credit
	On completion of the course, the students will be able to: CO 1 Understand scope of agricultural Microbiology and microflora of soil and their importance in agricultural Microbiology CO 2 Know about biofertilizers and biopesticides CO 3 Describe various plant diseases and their control CO 4 Explain interactions of plants pathogens with host and defense mechanisms in plants	
Unit I	1. Historical development, scope and concept of soil and agricultural Microbiology. 2. Distribution of microorganisms in soil, their importance in maintaining soil fertility, factors affecting soil microflora. 3. Microbes and bio-geochemical cycles (nitrogen, carbon, sulfur & phosphorous). 4. Microflora of rhizosphere, phyllosphere and spermosphere, R/S ratio; Nitrogen fixing bacteria (*Rhizobium, Azotobacter, Azospirillum* and blue green algae) and phosphate solubilizing microbes (bacteria, fungi) and mycorrhiza.	15/1
Unit II	1. Screening, selection of potential strains on the basis of plant growth promoting activities- Solubilization of nutrients, plant hormone synthesis 2. large scale production of bacterial, blue green algal and fungal fertilizers. 3. Methods of application and evaluation of biofertilizers. 4. Biopesticides- Bacterial - *Bacillus sphericus*; Fungal - *Culicinomyces*, *langenidium* and *Coelomomyces*; NPV of Heliothissps,	15/1

	5. Development of genetically modified crop plants for control insect pests, Bt cotton; Transgenic crop plants. 6. Plant pathogen interaction - positive and negative integrations	
Unit III	1. Diseases caused by Bacteria- fire blight of apple, potato scab, citrus canker, lethal yellowing of coconut 2. Diseases caused by Fungi- powdery scab of potato, damping off, lite blight of potato, downy mildews of pearl millet, grapes, *Fusarium* wilt of tomato, blast disease of rice, stem rust of wheat, corn smuts; Mycoplasma- 3. Biological control, its importance in crop pests and disease management, 4. Merits and demerits of biological control	**15/1**
Unit IV	1. Parasitism and Disease Development Parasitism and pathogenicity 2. Host range of pathogens, Disease triangle, Diseases cycle / Infection cycle, Relationship between disease cycles and epidemics; Pathogens Attack Plants – Mechanical forces, Microbial enzymes and toxins 3. Effect of pathogens on physiology of host – Photosynthesis, Translocation, transpiration, Respiration, Permeability, Transcription and translation. Environment and Plant Disease. 4. Defense Mechanisms of Plant: Disease Pre-existing structural and chemical defenses, Induced structural and biochemical defenses	**15/1**
	REFERENCE BOOKS 1. Subba Rao. 2000. Soil Microbiology. 4th Ed. Oxford & IBH 2. Subba Rao. Biofertilizers in Agriculture. Oxford & IBH 3. Subba Rao. Recent Advances in Biological Nitrogen Fixation. Oxford & IBH. 4. Rangaswamy and Bagyraj. Agricultural Microbiology. 5. Alexendra and Bold. 1999. Introduction to Mycology. Academic Press. 6. Sundara Rajan S. Practical Manual of Fungi. Anmol Publication. 7. Saminathan M.S. Biotechnology in Agriculture. McMillan. 8. Steinhaus. 1963. Insect Pathology. Vol I & II. Academic Press, New	

	York. 9. Burges H D & Hussey N W. 1971. Microbial Control of Insect and Mites. Academic Press, New York. 10. Burges H D. 1970-1980. Microbial Control of Pests and Plant Diseases. 11. Plant pathology. By George Agrios; academic press New York. 12. Microbial Ecology: Fundamentals and Applications by Rinald Atlas and Richard Bartha; Benjamin/Cummings Science Publis., 2725 Sand Hill Road, Menlo Park, California 94025, USA. 13. Plant pathology. By George Agrios; academic press New York	
DSC20MIC32	**ENZYMOLOGY AND ENZYME TECHNOLOGY**	**No. of Hours per unit/ credit**
	On completion of the course, the students will be able to: CO 1 Explain history, properties, classification, structure, and specificity of enzymes CO 2 Describe enzyme kinetics CO 3 Elucidate structural modifications and types of enzymes CO 4 Narrate various applications of enzymes	
Unit I	1. History and special properties of enzymes as catalysts 2. IUB system of nomenclature and classification of enzymes 3. Specificity of enzymes: Types: - substrate and product, group or relative, absolute – stereochemical and spatial specificity Theories to explain specificity – Lock and Key and Induced Fit hypotheses 4. Structure of enzymes: monomeric and oligomeric enzymes, Conceptof the Active Site 5. Methods employed to identify functional groups in the active site – trapping of the intermediate, use of substrate	**15/1**

	analogues, modification of amino acid side chains, some common functional groups and amino acids, chemistry of the active site 6. Co-factors in enzyme action: Organic – prosthetic groups, coenzymes and cosubstrates Inorganic – metal ions in enzyme function, metal activated enzymes and metallo- enzymes, ternary complexes	
Unit II	1. Kinetics of single-substrate enzyme catalysed reactions – Wilhelmy's and Brown's work, Henri and Michaelis-Menten relationships, Briggs and Haldane assumption and derivation, Lineweaver- Burk, Eadie-Hofstee, Hanes and Eisenthal and Cornish-Bowden modifications of the M-M Equation tderive KM, Significance of the M-M equation and KM 2. Kinetics of multisubstrate reactions 3. Haldane's relationship for reversible reactions 4. Sigmoid kinetics - Hill and Adair equations for cooperativity 5. Enzyme inhibition: basic concepts, kinetics, examples and significance of reversible and irreversible inhibition	15/1
Unit III	1. Covalent modification of enzyme structure – irreversible and reversible modification 2. Ligand induced conformational changes – basic concepts of allosterism and allosteric enzymes, models proposed to explain the mechanism of functioning (MWC and KNF); structural aspects of aspartate carbamoyltransferase, role of allosteric enzymes in metabolic regulation – feedback inhibition 3. Multienzyme systems – basic concepts, types with examples,	15/1

