SYLLABUS

Master of Technology in Biotechnology

Department of Biotechnology

Haldia Institute of Technology (Autonomous)

Program Outcomes (PO)

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Curriculum for M.Tech (Biotechnology)

Sl No	Category	Subject Code	Subject Name	Total Number of contact hours			Credits
				L	T	P	
SEMESTER-I							
Theory							
1	Program Core I	PC-MBT101	Genetic Engineering	3	0	0	3
2	Program Core II	PC-MBT102	Plant Genetic Engineering	3	0	0	3
3	Program Elective-I	PE-MBT103 A/B	Program Elective-I	3	0	0	3
4	Program Elective-II	PE-MBT104 A/B	Program Elective-II	3	0	0	3
5	Mandatory Learning Course	MLC-MBT101	Research Methodology and IPR	2	0	0	2
6	Audit Course	AC-MBT101A/B/C/D/E/F/G/H	Audit Course 1	2	0	0	0
	Total Theory			**16**	**0**	**0**	**14**
Practical							
1	Laboratory I	PC-MBT191	Genetic Engineering Lab	0	0	4	2
2	Laboratory II	PC-MBT192	Plant Genetic Engineering Lab	0	0	4	2
	Total Practical			0	0	8	4
	Total of Semester-I			**16**	**0**	**8**	**18**
SEMESTER-II							
Theory							
1	Program Core III	PC-MBT201	Bioinformatics	3	0	0	3
2	Program Core IV	PC-MBT202	Animal Cell Culture	3	0	0	3
3	Program Elective-III	PE-MBT203 A/B	Program Elective-III	3	0	0	3
4	Program Elective-IV	PE-MBT204 A/B	Program Elective-IV	3	0	0	3
5	Audit Course	AC-MBT201A/B/C/D/E/F/G/H	Audit Course 2	2	0	0	0
	Total Theory			**14**	**0**	**0**	**12**
Practical							
1	Laboratory III	PC-MBT291	Bioinformatics Lab	0	0	4	2
2	Laboratory IV	PC-MBT292	Animal Cell Culture Lab	0	0	2	1
3	Laboratory IV	PC-MBT293	Bioprocess Engineering Lab	0	0	2	1
	Total Practical			**0**	**0**	**8**	**4**
Sessional							
1	**Mini Project**	**SE-MBT281**	**Mini Project with Seminar**	**0**	**0**	**4**	**2**
	Total of Semester-II			**14**	**0**	**12**	**18**
SEMESTER-III							
Theory*							
1	Program Elective-V	PE-MBT301A/B/C/D/E/F/G	Program Elective-V	3	0	0	3
2	Open Elective	OE-MBT301A/B/C/D/E/F	Open Elective	3	0	0	3
	Total Theory			**6**	**0**	**0**	**6**
Sessional							
1	Major Project	SE-MBT381	Dissertation-I (Progress)	0	0	20	10
	Total of Semester-III			**6**	**0**	**20**	**16**
SEMESTER-IV							
Sessional							
1	Major Project	SE-MBT481	Dissertation-II (Completion)	0	0	32	16
	Total of Semester-IV			**0**	**0**	**32**	**16**
Total Credits for the Programme							**68**

***Students going to Industry full time for doing their Project & Thesis work (Dissertation) may opt for completion of these courses through Massive Open Online Courses (MOOCs)*

Code	Field
PC	Program Core Courses
PE	Program Electives Courses
MLC	Mandatory LearningCourses
AC	Audit courses
SE	Sessional Courses
OE	Open Elective Courses

MASTER OF TECHNOLOGY IN BIOTECHNOLOGY PROGRAMME

CURRICULUM STRUCTURE

List of Program Electives

- **Program Elective -I**
  1. Immunotechnology (PE-MBT103A)
  2. Cell Biology (PE-MBT103B)
- **Program Elective -II**
  1. Bioprocess Engineering (PE-MBT104A)
  2. Instrumentation in Biotechnology (PE-MBT104B)
- **Program Elective -III**
  1. Downstream Processing (PE-MBT203A)
  2. Bioreactor Design, Development and Scaleup (PE-MBT203B)
- **Program Elective -IV**
  1. Genomics and Proteomics (PE-MBT204A)
  2. Pharmaceutical Biotechnology (PE-MBT204B)
- **Program Elective -V**
  1. Biostatistics and Design of Experiments (PE-MBT301A)
  2. Modelling and Simulation in Bioprocess (PE-MBT301B)
  3. Problem solving through Programming in C(PE-MBT301C)
  4. Big Data Analytics (PE-MBT301D)
  5. Nanobiotechnology (PE-MBT301E)
  6. Environmental Biotechnology(PE-MBT301F)
  7. Food Biotechnology (PE-MBT301G)

List of Open Electives

1. Business Analytics (OE-MBT301A)
2. Operations Research (OE-MBT301B)
3. Cost Management of Engineering Projects(OE-MBT301C)
4. Industrial Safety (OE-MBT301D)
5. Composite Materials(OE-MBT301E)
6. Waste to Energy (OE-MBT301F)

Audit Course 1 & 2

1. English for Research Paper Writing (AC-MBT101A /AC-MBT201A)
2. Pedagogy Studies (AC-MBT101B/AC-MBT201B)
3. Constitution of India (AC-MBT101C/AC-MBT201C)
4. Disaster Management (AC-MBT101D/AC-MBT201D)
5. Value Education (AC-MBT101E/AC-MBT201E)
6. Stress Management by Yoga (AC-MBT101F/AC-MBT201F)
7. Personality Development through Life Enlightenment Skills (AC-MBT101G/AC-MBT201G)
8. Sanskrit for Technical Knowledge (AC-MBT101H/AC-MBT201H

FIRST SEMESTER

Course Code	PC-MBT101					
Category	Program Core I					
Course Title	Genetic Engineering					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: I
	3	0	0	3	48	

COURSE OBJECTIVE:

The objectives of the course are:

1. This course offer students to learn the tools and techniques used in genetic engineering and recombinant DNA technology.
2. To make students learn the application of recombinant DNA technology in the field of biomedical, agriculture and environment.

COURSE OUTCOME:

After successful completion of this course, the student will be able to:

1. **Understand, define** and **explain** the tools in recombinant DNA technology.
2. **Understand** techniques in recombinant DNA technology.
3. **Identify**, **select** and **implement** the PCR and its types in molecular biology and recombinant DNA technology.
4. **Understand and analyze** knowledge of mutagenesis.
5. **Apply** knowledge of genetic engineering in current applications of biotechnology.
6. **Comprehend** and **analyze** the impact of Human Genome Project in genetic engineering programme.

