MEERUT INSTITUTE OF ENGINEERING & TECHNOLOGY, MEERUT

Evaluation Scheme
(Effective from 2025-26)

M. Tech.
Biotechnology

Affiliated to

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY LUCKNOW

Department of Biotechnology

M. Tech Biotechnology Semester-wise Credit Distribution

Semester	**I**	**II**	**III**	**IV**
Credits for Courses	20	17	19	19
	Total Credit = 75			

1st Semester Evaluation Scheme

S. N.	Subject Code	Subject	Type of Subject	Category	Periods			Mid Term Examination				End Sem Examination		Total	Credits
					L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	MMBT 101	Bio-Separation & Fermentation Technology	Theory	Core	4	0	0	20	10	30		70	-	100	4
2	MMBT 102	Advance Bioinformatics	Theory	Core	4	0	0	20	10	30		70	-	100	4
3	MMBT 103	Advance Immunological Techniques	Theory	Core	3	0	0	20	10	30		70	-	100	3
4	MMBT 104	Applied Biochemistry	Theory	Core	3	0	0	20	10	30		70	-	100	3
5	MMRM101	Research Methodology	Theory	multidisciplinary	3	0	0	20	10	30		70	-	100	3
6	MMBT 151	Bio-Separation & Fermentation Technology Lab	Practical	Core	0	0	3	-	-	-	50		50	100	1
7	MMBT 152	Advance Bioinformatics Lab	Practical	Core	0	0	2	-	-	-	50		50	100	1
8	MMAE101	Soft Skill (Verbal & PDP)	Ability Enhancement Course	#AEC	2	0	0			50				50	1
	Total				19	0	5							750	20

2nd Semester Evaluation Scheme

S. N.	Subject Code	Subject	Type of Subject	Category	Periods			Mid Term Examination				End Sem Examination		Total	Credits
					L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	MMBT 201	Advance DownStream Processing	Theory	Core	4	0	0	20	10	30		70	-	100	4
2	MMBT 202	Recombinant DNA Technology	Theory	Core	4	0	0	20	10	30		70	-	100	4
3	MMBT 203	Advance Nanobiotechnology	Theory	Core	3	0	0	20	10	30		70	-	100	3
4	MMBT 204	Advance Stem Cell Technology	Theory	Core	3	0	0	20	10	30		70	-	100	3
5	MMBT 251	Advance Down Stream Processing Lab	Practical	Core	0	0	3	-	-	-	50		50	100	1
6	MMBT 252	Recombinant DNA Technology Lab	Practical	Core	0	0	3	-	-	-	50		50	100	1
7	MMAEA202/MMAEB202/MMAEC202/MMAED202	Language Proficiency (German/ Spanish/French/ Russian)	Ability Enhancement Course	#AEC	2	0	0			50				50	1
8	MMNC101/201	Environmental studies	Non Credit	NC	2	0	0	30	20	50		50		100	0
	Total				18	0	6							750	17

3rd Semester Evaluation Scheme

S. N.	Subject Code	Subject	Type of Subject	Category	Periods			Mid Term Examination				End Sem Examination		Total	Credits
					L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	MMBT 351	Seminar	Practical	Core	0	0	6					50		50	3
2	MMBT 352	Dissertation	Practical	Core	0	0	30					200	300	500	15
3	MMAE301	Quantitative Ability and Logical Reasoning	Ability Enhancement Course	#AEC	2	0	0			50				50	1
4	MMNC101/ 201	Disaster Management	Non Credit	NC	2	0	0	30	20	50		50		100	0
	Total				4	0	36							700	19

4th Semester Evaluation Scheme

S. N.	Subject Code	Subject	Type of Subject	Category	Periods			Mid Term Examination				End Sem Examination		Total	Credits
					L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	MMBT451	Dissertation	Practical				36					200	400	600	18
2	MMAE506	Design Thinking and Innovation	Ability Enhancement Course	#AEC	2	0	0			50				50	1
3	Total				2	0	36							650	19

CT	Class Test
TA	Teacher Assessment
TS	Theory Sessional
TE	Theory External
PS	Practical Sessional
PE	Practical External

AS	Applied science
AEC	Ability Enhancement Course

 # VE,AE and SE No Pen, Paper Test

1st Semester Evaluation Scheme

S. N.	Subject Code	Subject	Type of Subject	Category	Periods			Mid Term Examination				End Sem Examination		Total	Credits
					L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	MMBT 101	Bio-Separation & Fermentation Technology	Theory	Core	4	0	0	20	10	30		70	-	100	4
2	MMBT 102	Advance Bioinformatics	Theory	Core	4	0	0	20	10	30		70	-	100	4
3	MMBT 103	Advance Immunological Techniques	Theory	Core	3	0	0	20	10	30		70	-	100	3
4	MMBT 104	Applied Biochemistry	Theory	Core	3	0	0	20	10	30		70	-	100	3
5	MMRM101	Research Methodology	Theory	multidisciplinary	3	0	0	20	10	30		70	-	100	3
6	MMBT 151	Bio-Separation & Fermentation Technology Lab	Practical	Core	0	0	3	-	-	-	50		50	100	1
7	MMBT 152	Advance Bioinformatics Lab	Practical	Core	0	0	2	-	-	-	50		50	100	1
8	MMAE101	Soft Skill (Verbal & PDP)	Ability Enhancement Course	#AEC	2	0	0			50				50	1
	Total				19	0	5							750	20

MMBT 101	Bio-Separation & Fermentation Technology	LTP:4-0-0	Credit:4

	At the end of course, the student will be able to	BBL
CO 1	Interpret the principles of microbial fermentation, bioprocess design, and kinetics.	K2
CO 2	Apply engineering principles to the design, modeling, and analysis of bioreactors and scale-up strategies.	K3
CO 3	Evaluate and optimize bio-separation techniques for recovery and purification of biological products.	K3
CO 4	Integrate advanced unit operations such as membrane filtration, chromatography, and electrophoresis in DSP.	K3
CO 5	Design bioprocess strategies for industrial production under GMP and regulatory frameworks.	K3