	structural and functional aspects ofpyruvate dehydrogenase, fatty acid synthetase, 'Arom' complex and tryptophan synthetase 4. Membrane bound enzymes in metabolic regulation 5. Isoenzymes – basic concepts, method of detection, examples and their metabolic significance	
Unit IV	1. Applications of enzymes in medicine: In diagnosis – general principles and use of alanine amino transferase, aspartate aminotransferase, lactate dehydrogenase, creatine kinase, acid and alkaline phosphatase In therapy – specific applications of few selected enzymes, prodrug activation with examples, enzyme replacement therapy In forensic science - specific applications of few selected enzymes 2. Industrial applications of enzymes – catalysts in the manufacturing and other conversion processes 3. Enzymes as analytical tools 4. Immobilization of enzymes: basic concepts, methods used, properties of IME and their applications in industry, medicine, enzyme electrodes 5. Newer approaches to the application of enzymes – reactions in organic solvents	15/1
	REFERENCE BOOKS: 1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by T. Palmer Affiliated East-West Press Pvt. Ltd. New Delhi 2. Fundamentals of Enzymology – N. C. Price and L. Stevens, Oxford University Press	

	3. Nature of Enzymology – R. L. Foster, Croom Helm Applied Biology Series, London 4. Enzyme Technology – Pandey, Webb, Soccol and Larroche. Asiatech Publishers, INC New Delhi 5. Enzyme Nomenclature by IUBMB Academic Press Inc. 6. Enzyme structure and function – A. Fuerst, Freeman, USA 7. Immobilised Enzymes – M. D. Trevan 8. Enzymes – Boyer, Academic Press 9. Advances in Enzymology – Series edited by N. O. Kaplan, Academic Press 10. Enzyme Biotechnology by G. Tripathi, Technoscience Publications 11. Enzyme Reaction Engineering by T. P. Jayadev Reddy, Biotech Books, Delhi 12. Enzymes and Immobilised Cells in Biotechnology by A. Laskin Butterworths Biotechnology Series	
DSE20MIC31	**FERMENTATION TECHNOLOGY**	**No. of Hours per unit/ credit**
	On completion of the course, the students will be able to: CO 1 Describe fermentation equipment and its uses CO 2 Explain fermentation economics and patents CO 3 Explain control of different metabolic pathways, Contamination and computer applications in fermentation technology CO 4 Produce vitamins, organic acids, beverages, and vaccines	
Unit I	1. Basic functions of a fermenter, body construction, aeration, Agitation, baffles, etc.	**15/1**

	2. Design of other fermentation vessels: Airlift fermenter, tower fermenter Continuous fermenter, fedbatch fermenter, Waldhof type fermenter 3. Sterilization of fermentation equipment, air and media 4. Fermentation broth rheology and power requirements, concepts of Newtonian and non- Newtonianfluids, plastic fluids, effect of rheology on heat and oxygen transfer, Reynold's number, power number, aeration number and apparent viscosity	
Unit II	1. Fermentation media- Types of of fermentation media, sources of carbon, nitrogen trace elements,growth factors, precursors, buffers, antifoam agents, sterilization of media, screening for fermentation media. 2. Fermentation economics – A case study, market potential for product and fermentation, product recovery cost, Entrepreneurship, plan for industry, product selection process, site selection, finance, feasibility, excise and legal aspects 3. Patents – Introduction, composition of patent, background, patent practice and problems	**15/1**
Unit III	1. Environmental control of metabolic pathways 2. Genetic Control of Metabolic pathways 3. Growth and product formation: Concept of primary and secondary metabolites and their control, kinetics of growth and product formation (growth rate, yield coefficient, efficiency), economics 4. Contamination problems in fermentation industry 5. Computer applications in fermentation technology- General applications and specific applications	**15/1**
Unit IV	Industrial production of: 1. Lactic starter culture for food fermentations	**15/1**

	2. Vitamin- B12 3. Gluconic acid 4. Distilled alcoholic beverages – Whisky and Brandy 5. Bacterial vaccines	
	REFERENCE BOOKS: 1. Industrial Microbiology by L. E. Casida, John Wiley and Sons INC 2. Annual Reports on Fermentation processes Vol. I and II by D. Perlman, Academic press INC 3. Prescott and Dunn's Industrial Microbiology, 4th edition (1982) by Gerald Reed 4. Food processing: Biotechnological applications by S. S. Marwaha and J. K. Arora (2000), Asiatech publishers INC 5. Microbial technology Vol. I and II by H. J. Peppler and D. Perlman Academic Press INC 6. Principals of Fermentation Technology by P. Stanbury and A. Whitaker, Pergamon Press 7. Essays in Applied Microbiology by J. R. Norris and M. H. Richmond, John Wiley and Sons,Chicester, New York 8. Biology of Industrial Microorganisms by A. Demain and N. Solomon Butterworths BiotechnologySeries 9. Overproduction of Microbial Metabolites: Strain Improvement and Process Control strategies by Z. Vanek and Z. Hostalek Butterworths Biotechnology Series 10. Fermentation Microbiology and Biotechnology by E. M. T. El-Mansi and C. F. A. Bryce Taylor andFrancis Ltd. London 11. Legal protection for Microbiological and Genetic Engineering Inventions by R. Saliwanchik Butterworths Biotechnology Series 12. Methods in Industrial Microbiology by B. Sikyta,	

