

PANJAB UNIVERSITY CHANDIGARH

**Scheme and Syllabus of
MASTER OF ENGINEERING
M.E. (Biotechnology)
1st to 4th semester**

2019-2020

**University Institute of Engineering and Technology,
Panjab University, Chandigarh**

SCHEME AND SYLLABUS OF M.E. (BIOTECHNOLOGY) 1ST TO 4TH SEMESTER

SCHEME OF EXAMINATION OF M.E. BIOTECHNOLOGY

First Year - First Semester

S. No.	Subject Code	Subject Name	L-T-P	Contact hrs/week	Credits	Marks			Total Marks
						Theory		Practical*	
						Internal Assessment	University Exam		
1	ME BIO 101	Advances in Biochemistry	4 - 0 - 0	4	4	50	50		100
2	ME BIO 102	Biotechniques	4 - 0 - 0	4	4	50	50		100
3	ME BIO 103	Microbial Biotechnology	4 - 0 - 0	4	4	50	50		100
4	ME BIO 104	Bioseparation and Bioprocess technology	4 - 0 - 0	4	4	50	50		100
5	ME BIO 105	Elective I	3 - 0 - 0	3	3	50	50		100
6	ME BIO 106	Biotechnology Lab I (Practical)	0 - 0 - 3	3	2			50	50
7	ME BIO 107	Biotechnology Lab II (Practical)	0 - 0 - 3	3	2			50	50
		Total	20 - 0 - 6	25	23	250	250	100	600

* Practical marks are for continuous and end semester evaluation

Total Hrs/wk = 25 Total Credits = 23

ELECTIVE I

- Stem Cell Biology
- Cell & Cell Technology
- Food Processing and Biotechnology

SCHEME OF EXAMINATION OF M.E. BIOTECHNOLOGY

First Year - Second Semester

S. No.	Subject Code	Subject Name	L-T-P	Contact hrs/week	Credits	Marks			Total Marks
						Theory		Practical*	
						Internal Assessment	University Exam		
1	ME BIO 201	Research Methodology	4 - 0 - 0	4	4	50	50		100
2	ME BIO 202	Bioprocess and Bioreactor Engineering	4 - 0 - 0	4	4	50	50		100
3	ME BIO 203	Enzyme Engineering	4 - 0 - 0	4	4	50	50		100
4	ME BIO 204	Genetic Engineering	4 - 0 - 0	4	4	50	50		100
5	ME BIO 205	Elective II	3 - 0 - 0	3	3	50	50		100
6	ME BIO 206	Biotechnology Lab III (Practical)	0 - 0 - 2	2	1			50	50
7	ME BIO 207	Biotechnology Lab IV (Practical)	0 - 0 - 2	2	1			50	50
		Total	19 - 0 - 4	23	21	250	250	100	600

ELECTIVE II

- Advances in Biomaterials
- Pharmaceutical Biotechnology
- Protein Engineering

Total Hrs/wk = 23 Total Credits = 21

SCHEME OF EXAMINATION OF M.E. BIOTECHNOLOGY

Second Year – Third Semester

S. No.	Subject Code	Subject Name	L-T-P	Contact hrs/week	Credits	Marks			Total Marks
						Theory		Practical	
						Internal Assessment	University Exam		
1	ME BIO 301	Elective III	3 - 0 - 0	3	3	50	50		100
2	ME BIO 302	Elective IV	3 - 0 - 0	3	3	50	50		100
3	ME BIO 303	Thesis Work – I	0 - 0 - 20	20	10			100	100
		Total	6 - 0 - 0	26	16	100	100	100	300

Total Hrs/wk = 26 Total Credits = 16

ELECTIVE III

- Nano Biotechnology and Nano Devices
- Agriculture Biotechnology
- Bioprocess Control & Instrumentation

ELECTIVE IV

- Biological Waste Water Engineering
- Biostatistics & Computer Applications
- Polymer Science & Engineering

SCHEME OF EXAMINATION OF M.E. BIOTECHNOLOGY

Second Year – Fourth Semester

S. No.	Subject Code	Subject Name	L-T-P	Contact hrs/week	Credits	Marks		Total Marks
						Internal Assessment	University Exam	
1	ME BIO 401	Thesis Work – II	0 - 0 - 30	30	15	100	100	200

Total Hrs/wk = 30 Total Credits = 15

Instructions for Examiners to award marks/grades for Thesis

S.No.	Grade	Requirement
1	A+	Publication in SCI/SCIE indexed journal
2	A	Scopus / ESCI indexed journal
3	B+	Paper presented International / National conference

Total Marks: 1700

Total Credits: 75

SYLLABUS OF M.E. (BIOTECHNOLOGY) 1ST SEMESTER

Paper Title: Advances in Biochemistry

Paper Code: ME BIO 101

L T P 4 0 0

Credits: 4

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION-A

Microbial Biochemistry : Glycolysis, fate of pyruvate under aerobic and anaerobic conditions, TCA cycle and its industrial products, Energy from oxidation of inorganic electron donors; Iron oxidation; Methanotrophy and methylotrophy; Nitrate and Sulfate reduction; Acetogenesis; Methanogenesis; Anaerobic respiration; Chlorophylls and other pigments involved in microbial photosynthesis; Anoxygenic and oxygenic photosynthesis; Autotrophic CO₂ Fixation: Calvin cycle, Nitrogen fixation. (18)

Plant Biochemistry: Photosynthetic pathways, secondary metabolites of plants, shikimate –propionate pathway, alkaloids, Synthesis of pharmacologically active substances. (7)

SECTION-A

Medical Biochemistry:

Biosynthesis of Sphingomyelins, cholesterol and their regulation, lipid metabolism and related genetic disorders, Signal transduction and diseases, diabetes and cancer, targets of drug design. (8)

Antisense technology: Comparisons of different antisense strategies (antisense oligo nucleotides, ribozymes and siRNAs). RNA interference induced by siRNA molecules. Applications and challenges of antisense strategies (antisense oligo nucleotides and RNAi) in gene silencing, prostaglandins, thromboxane, cox1 and cox2 inhibitors. (12)

Recommended books:

- 1) Prescotts Microbiology, 8th Ed. by Joanne Willey, Linda Sherwood, Chris Woolverton, McGraw Hill Publishers,
- 2) Molecular cell biology, 6th Ed. By Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger. W.H. Freeman New York, Publishers.
- 3) Tietz Textbook of clinical chemistry and molecular diagnostics, 5th Ed. By Carl A. Burti, Edward R. Ashwood and David E. Bruns, Elsevier Publications.