Unit	Topic	Hrs
I	**Advanced Concepts in Fermentation Technology:** Fundamentals of microbial metabolism in industrial processes, Types of fermentation: submerged, solid-state, batch, fed-batch, continuous, advanced growth kinetics, Monod and non-Monod models, maintenance energy, yield coefficients, Media optimization using statistical tools (RSM), Inoculum preparation for industrial scale.	**08**
II	**Bioreactor Engineering & Scale:** Types and configurations: STR, airlift, bubble column, photobioreactors, Bioreactor dynamics: mass and heat transfer, aeration, agitation, scale-up parameters, Sterilization techniques and contamination control, Modeling of bioreactors using MATLAB/other simulation tools.	**08**
III	**Cell Disruption and Primary Recovery:** Cell harvesting: flocculation, sedimentation, centrifugation, Disruption methods: mechanical (bead mill, high-pressure homogenizer) and non-mechanical (enzymatic, osmotic), Filtration techniques: depth and membrane filtration, Solid-liquid separation challenges in DSP	**08**
IV	**Purification Strategies in Downstream Processing:** Chromatographic techniques: ion-exchange, affinity, hydrophobic interaction, HPLC, Electrophoretic methods: SDS-PAGE, IEF, 2D electrophoresis, Membrane-based separations: ultrafiltration, microfiltration, nanofiltration, Integration of unit operations and process intensification.	**08**
V	**Industrial Applications and Regulatory Aspects:** Industrial production: recombinant proteins, monoclonal antibodies, enzymes, biofuels; Process validation and quality assurance (GMP, GLP, QA/QC); Effluent treatment and biowaste valorization**;** Case studies: insulin, streptokinase, ethanol, lactic acid poduction.	**08**

Text Books:

1. Shuler, M.L. & Kargi, F., Bioprocess Engineering: Basic Concepts, 3rd Edition, 2021, Pearson Education.
2. Doran, Pauline M., Bioprocess Engineering Principles, 2nd Edition, 2012, Academic Press.
3. Stanbury, P.F., Whitaker, A. & Hall, S.J., Principles of Fermentation Technology, 3rd Edition, 2016, Butterworth-Heinemann.

Reference Books:

1. Bailey, J.E. & Ollis, D.F., Biochemical Engineering Fundamentals, 2nd Edition, 1986, McGraw-Hill Education.
2. Aiba, S., Humphrey, A.E. & Millis, N.F., Biochemical Engineering, 2nd Edition, 1973, Academic Press.
3. Belter, P.A., Cussler, E.L. & Hu, W.S., Bioseparations: Downstream Processing for Biotechnology, 2nd Edition, 1999, Wiley-Interscience.
4. Sivasankar, B., Bioseparations: Principles and Techniques, 1st Edition, 2005, PHI Learning Pvt. Ltd.

Web Links (If any)

MMBT 102	Advance Bioinformatics	LTP:4-0-0	Credit:4

At the end of course, the student will be able to		BBL
CO 1	Describe the features of biological databases and explain sequence alignment algorithms.	K2
CO 2	Apply bioinformatics tools for genome annotation and structural prediction of biomolecules.	K3
CO 3	Analyze genomic, transcriptomic, and proteomic data using computational approaches.	K3
CO 4	Interpret systems biology models and network-based approaches for complex biological data.	K3
CO 5	Design computational workflows for molecular docking and drug discovery applications.	K3

Unit	Topic	Hrs
I	**Biological Databases and Sequence Analysis:** Introduction to bioinformatics and its scope; Primary, secondary, and specialized databases (NCBI, EMBL, DDBJ, UniProt, PDB); Sequence alignment: global vs local, pairwise vs multiple; Algorithms: Needleman-Wunsch, Smith-Waterman, BLAST, FASTA; Scoring matrices: PAM, BLOSUM.	**08**
II	**Genomics and Genome Annotation:** Structural and functional annotation of genomes; Gene prediction algorithms: ab initio and homology-based approaches; Comparative genomics and synteny analysis; Transcriptomics: RNA-seq, microarray data analysis; Genome browsers: UCSC, Ensembl, NCBI Map Viewer.	**08**
III	**Protein Structure and Function Prediction:** Protein sequence analysis and motif identification; Secondary and tertiary structure prediction: Chou-Fasman, GOR, homology modelling; Protein domain databases: Pfam, PROSITE, SMART; Molecular visualization tools: PyMOL, RasMol; Protein-protein interaction databases: STRING, BioGRID.	**08**
IV	**Systems Biology and Pathway Analysis:** Introduction to systems biology and omics integration; Metabolic pathway databases: KEGG, Reactome, MetaCyc; Network biology: construction and analysis of gene and protein networks; Tools: Cytoscape, GeneMANIA, Pathway Studio; Regulatory networks and signal transduction pathways.	**08**
V	**Molecular Docking, Drug Discovery, and AI in Bioinformatics:** Basics of molecular docking and structure-based drug design; Docking tools: AutoDock, SwissDock, PatchDock; Virtual screening, QSAR modelling; Role of machine learning and AI in bioinformatics and drug discovery; Case studies on computational drug discovery.	**08**

Text Books:

1. Mount, D.W., Bioinformatics: Sequence and Genome Analysis, 2nd Edition, 2004, Cold Spring Harbor Laboratory Press.
2. Pevsner, J., Bioinformatics and Functional Genomics, 3rd Edition, 2015, Wiley-Blackwell.
3. Lesk, A.M., Introduction to Bioinformatics, 5th Edition, 2019, Oxford University Press.

Reference Books:

1. Baxevanis, A.D. & Ouellette, B.F.F., Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, 2005, Wiley-Interscience.
2. Jensen, L.J. & Bork, P., Systems Biology: A Textbook, 2nd Edition, 2017, Wiley-VCH.
3. Wishart, D.S. & Arndt, D., Computational Methods in Drug Discovery, 1st Edition, 2020, Springer Nature.

Web Links (If any)

MMBT 103	Advance Immunological Techniques	LTP:3-0-0	Credit:3

	At the end of course, the student will be able to	BBL
CO 1	Describe the structure, types, and functions of immune cells and molecules.	K2
CO 2	Apply immunological techniques such as ELISA, flow cytometry, and western blotting in diagnostics and research.	K3
CO 3	Analyze antigen-antibody interactions using advanced serological and immunoassay methods.	K3
CO 4	Interpret results from immunological experiments and evaluate immune responses in clinical settings.	K3
CO 5	Design experimental approaches using monoclonal antibodies, cytokine profiling, and immunophenotyping techniques.	K4