	Ellis Horwood Ltd. Chichester (1983) Industrial Microbiology by A. H. Patel, MacMillan India Ltd. 13. Principals of fermentation technology by P. Stanbury and A. Whitaker, Pergamon Press 14. Advances in Applied Microbiology Vols. 9 and 13, by W. W. Umbreit, Academic Press, New York 15. Essays in Applied Microbiology by J. R. Norris and M. H. Richmond, John Wiley and Sons, Chicester, New York	
DSE20MIC32	**QUALITY CONTROL MICROBIOLOGY –I**	**No. of Hours per unit/ credit**
	On completion of the course, the students will be able to: CO 1 Evaluate biosafety levels of laboratories CO 2 Explain good microbiological laboratory techniques CO 3 Describe various techniques of microbial control CO 4 Explain biosafety guidelines	
Unit I	1. Design of Basic laboratories – Biosafety Levels 1 and 2 - Code of practice; Laboratory design and facilities; Laboratory equipment; Health and medical surveillance; Training; Waste handling; Chemical, fire, electrical, radiation and equipment safety 2. The containment laboratory – Biosafety Level 3 - Code of practice; Laboratory design and facilities; Laboratory equipment; Health and medical surveillance 3. The maximum containment laboratory – Biosafety Level 4 - Code of practice; Laboratory design and facilities	**15/1**
Unit II	1. Good microbiological techniques - Good microbiological laboratory techniques - Safe handling of specimens in the	**15/1**

	laboratory; Use of pipettes; Avoiding the dispersal of infectious materials 2. Use of biological safety cabinets; Avoiding ingestion of infectious materials and contact with skin and eyes 3. Opening of ampoules containing lyophilized infectious materials; Storage of ampoules containing infectious materials 4. Standard precautions with blood and other body fluids, tissues and excreta 5. Contingency plans and Emergency procedures for microbiological laboratories.	
Unit III	1. Sterilization and sterility assurance - Microbial Control by Physical and Chemical Methods- Introduction; Physical Methods; 2. Chemical Methods 2. Experimental Parameters Influencing the Antimicrobial Agent Activity 3. Sterilization monitors - Physical indicators, Chemical indicators, biological indicators 4. Sterility assurance and the sterility assurance level 5. Sterility Testing of Pharmaceutical Products – Introduction; Test for Sterility: Pharmaceutical Products - Membrane Filtration; Direct Inoculation - Nutrient Broth; Cooked Meat Medium and Thioglycolate Medium; Sabouraud Medium; Sterile products 6. Sterilization Factors affecting sterilization effectiveness	**15/1**
Unit IV	1. Biosafety Guidelines - Microbiological risk assessment 2. Biological safety cabinets - Class I biological safety cabinet; Class II biological safety cabinets; Class III biological safety cabinet 3. Biological safety cabinet air connection; Selection of a biological safety cabinet; Using biological safety cabinets in the laboratory	**15/1**

	4. Safety equipment - Negative-pressure flexible-film isolators; Pipetting aids; Homogenizers, shakers, blenders and sonicators; Disposable transfer loops; Micro incinerators; Personal protective equipment and clothing.	
	REFERENCE BOOKS: 1. Geoff Hanlon and Norman Hodges -Essential Microbiology for Pharmacy and Pharmaceutical Science, John Wiley & Sons, Ltd. 2. Tim Sandle - Pharmaceutical Microbiology - Essentials for Quality Assurance and Quality Control, Woodhead Publishing publications, Elsevier. 3. Laboratory biosafety manual. – 3rd ed. WHO Library 4. Cataloguing-in-Publication Data ISBN9241546506. 5. Environmental Monitoring for cleanrooms and Controlled environments by Anne 6. MarieDixon, Informa Healthcare Newyork, London, ISBN 13; 978-0-8247-2359-0. 7. Cleanroom Microbiology for the non-Microbiologists, 8. Second Ed, by Devid M. Carlbarg, CRC Press, USA	
DSE20MIC33	**BIOSTATISTICS, BIOINFORMATICS AND SCIENTIFIC WRITING**	
	On completion of the course, the students will be able to: CO 1 Describe the method to collect samples, design the experiments, apply the measures of central tendency CO 2 Explain the concept of hypothesis testing, ANOVA, correlation and regression CO 3 Describe components, objectives, and applications of bioinformatics CO 4 Construct scientific documents, present and publish research papers, acknowledge legal aspects of scientific authorship	

Unit I	1. Basic concepts: definitions–statistics and biostatistics, population, sample, variable and the various types, statistic and parameter. 2. Collection and presentation of data: primary and secondary data, collection of data – enumeration and measurement, significant digits, rounding of data, accuracy and precision, recording of data. Tabular and diagrammatic presentation – arrays, frequency distribution, bar diagrams, histograms and frequency polygons. 3. Descriptive statistics: measures of central tendency, dispersion, skewness and kurtosis 4. Probability: definition, elementary properties, types, rules, Applications to Biological problems, distributions– Binomial, Poisson, Normal, chi-square($\chi 2$) distribution and test. 5. Sampling methods: principles of sampling, necessity– Merits and demerits, random sampling–lottery, geographical arrangement random number; deliberate or non-random sampling, stratified sampling, cluster sampling.	15/1
Unit II	1. Inference about populations: sample size, sampling distribution, standard error, estimation of population mean-confidence interval, Students distribution and its applications (*t*-test). 2. Hypothesis testing: definition of hypothesis, hypotheses-null and alternate hypotheses, general procedure, decision about H0: – one-tailed and two-tailed tests, type I and type II errors 3. Analysis of Variance (ANOVA): basic concepts, experimental designs – CRD, RBD, factorial experiment,	15/1

	repeated measures, other designs, general method, F-test, multiple comparison tests. 4. Correlation: introduction, types, methods of study- Scatter diagram, correlation graph, Karl Pearson's coefficient of correlation and its interpretation, test of significance. 5. Regression: Introduction, simple linear regression-model, equation, least-squares line, evaluating and using the equation, multiple regression – model, obtaining, evaluating and using the multiple regression equation.	
Unit III	1. Definition, components, objectives, databases- definition, biological databases, types and examples, data base management systems (DBMS) 2. Applications of bioinformatics - I: Data visualization - sequence and structure of nucleic acids and proteins, data visualisation tools. 3. Applications of bioinformatics - II: Pattern matching and sequence alignment of nucleic acidsandproteins- fundamentalprinciplesofpairwisesequencealignment, local and global alignment, multiple sequence alignment, sequence alignment tools and databases. 4. Applications of bioinformatics-III: Modeling and Simulation- components and process of modeling and simulation, algorithms-Monte Carlo, Metropolis, methods and tools used for proteins structure (secondary, motifs and domains). 5. Applications of bioinformatics-IV: Phylogenetic analysis: basic principles and methods of preparation of phylogenetic trees. Drug discovery and development: fundamental principles, rational drug design, chemoinformatics and pharma informatics resources, pharmacogenomics.	**15/1**