COURSE CONTENT:

COURSE CONTENT:

Module I: 12L Basics tools of Genetic Engineering

Restriction Enzymes, DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase, Linkers, Adaptors, Homopolymeric tailing

Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes

Hybridization techniques: Northern, Southern, Eastern; Southwestern and Far-western; Fluorescence in situ hybridization, Chromatin Immunoprecipitation, DNA-Protein Interactions, Sequencing methods (Nucleic acid and Proteomics)

Module II: 14L Cloning Vectors and Cloning Methodologies

Plasmids, Bacteriophages, Phagemids, Cosmids, Artificial chromosome vectors (YACs, BACs), Animal Virus derived vectors-SV-40,vaccinia/bacculo and retroviral vectors, Expression vectors, Protein purification Construction of siRNA vectors, Insertion of Foreign DNA into Host Cells, Transformation, Construction of libraries, cDNA and genomic libraries; Expression cloning, Protein-protein interactive cloning

Module III: 12L PCR and Its Applications

Primer design, Fidelity of thermostable enzymes, DNA polymerases, Types of PCR –multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR,PCR in gene recombination, Site specific mutagenesis, PCR in molecular diagnostics, Viral and bacterial detection, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific

Amplification), PTT (Protein Truncation Test)

Module IV: 10L Applications of Genetic Engineering
Introduction of DNA into mammalian cells, Transfection techniques, Gene silencing techniques, Introduction to siRNA, siRNA technology, Micro RNA, Gene knockouts and Gene Therapy, Creation of knockout mice, Disease model, Somatic and germ-line therapy- in vivo and ex-vivo, Suicide gene therapy, Gene replacement, Gene targeting, Differential gene expression and protein array.PCR in molecular diagnostics, Applications in medicine – Gene therapy; recombinant vaccines –humanized antibodies and their applications genetically modified food – bioremediation with recombinant micro organisms

References
1. S.B. Primrose, R.M. Twyman and R.W.Old, Principles of Gene Manipulation. 6thEdition, S.B. University Press, 2001.
2. J. Sambrook and D.W. Russel, Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. J. D. Watson et al., Recombinat DNA, W.H. Freeman and Company
4. B. R. Glick and J.J. Pasternak ,Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM press.
5. D. M. Glover and B.D. Hames, DNA cloning: A Practical Approach, IRL Press.
6. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

Course Code	**PC-MBT102**					
Category	**Program Core II**					
Course Title	**Plant Genetic Engineering**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Hrs.**	**Semester: I**
	3	**0**	**0**	**3**	**48**	

COURSE OBJECTIVE:

The objectives of the course are:

1. To make the students aware of the principles, practices and application of the plant tissue culture, plant genomics, genetic transformation and molecular breeding of plants being confident at the end of the course in all above mentioned areas.
2. To realize the importance of plant Genetic Engineering with its applicative value in pharmaceutical and food industry, agriculture and ecology.

COURSE OUTCOMES:

After completion of course, students would be able to:

1. **Understand** the **use** of different plant tissue culture (PTC) techniques for PTC Industries as well as research.
2. **Understand** the structure and organization of genes & complexity of plant genome and able to **identify** the tools for gene identification and its functional analysis.
3. **Understand, identify** and **illustrate** the different modern tools & techniques of Plant Genetic Engineering for crop improvement and sustainable agriculture.
4. **Evaluate** the impact of Plant Genetic Engineering in pharmaceutical and food industry, agriculture and

ecology.

5. **Understand** the Molecular Mapping & Marker Assisted Selection techniques and also able to **judge** the intellectual property, environmental, societal issues specific to transgenic crops.
6. **Management** of research and commercial laboratory in the field of Plant Genetic Engineering.

COURSE CONTENT:

Module I: [8 Lectures]

Plant Tissue Culture: An overview
Historical perspective; Totipotency; Organogenesis; Somatic embryogenesis; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation.

Module II: [10 Lectures]

Plant Genomics
Identification of candidate genes using: genetic information (positional cloning); biochemical and expression analysis (microarray analysis, proteomics, metabolomics); **Characterization and functional analysis of candidate genes using**: transformation, mutant populations, knockoutsystems; Heterologous expression systems; Protein analysis.

Module III: [10 Lectures]

The Gene transfer Techniques for the production of Transgenic
Overview of different gene transfer methods
• **Indirect Gene transfer Methods:** structural features of Ti plasmid, mechanism of gene transfer to plants Integration of T-DNA into plant genome, Molecular events in Agrobacterium mediated gene transfer.
• **Direct gene transfer methods:** Particle bombardment mediated transformation, Mechanism, Particle gun design, parameter for effective transformation; selicon carbide fiber mediated transformation and alternative methods.
• Reporter genes, Selectable and scorable markers, Binary and Co-integrative vectors, Removal of marker genes, Applications and limitations of Agrobacterium gene transfer.
• Plastid engineering: Introduction, importance, scope and technique.

Module IV:[10 Lectures]

Application of Genetic Engineering: Some Case studies
• Genetic Engineering for Herbicide resistance
• Genetic Engineering for Biotic and Abiotic Stress Resistance/Tolerance
• Genetic Engineering for Vitamins and other value addition compounds
• Genetic Engineering for Production of pharmaceutically important compounds
• Genetic Engineering for Bioenergy generation
• Terminator technology

Module V:[10 Lectures]

Molecular Mapping & Marker Assisted Selection (MAS)
Quantitative and qualitative traits; MAS for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield; Molecular polymorphism, RFLP, RAPD, STS, AFLP, SNP markers; Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning.

Reference books:

1. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & molecular biology of plants. Chichester, West Sussex: John Wiley & Sons.
2. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant biotechnology: An Introduction to Genetic Engineering. Oxford: Oxford University Press.
3. Primrose, S. B., & Twyman, R. M. (2006). Principles of gene manipulation and genomics. Malden, MA: Blackwell Pub.
4. Brown, T. A. (2006). Gene cloning and DNA analysis: An introduction. Oxford: Blackwell Pub.
5. **Web Reference:** ePgPathshala:http://epgp.inflibnet.ac.in/ahl.php?csrno=4

Course Code	**PE-MBT103A**					
Category	**Program Elective 1**					
Course Title	**Immunotechnology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: I**
	3	**0**	**0**	**3**	**40**	

COURSE OBJECTIVE:

The objectives of the course are:

1. Account for the structure and function of the immune system both at the molecular and cellular level.
2. Account for polyclonal, monoclonal and humanized antibodies and production of these.
3. Describe immunization/vaccination, immunological disease and immunotherapy.
4. Plan, carry out and present achieved results of immunological serum analyses by means of different immunotechniques.
5. Discuss immunological techniques and their applications in biotechnical industry.