Unit	Topic	Hrs
I	**Immune System Components and Antigen-Antibody Interactions:** Overview of innate and adaptive immunity; Cells of the immune system and their roles; Structure and classes of immunoglobulins; Antigen-antibody interactions: affinity, avidity, cross-reactivity.	**06**
II	**Immunological Assays and ELISA Techniques:** Principle and types of ELISA: direct, indirect, sandwich, competitive; Radioimmunoassay (RIA) and Chemiluminescent immunoassays; Applications of ELISA in diagnostics and research**.**	**06**
III	**Western Blotting and Immunodiffusion Techniques:** Western blotting: protocol, detection, interpretation; Ouchterlony double diffusion, radial immunodiffusion; Immunoelectrophoresis and counter-current electrophoresis**.**	**06**
IV	**Flow Cytometry and Cell Sorting:** Principle and instrumentation of flow cytometry; Fluorochromes and detection systems; Applications in immunophenotyping, apoptosis, and cell cycle analysis.	**06**
V	**Monoclonal Antibodies and Cytokine Analysis:** Production and purification of monoclonal antibodies (Hybridoma technology)**;** Cytokine profiling: multiplex assays, ELISpot**;** Advanced immunotechniques in vaccine and biomarker development.	**06**

Text Books:

1. Kuby, J., Immunology, 7th Edition, 2013, W.H. Freeman & Company.
2. Kindt, T.J., Goldsby, R.A., Osborne, B.A., Immunology, 6th Edition, 2007, W.H. Freeman.
3. Male, D., Brostoff, J., Roth, D.B., Roitt's Essential Immunology, 13th Edition, 2016, Wiley-Blackwell.

Reference Books:

1. Abbas, A.K., Lichtman, A.H., Pillai, S., Cellular and Molecular Immunology, 10th Edition, 2021, Elsevier.
2. Paul, W.E., Fundamental Immunology, 7th Edition, 2012, Lippincott Williams & Wilkins.

Web Links (If any)

MMBT 104	Applied Biochemistry	LTP:3-0-0	Credit:3

At the end of course, the student will be able to		BBL
CO 1	Explain biochemical principles governing the structure and function of biomolecules.	K2
CO 2	Apply enzyme kinetics and regulation in biochemical pathways.	K3
CO 3	Analyze metabolic pathways and their integration in physiological and pathological states.	K4
CO 4	Evaluate the biochemical basis of diseases and therapeutic targets.	K4
CO 5	Utilize biochemical techniques for research and diagnostic applications.	K3

Unit	Topic	Hrs
I	**Biomolecules and Bioenergetics:** Structure and function of carbohydrates, lipids, proteins, and nucleic acids; Bioenergetics: laws of thermodynamics, Gibbs free energy, redox reactions; High-energy compounds: ATP, NADH, FADH2**.**	**06**
II	**Enzymology:** Classification, structure, and mechanism of enzyme action; Enzyme kinetics: Michaelis-Menten equation, Lineweaver-Burk plot; Enzyme inhibition and regulation; coenzymes and cofactors	**06**
III	**Metabolism and Its Regulation:** Glycolysis, TCA cycle, oxidative phosphorylation, and gluconeogenesis; Lipid metabolism: beta-oxidation, ketogenesis; Amino acid metabolism: urea cycle and transamination.	**06**
IV	**Molecular Basis of Diseases:** Inborn errors of metabolism; Biochemical basis of diabetes, cancer, and cardiovascular diseases; Oxidative stress and antioxidants.	**06**
V	**Biochemical Techniques and Applications:** Chromatography, electrophoresis, spectrophotometry; Radioisotopes in biochemistry; Clinical biochemistry and biomarker discovery.	**06**

Text Books:

1. Lehninger, A.L., Nelson, D.L., Cox, M.M., Lehninger Principles of Biochemistry, 7th Edition, 2017, W.H. Freeman.
2. Voet, D., Voet, J.G., Biochemistry, 5th Edition, 2010, Wiley.
3. Stryer, L., Biochemistry, 8th Edition, 2019, W.H. Freeman.

Reference Books:

1. Murray, R.K., Bender, D.A., Botham, K.M., Harper's Illustrated Biochemistry, 31st Edition, 2018, McGraw-Hill.
2. Satyanarayana, U., Biochemistry, 5th Edition, 2017, Elsevier.

Web Links (If any)

MMRM101	Research Methodology	LTP:3-0-0	Credit:3

At the end of course, the student will be able to		BL
CO 1	Understand the meaning, objectives, and types of research, and differentiate between research methods and methodology.	K2
CO 2	Apply research design techniques, and develop theoretical and conceptual frameworks based on literature survey findings.	K3
CO 3	Apply various data collection methods, sampling techniques, and case study methods in research.	K3
CO 4	Analyze data using statistical techniques and hypothesis testing, and interpret research results effectively.	K4
CO 5	Analyze the structure of a research report and understand intellectual property rights, plagiarism issues, and global frameworks related to patents and copyrights.	K4

Unit	Topic	Hrs
I	Introduction: Meaning and Objectives of Research, Types and Significance of Research, Research Methods Versus Methodology and Scientific Methods, Techniques involved in defining the research problem.	**08**
II	Literature Survey: Developing a Theoretical and Conceptual Framework, Literature Review, Broadening knowledge base in Research Area. Research Design: Methods of Research Design, Research Process and Steps involved, Features of Good Designs and Experiential Designs.	**08**
III	Data Collection: Classification of Data, Methods of Data Collection, Sampling, Sampling Techniques, Procedures and Methods, Case Study Method	**08**
IV	Data Analysis: Data Analysis, Statistical Techniques, Hypothesis, Hypothesis Testing, Data Processing Software, Statistical Inference. Interpretation: Meaning, Techniques of Interpretation, Precautions and Interpretation of Results.	**08**
V	Report Writing: Dissertation and Thesis, Significance of Report Writing, Layout of the Research Report, Types of Reports, Referencing Styles, Research Journals, Indexing and Citation f Journals. Intellectual Property Rights: Intellectual Property, Plagiarism, Patents, Process of Patenting, Copyright Acts, Trademarks and Names, WIPO, WTO and UNESCO	**08**

Text Books:

1. Research Methodology: Methods and Techniques by C.R. Kothari
2. The Craft of Research" by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams
3. Empirical Research in Software Engineering by Runeson, Host, Regnell, and Wohlin

MMBT 151	Bio-Separation & Fermentation Technology Lab	LTP:0-0-3	Credit:1

	At the end of course, the student will be able to	BBL
CO 1	Perform microbial culture techniques and optimize growth conditions.	K3
CO 2	Operate laboratory-scale fermenters for biomass and product formation.	K3
CO 3	Apply separation techniques like centrifugation, precipitation, and filtration.	K3
CO 4	Execute chromatographic methods for biomolecule purification.	K3
CO 5	Analyze the yield and purity of fermentation products using standard assays.	K4
	List of Experiments	
	1. Preparation and sterilization of culture media. **2.** Cultivation of microorganisms in batch fermenters. **3.** Monitoring of biomass and product during fermentation. **4.** Product recovery by centrifugation and precipitation. **5.** Extraction and purification using solvent extraction. **6.** Protein separation by ion-exchange chromatography. **7.** Enzyme purification using gel filtration chromatography. **8.** Determination of product concentration using UV-Vis spectrophotometry. **9.** SDS-PAGE analysis for protein purity. **10.** Downstream processing and yield estimation.	