Unit IV	1. Basic concepts of scientific writing: Language- good English and grammar, use and misuse of words, jargon, abbreviations, literary ornaments, Main requirements of a scientific document. 2. Scientific Document: definition and types – research papers, review papers, proceedings, projectreports, these, book reviews. 3. Compilation of experimental record and programme of writing, Structure of a scientific paper: the AIMRAD system writing a paper according to the system, preparing effective tables, graphs and photographs 4. Presenting and publishing research: Publishing in journals- printed and electronic journals; selection of a journal preparation and submission of the manuscript Presenting in conferences: oral and poster presentations 5. Legal aspects of scientific authorship: copyright considerations, Plagiarism-definition, types, causes and detection of plagiarism.	**15/1**
	REFERENCE BOOKS: 1. Biostatistics A foundation for Analysis in the Health Sciences, by Wayn Daniel (7th Ed) Wiley-India edition 2. Biostatistics by N. Gurumani MJP Publishers 3. Statistical Methods for the Analysis of Repeated Measurements by C. S. Davis 4. Statistical Method in Biological Assays by D. J. Finney 5. Statistical Methods for Rates and Proportions by Fleiss, Joseph L., Levin Bruce and Paik Myunghee Cho 6. Fundamentals of Biostatistics (2ndEd) Irfan Ali Khan and Atiya Khanum, Ukaaz Publications, Hyderabad. 7. Design and analysis of experiments by D. C. Montgomery, John Wiley & Sons.	

8. Sampling methods by M. N. Murthy, Indian Statistical Institute, Kolkata.
9. Bioinformatics: A Beginner's Guide by Jean-Michel Claverie and C. Notredame (2003), Wiley Dream tech India(P) Ltd., New Delhi-110002
10. Elementary Bioinformatics by I. A. Khan (2005), Pharma Book Syndicate, Hyderabad
11. Bioinformatics Computing by B. Bergeron (2003), Prentice-Hall of India Private Limited, New Delhi-110001
12. Bioinformatics (Instant Notes Series) by D. R. Westhead, J. H. Parishand R. M. Twyman (2003), Viva Books Private Limited, New Delhi, Mumbai, Chennai, Kolkata
13. Bioinformatics a Primer by P. Narayanan (2005), New Age International(P) Limited, Publishers, New Delhi-110002
14. Bioinformatics: A practical guide to the analysis of genes and proteins (2^{nd} Ed) by A. D. Baxevanis and B. F. F. Ouellette (2001), John Wiley & Sons, New York.
15. Bioinformatics. Managing Scientific Data by Z. Lacroix and T. Critchlow (2003), Morgan Kaufmann Publishers
16. Bioinformatics: sequence and genome analysis by D. W. Mount (2001), Cold Spring Harbor Laboratory Press, New York.
17. Bioinformatics: Managing Scientific Data by L. Zoe and C. Terence (2004), Morgan Kaufmann Publishers, New Delhi
18. How to write and publish a scientific paper by R. A. Day
19. Writing Scientific Research Articles - Strategy and Steps by Margaret Cargill and Patrick O' Connor. Wiley Blackwell
20. From Research to Manuscript-A Guide to Scientific Writing by Michael Jay Katz, Springer.

DSC20MI C39	**PRACTICAL COURSE - Microbiology Lab-III**	
	Agricultural Microbiology and Phytopathology	**4/2**
	1. Quantitative estimation of IAA produced by PGPB 2. Isolation of siderophore producing organisms 3. Isolation of fungal cell wall degrading enzyme producing organism from soil- Cellulase 4. Production of phosphate based biofertilizer 5. Production of nitrogen based biofertilizer 6. Isolation and identification of phytopathogenic fungi from infected plant parts 7. Estimation of total phenols in diseased and healthy plant tissues 8. Quality control testing of market biofertilizer as per FCO	
	REFERENCE BOOKS: Agricultural Microbiology and Phytopathology 1. Practical Microbiology by Dubey and Maheshwari, S. Chand and company Ltd. 2. Laboratory experiments in microbiology by Gopal Reddy et al 3. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom production technology by K R Aneja 4. Practical Handbook on Agricultural Microbiology by Natarajan Amaresan, Prittesh Patel, Dhruti Amin	
	Enzymology and Enzyme Technology	**4/2**
	1. Quantitative estimation and determination of specific activity of α-amylase 2. Salt (ammonium sulphate) precipitation of α-amylase 3. Study of the effect of substrate concentration [S_0] on α-amylase and determination of V_{max} and K_m 4. Study of the effect hydrogen ion concentration (*p*H) and determination of optimum pH for activity of α-amylase	