COURSE OUTCOMES:

After completion of course, students would be able to:

1. Conceptualize and **infer how** the innate and adaptive immune responses coordinate to fight invading pathogens.
2. Apply the knowledge of basic Immunology to **identify** problems and formulate **solutions** for the protection of human health.
3. **Understand** the theories of different immunological techniques and **apply** them efficiently in **solving** problems related to scientific research, health care, forensic sciences, drug industries for **formulation** of newer medicines etc.
4. **Explore** strategies to **improve** existing vaccines and how to approach these.
5. **Design** immunological techniques and apply them in biotechnical industry.
6. **Interpret** and **analyze** results of scientific experiments involving *in vivo* models used in different researches including tumor and cancer biology, autoimmune diseases, immunodeficiency diseases etc.

COURSE CONTENT:

Module 1: 10L

Introduction to Immunotechnology: Kinetics of immune response, memory; Techniques for analysis of Immune response. Genetic bases of immune response: Heterogenecity; Principles of Immunization; Animal models and

transgenic animals and their use in immunology, gene knock outs.

Module II: 10L

Molecular basis of Immunology: Immunochemistry of Antigens - immunogenecity, Antigenecity, haptens, Toxins-Toxiods, Hapten-carrier system; Role and properties of adjuvants, Immune modulators; Antibody Related Techniques-Hybridoma Rabbit, human; Antigen – Antibody interaction, affinity, cross reactivity, specificity, epitope mapping; Immuno assays RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, Surface plasmon resonance, flow cytometry and immunoelectron microscopy;Cell imaging Techniques- In vitro and In vivo.

Module III: 10L

New Generation Antibodies; Multigene organization of immunoglobulin genes, Ab diversity; Chimeric antibodies, Antibody engineering; Phage display libraries; Antibodies as *in vitro* and *in vivo* probes. Large scale manufacture of antibodies; Manufacturing of immuno diagnostics.

Module IV: 10L

Vaccine technology: Rationale vaccine design based on clinical requirements, Active immunization, live, killed, attenuated, Sub unit vaccines; Recombinant DNA and protein based vaccines, plant-based vaccines and reverse vaccinology; Peptide vaccines, conjugate vaccines; Passive Immunization; Antibody, Transfusion of immuno-competent cells, Stem cell therapy;

Reference books:

1. Essential Immunology, Roitt, I.M., 9th Ed. (1997), Blackwell Scientific, Oxford, UK
2. Immunology, Kuby, J. 3rd Ed. (1997), Freeman, W.H, Oxford, UK
3. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002
4. Immunobiology, The Immune system in Health and Disease, Seventh Edition by Janeway, Travers et al, Garland Publishing, 2008.

Course Code	**PE-MBT103B**					
Category	**Program Elective I**					
Course Title	**Cell Biology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: I**
	3	**0**	**0**	**3**	**48**	

COURSE OBJECTIVE:

The objectives of the course are:

This course gives a detailed overview on Cell Biology including all cellular components with their basic structure and function along with bioenergetics, ATP generation, membrane transport signal transduction pathways, its implication in cancer, cell cycle and apoptosis. With this knowledge, students would build up a concrete base on cell biology to work in research field and in various project works.

COURSE OUTCOME:

After completion of the course**,** Students can be able to

1. **Learn** and **understand** the basic chromatin structure, membrane components, cellular transport in details.
2. **Remember, define, and repeat** their concept with requisite background knowledge in the field of bioenergetics, ATP generation, signal transduction pathways and their implication in cancer.

3. **Conceptualize** general principles of cell communication, molecular motors, cytoskeleton components **understanding t**heir roles in the biological system.
4. **Learn** the details of various signal transduction processes in correlation with the biological impact like onset of cancer.
5. **Employ** their creative potential in **investigating and developing** new ideas in Cell Biology based projects.

COURSE CONTENT:

Module I: (8L)

Cell, DNA and chromosome

Cell Chemistry and Biosynthesis, chemical components of cells, catalysis and use of energy by cells, how cells obtain energy from food, The structure and function of DNA, chromosomal DNA and its packaging in the chromatin fibre, the global structure of chromosomes, microscopy for visualization of cells

Module II: (12L)

Membrane Structure, Transport & Electrical Properties of membranes, protein sorting

Lipid bilayer, membrane proteins Principles of membrane transport, carrier proteins and active membrane transport, mitochondria, electron transport chains and their proton pumps, Chloroplasts and photosynthesis, the genetic systems of mitochondria and plastids, the evolution of electron transport chains, protein targeting, Molecular mechanisms of membrane transport

Module III: (16L)

Cell Communication, Cytoskeleton

General principles of cell communication, Cell junction, cell-cell adhesion, the extracellular matrix of animals, integrins, signaling through G-protein linked cell surface receptors, signaling through enzyme linked cell surface receptors, Cytoskeleton structure and its role as a target for anticancer drugs.

Module IV:(12L)

The Cell Cycle and programmed cell death

An overview of the cell cycle, components of the cell cycle control system, apoptosis (Intrinsic and extrinsic pathway), fluorescence-activated cell sorting.

References:

1. H.R. Lodish et al.: Molecular Cell Biology
2. Bruce Alberts et al and J. D. Watson: Molecular Biology of the Cell

Course Code	**PE-MBT104A**					
Category	**Program Elective II**					
Course Title	**Bioprocess Engineering**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: I**
	3	**0**	**0**	**3**	**48**	
Pre-requisites (if any)	- **Knowledge of Chemistry**					

COURSE OBJECTIVE:

The objective of the course is:

To develop skill of the students in the area of Bioprocess technology. This will be very helpful in understanding Bioreactor design and its application, simulation of different models etc.

COURSE OUTCOME:

After completion of the course students will be able to:

1. **Understand, define** and **recall** the basic Bioprocess engineering concepts of growth and product formation.
2. **Understand** the kinetics of different fermentation process.
3. **Understand** the Instrumentation and Control of different types of Bioreactors.
4. **Analyze** cell culture kinetics.
5. **Analyze** the mass and heat transfer in Biochemical process.

COURSE CONTENT:

Module I: [14 lectures]
Recapitulation: Stoichiometry of Growth and Product formation. Kinetics of Growth and Product formation in Batch, Continuous and Fed batch systems. Media Sterilization and Air Sterilization. Design of Stirred Tank Bioreactors. Modeling of growth kinetics –structured and unstructured model.

Module II: [10 lectures]
Design of Immobilized biocatalytic reactors, membrane reactors, Plant cell bioreactors, Instrumentation and Control of Bioreactors.