Text Books:

1. Doran, Pauline M., Bioprocess Engineering Principles, 2nd Ed., 2013, Academic Press.
2. Stanbury, P.F., Whitaker, A., Hall, S.J., Principles of Fermentation Technology, 3rd Ed., 2017, Elsevier.
3. Harrison, R.G., Todd, P., Rudge, S.R., Petrides, D., Bioseparations Science and Engineering, 2nd Ed., 2015, Oxford University Press.

Reference Books:

1. Bailey, J.E., Ollis, D.F., Biochemical Engineering Fundamentals, 2nd Ed., 1986, McGraw-Hill.
2. Shuler, M.L., Kargi, F., Bioprocess Engineering: Basic Concepts, 2nd Ed., 2002, Prentice Hall.

Web Links (If any)

MMBT 152	Advance Bioinformatics Lab	LTP:0-0-3	Credit:1

	At the end of course, the student will be able to	BBL
CO 1	Execute sequence retrieval and data mining using public databases.	K3
CO 2	Perform sequence alignment and phylogenetic tree construction.	K3
CO 3	Analyze protein structures using computational tools.	K4
CO 4	Predict gene functions using genome annotation tools.	K4
CO 5	Utilize molecular docking and modeling tools for protein-ligand interactions.	K4

List of Experiments

1. Retrieval of nucleotide and protein sequences using NCBI and UniProt databases. (CO1)
2. Use of ENSEMBL and GeneCards for genome browsing and functional gene annotation. (CO1)
3. Pairwise and multiple sequence alignment using Clustal Omega and MUSCLE. (CO2)
4. Phylogenetic tree construction using MEGA software. (CO2)
5. Retrieval of protein 3D structures from PDB database. (CO3)
6. Visualization and analysis of protein structures using PyMOL and Chimera. (CO3)
7. ORF and gene prediction using GeneMark and Glimmer. (CO4)
8. Functional annotation using BLASTx, InterProScan, and GO analysis. (CO4)
9. Homology modeling using SWISS-MODEL and MODELLER. (CO5)
10. Molecular docking using AutoDock and visualization with Discovery Studio. (CO5)

Text Books:

1. Mount, D.W., "Bioinformatics: Sequence and Genome Analysis", 2nd Ed., 2004, Cold Spring Harbor Laboratory Press.
2. Baxevanis, A.D., Ouellette, B.F.F., "Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins", 3rd Ed., 2005, Wiley-Interscience.
3. Lesk, A.M., "Introduction to Bioinformatics", 5th Ed., 2019, Oxford University Press.

Reference Books:

1. Pevsner, J., "Bioinformatics and Functional Genomics", 3rd Ed., 2015, Wiley-Blackwell.
2. Krane, D.E., Raymer, M.L., "Fundamental Concepts of Bioinformatics", 1st Ed., 2002, Pearson Education.

Web Links (If any)

MMAE 101	SOFT SKILLS (Verbal & PDP)	LTP:2-0-0	Credit:1

	At the end of course, the student will be able to	BBL
CO 1	Understand the concept of sentence formation and usefulness of enriched vocabulary.	K2
CO 2	Enhance the listening and comprehending skills.	K2
CO 3	Apply the reading and writing skills to prepare clear and well-structured official and business documents.	K3
CO 4	Build the skills necessary to deliver impactful presentations.	K3
CO 5	Build necessary work-place skills to be a successful professional.	K3

Unit	Topic	Hrs
I	**Applied Grammar and Usage:** Types of Sentences: Simple, Compound and Complex, Subject-verb agreement, Advanced Vocabulary: Antonyms, Synonyms, Use of jargons.	**05**
II	**Listening and Speaking Skills** Listening : Stages and Art of Listening, Traits of a Good Listener, Interpersonal communication skills: Emotional Intelligence, Decision Making, Negotiation and Persuasion.	**05**
III	**Reading and Writing Skills:** Reading style: Skimming; Scanning; Churning & Assimilation, Effective writing tools; Report writing; CV and Resume-writing.	**05**
IV	**Presentation and Interaction Skills** Oral Presentation, Personal Interaction :Introducing Oneself- one's career goals, Activity: SWOT Analysis, Group Discussion: Non verbal Communication; Interview Skills: Preparation and Performance.	**05**
V	**Work- place skills:** Leadership qualities; Problem Solving & Conflict Resolution : Case Analysis of a Challenging Scenario Stress Managing Techniques.	**05**

Text Books:

1. Bhatnagar Nitin and Mamta Bhatnagar, Communicative English For Engineers And
2. Professionals, 2010, Dorling Kindersley (India) Pvt. Ltd.
3. Butterfield, Jeff., "Soft Skills for Everyone", Cengage Learning, Cengage Learning India
4. John Adair, Decision Making and Problem Solving Strategies,2010, Replika Press, New Delhi.

Reference Books:

1. Heike, Hering., "How to Write Technical Reports: Understandable Structure, Good Design, Convincing Presentation". Springer Nature, 2nd Edition
2. Jon Kirkman and Christopher Turk, Effective Writing: Improving Scientific, Technical and Business Communication, 2015, Routledge
3. Clifford A Whitcomb & Leslie E Whitcomb, Effective Interpersonal and Team Communication Skills for Engineers, 2013, John Wiley & Sons, Inc., Hoboken: New Jersey.