	5. Study of the effect of temperature and determination of optimum temperature for activity of α-amylase 6. Study of the effect of metal ions on α-amylase activity 7. Immobilisation of α-amylase by entrapment in alginate gel 8. Determination of loading efficiency of immobilized α-amylase	
	REFERENCE BOOKS: Enzymology and Enzyme Technology 1. An Introduction to Practical Biochemistry by D. T. Plummer TMH Publishers 2. Immobilised Enzymes – M. D. Trevan 3. Advances in Enzymology – Series edited by N. O. Kaplan, Academic Press	
	Fermentation Technology	4/2
	1. Calibration of Colorimeter, Weighing balance, Thermometer 2. Validation of Refrigerator, Autoclave, Incubator, 3. Preparation of SOP for Laboratory instruments – hot air oven, incubator, pH Meter, 4. Preparation of SOP for sterilisation of media (autoclave) /glassware (hot air oven), 5. Preparation of HACCP flow chart 6. Preparation of dilutions 7. Disinfectant preparation and validation	
	REFERENCE BOOKS: Fermentation Technology 1. Indian Pharmacopia 2. US Pharmacopia	
	Quality Control Microbiology I	
	1. Microbial Examination of Non-Sterile Products - Bacterial Endotoxin Testing by Gel Clot Method 2. Test for Confirmation of Labelled LAL Reagent Sensitivity (LAL Test)	

	3. Antibiotic Potency Testing 4. Microbial limit test of finished nonsterile pharmaceutical product 5. Enumeration of air microflora of working place 6. Detection of pathogens in the air of working place 7. Enumeration of surface microflora of working place (contact method) 8. Finger disinfection microbiological testing	
	REFERENCE BOOKS: Quality Control Microbiology I 1. Indian Pharmacopia 2. US Pharmacopia	
	Biostatistics, Bioinformatics and Scientific Writing	
	1. Biostatistics Measures of central tendency – Mean, median and mode Measures of dispersion – variance and standard deviation Estimation of confidence interval for a normal distribution Plotting of Histograms and frequency polygons Analysis of Variance (ANOVA) – CRD, RBD Student's t-test and chi-square test on sample data 2. Bioinformatics Using PubMed/Medline for biological information Retrieving protein and nucleic acid sequences from databases Single and multiple Sequence alignment using BLAST, Clustal and Clustal W Construction of Phylogenetic trees Study of GenBank genomic entries 3. Scientific writing Preparing tables and charts using MS Excel Preparing a PowerPoint presentation	
	REFERENCE BOOKS: Biostatistics, Bioinformatics and Scientific Writing	

	1. Biostatistics A foundation for Analysis in the Health Sciences, by Wayne Daniel (7th Ed) Wiley-India edition 2. Biostatistics by N. Gurumani. MJP Publishers 3. Bioinformatics: A practical guide to the analysis of genes and proteins (2nd Ed) by A. D. Baxevanisand B. F. F. Ouellette (2001), John Wiley & Sons, New York. 4. Bioinformatics. Managing Scientific Data by Z. Lacroix and T. Critchlow (2003), MorganKaufmann Publishers 5. Bioinformatics: A Beginner's Guide by Jean-Michel Claverie and C. Notredame (2003), WileyDreamtech India (P) Ltd., New Delhi – 110 002 6. Operate Computers yourself Part – 2 by D. S. Minhas and G. Minhas, Dreamland Publications, j-128, Kirti Nagar, New Delhi – 110 015 7. Writing Scientific Research Articles – Strategy and Steps by Margaret Cargill and PatrickO'Connor. Wiley Blackwell	
RPR20MI C31	**Research Project**	**4/4**
	SEMESTER – IV	
DSC20MI C41	**FOOD AND DAIRY MICROBIOLOGY**	
	On completion of the course, the students will be able to: CO 1 Write about food spoilage and various methods of food preservation CO 2 Prepare various Indian and western fermented foods CO 3 Describe different food borne disease, their preservation, and control	

	CO 4 Explain role of enzymes in food processing, various applications of enzymes, and Laws regarding food safety	
Unit I	1. Micro-organisms and Food Materials 2. General principles underlying microbial spoilage of food 3. New-Microbial spoilage of cereals and cereal products 4. Microbial spoilage of sugars and sugar products 5. Canning of food, Microbial spoilage of heated canned food 6. General principles of Preservation of food: Asepsis, Removal of microorganisms, Maintenance of anaerobic conditions, 7. Methods of food preservation: Thermal processing, cold preservation, Preservation by using chemical preservatives, Food dehydration, Preservation by using Irradiation	**15/1**
Unit II	1. Milk: Definition, composition, Factors affecting composition, Nutritive value of milk 2. Spoilage of milk and milk products: Milk as a substrate for microorganisms Microbial contamination of milk - sources of contamination, types of microorganisms present in milk Biochemical activities during microbial spoilage of milk 3. Fermented foods: Microbiology and biochemistry of Fermented cereal foods: Amboli, Jalebi Fermented cereal legume foods: Idli, Dhokla Fermented vegetable products: Sauerkraut, Pickles Fermented milk products: Yoghurt, Cultured butter milk	**15/1**
Unit III	1. Food borne diseases: -Food born intoxications: Botulism and and Food borne infections: Bacillary dysentery 2. Transmission, and prevention and control of food borne diseases	**15/1**

	3. Fermented dairy products and their role in controlling food borne diseases 4. Methods for the Microbiological Examination of Foods – Direct examination, cultural techniques, enumeration methods (plate count), rapid methods (immunological methods)	
Unit IV	1. Probiotics: probiotic microbial strains, ideal characteristics of probiotic strains, applications of probiotics, immunogenic effects of probiotics, prebiotics 2. Enzymes in food processing: Need of enzymes, sources of enzymes 3. Applications of enzymes in: Production of high fructose syrup Fruit juice industry, Baking industry, Oils and fat processing 4. Food safety and standards: Food safety issues, Food adulteration, Contaminations with harmful microbes, Metallic contamination, Food Laws and standards, Industrial food safety Laws and standards, HACCP, Indian Food Laws and standards	15/1
	REFERENCE BOOKS: 1. Food processing Biotechnological application (2000) by S. S. Marwaha & K. Arora, Asiatech Publishers INC, New Delhi 2. Food science, Fifth Edition, Norman N. Potter 1996, CBS publishers and distributors 3. The technology of food preservation, Fourth Edition, Norman W. Desrosier BI Publisher and Distributors, Delhi (1987) 4. Dairy Microbiology by Robinson 5. Dairy Microbiology by Robinson 6. Outlines of Dairy technology by Sukumar De 7. Milk and Milk Products – Clarence	