Paper Title: Biotechniques

Paper Code: ME BIO 102

L T P 4 0 0

Credits: 4

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION A

Flow cytometry and cell sorting, Techniques for Protein-Protein and receptor-ligand interaction (FRET, SPR, and ITC) Two hybrid system

Advances and applications of Chromatographic and mass spectrometric techniques, 2D-DIGE, Qualitative and quantitative Proteomics (ICAT, ITRAQ, SILAC approaches), protein-based microarrays, Organelle/tissue/plasma proteomics (18)

TIRF and confocal microscopy, and their applications for fixed and live-cell imaging, Dynamic analysis using photobleaching and photoactivation, FRAP and FLIP (6)

SECTION B

Principle, sample preparation and applications of Electron microscopy (TEM, SEM, Cryo, Field Emission, Environmental SEM/TEM, Electron Tomography) and Atomic force microscopy (6)

History of sequencing, Next generation sequencing, RNA sequencing and transcriptome analysis, FISH, Luminex Multiplex assays, RACE, RFLP, RAPD, chromatin analysis using ChIP, designing, handling and use of siRNA, miRNA techniques, DNA and RNA microarrays. (12)

Use of radioactive and stable isotopes and their detection; Applications of radioisotopes in advanced research (3)

Recommended books:

1. Freifelder D., Physical Biochemistry, "Application to Biochemistry and Molecular Biology", 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.
2. Keith Wilson and John Walker, "Principles and Techniques of Practical Biochemistry", 5th Edition, Cambridge University Press, 2000.
3. Kwon, Young Min, Ricke, Steven C. (Eds), "High-Throughput Next Generation Sequencing Methods and Applications", Volume. 733, Humana Press, 2011.
4. Receptor Binding Techniques: Second Edition, edited by Anthony P. Davenport, 2005
5. Protein-Ligand Interactions: Methods and Applications, edited by G. Ulrich Nienhaus, 2005
6. New and Emerging Proteomic Techniques, edited by Dobrin Nedelkov and Randall W. Nelson, 2006
7. Cell Imaging Techniques, Methods and Protocols, edited by Douglas J. Taatjes and Brooke T. Mossman, 2006

Paper Title: Microbial Biotechnology

Paper Code: ME BIO 103

L T P 4 0 0

Credits: 4

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION A

Bioprospecting of microbial diversity- scope and techniques (2)

Process technology for the microbial production of:
Organic acids- itaconic acid, propionic acid
Enzymes: Inulinase, peroxidases, chitinase
Microalgal pigments- β carotene from algae (14)

Large scale production of Bio- therapeutics from recombinant microorganism
- Insulin, antibodies (6)

Development and use of next generation antibiotics (2)

SECTION B

Bioleaching of ores (3)

Microbial fuels (Methane, Hydrogen) (5)

Fermentation technology for waste stabilization (4)

Role of microbial biotechnology in agriculture: microbes as biocontrol agents
and as biofertilizers (4)

GMP for production of antibiotics and vaccines (2)

Microbial biotechnology of the extreme environments- thermo and cold adapted enzymes,
use of halophilic microbes in biotechnological applications (3)

Recommended books:

1. Brock, T.D., Biotechnology : A Text of Industrial Microbiology. Smaeur Associate (1990) IInd ed.
2. Crueger, W. and Crueger, A., Bio-Technology, A Handbook of Industrial Microbiology. Ponima Pub (2000) IInd ed.
3. Stanbury P.F. and Whitakar A., Principles of Fermentation Technology, Orgamon Press, (1995) 2nd edition.
4. Maheshwari, D. K., Dubey, R.C and Kang, S.C., Biotechnological applications of microorganisms: A techno-commercial approach. I K International Publishing House (2006).
5. Waites, M. J.,Morgan N.L., Rockey J.S and Higon G. Industrial Biotechnology: An Introduction. Blackwell Scientific Press, UK (2007).
6. Patel, A.H., Industrial Microbiology. Mac Millan India Ltd, New Delhi (2005)

Paper Title: Bioseparation and Bioprocess technology

Paper Code: ME BIO 104

L T P 4 0 0

Credits: 4

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION-A

INTRODUCTION TO BIOSEPARATION: Characterization of biomolecules and fermentation broth.

Guidelines to recombinant protein purification. (4)

SOLID-LIQUID SEPARATION AND CELL DISRUPTION: Solid liquid separation- microfiltration and centrifugation – theory and design for scaleup operation. Cell disruption – Homogeniser , dynamill – principle, factors affecting disruption, batch and continuous operation. Cell disruption by chemical methods. (9)

CONCENTRATION AND PURIFICATION: Liquid- liquid extraction – theory and practice with emphasis on Aqueous two phase extraction. Solid liquid extraction. Precipitation techniques using salt and solvent.

Separation by ultrafiltration, Dialysis, Electrophoresis. (10)

SECTION-B

BLACK BOX MODEL: Yield coefficients, black box stoichiometries, elemental balances, heat balance, degrees of reduction balances, systematic analysis of black box stoichiometries. (5)

DESIGN OF FERMENTATION PROCESSES: Kinetics of substrate utilization, biomass growth and product formation, inhibition on cell growth and product formation. Design and operation of continuous cultures, chemostat in series, batch and fed batch cultures, total cell retention cultivation. (12)

CASE STUDIES IN FERMENTATION DERIVED PRODUCTS: Case studies on Production of green chemicals, algal biofuels, recombinant Insulin. Case studies should deal with medium design, reactor design & process optimization etc. (5)

Recommended books:

1. Shuler, M.L. and Kargi, F. Bioprocess Engineering: Basic concepts, 2nd ed., Prentice-Hall, 2002.
2. Doran Pauline M, Bioprocess Engineering Principles, Academic Press, 1995
3. Nielsen, J. and Villadsen, J. “Bioreaction Engineering Principles”. Springer, 2007.
4. Blanch, H.W and Clark D.S., “Biochemical Engineering”, Marcel Dekker,1997

Paper Title: Stem Cell Biology

Paper Code: ME BIO 105 (Elective)

L T P 3 0 0

Credits: 3

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION-A

1. Basic biology of stem cells; Types & sources of stem cell with characteristics: amniotic fluid, cord blood haematopoetic, placenta, bone marrow, embryonic, adult, primordial germ cells, cancer stem cells, Induced Pluripotent Stem cells. **(8)**
2. Stem cell Characterizations: isolation & characterizations, Markers & their identification, growth factor requirements and their maintenance in culture. feeder and feeder free cultures. **(10)**
3. Cell cycle in stem cells **(5)**

SECTION-B

4. Molecular basis of stem cell renewal and differentiation, Metaplasia and transdifferentiation. **(7)**
5. Molecular basis of pluripotency and stem cell niche. **(7)**
6. Regulatory mechanisms in stem cell: Transgene expression and RNA interference in Embryonic stem cells, Lentiviral vector mediated gene delivery in human embryonic stem cells. Ethics in stem cell. **(8)**

Recommended Books:

1. Essential of Stem Cell Biology” by R. Lanza, J. Gearhart et al (Eds), Essentials of Stem Cell Biology, Third Edition 2013, by Robert Lanza (Editor), Anthony Atala (Editor)
2. Stem Cells: From Basic Research to Therapy, Volume 1: Basic Stem Cell Biology, Tissue Formation during Development, and Model Organisms, 2014 by CRC Press, Federico Calegari (Editor), Claudia Waskow (Editor)
3. Translational Approaches In Tissue Engineering & Regenerative Medicine” by J. J. Mao, G. Vunjak-Novakovic *et al* (Eds), 2008, Artech House, INC Publications.

Paper Title: Cell & Cell Technology (Elective -I)

Paper Code: ME BIO 105

L T P 3 0 0

Credits: 3

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

History and Introduction of Animal Cell Culture- Past, present and future of animal cell culture, terminology of cell and tissue culture, normal and transformed cells, culture types (cell culture, organ culture, explant), their advantages and limitations, Biology and characteristics of cultured cells (cell adhesion molecules, intercellular junctions, extracellular matrix, cytoskeleton). (5)

Animal Cell Culture Laboratory and Facilities- Infrastructure, equipments and culture vessels. (2)

Component of Cell Culture Environment- Media (basal media, serum media and serum replacement media, specialized media and choice of media.), conditioned medium, feeder cells, physiochemical factors. (5)

Primary Culture and Cell Lines- Establishment of Primary culture from various sources, isolation of cells (mechanical disaggregation, enzymatic disaggregation), Secondary cell culture (subculturing and establishment of continuous cell lines, cell cloning and selection, cell Sorting and separation techniques) (10)

SECTION-B

Growth and Scale up of Cell Culture- Growth characteristics and kinetics, growth in suspension (stirrer culture, continuous flow culture, air-lift fermentor culture), growth in monolayer (roller bottle culture, multisurface culture, multiarray disks, spirals and tubes) (5)

Genetic Engineering of Animal and Animal Cells -Transfection techniques, development of transgenic animals (xenotransplantation, knockout, human disease models, reproductive and therapeutic cloning). (5)

Mammalian Cell Expressin System- Methodology and production of medical/pharmaceutical products using mammalian culture (tissue plasminogen activator, Factor-VIII) their transport and cellular therapies. (7)

GLP and Quality Control of Cell Line-Testing for microbial contamination, regulatory aspects of GLP, authentication of cell line (isoenzyme analysis, DNA fingerprinting, multiplex PCR). (6)

Recommended books:

1. Freshney, 2009, Animal Cell Culture, Oxford University Press, New York. 3rd edition.
2. Davis, 2007, Basic cell culture, Oxford University Press, New York. 2nd edition.
3. Bernard R. Glick and J. J. Pasternak, 2003, Molecular biotecnlogy, ASM Press, Washigton, 3rd edition

Paper Title: Food Processing and Biotechnology (Elective-I)

Paper Code: ME BIO 105

L T P 3 0 0

Credits: 3

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each

SYLLABUS

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

Historical developments in food processing, World and Indian food processing scenario, food processing industries-types, technology of processing. (4)

Effect of processing on nutritive value of foods, Quality control and assurance, Sensory evaluation of foods (4)

Constituent of food – contribution to texture, flavour and organoleptic properties of food; food additives – intentional and non-intentional and their functions; enzymes in food processing. (7)

Manufacture of Bread and baked goods, dairy products – milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages. (8)

SECTION-B

Post Processing Technology: coating and enrobing; functions of a package, types of containers, package design considerations, packing materials- properties and testing procedures, packing of fresh and processed foods. (6)
Aseptic packaging, retort pouch processing technology, RFID/smart tag in labeling of foods, recent trends in packaging. (3)

Present scope of food technology, setting up of food processing units, selection of processing technology, marketing concept. Foods of increasing sophistication: Newer foods, GM foods, organic foods. (5)

Food safety and regulations: FDA, Codex Alimentarius, PFA, FPO, BIS, ISO, Agmark, Overview of Food Safety and Standards Act, 2006, HACCP, Food Safety Management System, Process Control, Food plant sanitation, personal hygiene, hygienic water for processing; Food Industry waste: types, disposal and management. (8)

Recommended books:

1. Principles and practices for the safe processing of food, ed. By D.A. Shapton and N.E. Shapton, Butter worth, Heinmann Ltd., Oxford, 1997.
2. Principles of food processing by Dr. Heldman and R.W. Hartel Champman and Hall, New York, 1997.
3. Food Processing by J.M. Conor and W.A. Shieps, John Willey and Sons, NY, 1997.
4. Food processing operations and scale up by K.J. Valentis, L. Levine and J.P Clark, Marcel Dekker, NY, 1970.
5. Food safety by J.M. Jones Eagen Pres, USA, 1995.
6. Elements of Food Technology, edited by N.W. Desnosic, Awi Publications Co., Inc., Watpert, Connection, 1977.
7. Food Processing Technology- Principles and Practice by PJ Fellows, Woodhead Publishing Ltd, 2005.
8. Brenner, J.G., Butters, J.R., Cowell, N.D. and Lilly, A.E.V. Food engineering operations, 2nd ed., Applied Sciences Pub.ltd., London,1979.