Web Links (If any)

S. N.	Subject Code	Subject	Type of Subject	Category	Periods			Mid Term Examination				End Sem Examination		Total	Credits
					L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	MMBT 201	Advance DownStream Processing	Theory	Core	4	0	0	20	10	30		70	-	100	4
2	MMBT 202	Recombinant DNA Technology	Theory	Core	4	0	0	20	10	30		70	-	100	4
3	MMBT 203	Advance Nanobiotechnology	Theory	Core	3	0	0	20	10	30		70	-	100	3
4	MMBT 204	Advance Stem Cell Technology	Theory	Core	3	0	0	20	10	30		70	-	100	3
5	MMBT 251	Advance Down Stream Processing Lab	Practical	Core	0	0	3	-	-	-	50		50	100	1
6	MMBT 252	Recombinant DNA Technology Lab	Practical	Core	0	0	3	-	-	-	50		50	100	1
7	MMAEA202 /MMAEB202/MMAEC202/MMAED202	Language Proficiency (German/ Spanish/French/ Russian)	Ability Enhancement Course	#AEC	2	0	0			50				50	1
8	MMNC101/ 201	Environmental studies	Non Credit	NC	2	0	0	30	20	50		50		100	0
	Total				18	0	6							750	17

MMBT 201	Advanced Downstream Processing	LTP:4-0-0	Credit:4

At the end of course, the student will be able to		BBL
CO 1	Explain the principles and steps involved in bio-separation processes.	K2
CO 2	Apply unit operations for concentration and purification of biomolecules.	K3
CO 3	Analyze chromatographic and membrane-based separation techniques.	K4
CO 4	Analyze different downstream process designs to determine their efficiency and suitability for the recovery and purification of various bioproducts.	K4
CO 5	Analyze the critical parameters involved in large-scale bio-product recovery to develop improved and integrated downstream protocols.	K4

Unit	Topic	Hrs
I	**Introduction to Downstream Processing:** Definition, importance, and objectives of downstream processing, Stages of downstream processing: recovery, isolation, purification, and polishing, Characteristics of biomolecules relevant to DSP: size, charge, hydrophobicity, stability, Economic considerations and yield optimization.	**08**
II	**Cell Disruption and Solid-Liquid Separation:** Methods of cell disruption: mechanical (bead mill, homogenization), non-mechanical (chemical, enzymatic, osmotic), Recovery of intracellular and extracellular products, Solid-liquid separation: filtration (depth and surface), centrifugation (batch and continuous), Design aspects and performance parameters.	**08**
III	**Extraction and Precipitation:** Solvent extraction: principles, equipment, and applications, Aqueous two-phase extraction: PEG-salt systems, Protein and nucleic acid precipitation using ammonium sulfate, TCA, organic solvents, Optimization and scalability.	**08**
IV	**Chromatographic Techniques:** Basics of chromatography: adsorption, partition, ion exchange, affinity, size exclusion, Instrumentation and process scale chromatography, Parameters affecting chromatographic separation, HPLC applications in biotechnology.	**08**
V	**Membrane Separation and Final Product Formulation:** Types of membrane processes: microfiltration, ultrafiltration, nanofiltration, reverse osmosis, Dialysis and diafiltration, Drying techniques: spray drying, freeze drying, tray drying, Product formulation, stabilization, and packaging.	**08**

Text Books:

1. Belter, P.A., Cussler, E.L., Hu, W.S., "Bioseparations: Downstream Processing for Biotechnology", 2nd Ed., 1988, Wiley.
2. Asenjo, J.A., "Separation Processes in Biotechnology", 1st Ed., 1990, CRC Press.
3. Doran, P.M., "Bioprocess Engineering Principles", 2nd Ed., 2012, Academic Press.

Reference Books:

1. Shuler, M.L., Kargi, F., "Bioprocess Engineering: Basic Concepts", 2nd Ed., 2002, Prentice Hall.
2. Harrison, R.G., Todd, P., Rudge, S.R., Petrides, D.P., "Bioseparations Science and Engineering", 2nd Ed., 2015, Oxford University Press.

Web Links (If any)

MMBT 202	Recombinant DNA Technology	LTP:4-0-0	Credit:4

At the end of course, the student will be able to		BBL
CO 1	Explain the principles of recombinant DNA technology, including the basic concepts and tools used.	K2
CO 2	Apply molecular biology techniques to clone genes, express them, and analyze gene function in prokaryotic and eukaryotic systems.	K3
CO 3	Analyze vectors and various cloning strategies employed in gene manipulation.	K4
CO 4	Analyze the principles and protocols of modern genome-editing tools to understand their application in gene modification experiments.	K4
CO 5	Analyze ethical, safety, and regulatory considerations associated with recombinant DNA technology in the context of human and agricultural biotechnology.	K4

Unit	Topic	Hrs
I	**Introduction to Recombinant DNA Technology:** Overview and basic principles of recombinant DNA technology, Historical developments: key discoveries and pioneers, Applications of recombinant DNA technology in various fields, such as medicine, agriculture, and environmental science, Ethical, safety, and regulatory concerns in recombinant DNA technology, Impact on society: Genetic modifications and genetically modified organisms (GMOs).	**08**
II	**DNA Manipulation and Cloning Techniques:** Methods of DNA extraction, purification, and quantification, Restriction enzymes: types, applications, and recognition sites, Ligation reactions: principles and techniques, use of DNA ligase, Transformation techniques: electroporation, chemical methods, microinjection, Gene cloning techniques: plasmids, cosmids, bacteriophage vectors, Construction of genomic and cDNA libraries.	**08**
III	**Vectors and Cloning Strategies:** Types of vectors used in gene cloning: plasmid vectors, viral vectors, artificial chromosomes, Shuttle vectors, expression vectors, and their applications in recombinant protein production, Cloning strategies: insertion and replacement strategies, gene fusion techniques, Use of bacterial, yeast, and mammalian expression systems, Selection and screening of clones: antibiotic resistance, colorimetric assays, PCR-based methods.	**08**
IV	**Gene Expression and Protein Production:** Principles of gene expression in prokaryotic and eukaryotic systems, Recombinant protein expression systems: E. coli, yeast, mammalian cell systems, Inducible vs. constitutive expression systems, Optimization of recombinant protein expression: codon optimization, choice of promoter, Purification of recombinant proteins: affinity chromatography, ion exchange chromatography, gel filtration, Applications of recombinant proteins: enzymes, hormones, therapeutic proteins.	**08**
V	**Gene Editing Techniques:** Overview of gene editing tools: CRISPR-Cas9, TALENs, ZFNs, Mechanisms of gene editing: precision, accuracy, and applications in genome engineering, Applications of gene editing in medicine: gene therapy, correction of genetic disorders, and applications in agricultural biotechnology, Ethical concerns and risks of gene editing in humans and GMOs, Current status of gene editing research and future directions in biotechnology.	**08**

Text Books:

1. Brown, T.A., Genomes, 3rd Ed., 2007, Garland Science.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P., Molecular Biology of the Cell, 6th Ed., 2014, Garland Science.
3. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R., Molecular Biology of the Gene, 7th Ed., 2013, Pearson.

Reference Books:

1. Sambrook, J., Russell, D.W., Molecular Cloning: A Laboratory Manual, 4th Ed., 2012, Cold Spring Harbor Laboratory Press.
2. Glick, B.R., Pasternak, J.J., Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Ed., 2010, ASM Press.