	8. Food Science (5th ed) Norman N. Potter, Joseph N. Hotchkiss	
DSC20MIC42	**INDUSTRIAL WASTE MANAGEMENT**	
	On completion of the course, the students will be able to: CO 1 Explain types and characteristics of industrial wastes CO 2 Write Microbiology and biochemistry of wastewater treatment CO 3 Describe methods of industrial waste treatment CO 4 Explain biological methods of industrial waste	
Unit I	1. Types and Characterization of industrial wastes: Types of industrial wastes General characteristics of different industrial wastes, pH, suspended solids, volatile solids, COD,BOD and organic carbon 2. Effects of industrial wastes on aquatic life- Effects of industrial wastes of high BOD, effects of waste with toxicants 3. Self-purification in natural waters: Introduction, physical process, chemical process, biological process	**15/1**
Unit II	1. Microbiology and biochemistry of wastewater treatment: introduction Cell physiology and important microorganisms – important microorganisms, role of enzymes, principles of growth, plasmid borne metabolic activities Impact of pollutants on biotreatment 2. Methods of industrial waste treatment: Part-I: - Physico-chemical Methods - neutralization, oxidation of cyanides, Chromium reduction, reverse osmosis, carbon adsorption, destruction of phenolic compounds	**15/1**

Unit III	1. Methods of industrial waste treatment: Part-II: - Biological methods - I Activated sludge process- Process, microbiology, sludge bulking Trickling filters- Process, Microbiology and applications 2. Methods of industrial waste treatment: Part-III: - Biological methods - II Lagooning- Aerobic and anaerobic, applications Anaerobic digestion- Process, microbiology of bio-gas formation, applications	**15/1**
Unit IV	1. Biomanagement of industrial waste: technological options for treatment of liquid and solid wastes bioaugmentation, packaged microorganisms, use of genetically engineered microorganisms inwastewater treatment 2. Industrial waste treatment: methods of treatment of wastes from Dairies, Distilleries, paper and pulp industries, fertilizer industries and pharmaceutical industries. 3. Zero waste discharge concept in industries. 4. Waste disposal control and regulations: Water pollution control, Regulation and limits for disposal into lakes, rivers, oceans and land.	**15/1**
	REFERENCE BOOKS: 1. Industrial Pollution Control Vol. - I by E. J. Middlebrooks 2. The treatment of industrial wastes. (2nd ed) by E. B. Besselievre and M. Schwartz 3. Environmental Biotechnology (Industrial pollution management) by S. N. Jogdand, Himalaya Publishing House 4. Water and water pollution Handbook Vol. – I by Leonard L. Ciaccio 5. Wastewater Treatment by M.N. Rao and A. K. Datta	

	6. Industrial Pollution by N. L. Sax. Van Nostrand Reinhold Company 7. Encyclopaedia of Environmental Science and Technology Vol. – II by Ram Kumar 8. Water Pollution Microbiology by R. Mitchell 9. Handbook of Water Resources and Pollution Control by H.W. Gehm and J. I. Bregman 10. Environmental Microbiology by P. D. Sharma, Narosa Publishing House, New Delhi	
DSE20MIC41	**RECOMBINANT DNA TECHNOLOGY**	
	On completion of the course, the students will be able to: CO 1 Explain basic tools of recombinant DNA technology CO 2 Describe basic cloning strategies CO 3 Describe cloning procedure in eukaryotes CO 4 Explain various applications of DNA technology	
Unit I	1. Enzymes: restriction endonucleases, exonucleases – DNA and RNA; DNA polymerases, DNA ligases, alkaline phosphatase, terminal transferase, reverse transcriptase, Polynucleotide kinase 2. Linkers and adaptors 3. Cloning vehicles (vectors): desirable features of ideal cloning vehicles Plasmids: - pUC, pBR322 and its derivatives Viral based: - λ phage – basic and derivative vectors, phage M13 Specialist purpose vectors: - Expression, shuttle, Cosmids, phagemids, gene inactivation, integrative Artificial chromosomes: - BAC, YAC, PAC 4. Gene probes: development of DNA and RNA probes	**15/1**

	labeling of DNA and RNA probes- Radioactive labelling of probe-Nick translation, random primed radiolabelling, probes developed by PCR Non- radioactive labelling of probe -HRP method, DIG labelling system and Biotin-streptavidin labelling system	
Unit II	1. Basic Cloning Strategies General principles: DNA fragmentation, ligation to vectors, introduction into the host cell, cell based and PCR based strategies 2. Cloning in *Escherichia coli* and other bacteria: Construction of genomic libraries – Maniatis' strategy, EMBL 3A vector strategy 3. Construction of complementary DNA (cDNA) libraries – Maniatis' hairpin-primed 3. second- strandDNA synthesis, oligo-dC tail method, the Gubbler-Hoffman method, direction cDNA cloning, plasmid- linked cDNA synthesis, CAPture method 4. Screening of libraries Selection of recombinants- Mechanisms and methods- Direct selection of recombinants, Insertional inactivation method, Blue white selection method, Red-white selection method, Colony hybridization, plaque hybridisation	**15/1**
Unit III	1. Cloning in yeast and fungi: Vector systems: YEp, YCp, YAC, modular expression vector, yeast secretion vector (pGAP), Introduction of DNA, selectable markers, Heterologous protein production – source of DNA, level of heterologous RNA, amount of protein produced, nature of product 2. Cloning in animals: Vectors systems: plasmid-based vectors - pSV2-dhfr, pRSV-neo, virus based vectors - adenovirus, adeno-	**15/1**