Module III: [14 lectures]

Large scale mammalian cell culture – non perfused attachment system and perfusion for cell cultivation, suspension culture, microcarrier culture system, microencapsulation, fluidized bed system, aeration, mixing & hydrodynamics in bioreactors, cell culture kinetics, large scale stirred tank and air lift reactors for cultivation of animal cell

Module IV: [10 lectures]
Mass transfer studies in stirred tank reactor, Heat transfer for biochemical processes. RTD studies, Scale up

References:

1. Bioprocess Engineering: Basic Concepts (2nd Edition), Shuler and Kargi, Prentice Hall International.
2. Chemical Reaction Engineering, Octave Levenspiel, John Wiley & Sons
3. Bioprocess Engineering Principles, Pauline M. Doran, Elsevier Science & Technology Books
4. BIOPROCESS ENGINEERING: Kinetics, Sustainability, and Reactor Design, second edition, Shijie Liu, Elsevier

Course Code	PE-MBT104B					
Category	Program Elective-II					
Course Title	Instrumentation in Biotechnology					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: II
	3	0	0	3	40	
Pre-requisites (if any)	- Physics, Chemistry and Biology in 10+2 level					

COURSE OBJECTIVES:

The objectives of the course are:

1. To learn about how to develop and formulate methods to meet the need of pure products like proteins, enzymes etc related to the biopharmaceuticals clinical research.
2. To create general understanding of pH measurement, microscopy, luminescence spectroscopy, electrophoresis, sequencing methods, mass spectroscopy and protein sequencing
3. Overall, at the end of the course, the students will have scientific understanding of the basic concepts in instrumentation used in Biotechnology.

COURSE OUTCOME (CO):

After successful completion of this course, the student will be able to:

1. **Use various techniques for solving** various industrial and research problems.
2. **More confident to use** the knowledge in pursuing bioprocess knowledge in industrial biotechnological application.
3. **Demonstrate a broad understanding** of life science analytical sophisticated technologies and to gain the ability to plan and execute experiments, and analyze and interpret outcomes.
4. **Prepare analyze, interpret, maintain and communicate** scientific data effectively.
5. **Develop and present a strategic plan** for ongoing personal and professional development to enhance work performance.
6. **Understand the basic principles of engineering knowledge to solve** a critical problem.

COURSE CONTENT:

Module I: [10 Lectures]

Some Chemical and Biochemical Methods for Recovery of Bulk Products

pH measurements, Buffer preparation, Cell and tissue disruption, Precipitation procedures for proteins and nucleic acids, Filtration and Membrane based purification: Microfiltration, Ultrafiltration, Reverse osmosis (UF and RO); Dialysis; Electrodialysis; Diafiltration; Pervaporation, and lyophilisation; Centrifugation: Basic principle and application; Differential, density and Ultracentrifugation.

Module II: [8 Lectures]

Low Pressure and High Pressure Liquid chromatography (HPLC)

Basic principles of LPC and HPLC, Instrumentation, quantification, Macromolecular separation by gel filtration, hydrophobic, reverse phase, ion exchange chromatography.

Module III: [8 Lectures]

Luminescence in Biotechnology

Basic principle, instrumentation, measurement, chemoluminescence immunoassay, bioluminescence assay, molecular biological application of luminescence. Flow cytometry for Biotechnology, Tools- High throughput flow cytometry-fluorescence activated cell sorter— application in biotechnology.

Module IV: [8 Lectures]

Microscopic techniques in biotechnology

Light microscopy, phase contrast, dark field, and fluorescence microscopy Application of confocal microscopy; Electron microscopy: Basic principles, instrumentation, Transmission Electron microscopy, Scanning electron Microscopy. Atomic force microscopy.

Module V: [6 Lectures]

Proteomics for biotechnology

Electrophoresis: Capillary and Slab Gel electrophoresis (1D and 2D); Basic principles, instrumentation, application in biotechnology; Mass spectrometry in Protein and Proteomics; Basic principles of MALDI-Mass spectrometry; MALD – TOF Analyzer; Microarray Technology, Basic Principles, Slide printing.

References:

1. Protein Purification Methods, E L V Harris and S. Angal, Ed. IRL Press at Oxford University Press, 1989.
2. Bioseparation: Downstream processing for Biotechnology, Belter, P.A. and Cussler, E.L. Hu, W.S (1988), Wiley, New York.
3. Biochemical Engineering Fundamentals, J. E. Bailey and D. F. Ollis, 2nd Edition, Mc-Graw Hill, Inc., 1986.
4. Fundamentals of Biochemistry, Voet D, Voet JG & Pratt CW, 2nd Edition. Wiley 2006.
5. Principles of Gene Manipulation and Genomics, Primrose S &Twyman R, 7th Edition,Blackwell, 2006.
6. Principles of Physical Biochemistry, 2nd Edition, Keith Van Holde, Chien and Ho. Pearson
7. Principles of Fluorescence Spectroscopy (Springer) J.R. Lakowicz;

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/102106048/
2. NPTEL: http://nptel.ac.in/courses/102103044/
3. NPTEL: http://nptel.ac.in/courses/102107028/
4. NPTEL: https://onlinecourses.nptel.ac.in/noc18_bt30/preview
5. ePgPathshala: http://epgp.inflibnet.ac.in/view_f.php?category=1204
6. ePgPathshala: http://epgp.inflibnet.ac.in/view_f.php?category=1354

Course Code	MLC-MBT101					
Category	Mandatory Learning Course					
Course Title	Research Methodology and IPR					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: I
	2	0	0	2	35	

COURSE OBJECTIVE:

The objectives of the course are:

1. To learn the basic research terminology.
2. To study the various research designs and techniques.
3. To identify various sources of information for literature review and data analysis.
4. To study the content of research report and thesis.
5. To emphasize on IPR issues and need for knowledge in patents in biotechnology.

COURSE OUTCOME (CO):

After successful completion of this course, the student will be able to:

1. Understand the basic concepts of research and its methodologies.
2. Select and define appropriate research problem and parameters.
3. Understand, Identify and develop various research designs and techniques.
4. Examine and Analyze quantitative, qualitative methods for data collection, observation and result.
5. Understand, implement the presentation tools and formulate a research report, thesis.
6. Understand the awareness of the patent and copyright for their innovative works.

COURSE CONTENT:

Module I: [5 Lectures]

Introduction to Research Methodology: Meaning of Research, Objectives of Research, Purpose of Research, Types of Research, Research Approaches, Significance of Research, Criteria of Good Research.
Selection and formulation of a Research Problem: Meaning of research problem, choosing the problem, Review of Literature, Formulating the problem, Objective of formulating the problem, Techniques involved in formulating problem.