Web Links (If any)

MMBT 203	Advance Nanobiotechnology	LTP:3-0-0	Credit:3

At the end of course, the student will be able to		BBL
CO 1	Describe the fundamental principles of nanotechnology and its applications in biotechnology.	K2
CO 2	Analyze the synthesis and characterization of nanoparticles and their biological interactions.	K4
CO 3	Apply nanomaterials for the development of nanocarriers and diagnostic tools in biotechnology.	K3
CO 4	Analyze the working principles, components, and applications of nano-based biosensors used for the detection of specific biomolecules.	K4
CO 5	Analyze the safety, ethical, and regulatory considerations involved in the development and application of nanobiotechnology-based solutions.	K4

Unit	Topic	Hrs
I	**Introduction to Nanobiotechnology:** Definition of nanotechnology, Scale and size: Nanometers and their significance in biological systems, Nanotechnology vs. conventional technology, Types of Nanomaterials, Unique properties of nanomaterials: Surface area to volume ratio, optical, magnetic, and electronic properties, Applications of Nanobiotechnology, Nanotechnology in Biotechnology, Ethical, Safety, and Regulatory Issues.	**08**
II	**Nanomaterials Synthesis and Characterization:** Methods of nanoparticle synthesis: chemical, physical, and biological methods, Characterization techniques: SEM, TEM, AFM, XRD, FTIR, and UV-Vis spectroscopy, Nanoparticle surface modification and functionalization, Interactions between nanomaterials and biological systems.	**08**
III	**Nanocarriers and Drug Delivery Systems:** Nanocarriers: Types and applications (liposomes, dendrimers, micelles), Nanoparticle-based drug delivery systems: principles, advantages, and challenges, Targeted drug delivery and controlled release systems, Applications of nanocarriers in cancer therapy, gene delivery, and vaccines.	**08**
IV	**Nano-based Biosensors and Diagnostics:** Introduction to biosensors: Types and principles of operation, Nano-based biosensors: Mechanisms, fabrication techniques, and applications, Biosensors for the detection of biomolecules, pathogens, and environmental contaminants, Nanodiagnostics: Applications in early disease detection, personalized medicine, and environmental monitoring.	**08**
V	**Safety, Regulatory, and Ethical Considerations in Nanobiotechnolog:** Toxicity of nanoparticles and the potential risks to human health and the environment, Nanotoxicology: Mechanisms of toxicity, assessment methods, and safety regulations, Regulatory frameworks for nanobiotechnology products: FDA, EPA guidelines, Ethical concerns in the development and application of nanobiotechnology.	**08**

Text Books:

1. Roco, M.C., Nanotechnology: A Soft Matter Approach, 2nd Ed., 2013, Wiley-VCH.
2. Niemeyer, C.M., Mirkin, C.A., Nanobiotechnology: Concepts, Applications and Perspectives, 2004, Wiley-VCH.
3. Wilson, W., Nanotechnology in Medicine, 1st Ed., 2007, Wiley-Blackwell.

Reference Books:

1. Bhushan, B., Springer Handbook of Nanotechnology, 3rd Ed., 2010, Springer.
2. Pradeep, T., Nano: The Essentials - Understanding Nanoscience and Nanotechnology, 2012, McGraw-Hill.

Web Links (If any)

MMBT 204	Advance Stem Cell Technology	LTP:3-0-0	Credit:3

At the end of course, the student will be able to		BBL
CO 1	Explain the fundamental properties of stem cells and their classification.	K2
CO 2	Analyze stem cell signalling pathways and the role of microenvironment in stem cell behaviour.	K4
CO 3	Demonstrate techniques used in isolation, culture, and characterization of stem cells.	K3
CO 4	Analyze various therapeutic applications of stem cells in the context of tissue repair, regeneration, and disease modeling.	K4
CO 5	Apply ethical and regulatory principles to understand challenges in stem cell-based clinical research.	K3

Unit	Topic	Hrs
I	**Introduction to Stem Cells:** Definition and properties of stem cells, Types of stem cells: Embryonic stem cells (ESCs), adult stem cells (ASCs), and induced pluripotent stem cells (iPSCs), Concept of pluripotency, totipotency, and multipotency, Overview of stem cell niche and microenvironment History and milestones in stem cell research.	**08**
II	**Stem Cell Biology and Signaling Pathways:** Regulation of stem cell self-renewal and differentiation, Key signaling pathways: Wnt, Notch, Hedgehog, TGF-β/BMP, Role of epigenetics and transcription factors (Oct4, Sox2, Nanog, etc.), Mechanisms of lineage commitment and trans-differentiation, Stem cell metabolism and metabolic reprogramming.	**08**
III	**Stem Cell Culture and Characterization:** Techniques for isolation and enrichment of stem cells from various sources (bone marrow, cord blood, adipose tissue), Culture conditions: Feeder layers, media, and supplements, Characterization methods: Flow cytometry, immunostaining, RT-PCR, microarrays, Genetic manipulation of stem cells: CRISPR/Cas9, viral transduction, Stem cell banking and quality control.	**08**
IV	**Therapeutic Applications and Tissue Engineering:** Stem cells in regenerative medicine: Skin, liver, pancreas, neural, cardiac, and musculoskeletal applications, Use of stem cells in gene therapy and treatment of genetic disorders, Stem cell-derived organoids and lab-grown tissues, Drug screening and disease modeling using iPSCs, Role of 3D bioprinting in stem cell-based tissue engineering.	**08**
V	**Translational Research, Ethics, and Regulatory Framework:** Clinical trials and global progress in stem cell therapies, Safety concerns: Tumorigenicity, immune rejection, genetic instability, Ethical issues: ESC research, cloning, consent, and commercialization, National and international guidelines: ICMR, ISSCR, FDA, EMA, Future prospects and challenges in stem cell translational research.	**08**

Text Books:

1. Lanza, R., Gearhart, J., et al. – Essentials of Stem Cell Biology, 3rd Ed., 2014, Academic Press.
2. Moore, K.A., Lemischka, I.R. – Stem Cells and Tissue Engineering, 1st Ed., 2011, Springer.
3. Trounson, A., DeWitt, N.D. – Stem Cell Research and Therapy, 2015, Academic Press.

Reference Books:

1. Freshney, R.I. – Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 7th Ed., 2015, Wiley-Blackwell.
2. 6. Atala, A. – Foundations of Regenerative Medicine, 1st Ed., 2009, Academic Press.
3. 7. Blau, H.M., Nusse, R. – Stem Cells: From Biology to Therapy, 2016, Cold Spring Harbor Laboratory Press.