Paper Title: Biotechnology Lab I

Paper Code: ME BIO 106

L T P 0 0 3

Credits: 2

Internal Assessment: 50

SYLLABUS

List of Experiments:

- 1) Production of microbial inoculants.
- 2) Assay of biocontrol activity of microorganisms.
- 3) Preparation of Plasma from blood and estimation of glucose.
- 4) Estimation of total cholesterol/ lipid profile in blood.
- 5) Estimation of plant secondary metabolite.
- 6) Hemolytic activity assay of bacteria
- 7) Isolation of nitrogen fixing bacteria from environment
- 8) Analysis of transfection efficiency
- 9) Determination of the phenol coefficient of a given disinfectant
- 10) Estimation of chemical oxygen demand (COD) of given sample

Paper Title: Biotechnology Lab II

Paper Code: ME BIO 107

L T P 0 0 3

Credits: 2

Internal Assessment: 50

SYLLABUS

List of Experiments:

- 1) Separation and identification of compounds using Column Chromatography.
- 2) Proteomic analysis of bacterial cell lysate using 2D Gel electrophoresis.
- 3) Synthesis of Gold nanoparticles and their characterization using SEM/TEM.
- 4) Virtual designing of siRNA using bioinformatics tools.
- 5) Determination of growth curves for microbial cultures and liquid-liquid extraction of metabolites from fermentation broth.
- 6) Cell disruption methods and their effect on the extracted lipid composition.
- 7) Chromatographic separation of metabolites/drugs/bio molecules.
- 8) Estimation of Monods Kinetic Parameters.
- 9) Evaluate the temperature and pH effect on culture growth.

SYLLABUS OF M.E. (BIOTECHNOLOGY) 2nd SEMESTER

Paper Title: Research Methodology

Paper Code: ME BIO 201

L T P 4 0 0

Credits: 4

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

Introduction to Educational Research: Concept, types-basic, applied and action, Need for educational research. (4)

Reviewing Literature: Need, Sources-Primary and Secondary, Purposes of Review, Scope of Review, Steps in conducting review. (4)

Identifying and defining research problem: Locating. Analyzing stating and evaluating problem, Generating different types of hypotheses and evaluating them. (4)

Method of Research: Descriptive research design-survey, case study, content analysis, Ex-post Facto Research, Correlational and Experimental Research. (6)

Sampling Techniques: Concept of population and sample' sampling techniques-simple random sampling, stratified random sampling, systematic sampling and cluster sampling, snow ball sampling, purposive sampling, quota sampling techniques determining size of sample. (6)

SECTION-B

Design and development of measuring instruments, Tests, questionnaires, checklists, observation schedules, evaluating research instruments, selecting a standardized test. (8)

Procedure of data collection: Aspects of data collection, coding data for analysis. (4)

Statistical Methods of Analysis: Descriptive statistics: Meaning, graphical representations, mean, range and standard deviation, characteristics and uses of normal curve.

Inferential statistics: t-test. Chi-square tests. Correlation (rank difference and product moment), ANOVA (one way) (4)

Procedure for writing a research proposal; Purpose, types and components of research proposal. (2)

Procedure for writing a research report: Audiences and types of research reports, Format of Research report and journal Strategies for evaluating, research, disseminating and utilizing research- An Overview. (3)

Recommended books:

1. Borg, W and Gall, M. Educational Research: An Introduction, New York, Longman, 2003 2.
2. Cohen, L. Educational Research in class rooms and schools! A Manual of Materials and Methods NY: Harper and Row Publishers, 2000
- 3 CPSC: Developing Skills in Technican Education Research Modules 1 to 11 Singapore, Colombo
Plan Staff College for Technician Education
4. Garrett, HE and Woodworth, RS Statistics in Psychology and Education, Educational Research, Bombay:
Vakils Fetter and Simons Ltd. 2003
5. Gay, LR, Educational Research, Ohio: Charles E. Merril Publishing Company 2000 Wiersma
William Research Methods in Education- An Introduction London, Allyn and Bacon, Inc. 2000

Paper Title: Bioprocess & Bioreactor Engineering

Paper Code: ME BIO202

L T P 4 0 0

Credits: 4

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

1. **Overview:** biological systems, media design, media sterilization and ideal reactor types. (5)
2. **Scale-up of bioreactors:** introduction, scale-up methods, correlations and illustrations. (8)
3. **Heat transfer:** heat transfer equipment, heat transfer between fluids, design equations for heat transfer systems, applications of design equations. (10)

SECTION-B

4. **Mass transfer:** molecular diffusion, diffusion and film theories, oxygen uptake in cell cultures oxygen transfer in fermenters, measurement of dissolved oxygen concentrations, mass-transfer correlations, measurement of k_{La} . (8)
5. **Design and analysis:** Reactor dynamics and stability, reactors with non-ideal mixing. (6)
6. **Bioreactor system supplies:** water, steam, air and gases. (8)

Recommended books:

1. Shuler, M.L. and Kargi, F. Bioprocess Engineering : Basic concepts, 2nd ed., Prentice-Hall, 2002.
2. Doran Pauline M, Bioprocess Engineering Principles, Academic Press, 1995 .
3. Stanbury P.F. and Whitakar A. Principles of Fermentation Technology, Orgamon Press., 2nd edition, 1995.
4. Asenjo J.A.& Merchule J.C. Bioreactor Sytem Design, Dekker. C R C Pr. 1st edition, 1994. (Eds.)

Paper Title: Enzyme Engineering

Paper Code: ME BIO 203

L T P 4 0 0

Credits: 4

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

INTRODUCTION

Introduction to enzymes, Classification, Sources, Mechanism of enzyme action. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes Biocatalysis:

Definition of Biocatalysis, advantages and disadvantages of Biocatalysis over chemical catalysis.