Module II: [6 Lectures]

Hypothesis: Meaning of Hypothesis, Types of Hypothesis, Concept of Hypothesis Testing, Procedure for Testing Hypothesis, Statistical Testing of Hypothesis.
Research Design: Meaning and Objectives, Need for Research Design, Components of Research Design, Classifications of Research Design, Principles of experimental design.

Module III: [10 Lectures]

Methods of Data Collection: Meaning and importance of Data, Primary sources of Data, Secondary sources of Data, Methods of collecting Data.
Processing and Analysis of Data: Recapitulation (Measures of Central Tendency, Dispersion, correlation and Regression, Chi- square test: Applications, Steps, characteristics, limitations, Analysis of Variance and Co-variance.)**Observation:** Meaning of Observation, Process of Observations, Types of Observation.

Module IV: [7 Lectures]

Presentation tool: Introduction to Presentation Tool, Features & Functions, Creating Presentations, Customizing Presentation. [Tools used: Microsoft PowerPoint, Open Office or any other tool].
Research Report Writing: Meaning of Research Report, Types of Research Report, and Contents of the Research Report.

Module V: [7 Lectures]

Nature of Intellectual Property: Patents, Designs, Trade and Copyright.
Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property, Procedure for grants of patents, Patenting under PCT.
Patent Rights: Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications.
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc., Traditional knowledge Case Studies, IPR and IITs.

Reference books:
1. Kothari, C.R. Research methodology: Methods and techniques. New Age International (P) Ltd., New Delhi.
2. Kumar, R. Research methodology: A step-by-step guide for beginners. Los Angeles: SAGE.
3. Reddy G.B. Intellectual Property Rights and the Law, Gogia Law Agency.

4. Singh K, Intellectual Property rights on Biotechnology

Web Reference:
1. http://nptel.ac.in/courses/121106007/
2. http://nptel.ac.in/courses/107108011/

Course Code	**PC-MBT191**					
Category	**Laboratory I (Program Core)**					
Course Title	**Genetic Engineering Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: I**
	0	**0**	**2**	**2**	**--**	

COURSE OBJECTIVE:

The objectives of the course are:
1. The course covers practical knowledge of selected Molecular Biological techniques.
2. The course covers the basic and advanced techniques of genetic engineering.

COURSE OUTCOME (CO):

After successful completion of this course, the student will be able to:

1. **Demonstrate** and **explain** Cloning strategies.
2. **Understand** and **analyze** the expression of recombinant proteins.
3. **Learn, demonstrate** and **explain** the different types of PCR.
4. **Demonstrate** and **explain** the working principle of RNAi in model organism.

COURSE CONTENT:

1. Isolation and characterization of genomic DNA from Bacteria, plant and animal and soil samples
2. Isolation and characterization of RNA
3. Preparation cDNA and amplification
4. Designing cloning strategies
5. Hybridization -southern (Demonstration)
6. RAPD analysis of different strains of bacteria and plant samples.
7. Allelic specific PCR

References:

1. Joe Sambrook and David William Russel. "Molecular cloning: A laboratory manual", CSHL press.

Course Code	**PC-MBT192**					
Category	**Laboratory II (Program Core)**					
Course Title	**Plant Genetic Engineering Laboratory**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: I**
	0	**0**	**2**	**2**	**48**	

COURSE OBJECTIVE:

The objectives of the course are:

1. To learn different aseptic techniques for establishment of an aseptic *in vitro* culture.
2. To study and prepare the different composition of plant tissue culture media
3. To develop the skills in plant tissue culture techniques for established the protocols of plant gene transfer technology.
4. To train students in strategizing research methodologies employing genetic engineering techniques.

COURSE OUTCOME (CO):

After successful completion of this course, the student will be able to:

1. **Define** and **recall** the various components of plant tissue culture.
2. **Describe**, **discuss** and **explain** various aseptic culture techniques for establishment of plant tissue culture.
3. **Calculate** the composition of various plant tissue culture media and prepare it.
4. **Understand** and **explain** the various modern tools used in plant gene transfer technology presently used in PTC-Industry.
5. **Explain** and **demonstrate** various protocols of plant gene transfer technology.
6. **Management** of research and commercial laboratory in the field of Plant Biotechnology.

COURSE CONTENT:

1. Introduction to plant tissue culture laboratory and its organization
2. Different aseptic culture techniques for establishment and maintenance of cultures
3. Preparation of stock solutions of various plant tissue culture medium (e.g. MS, B5, N6, WPM etc.) and plant growth regulator
4. Germination of seeds *in vitro*
5. Micropropagation of Tobacco plant by leaf disc culture
6. Techniques of *in vitro* culture (Explant selection, sterilization, inoculation, Multiplication, subculture and hardening)
7. Preparation of competent cells
8. Transformation of competent cells with plant transformation vectors
9. Small scale plasmid preparation
10. Restriction digestion
11. DNA check run by agarose electrophoresis
12. Demonstration of *Agrobacterium* mediated plant transformation (crown gall/ hairy root/GUS gene transfer)
13. Isolation of plant genomic DNA
14. Molecular analysis of transformed plants by Polymerase Chain Reaction
15. Perform RAPD or ISSR to assess the genetic variability

Reference books:

1. J. Reinert, M.M. Yeoman (1982) Plant cell and tissue culture: a laboratory manual. Published: Berlin, Springer-Verlag.
2. H.S. Chawla (2003) Plant Biotechnology: Laboratory Manual for Plant Biotechnology. Oxford & IBH Publishing Co. Pvt Ltd., New Delhi.

SECOND SEMESTER

Course Code	**PC-MBT201**					
Category	**Program Core III**					
Course Title	**Bioinformatics**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: II**
	3	**0**	**0**	**3**	**48**	

COURSE OBJECTIVES:

1. Student will exhibit depth and breadth of knowledge by demonstrating a well-developed understanding of biological sciences.
2. Student will be able to critically analyze and solve problems in biotechnology by gathering, synthesizing and critically evaluating information from a range of sources.

COURSE OUTCOMES:

By the end of the course, student should be able to:

1. **Understand** the theoretical basis behind bioinformatics**. Search** databases accessible on the internet for literature relating to Molecular Biology and Biotechnology.
2. **Manipulate** DNA and protein sequences using stand-alone PC programs and programs available on the internet.
3. **Find** homologues**, analyze** sequences, **construct** and **interpret** evolutionary trees.
4. **Analyze** protein sequences**, identify** proteins, and **retrieve** protein structures from databases. **View** and **interpret** these structures.
5. **Understand** structure determination, homology modeling and computational drug design.
6. **Query** biological data**, interpret** and **model** biological information and **apply** this to the solution of biological problems in any arena involving molecular data.