Web Links (If any)

MMBT251	Advance Down Stream Processing Lab	LTP:0-0-3	Credit:1

	At the end of course, the student will be able to	BBL
CO 1	Explain the fundamental properties of stem cells and their classification.	K2
CO 2	Analyze stem cell signalling pathways and the role of microenvironment in stem cell behaviour.	K4
CO 3	Demonstrate techniques used in isolation, culture, and characterization of stem cells.	K3
CO 4	Analyze various therapeutic applications of stem cells in the context of tissue repair, regeneration, and disease modeling.	K4
CO 5	Apply ethical and regulatory principles to understand challenges in stem cell-based clinical research.	K3
	List of Experiments	
	1. Preparation of cell lysate and study of mechanical (sonication/bead milling) and chemical disruption methods (CO1) **2.** Differential centrifugation for separation of sub-cellular components (CO2) **3.** Filtration (depth and membrane) and microfiltration of biomass (CO2) **4.** Ammonium sulfate precipitation for protein concentration (CO3) **5.** Dialysis and ultrafiltration for protein desalting and concentration (CO3) **6.** Protein purification using ion-exchange chromatography (CO3) **7.** Protein purification using gel filtration chromatography (CO3) **8.** Protein purification using affinity chromatography (CO3) **9.** SDS-PAGE for molecular weight determination of purified protein (CO4) **10.** Native PAGE for assessing protein purity (CO4) **11.** Enzyme activity assay and yield calculation from crude and purified fractions (CO5) **12.** Determination of specific activity and purification fold (CO-5)	

Text Books:

1. Scopes, R.K. – Protein Purification: Principles and Practice, 3rd Ed., 2013, Springer.
2. Karsa, D.R., Stephenson, R.A. – Chromatography in Biotechnology, 1st Ed., 1990, Ellis Horwood.
3. Freifelder, D. – Physical Biochemistry: Applications to Biochemistry and Molecular Biology, 2nd Ed., 1982, W.H. Freeman.

Reference Books:

1. Shuler, M.L., Kargi, F. – Bioprocess Engineering: Basic Concepts, 2nd Ed., 2002, Prentice Hall.
2. Petrides, D. – Downstream Process Development: Process Evaluation, Economics, and Design, 1st Ed., 2015, Wiley.
3. Wilson, K., Walker, J. – Principles and Techniques of Biochemistry and Molecular Biology, 7th Ed., 2010, Cambridge University Press.

Web Links (If any)

MMBT252	Recombinant DNA Technology Lab	LTP:0-0-3	Credit:1

	At the end of course, the student will be able to	BBL
CO 1	Demonstrate aseptic techniques and basic molecular biology lab practices.	K3
CO 2	Isolate plasmid and genomic DNA from prokaryotic/eukaryotic cells.	K3
CO 3	Perform restriction digestion, ligation, and transformation in bacterial systems.	K4
CO 4	Analyze recombinant clones using colony PCR, blue-white screening, and gel electrophoresis.	K4
CO 5	Analyze the steps and outcomes of gene cloning and protein expression experiments to identify factors affecting success or failure.	K4
	List of Experiments	
	1. Preparation of LB media and culture maintenance of E. coli (CO1) **2.** Isolation of plasmid DNA by alkaline lysis method (CO2) **3.** Isolation of genomic DNA from bacteria or yeast (CO2) **4.** Restriction digestion of plasmid DNA with specific restriction enzymes (CO3) **5.** Ligation of DNA fragments into plasmid vectors (CO3) **6.** Preparation of competent E. coli cells and transformation with recombinant plasmids (CO3) **7.** Blue-white screening of transformed colonies using X-gal/IPTG plates (CO4) **8.** Colony PCR and gel electrophoresis to confirm insert presence (CO4) **9.** Expression of recombinant protein in transformed E. coli (CO5) **10.** SDS-PAGE analysis of recombinant protein expression (CO5) **11.** Troubleshooting of cloning failures (e.g., false positives, enzyme inactivation) (CO5) **12.** Documentation and analysis of experimental data using lab notebooks and software Tools (CO5)	

Text Books:

1. Sambrook, J., Russell, D.W. – Molecular Cloning: A Laboratory Manual, 3rd Ed., 2001, Cold Spring Harbor Laboratory Press.
2. Brown, T.A. – Gene Cloning and DNA Analysis: An Introduction, 7th Ed., 2016, Wiley-Blackwell.
3. Primrose, S.B., Twyman, R.M. – Principles of Gene Manipulation and Genomics, 7th Ed., 2006, Wiley-Blackwell.

Reference Books:

1. Green, M.R., Sambrook, J. – Molecular Cloning: A Laboratory Manual, 4th Ed., 2012, Cold Spring Harbor Press.
2. Glick, B.R., Pasternak, J.J., Patten, C.L. – Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Ed., 2010, ASM Press.
3. Watson, J.D. et al. – Recombinant DNA: Genes and Genomes – A Short Course, 3rd Ed., 2006, Freeman.

Web Links (If any)

MMAEA202	German Language	LTP:2-0-0	Credit:1

At the end of course, the student will be able to		BBL
CO 1	Describe and pronounce German alphabets, numbers, and greetings with correct intonation and sound pattern.	K2
CO 2	Explain the use of basic grammatical components such as articles, nouns, and verbs in forming simple German n sentences.	K2
CO 3	Understand basic information about oneself, family members, and professions in German.	K2
CO 4	Illustrate the use of German vocabulary and sentence structures to talk about time, dates, days, and daily routines	K2
CO 5	Illustrate comprehension of simple conversations and respond appropriately in role-play scenarios.	K2

Unit	Topic	Hrs
I	Alphabets, Numbers, Pronunciation, Greetings.	**06**
II	Basic Grammar: Articles, Nouns, Verbs, Sentence Formation.	**06**
III	Introducing Yourself, Family, Professions.	**06**
IV	Time, Date, Days, Months, Daily Routine.	**06**
V	Simple Conversations and Role Plays. .	**06**

Text Books/ Reference Books:

1. Cornelson: Studio d A1 (Deutsch als Fremdsprache)
2. Klett: Mit Erfolg Zu Start Deutsch 1 Prufungsvorbereitung

Web Links (If any)

MMAEB202	Spanish Language	LTP:2-0-0	Credit:1

	At the end of course, the student will be able to	BBL
CO 1	Understand Spanish alphabets, numbers, greetings, and pronunciation rules.	K2
CO 2	Describe vocabulary and expressions related to days, months, seasons, time, and daily routines in Spanish.	K2
CO 3	Explain how to introduce oneself and others, including the use of nationalities, professions, and family terms.	K2
CO 4	Summarize the use of basic verbs (Ser, Estar, Tener), regular verb conjugations, and sentence structures.	K2
CO 5	Summarize basic spoken Spanish by participating in simple conversations, role plays, and situational dialogues.	K2