Stereo selective biocatalysts for the synthesis of chiral pharmaceutical intermediate such as synthesis of ACE inhibitors, definition, mode of action of inhibitors. (10)

KINETICS OF ENZYME ACTION: Methods for investigating the kinetics of Enzyme catalysed reactions – Initial velocity Studies, Estimation of Michaelis Menten parameters, Effect of pH and temperature on enzyme activity, kinetics of inhibition. Modeling of rate equations for single and multiple substrate reactions. (13)

SECTION-B

IMMOBILIZED ENZYMES: Techniques of enzyme immobilization; kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, design and configuration of immobilized enzyme reactors; applications of immobilized enzyme technology, Economic argument for immobilization. (7)

MODELLING OF DIFFUSION SYSTEMS

External mass transfer, Internal diffusion and reaction within biocatalysts, derivation of finite model for diffusion-reaction systems, dimensionless parameters from diffusion-reaction models, the effectiveness factor concept. (8)

DESIGN AND ANALYSIS OF BIOLOGICAL REACTORS

Ideal bioreactors-batch, fed batch, continuous, cell recycle, plug flow reactor, two stage reactors, enzyme catalyzed reactions, reactor dynamics and stability. (7)

Recommended books:

1. Trevor Palmer and Philip L Bonner. "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry", East- West Press, 2004
2. Shuler, M.L. and F. Kargi, "Bioprocess Engineering: Basic Concepts" 2nd Edition, Pearson, 2002.

3. Bailey.J.E and Ollis.D.F, "Biochemical Engineering Fundamentals", 2nd Edition, McGraw-Hill, 1986.
4. Faber, Kurt "Biotransformations in Organic Chemistry: A Textbook." 5th Edition. Springer,2008

Paper Title: Genetic Engineering

Paper Code: ME BIO 204

L T P 4 0 0

Credits: 4

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

Scope of Genetic Engineering- Milestones in Genetic Engineering, genetic code, genetic elements that control gene expression. (2)

Molecular Tools in Genetic Engineering – Restriction and DNA Modifying enzymes (Polymerases, Reverse Transcriptase, Ligases, Alkaline phosphatase, Terminal deoxynucleotide transferases, Nucleases - S1 nucleases etc.), Vectors for *E. coli* (Plasmids, Phages, Cosmids, Fosmids, Phagemids, BAC), Vectors for Eukaryotes (YEPs, YIPs, YRPs, YAC), Vectors for plants (Ti and Ri plasmids, caulimoviruses, geminiviruses), Vectors for animals (P-elements, baculovirus, adenovirus, papillomavirus and retrovirus). (10)

Nucleic Acid Amplification and Gene Cloning Strategies- PCR analysis, their types and applications, prokaryotic and eukaryotic transformations, Creating and screening DNA libraries (Genomic library and cDNA library preparations). (6)

Directed Mutagenesis and Protein Engineering- *in-vitro* mutagenesis, *in-vivo* mutagenesis, error-prone PCR, adding disulphide bond, increasing enzymatic activity, modifying metal cofactor requirement *etc.* (5)

SECTION-B

Molecular Markers and Diagnostic Systems- Molecular Markers (RFPL, AFLP, RAPD, SSR, SNP, CAPs, SSR and their applications), Human molecular genetics (genetic linkage and genetic mapping), Detection of microbes (radioactive, non-radioactive hybridization procedure, molecular beacons, DNA fingerprinting, bacterial biosensor), Diagnosis of genetic diseases (cystic fibrosis, sickle cell anemia, PCR/OLA). (10)

Application of Genetic Engineering in Plants, Animals and Microbes- Transgenic plants (Disease resistant, insect resistance, herbicide tolerance and biopharming), in Animals (hormones and pharmaceutical protein production, generation of transgenic animal, Gene therapy, to fight AIDS), Transgenic Microbes (Production of restriction endonucleases, small biological molecules such as ascorbic acid, indigo, antibiotics and enzymes, insulin, growth hormones, monoclonal antibodies/magic bullets, humanized monoclonal antibodies, biopolymers such as xanthum gum, animal adhesive biopolymer, bioremediation i.e. degradation of xenobiotics, clearing oil spills, starch and cellulose utilization and case studies. (10)

Regulation and Patenting in Molecular Biology- importance of regulation, regulating food and food ingredients, GMOs release and controversy, Human gene therapy. (2)

Recommended books:

1. Gene Cloning and DNA Analysis, An Introduction. T.A.Brown, Wiley –Blackwell publication, 2010.

2. Recombinant DNA by Watson., Scientific American books, New York, 1992.

3. Bernard R. Glick and J. J. Pasternak, 2003, Molecular biotechnology, ASM Press, Washington, 3rd edition

Paper Title: Advances in Biomaterials (Elective- II)

Paper Code: ME BIO 205

L T P 3 0 0

Credits: 3

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION A

CLASSIFICATION OF BIOMATERIALS AND THEIR PROPERTIES: **Metals-** crystal structure, properties, processing, oxide formation and corrosion, Examples-Stainless steel, Ti and Ti-based alloys. **Ceramics-** classification- inert, bioactive and resorbable ceramics, structure and processing, Examples- Alumina, Carbon, hydroxyapatite. **Composite material-** -basic concept, matrix phase, particle reinforcement-organic and inorganic, fibre reinforcement. Synthesis techniques. Example- Ceramic- Polymer composites. **Polymers-** natural and synthetic polymers- structure- property relationship (15)

CHARACTERIZATION OF BIOMATERIALS: atomic bonding, crystal lattice. Methods of material characterization: Thermal analysis, TGA, DTA, DSC, basic principle. Mechanical properties(stress strain curve, tensile strength) optical properties, surface properties, tribology (8)

SECTION B

TESTING OF BIOMATERIAL: In vitro assessment of cell and tissue compatibility. In vivo assessment of tissue compatibility (4)

HOST RESPONSE TO BIOMATERIALS: Biomaterial-Blood interaction, blood coagulation, foreign body reaction, inflammation, wound healing process (5)

APPLICATIONS OF BIOMATERIALS: **Soft tissue application-** cardiovascular, skin and facial implants. **Hard tissue application** – orthopedic and dental implants. **Tissue engineering scaffolds-** scaffolds for bone and skin tissue engineering. **Drug delivery-** Targeted drug delivery. Coating on implant surface (10)

IMPLANT FAILURE: Wear, cracks, fatigue, degradation of material in the biological environment. (3)

Recommended books:

Biomaterials. Bhat, S.V. Alpha Science International, 2005, 2nd edition.