	associated, baculovirus, herpes virus, retrovirus, Sindbis and Semliki forest disease virus, vaccinia and pox virus, EB virus Cloning in mammalian cell-lines: methods of DNA transfection – chemical, physical and biological (viral, bacterial) methods, choice of cell-lines, transient and stable expression Transgenesis of whole animals: microinjection of DNA in mice and other animals, Embryo stem cell technology, DNA construct, aberrant expression 3. Cloning in Plants: Vectors systems: Ti plasmid of *Agrobacterium tumefaciens* and Ri plasmid of *Ag. Rhizogenes*, viruses – caulimovirus, geminivirus, BMV, TMV, PVX *Agrobacterium*- mediated gene transfer, direct DNA transfer, gene targeting, *inplanta* transformation Plant cell transformation- Methods- Ultrasonication, liposome mediated gene transfer, electroporation, particle bombardment gun	
Unit IV	Applications of rDNA Technology 1. Production of useful molecules in bacteria, plants and animals 2. Improvement of agronomic traits in plants 3. Study, prevention and cure of diseases 4. Genetically modified foods 5. Protein engineering and its applications	15/1
	REFERENCE BOOKS: 1. Principles of Gene Manipulation and Genomics by S. B. Primrose and R. M. Twyman, BlackwellPublishing, Oxford, UK 2. Molecular Biology and Biotechnology (4th Ed) by J. M. Walker	

	and R. Rapley, Panima PublishingCorporation, New Delhi 3. Recombinant DNA by J. D. Watson and others 4. Genetic Engineering by Chakravarty, CRC Publications 5. Genetic Engineering by Sandhya Mitra 6. Molecular Cloning (Volumes 1, 2, 3) by Sambrook and Russell. Cold Spring Harbor LaboratoryPress International Edition 7. Principles of Genetics by E. J. Gardner. John Wiley and Sons, New York 8. Maximizing Gene Expression by W. Reznikoff and L. Gold, Butterworths Biotechnology Series 9. Yeast Genetic Engineering by P. J. Barr and others, Butterworths Biotechnology Series	
DSE20MIC42	**Quality Control Microbiology-II**	
	On completion of the course, the students will be able to: CO 1 Describe regulatory affairs concerning pharmaceutical drug CO 2 Explain cleanrooms classification, contamination, testing, and microbiological environmental monitoring CO 3 Determine bioburden of finished products CO 4 Explain quality management systems in pharmaceutical	
Unit I	1. Pharmaceutical Drug Regulatory Affairs- Introduction to Regulatory Affairs 2. Drug Regulatory bodies - United States Food and Drug Administration (USFDA); International Conference on Harmonization of technical Requirement for registration of Pharmaceuticals for Human use (ICH); European Medicines Agency (EMA); Central Drugs Standard Control Organization (CDSCO); Medicines and Healthcare Products Regulatory Agency (MHRA).	15/1

Unit II	1. Cleanrooms and environmental monitoring - Introduction; Cleanroom contamination 2. Cleanroom classification; Isolators; Cleanroom certification; HEPPA and ULPA filters; Cleanroom testing 3. Microbiological environmental monitoring- Monitoring of air born viable particles, surface 4. monitoring, water monitoring; Aseptic technique; Other cleanroom disciplines;Cleanroom standards	**15/1**
Unit III	1. Bioburden determination – Introduction; Total microbial count - Traditional counting Methods, Detection of objectionable organisms, Nonsterile products and microbial limits testing;In-process material bioburden assessment; Pre-sterilization bioburden assessment; Alternative methods of bioburden assessment 2. Microbiological analysis of raw materials and finished products – Microbial count limits for finished products; 3. Endotoxin and pyrogen testing - Introduction; Pyrogenicity; Bacterial endotoxin; Quantifying endotoxin; The *limulus* amoebocyte lysate test - method, applications, interference; Alternative test methods	**15/1**
Unit IV	1. Quality Management Systems in Pharmaceutical Manufacturing - Introduction;Pharmaceutical Quality System; 2. Good Manufacturing procedures – Specifications, Batch Manufacturing records, Standard Operating Procedures; Validation- Validation- validation master plan, Qualifications and its types, GMP 3. Inspections; Hazard Analysis and Critical Control Point (HACCP) - Definition, Principles and Guidelines for application of HACCP principles. 4. Auditing the microbiology laboratory- Introduction; Record keeping – Batch Manufacturing Record; Quality audits;	**15/1**

	Auditors and the audit process; Auditing the microbiology laboratory	
	REFERENCE BOOKS: 1. Geoff Hanlon and Norman Hodges - Essential Microbiology for Pharmacy and pharmaceutical Science, John Wiley & Sons, Ltd. 2. Tim Sandle - Pharmaceutical Microbiology - Essentials for Quality Assurance and QualityControl, Woodhead Publishing publications, Elsevier. 3. Laboratory biosafety manual. – 3rd ed. WHO Library Cataloguing-in-Publication Data ISBN9241546506. 4. Environmental Monitoring for cleanrooms and Controlled environments by Anne Marie 5. Dixon, Informa Healthcare Newyork, London, ISBN 13;978-0-8247-2359-0. 6. Cleanroom Microbiology for the non-Microbiologists, Second Ed, by Devid M. Carlbarg, CRC Press, USA.	
DSE20MIC43	**ENVIRONMENTAL MICROBIOLOGY**	
	On completion of the course, the students will be able to: CO 1 Understand developments in the field of environmental microbiology with special emphasis on the role of microbes in mitigating environment pollution. CO 2 acquaint with various cultural, biochemical and molecular techniques used in understanding microbial diversity CO 3 Understand the role of microbes in management of waste plant biomass CO 4 Understand the role of microbes in bioremediation of environmental pollutants like petroleum hydrocarbons, pesticides, plastic and electronic waste; also understands	