COURSE CONTENT:

Module I: Introduction to bioinformatics
Sequence databases; Similarity matrices; Pair wise alignment: Features of dynamic Programming, alignment by Bayesian Statistical Methods, multiple sequence alignment: local multiple sequence alignment: MEME, PSSM, HMM(algorithms and applications) Progressive methods for global multiple sequence alignment: CLUSTALW, PILEUP, T COFFEE; Statistical significance of alignment results.

Module II: Pattern analysis in sequences
Motif representation: consensus, regular expressions; PSSMs; Markov models; Regulatory sequence identification using Meme; Gene finding: composition based finding, sequence motifbasedfinding.

Module III: Pattern analysis in sequences and Phylogenetic tree construction methods
Motif representation, Markov models; .Distance Based methods: clustering based methods, optimality based methods: Fitsch-Margoliash and Minimum evolution methods, Neighbor joining, Character Based methods: Maximum parsimony methods, Maximum likely hood method, , genetic algorithm, Phylogenetic tree evaluation.

Module IV: Structure-Prediction of Biomolecules with applications in Bioinformatics
Structure classification of proteins (SCOP, CATH); Secondary structure prediction of various protein categories (e.g. transmembrane proteins and helical proteins), RNA secondary structure prediction methods. Patterns, motifs and Profiles in sequences: Derivation and search methods; Derived Databases of patterns, motifs and profiles e.g. Prosite, Blocks, Prints- S, P fam. Protein structure prediction by comparative modelling approaches (homology modeling and fold recognition); ab initio structure prediction methods.

Module V: Molecular Modeling and drug design
Force fields and their evaluation (e.g MM2, AMBER) Monte Carlo and molecular dynamics simulations (e.g. GROMACS); simulation approaches towards protein and nucleic acid conformation determination; Energy minimization techniques; Structure comparison using

database formalisms(DALI, VAST etc.); CASP for dry-wet structure comparisons. Classification of drug targets, Target discovery and validation methodologies Types of drug targets and characterization of drugs, Structure based drug design methods including computer-aided drug design (pharmacophore development) and recent technology developments; Target selection, Ligand (lead compound) design ,optimization and analysis; Protein-ligand docking; QSAR; physicochemical molecular descriptors; ADME parameters and their optimization; drug deliverability, metabolism, toxicity and pharmacokinetics; molecular diversity and Combichem;, discussion of drug design to drug discovery to drug development with pharmaceutical/biotech drug case studies.

References:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis, 2nd Edition, CSHL Press, 2004.
2. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss, 2003.
3. Zhumur Ghosh, Bibekananda Mallick. Bioinformatics Principles and Applications: OXFORD University Press
4. A. Baxevanis and F. B. F. Ouellette, Bioinformatics: a practical guide to the analysis of genes and proteins, 2nd Edition, John Wiley, 2001.
5. P. E. Bourne and H. Weissig. Structural Bioinformatics.Wiley. 2003.
6. C. Branden and J. Tooze, Introduction to Protein Structure, 2nd, Edition, Garland Publishing, 1999.
7. W.B. Pratt and P. Taylor, Principles of Drug Action, Churchill Livingston
8. Andrew Leach, Molecular Modelling: Principles and Applications, Pearson Education
9. N. R. Cohen, Editor, Guidebook on Molecular Modeling in Drug Design. Academic Press, San Diego, 1996.

Course Code	**PC-MBT202**					
Category	**Program Core IV**					
Course Title	**Animal Cell Culture**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: II**
	3	**0**	**0**	**3**	**48**	

COURSE OBJECTIVES:

The goal of Animal Cell Culture course is for students to acquire the necessary theoretical skills on animal tissue culture perspective. First, it provides detailed insights regarding the isolation of animal cells for *in vitro* studies, maintenance of animal cells *in vitro*, manipulation of animal cells *in vitro*, application of molecular techniques to *in vitro* situations. Furthermore the students will acquire knowledge in areas of cloning, large animal models for disease and development of therapies and treatments. This class will cover basic cellular and molecular biology techniques involved in animal cell culture and their applications in a real world research setting.

COURSE OUTCOMES:

At the end of the course, a student will be able to:

1. **Explain** the various components of cell and tissue culture media as well as establishment and optimization of media for particular purposes in different species and cell lines.
2. **Explain, design, analyze** and **perform** the common cell culture techniques, cytotoxicity and viability assays for toxicological and pharmacological studies.
3. **Design** the experiment for development of primary established cell culture and characterize the various cell lines used in mammalian tissue culture in relation to their origins and uses.
4. **Describe, analyze** and **design** the criteria in consideration for scale up of cell culture as well as the appropriate

cell model for a large scale process involved in the production of human and animal viral vaccines and pharmaceutical proteins.

5. **Explain, assess** and **design** the strategies involved in toxicological study, cell cycle regulation study, apoptosis, drug testing, transgenic animal technology as well as **analyze** important social & environmental problems regarding genetically modified cell and organ models and identify ways to contribute to the solutions, including professional, economic and ethical considerations in social, industrial, medical & agricultural fields.

6. **Explain, assess** and **coalesce** the multidisciplinary need of animal biotechnology with the solution provided by the optimized and modernized animal tissue culture techniques at lab scale, pilot scale and ultimately industrial scale level as well as be able to **communicate** efficiently by preparing proper technical plans through meticulous reports at the end followed by sound oral explanations.

COURSE CONTENT:

Module I: (12 hrs)

Cell culture Laboratory design &Equipments, History of animal cell culture; Different tissue culture techniques; Types of primary culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture etc.; Behavior of cells in culture conditions: division, growth pattern, estimation of cell number; Development of cell lines; Characterization and maintenance of cell lines, Cryopreservation; Common cell culture contaminants; Cell cloning and selection; Transfection and transformation of cells. Marker gene characterization; Stem cell: types, properties and their applications in animal cloning, therapeutics; Transient Recombinant Protein Expression in Mammalian Cells; Production of human and animal viral vaccines and pharmaceutical proteins. Overview of Cell Culture Engineering for the Insect Cell-Baculovirus Expression Vector System.

Module II: (12 hrs)

Media and reagents

Types of cell culture media; Ingredients of media; Physiochemical properties; CO_2 and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics, growth supplements; Foetal bovine serum; Serum free media; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents.

Module III: (12 hrs)

Growth and scale up of animal cell:

Animal cell growth characteristics and kinetics; Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Micro-carrier attached growth; Cell culture in continuous, perfusion and hollow fibre reactor; Microencapsulation; Growth monitoring; Mass transfer in mammalian cell culture.