Unit	Topic	Hrs
I	Greetings, Spanish Alphabets, Numbers, Pronunciation Rules.	**04**
II	Days of the Week, Months, Seasons, Telling Time, Daily Activities.	**04**
III	Introducing Yourself and Others, Nationalities, Professions, Family Vocabulary.	**04**
IV	Basic Verbs (Ser, Estar, Tener), Regular Verb Conjugation, Articles, Sentence Formation.	**04**
V	Simple Conversations, Role Plays, Situational Dialogues.	**04**

Text Books/ Reference Books:

1. 1. Aula Internacional 1 – Nueva edición
2. Español en Marcha – Nivel básico
3. DELE A1 Preparation Resources

Web Links (If any)

MMAEC202	French Language	LTP:2-0-0	Credit:1

	At the end of course, the student will be able to	BBL
CO 1	Understand the French alphabet, numbers, greetings, and pronunciation rules.	K2
CO 2	Describe vocabulary related to time, days of the week, months, and daily routines in French.	K2
CO 3	Explain how to introduce yourself and others in French, including terms for nationalities, professions, and family members.	K2
CO 4	Understand the conjugation of regular **-ER** verbs, sentence structure, and the use of articles in French	K2
CO 5	Summarize basic spoken French by engaging in simple conversations and role-play activities.	K2

Unit	Topic	Hrs
I	Greetings, Alphabets, Numbers, Pronunciation.	**04**
II	Time, week Days, Months, Daily Routine	**04**
III	Introducing Yourself and Others, Nationalities, Professions, Family Vocabulary	**04**
IV	Er verbs , sentence formation , Articles.	**04**
V	Simple Conversations and Role Plays Activity.	**04**

Text Books/ Reference Books:

1. Cosmopolite
2. Apprenons le Français

Web Links (If any)

MMAED202	Russian Language	LTP:2-0-0	Credit:1

At the end of course, the student will be able to		BBL
CO 1	Explain the sounds and structure of the Russian alphabet, vowels, numbers, and basic greetings.	K2
CO 2	Describe the concept of gender in Russian and relate it to common vocabulary.	K2
CO 3	Understand the use of basic grammatical elements such as articles, nouns, and verbs in simple Russian sentences.	K2
CO 4	Understanding how to express time, date, and formulate simple questions in Russian.	K2
CO 5	Explain how to introduce oneself and conduct a basic conversation using conjugated verbs and learned vocabulary.	K2

Unit	Topic	Hrs
I	Russian Alphabets, Russian vowels, Numbers, Pronunciation, Greetings.	**04**
II	Genders, Classroom objects, Animals Name, Foods & Drinks, Learn basic vocabulary.	**04**
III	Basic Grammar: Articles, Nouns, Verbs, Colours, Family.	**04**
IV	Time, Date, Days, Months, Difference, Question words, How to tell the time in Russian, Verbs Conjunction.	**04**
V	My Self in Russian language, Using conjugated verbs, Simple Conversations.	**04**

Text Books/ Reference Books:

1."RUSSIAN" – V.N. Wagner & Y.G. Ovsienko (People's Publishing House)

2. "Russian in Exercises – Author S.A. Khavronina& A.I. Shirochenskaya (People's Publishing House)

3." Survival Russian a course in conversational Russian – N.B. Karavanova(this very important book)

Web Links (If any)

MMNC101/201	Environmental Studies	LTP:2-0-0	Credit:NC

At the end of course, the student will be able to		BBL
CO 1	Understand the basic concepts of environment and ecosystem emphasizing on structural and functional aspects.	K2
CO 2	Understand the important concepts of biodiversity, its significance and conservation.	K2
CO 3	Understand the concept and classification of Natural Resources emphasizing on associated problems and conservation strategies.	K2
CO 4	Understand the causes and effects of environmental pollution and contribute to the preventive measures in the immediate society.	K2
CO 5	Understand the role of Government and legal aspects related to protection of environment and control of environmental pollution.	K2

Unit	Topic	Hrs
I	**ENVIRONMENT & ECOSYSTEM** The Multidisciplinary nature of environmental studies: Definition, scope and importance of environment, need for public awareness and environmental education, Concept of an ecosystem: Structure and function of an ecosystem, role of producers, consumers and decomposers, energy flow and nutrient cycling (carbon, nitrogen and sulphur) in the ecosystem, food chains, food webs and ecological pyramids, Types of ecosystems: Introduction, types and characteristic features of desert, grassland, forest and pond ecosystems.	**05**
II	**BIODIVERSITY AND ITS CONSERVATION** Introduction to biodiversity definition: genetic, species and ecosystem diversity, bio geographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, national and local levels, India as a mega-diversity nation, hot-spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, endangered and endemic species of India, Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity and conservation through legal aspects.	**05**
III	**ENVIRONMENTAL POLLUTION & GLOBAL ENVIRONMENTAL ISSUES** Causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, thermal pollution and radiation pollution, Solid waste Management: causes, effects and control measures of urban and industrial waste; E-Waste management, Human population and environment: Characteristics, population growth; causes, impacts and control measures of population explosion in India, role of individual in prevention of pollution, Global Environmental issues: Climate change, global warming, acid rain, ozone layer depletion, chemical and nuclear accidents.	**05**
IV	**ENVIRONMENTAL POLICY, LEGISLATION & EIA** Role of Government in environmental protection, Environmental Protection Act-1986, Air (prevention and control of pollution) Act- 1981, Water (prevention and control of pollution) Act-1974, Forest Conservation Act-1980, Wild life Protection Act-1972, EIA: Objective and process; EIA in India, Towards Sustainable Future: Concept of Sustainable Development.	**05**
V	**Translational Research, Ethics, and Regulatory Framework:** Clinical trials and global progress in stem cell therapies, Safety concerns: Tumorigenicity, immune rejection, genetic instability, Ethical issues: ESC research, cloning, consent, and commercialization, National and international guidelines: ICMR, ISSCR, FDA, EMA, Future prospects and challenges in stem cell translational research.	**05**

Text Books:

1. A Text Book of Environmental Studies for Undergraduate Courses, Third Edition (2021), by Erach Bharucha, University Press (India) Private Limited.
2. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers (2018).
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 3rd edition, Pearson Education (2015).
4. Environmental Chemistry (Ninth Multicolour Edition, 2018) by Anil K DE, New Age International Publishers

Reference Books:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007

Web Links (If any)