	utility of microbes in mineral and oil recovery.	
Unit I	1. Introduction of environment microbiology, development of microbial ecology 2. Understanding microbial diversity in the environment by culture-dependent and culture-independent approaches 3. Analysis by FAME, measuring metabolic capabilities using BIOLOG, G+C analysis, slot-blot hybridization of community DNA, and fluorescent *in situ* hybridization of intact cells, metagenomic analysis of solid and aquatic sediments	**15/1**
Unit II	1. Microbial diversity in extreme environments- Occurrence, diversity, adaptations and potential applications of oligotrophs, thermophiles, psychrophiles, organic solvent and radiation tolerants, metallophiles, acidophiles, alkaliphiles and halophiles 2. Biotechnological applications of the same	**15/1**
Unit III	1. Biomass waste management of plant's residues 2. Lignocellulolytic microorganisms, enzymes and their biotechnological applications in: (i) biopulping, (ii) biobleaching, (iii) textiles (iv) biofuels, (v) animal feed production	**15/1**
Unit IV	1. Bioremediation of environmental pollutants 2. Petroleum hydrocarbons and pesticide 3. use of biosensors for their detection 4. Microbial enhanced oil recovery 5. bioleaching of copper, gold and uranium, electronic waste management	**15/1**
	REFERENCE BOOKS: 1. Microbial Ecology by R.M. Atlas, R. Bartha. 3rd edition. Benjamin Cummings Publishing Co, USA. 1993. 2. Environmental Microbiology by A.H. Varnam, M.G. Evans. Manson Publishing Ltd. 2000.	

	Auditors and the audit process; Auditing the microbiology laboratory	
	REFERENCE BOOKS: 1. Geoff Hanlon and Norman Hodges - Essential Microbiology for Pharmacy and pharmaceutical Science, John Wiley & Sons, Ltd. 2. Tim Sandle - Pharmaceutical Microbiology - Essentials for Quality Assurance and QualityControl, Woodhead Publishing publications, Elsevier. 3. Laboratory biosafety manual. – 3rd ed. WHO Library Cataloguing-in-Publication Data ISBN9241546506. 4. Environmental Monitoring for cleanrooms and Controlled environments by Anne Marie 5. Dixon, Informa Healthcare Newyork, London, ISBN 13;978-0-8247-2359-0. 6. Cleanroom Microbiology for the non-Microbiologists, Second Ed, by Devid M. Carlbarg, CRC Press, USA.	
DSE20MIC43	**ENVIRONMENTAL MICROBIOLOGY**	
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	2. Laboratory Methods in Food Microbiology by D. W. Harrigan, Academic Press 3. Handbook of Techniques in Microbiology by A. S. Karwa, M. K. Rai and H. B. Singh Scientific Publishers, Jodhpur	
	Industrial Waste Management	**4/2**
	1. Determination of total solids (TS), total suspended solids (TSS), total dissolved solids (TDS), total volatile solids (TVS) 2. Determination of Alkalinity of industrial effluent 3. Determination of COD of industrial effluent 4. Determination of BOD of industrial effluent 5. Detection and isolation pectinase producing bacteria 6. Determination of oil & grease content from the waste water sample 7. Development of an activated sludge culture 8. Development of an anaerobic digestion culture and production of bio-gas	
	REFERENCE BOOKS: Industrial Waste Management 1. Standard Methods in Water and Wastewater Analysis by APHA, AWWA and WPCF 2. Analysis of Plants, Irrigation water and Soils by R. B. Somawanshi and others. Mahatma PhuleAgricultural University, Rahuri 3. Microbiological aspects of Anaerobic Digestion – Laboratory Manual by D. R. Ranade and R. V.Gadre, MACS Agharkar Research Institute, Pune 4. Pollution Microbiology: A Laboratory Manual by Melvin S. Finstein, Marcel Dekker Inc.	
RPR20MIC41	Project work	**6/6**

Nature of Question Paper

Instructions: 1) Question 1 is **compulsory**.
2) Figures to the right indicate **full** marks.
3) Draw neat labeled diagrams **wherever** necessary.
4) Use of calculator is allowed.

Time: 3 hours **Total Marks: 80**

Theory papers

Q.1. Select correct alternative. **(16)**

i)
a) b) c) d)

ii)
a) b) c) d)

iii)
a) b) c) d)

iv)
a) b) c) d)

v)
a) b) c) d)

vi)
a) b) c) d)

vii)
a) b) c) d)

viii)
a) b) c) d)

ix)
a) b) c) d)

x)
a) b) c) d)

xi)
a) b) c) d)

xii)
a) b) c) d)

xiii)

a) b) c) d)

xiv)

a) b) c) d)

xv)

a) b) c) d)

xvi)

a) b) c) d)

Section I

Q.2. Attempt any One. **(16)**

i)
ii)

Q.3. Attempt any Two **(16)**

i)
ii)
iii)

Q.4 Attempt any Four **(16)**

i)
ii)
iii)
iv)
v)
v)

Section II

Q.5. Attempt any Two. **(16)**

i)
ii)

Q.6. Attempt any Two **(16)**

i)
ii)
iii)

Q.7 Attempt any Four **(16)**

i)
ii)
iii)
iv)
v)
vi)

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

SCHEME OF MARKING (THEROY)

Semester	Marks	Evaluation	Paper	Standard of passing
III	80	Semester wise	Each paper of 80 marks	40 % (32 marks)
IV	80	Semester wise	Each paper of 80 marks	40 % (32 marks)

SCHEME OF MARKING (CIE) Continuous Internal Evaluation

Semester	Marks	Evaluation	Paper	Standard of passing
III	20	Semester wise	one	40 % (8 marks)
IV	20	Semester wise	one	40 % (8 marks)

SCHEME OF MARKING (PRACTICAL)

Semester	Course	Marks	Evaluation	Standard of passing
III	Practical III And research project	250	Semester	40 %
IV	Practical IV And research project	250	Semester	40 %

***A separate passing is mandatory**