Module IV: (12 hrs)

Application of animal cell culture

Toxicological study, cell cycle regulation study, apoptosis, drug testing, various important techniques like FACS, confocal, immunoflourescence, immunohistochemistry etc. in animal cell culture.

Tumorigenesis , angiogenesis, metastasis in *in vivo* and *in vitro* studies, application of organ culture in virology and toxicology, cytogenetics studies, chromosome preparation and banding techniques, principles of cell

separation and purification of cells and their products.
Transgenic Animals and Animal Cloning: Methodology, Embryonic stem cell method, Microinjection method, Retroviral method, Applications of transgenic animals, Transgenic animals as bioreactors.

References:

1. Nanochemistry: A Chemical Approach to Nanomaterials (Hardcover) by Geoff Ozin, A Arsenaultn (Publisher: Royal Society of Chemistry; 1 edition (November 22, 2005) ISBN: 085404664X)
2. Nanoscale Technology in biological systems, Ralph S. Greco, Fritz B. Prinz, R. Lane Smithm CRC Press, 2005
3. Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience by Edward L. Wolf (Publisher: Wiley-VCH; 2 edition (October 20, 2006) ISBN: 3527406514)
4. Cancer Nanotechnology, eds. H. S. Nalwaand Thomas Webster, American Scientific Publishers,2007, ISBN: 1- 58883-071-3
7. Introduction to Nanotechnology, Charles P. Poole, Jr., Frank J. Owens; John Wiley & Sons,2003, ISBN 0471079359
8. L.E. Foster, Nanotechnology-Science, Innovation and opportunity, Person education inc, 2007.
9. Freshney R. Ian, "Culture of animal cells: A manual of Basic Technique", Willey-Liss Publisher, 5th edition (2005).
10. Davis. J.M Basic Cell Culture Second Edition, Oxford University Press. (First Indian Edition, 2005)
11. Jenkins N, ed., "Animal Cell Biotechnology: Methods and Protocol", Humana Press (1999).
12. Minuth W.W., Strehl R., Schumacher K., "Tissue Engineering: Essential for Daily Laboratory Works", Willey Publisher (2005).

Course Code	**PE-MBT203A**					
Category	**Program Elective III**					
Course Title	**Downstream Processing**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: II**
	3	**0**	**0**	**3**	**48**	

COURSE OBJECTIVES:

The objectives of the course are:

- To study the characteristics of biomolecules and to understand the principles of solid-liquid separation processes.
- To impart knowledge on various product isolation methods.
- To understand the principles of various types of high resolution techniques for valuable product purification.
- To study the principle of purification as well as concentration of product by different techniques like: precipitation, crystallization, drying and lyophilisation.
- To learn about how to develop and formulate methods to meet the need of pure proteins, enzymes and other valuable products related to biopharmaceuticals, clinical research and development.

COURSE OUTCOME (CO):

After successful completion of this course, the student will be able to:

1. **Describe the principles** that underlie major unit operations used in downstream processing of biotechnological and biopharmaceuticals.
2. **Define** terms associated with downstream processing and downstream process development.
3. **Design, execute and document** bench-scale studies to determine appropriate operating ranges and scale-up parameters for downstream processing steps.
4. **Design and formulate effective strategies** of downstream processing based on characteristics of biomolecules and to **learn the various techniques** of product capturing, isolation, purification and polishing.
5. **Analyze** the quality and characteristics of the purified product.
6. **Explain, recommend and demonstrate** the suitable downstream approaches comprising of new concepts and emerging technologies that are likely to benefit product recovery for small and large scale in the future.

COURSE CONTENT:

Module I: [5 Lectures]
Requirement of Downstream Processing
Overview of a bioprocess including upstream and downstream processing, Importance of downstream processing in biotechnology, characteristics of biological molecules and their separation characteristics based on stability & other biological properties, New Separation process in modern biotechnology; Selection of purification methodologies, Characteristics of fermentation broth & its pretreatment.

Module II: [5 Lectures]
Biomass Removal and Cell Disruption
Biomass removal and Cell disruption: Cell disruption by Mechanical and non mechanical methods, Chemical lysis, Enzymatic lysis, physical methods, Sonication, Types of Homogenizers, Flocculation.

Module III: [8 Lectures]
Product Isolation
Liquid - liquid extractions, Precipitation (salt, pH, organic solvent, high molecular weight polymer). Separation of particulate by filtrations, Rotary Vacuum Filtration, Centrifugation & Ultracentrifugation (Batch, continuous, basket), settling, sedimentation, decanting; Electrophoresis.

Module IV: [5 Lectures]
Membrane Based Separation
Membrane based purification: Microfiltration, Ultrafiltration, Reverse osmosis (UF and RO); Dialysis; Electrodialysis; Diafiltration; Pervaporation; Perstraction, Biotechnological application, Structure and characteristics of membranes; Liquid membranes; Supported liquid membrane; Membrane reactors.

Module V: [12 Lectures]
Separation by Adsorption and Chromatography

Types of adsorption; adsorbents types and properties, Types of adsorption isotherms and their importance; Chromatography: general theory, partition coefficients, zone spreading, resolution and plate height concept and other chromatographic terms and parameters; chromatographic method selection; selection of matrix; separation based on size, charge, hydrophobicity and affinity**:** Gel filtration, Ion exchange chromatography and Chromatofocussing; Reverse phase chromatography (RPC) and hydrophobic interaction chromatography (HIC), Affinity chromatography (Specific vs Nonspecific); Covalent chromatography; HPLC, role of HPLC in protein characterization.

Module VI: [5 Lectures]
Product Polishing, Crystallization, Drying and Case Studies

Polishing of bioproducts by crystallization of small and large molecules, drying and formulations; CIPP/RIPP schemes for ethanol, methanol, citric acid and large scale upstream and downstream processing of recombinant products: intracellular proteins, penicillin, streptomycin, insulin, casein, interferon etc.