Biomaterials Science: An Introduction to Materials in Medicine, Edited by: Ratner, B.D., Hoffman, A.S., Schoen, F.J. and Lemons, J.E. Academic Press, 2013, 3rd edition.

Biomaterials: An Introduction. Park, J. and Lakes, R.S. Springer Science+ Business Media, 2007, 3rd edition.

Essential Biomaterials Science. Williams, D. Cambridge University Press, 2014, 1st edition.

Paper Title: Pharmaceutical Biotechnology (Elective -II)

Paper Code: BIO 205

L T P 3 0 0

Credits: 3

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

History of pharmacy, pharmaceutical industry & development of drugs, economics and regulatory aspects, quality management, GMP, drug kinetics and bio-pharmaceutics, mechanism of drug absorption, distribution, metabolism and excretion, factors affecting ADME process, advance drug delivery systems, controlled release, transdermals, liposomes and drug targeting. (23)

SECTION-B

Factors contributing to immunogenicity (product related factors, host related factors), consequences of immunogenicity to biopharmaceuticals, drug design, principles and applications of SAR and PAR (QSAR), study of artificial enzymes, computer-aided drug design (CADD) and molecular modeling. (22)

Recommended books:

1. Gary ,w. 2007. Pharmaceutical biotechnology: Concepts and applications, Wiley publishers.
2. Hugo and Russell's . 2011. Pharmaceutical microbiology, 8th Edition; Wiley publishers.
3. Kokare, C.R. 2008. Pharmaceutical microbiology; principles and Applications, 6th Edition, Nirali Prakashan

Paper Title: Protein Engineering (Elective-II)

Paper Code: ME BIO 205

L T P 3 0 0

Credits: 3

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each

SYLLABUS

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

Biology of Proteins

Basic constituents, hierarchical arrangements, over-view of protein preparation, modification, maturation; protein protein interactions, Heat shock proteins, their structure and functions in cells, protein mimicry, assisted protein maturation processes in cells, Protein trafficking and dislocation, protein secretion from cell, biomarker discovery, ribosome profiling. (11)

Protein folding and assembly

Protein folding pathways in prokaryotes and eukaryotes; Single and multiple folding pathways; Protein folding of single domain and multi-domain proteins; Inclusion bodies and recovery of active proteins; Osmolyte assisted protein folding; Structure of chaperones and role of chaperones in protein folding, kinetics and thermodynamics of protein folding and unfolding reactions. (12)

SECTION-B

Protein modifications

Strategies for protein engineering, Random and site directed mutagenesis, Role of low-fidelity enzymes in protein engineering, Gene shuffling and Directed evolution of proteins, Antibody engineering. (8)

Prediction and design of protein structures

Similar structure and function of homologous proteins, Role of multiple alignment, Homology and ab-initio method for protein structure prediction, Phage display systems; Structure based drug design, Rational protein design. (7)

Proteomics Technologies:

Protein Arrays/ Protein Chips and their application, 2D Gel Electrophoresis and its application
Mass Spectrometry and Protein Identification, Proteomics Databases Proteomics Analysis Tools at ExPaSy. (7)

Recommended books:

1. Introduction to Protein structure, 2nd Ed by Carl Branden and John Tooze, Garland Press, 1999.
2. Structure and Mechanism in Protein Science, Alan Fersht, Freeman, 1999.
3. Protein engineering in Industrial biotechnology, Ed. Lilia Alberghina, Harwood Academic Publishers, 2002.
4. Proteins – Structures and Molecular Properties, 2nd Edition, Thomas E. Creighton, W. H. Freeman and Company, New York
6. Igor Jurisica, Dennis Wagle. Knowledge Discovery in Proteomics. 2006. Chapman & Hall / CRC Press.
7. Pennington SR (Ed), Dunn M. J. (Ed) Proteomics: from protein sequence to function. 2002 Viva Books Pvt. Ltd.
8. Srivastava Sudhir (Ed). Informatics in Proteomics 2005 Taylor & Francis Group / CRC.

Paper Title: Biotechnology Lab III

Paper Code: ME BIO 206

L T P 0 0 2

Credits: 1

Internal Assessment: 50

SYLLABUS

List of Experiments:

1. Media optimization (pH, Temperature, Carbon & Nitrogen sources) for enzyme production.
2. Enzyme immobilization by various methods.
3. Kinetic study of free enzyme and immobilized enzyme.
4. Determination of the parameters of oxygen transport in water.
5. To study the mass and energy balance during cell-growth.
6. Determination of reaction kinetics of a substrate in a fed-batch system.
7. To determine residence time distribution for reactors.
8. Determination of characteristics parameters for the design of stirred vessels.

Paper Title: Biotechnology Lab IV

Paper Code: ME BIO 207

L T P 0 0 2

Credits: 1

Internal Assessment: 50

SYLLABUS

List of Experiments:

1. Analysis of protein by gel electrophoresis under denaturing conditions (SDS-PAGE).
2. Amplification of DNA using PCR and detection of amplified fragment using agarose gel electrophoresis.
3. Digestion of plasmid DNA by restriction endonuclease.
4. Ligation and Transformation assay.
5. Induction and expression of a gene cloned in an expression vector in *E.coli*.
6. Western blot analysis.
7. Identification of N- terminal amino acid of a protein using dansyl chloride method.

SYLLABUS OF M.E. (BIOTECHNOLOGY) 3rd SEMESTER

Paper Title: Nanobiotechnology and Nanodevices (Elective - III)

Paper Code: ME BIO 301

L T P 3 0 0

Credits: 3

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION A

INTRODUCTION TO NANOBIO TECHNOLOGY: Basic concept, recent advances and applications of nanobiotechnology (2)

NANOFABRICATION TECHNIQUES FOR BIOLOGICAL APPLICATIONS: Top down techniques- electron beam lithography, nanoimprint lithography. Bottom up approaches- block copolymer micelle nanolithography, sol gel process. (7)

HYBRID BIO NANODEVICES: Fabrication and applications (4)

NANO FLUIDIC DEVICES : Basic theory, construction of nanofluidic devices, lab on a chip (4)

NANOSTRUCTURED SURFACE AND CELLULAR BEHAVIOUR: Creation of cell interactive surfaces by chemical and topographical nanopatterning, surface functionalization of nanoparticles, cellular response to the nanostructured surfaces (5)

SECTION B

DNA BASED NANOSTRUCTURES: DNA based nanowires and network – fabrication and their applications, self assembled DNA nanostructures and nanodevices, DNA programmed organization of nanostructures (5)

PROTEIN NANOTECHNOLOGY: Protein based self-assembly nanostructures – s layers, nanopores. Protein nanoarrays- construction and application (5)

NANOTECHNOLOGY AND DIAGNOSTICS: Quantum dots, Surface plasmon resonance based nanosensors, nanowires, SERS active nanoparticles, nanoparticles as contrast agents for MRI (5)

NANOTECHNOLOGY AND THERAPEUTICS: Nanodiamonds, carbon nanotubes , virus based nanoparticles, dendrimers , gold nanoparticles (5)

NANOTECHNOLOGY IN TISSUE ENGINEERING: Nanofabrication techniques to develop scaffolds for tissue engineering (3)

Recommended Books

1. Nanobiotechnology: Concepts, Applications and Perspectives. Edited by: Niemeyer, C.M. and Mirkin, C.A. WILEY-VCH, Verlag GmbH & Co, 2004 ,1st edition.
2. Nanobiotechnology- II, More Concepts and Applications. Edited by: Mirkin, C. A. and Niemeyer, C.M. WILEY-VCH, Verlag GmbH & Co, 2007, 1st edition.
3. The Nanobiotechnology Handbook. Edited by: Xie, Y . CRC Press, Taylor & Francis Group, 2013, 1st edition
4. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, Edited by: Vo-Dinh,T. CRC Press, Taylor & Francis Group, 2007, 1st edition.

Paper Title: Agriculture Biotechnology (Elective - III)

Paper Code: ME BIO 301

L T P 3 0 0

Credits: 3

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

Introduction and History of Plant Biotechnology

(2)

General Concept and Methodology- Nutrition of cell and organ culture, PGRs and their use in micropropagation, totipotency, cloning (isolation and culture of single cells, propagation from non-meristematic tissues-non zygotic embryogenesis and organogenesis, transfer and establishment of whole plants in soil, shoot tip culture (clonal propagation and production of virus free plants), embryo rescue,. (10)

Hybrid Plants- Protoplast isolation, culture and fusion, selection and regeneration of hybrid plants, symmetric and asymmetric hybrid, cybrid. (3)

Production of Haploid/Double Haploid Plants- Androgenesis and gynogenesis, homozygous lines. (3)

***In-vitro* Pollination and Fertilization:** Ovular, ovary and stigmatic pollination, techniques for *in-vitro* fertilization, chemical, physical and electroporation fusion. (4)

SECTION-B

Plant Transformation, Productivity And Performance- Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors (binary and co-integrate), use of 35S and other promoters, selection markers, reporter genes, viral vectors and their application, transformation methods – biological, physical and chloroplast transformation. Herbicide resistance, insect resistance, virus resistance, thionins, PR proteins, nematode resistance, abiotic stress, post harvest losses, product shelf life improvement, male sterile lines, bar and barnase systems. (12)

Plant Metabolic Engineering - control mechanisms, manipulation for Plant secondary metabolic pathways and their commercial relevance. (5)

Recent Advances in Agricultural Biotechnology: Use of enzymes as biopesticides, nanopesticides, management of agro waste, phytoremediation of heavy metals, biodegradable plastics, therapeutic proteins, edible vaccines. (6)

Recommended Books

1. Bhojwani, S.S. & M.K. Razdan. Plant Tissue Culture – Theory and Practices. 5th Ed. Elsevier Science Pub. Co. Inc., New York. 776pp. 2005.
2. Singh, B.D. Biotechnology. Kalyani Publishers, New Delhi. 574 pp. 2004.
3. Trigiano, R. N., Gray, D. J. Plant Tissue Culture, Development, and Biotechnology. CRC Press Inc, 2010.

Paper Title: Bioprocess Control and Instrumentation (Elective-III)

Paper Code: ME BIO 301

L T P 3 0 0

Credits: 3

Internal Assessment: 50

University Examination: 50

Course Duration: 45 lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION-A

Introduction, need for process control, design elements of a control system, Difference between feedback and feed forward control configuration, Hardware for a process control system. (5)

Block Diagrams, Laplace transforms and transfer functions, difference between lumped and distributed parameter system. (4)

Dynamic behavior of first and higher order systems, interacting and non-interacting systems, dead time. (8)

Different modes of control actions and their basic characteristics, controllers and their characteristics, control valve. (6)

SECTION-B

Stability Analysis of Feedback Systems-Notion of Stability, characteristic equation, Routh- stability criterion. Root Locus Analysis (8)

Introduction to Advanced Control Systems- Cascade control, Over-ride Control, feed forward control, Ratio control, Inverse response, Control system design concepts. (7)

Physical and Chemical Sensors, on line sensors for cell properties, off line analytical methods. (7)

Recommended books:

S. No.	NAME	AUTHOR(S)	PUBLISHER
1.	Process System Analysis and Control	D.R. Coughanowr	Mc Graw Hill, 2 nd Edition 1991.
2.	Essentials of Process Control	W.L.Luyben and M.L.Luyben	Mc Graw Hill International Editions, 1997
3.	Biochemical Engineering Fundamentals	J.E. Bailey and D.F. Ollis	McGraw Hill International Editions, 2 nd edition 1986

Paper Title: Biological Waste Water Engineering (Elective - IV)

Paper Code: ME BIO 302

L T P 3 0 0

Credits: 3

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION-A

Measurement of Organic Pollutant: Parameters - BOD, COD & TOC, Factors affecting on BOD, BOD equations, methods of estimating BOD, Biological v/s Physicochemical analysis. (5)

Microbial Growth Kinetics: Microbial Growth Kinetics terminology, rate of utilization of soluble substrates, other rate expression for the utilization of soluble substrate, rate of soluble substrate production from biodegradable particulate organic matter, rate of biomass growth with soluble substrate, rate of oxygen uptake, effects of temperature, total volatile suspended solids and active biomass, net biomass yield and observed yield.

(7)

Biological Treatment: Overview of biological wastewater treatment, objectives of the treatment, role of Micro-organisms, Types of biological processes for wastewater treatment, suspended and attached growth systems, Municipal wastewater treatment, Unit operations of Pre and primary treatment. (10)

SECTION-B

Aerobic Suspended Growth Biological Treatment Systems: Aerobic biological oxidation, process description, process description, stoichiometry, environmental factors, plug flow activated sludge, Complete Mix activated sludge, Extended Aeration system, Oxidation Ditch systems, Intermittently aerated and decanted systems, Oxygen activated sludge, Principles of aeration, factors affecting oxygen transfer, Oxygenation and mixing requirements, Final clarification. Aerobic attached Growth Biological Treatment systems, Introduction to attached growth systems, Mass transfer limitations, trickling filtrations, Oxygen transfer and utilization, Applications rotating biological contactors, Bio-Towers, Process design considerations. (13)

Anaerobic Decomposition: Mechanism of anaerobic fermentation – a multistep process, Microbiology and biochemistry of anaerobic processes, substrate inhibition, optimal anoxic environment, kinetic constants, stuck reactors, standard rate, high rate and multistage anoxic digesters. (10)

Recommended Books

1. Wastewater Engineering: Treatment and Reuse by Metcalf & Eddy, McGraw Hill Publications 4th Edition, 2012.
2. Environmental Biotechnology by T. Srinivas, New Age International (P) Ltd., 2008.
3. Environmental biotechnology: Principles and Applications by J B. E. Rittman and. P. L. McCarty, McGraw Hill Publications, 2009.

Paper Title: Biostatistics & Computer Applications (Elective - IV)

Paper Code: ME BIO 302

L T P 3 0 0

Credits: 3

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

Introduction to biostatistics: Basic definitions and applications, sampling representative sample size, sampling bias and sampling techniques. Data collection and presentation: types of data, methods of collection of primary and secondary data, methods of data collection, graphical representation by histogram, polygon, ogive curves and pie diagram.

Measures of central tendency: Measures of central tendency: mean, median, mode. Measures of variability of variation. Correlation and regression: positive and negative correlation and calculation of Karl Pearson's coefficient of correlation. Linear regression and regression equation and multiple linear regressions. ANOVA, one and two way classification. Calculation of an unknown variable using regression equation.

Tests of significance: Tests of significance: small test (Chi-square t-test, F-test), large sample test (Z-test) and standard error. Introduction to probability theory and distribution (concept without deviation) binomial, poisson and normal (only definitions and problems) computer oriented statistical techniques. Frequency table of single discrete variable, bubble plot. Computation of mean, variance and standard deviations, t test, correlation coefficient.

SECTION-B

Computer: Introduction and application: Introduction to computers and computer applications: Introduction to computers, Computer applications in research, basics, organization, PC, mainframes and Super-computers, concept of hardware and software, concept of file, folders and directories, commonly used commands, flow charts and programming techniques. Introduction in MS Office software concerning Word processing, spreadsheets and presentation software.

Scientific writing in research: Research: Definition, importance and meaning of research, characteristics of research, types of research, steps in research, identification, selection and research problems, formulation of hypothesis. Scientific writing- characteristics. Logical format for writing thesis and papers. Essential features of abstract, introduction, review of literature, materials, methods, and discussion. Effective illustration- table and figures. Reference styles- Harvard and Vancouver systems.

Recommended Books

- 1 Elements of Mathematical statistics" by V.C.Kapoor and Gupta.
- 2 Research methods in Biological sciences. Palanisamy S. and M. Shanmugavelu. 1997. Palani Paramount publications, Tamil Nadu. India
- 3 Veerarajan, T. "Probability, Statistics and Random Processes". 3rd ed., Tata Mc Graw-Hill,
- 4 Biostatistical methods by Lachin

Paper Title: Polymer Science and Engineering (Elective - IV)

Paper Code: ME BIO 302

L T P 3 0 0

Credits: 3

Internal Assessment: 50

University Examination: 50

Course Duration: 45 lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION-A

Introduction to polymers: Basic concept, classification of polymers, molecular weight and its distribution, preparation of polymeric materials and their characterization. Step growth and chain polymerization, copolymerization, kinetics and molecular weight distribution in polycondensation and free radical addition polymerization, control of molecular weight. (15)

Dilute Solution viscometry, conformation and molecular dimensions of polymer chains, Thermodynamics of polymer solutions. Rubber elasticity, flow curve and its determination. (10)

SECTION-B

Polymerization processes (6)

Polymeric materials with discussion on electrical, optical, transport and mechanical properties. (4)

Viscoelasticity, linear viscoelastic models. (5)

Bio-polymer materials, applications in bio-technology and controlled drug delivery system. (5)

Recommended Books

S. No.	Title	AUTHOR(S)	PUBLISHER
1.	Polymer Science and Technology	J.R.fried	Prentice Hall
2.	Polymer Science and Engineering	D.J.Williams	Prentice Hall
3.	Principles of Polymerization	George Odian	John Wiley & Sons,Inc.

Paper Title: Thesis Work – I

Paper Code: ME BIO 303

L T P 0 0 0

Credits: 10

Internal Assessment: 100

SYLLABUS OF M.E. (BIOTECHNOLOGY) 4th SEMESTER

Paper Title: Thesis Work – II

Paper Code: ME BIO 401

L T P 0 0 0

Credits: 15

Internal Assessment: 100

University Examination: 100