References:

1. Protein Purification Methods, E L V Harris and S. Angal, Ed. IRL Press at Oxford University Press, 1989.
2. Bioseparation: Downstream processing for Biotechnology, Belter, P.A. and Cussler, E.L. Hu, W.S (1988), Wiley, New York.
3. Biochemical Engineering Fundamentals, J. E. Bailey and D. F. Ollis, 2nd Edition, Mc-Graw Hill, Inc., 1986.
4. Priniciples of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984)
5. Downstream Processing" by J.P. Hamel, J.B. Hunter and S.K. Sikdar, American Chemical Society
6. Protein Purification" by M.R. Ladisch, R.C. Wilson, C.C. Painton and S.E. Builder, American Chemical society ,Verlag
7. Protein purification: Principle and practice, third edition, Robert K. Scopes, Springer, editor: Charles R. Cantor
8. Guide to protein purification: Methods in enzymology, volume 182
9. Principles of Bioseparations Engineering by Raja Ghosh. World Scientific Publishing Co

Web Reference:

7. NPTEL: http://nptel.ac.in/courses/102106022/
8. NPTEL: http://nptel.ac.in/courses/102106048/
9. NPTEL: http://nptel.ac.in/courses/102103044/
10. NPTEL: http://nptel.ac.in/courses/104104066/
11. NPTEL: http://nptel.ac.in/courses/102107028/
12. ePgPathshala: http://epgp.inflibnet.ac.in/view_f.php?category=1204
13. ePgPathshala: http://epgp.inflibnet.ac.in/view_f.php?category=1354

Course Code	PE-MBT203B					
Category	Program Elective III					
Course Title	Bioreactor design, Development and Scale up					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: II
	3	0	0	3	48	

COURSE OBJECTIVE:

The objectives of the course are:

1. To understand the relationship between biological phenomena and engineering design for effective bioreactor operations to achieve production
2. To apply the knowledge of bioprocess engineering to understand the basics of reactor design.

COURSE OUTCOME (CO):

After successful completion of this course, the student will be able to:

1. Apply the knowledge of bioprocess engineering to **identify and formulate problems** in chemical and biochemical reaction engineering and find appropriate solutions.
2. Able to analyze and **interpret the data of complex problem** using **modern engineering and computational tools** including prediction and modeling of different engineering activities.
3. Understand the relationship between **biological phenomena and engineering design** for effective bioreactor operations.
4. Able to analyze and formulate mechanisms for bioprocess achieve production goals for **societal issues** and **ability to learn** in the broad context of technological changes.

COURSE CONTENT:

Module I: 12L
Inoculums development, Introduction to fermentation process, Microbial growth kinetics Sterilization, Inocula Development, criteria for the transfer of inoculums, Development of inocula. Batch and continuous bioreactors, critical dilution rate, biomass productivity, comparison with batch cultures, residence time distribution, Test of validity, imperfect mixing, wall growth Transient state analysis, Turbidostat, Chemostat in series Applications. Fed batch operation, Perfusion system, Bioreactor consideration in immobilized cell system.

Module II : 12L
Plant and Animal Cell Bioreactor Plant cell bioreactors: characteristics of plant cell suspensions, plant cell bioreactor requirements, plant cell bioreactor design, plant cell bioreactor operation, alternative cultures for plant cells. Animal cells: Animal cell bioreactors, animal cell bioreactor operation, and animal cell bioreactor design.

Module III : 12L
Advanced Bioreactor: Stirred vessel reactors, Bubble column reactors, biochemical loop reactors and its applications, Biological wastewater treatment in reciprocating jet bioreactors, tower-shaped reactors for aerobic biological wastewater treatment, Membrane bioreactors, Scale up of bioreactors.

Module IV: 12L
Bioreactor Instrumentation and Control Measurement of physical and chemical parameters in bioreactors: monitoring and control of dissolved oxygen, pH, impeller speed and temperature in stirred tank fermenter. Modeling of bioreactors, the model cycles, kind of models, complexity of the model, solving equations, parameter sensitivity, experimental design / parameter optimization / testing of the model.

References:
1. James E. Bailey and David F. Ollis, "Biochemical Engineering Fundamentals", 2nd Edition, McGraw Hill International Edition.
2. Michael L. Shuler and Fikret Kargi, "Bioprocess Engineering: Basic Concepts", 2nd Edition, Prentice Hall.
3. Aiba S. and Nancy F. Millis, "Biochemical Engineering", 2nd Edn., Academic Press.

Course Code	**PE-MBT204A**					
Category	**Program Elective IV**					
Course Title	**Genomics and Proteomics**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: II**
	3	**0**	**0**	**3**	**48**	

COURSE OBJECTIVE:

The objectives of the course are:

1. This course will help students understanding the principles of genomic analysis of prokaryotes and eukaryotes.
2. This course is to teach students techniques in genomics and proteomics and application of these techniques in diverse fields.

COURSE OUTCOME (CO):

After successful completion of this course, the student will be able to:

1. **Identify** and **describe** the structural organization of prokaryotic and eukaryotic genomes.
2. **Explain** the current genomics technologies and demonstrate how these can be used to study gene function.
3. **Execute** various techniques including DNA sequencing, PCR and proteomics.
4. **Interpret** data obtained through high throughput expression studies.
5. **Propose** a experimental proposal to address a particular biological question.

COURSE CONTENT:

Module I: 12L Introduction
Structural organization of genome in Prokaryotes and Eukaryotes, Organelle DNA mitochondrial, chloroplast, DNA sequencing principles and methods, Recognition of coding and non-coding sequences, Gene annotation, Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Module II: 12L Genome sequencing projects
Microbes, plants and animals, Accessing and retrieving genome project information from web, Comparative genomics, Identification and classification using molecular markers-16SrRNA typing/sequencing, EST's and SNP's.

Module III: 12L Proteomics
Protein analysis (includes measurement of concentration, amino acid composition, N-terminal sequencing), 2-Delectrophoresis of proteins, Peptide fingerprinting, LC/MS-MS for identification of proteins and modified proteins, MALDI- TOF, SAGE and Differential display proteomics, Protein-protein interactions, Pull-down assays (using GST-tagged protein); Protein arrays-definition; Applications- diagnostics, expression profiling.

Module IV: 12L Functional genomics and proteomics
Analysis of microarray data, Protein and peptide microarray-based technology, PCR-directed protein in situ arrays, Structural proteomics, Pharmacogenomics and pharamacogenetics and drug development; Toxicogenomics.

References:
1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM &Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics,2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.

Course Code	**PE-MBT204B**					
Category	**Program Elective IV**					
Course Title	**Pharmaceutical Biotechnology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: II**
	3	**0**	**0**	**3**	**48**	

COURSE OBJECTIVE:

The objectives of the course are:
1. The course covers various topics in Drug development, formulation and marketing.
2. The course will also cover properties of biopharmaceuticals and delivery methods

COURSE OUTCOME (CO):

After successful completion of this course, the student will be able to:
1. **Provide** an introduction to Drug development and the innovative processes in pharmaceuticals.
2. **Understand**, **define** and **differentiate** drug delivery methods.
3. **Understand** the process and methodology of drug action and mechanism.
4. **Applying** interdisciplinary subjects to **analyze** and **evaluate** different therapeutic approaches.
5. **Understand**, **define** and **differentiate** traditional and recombinant therapeutic molecules and their production.

COURSE CONTENT:

Module I: Drug development, Manufacturing, Formulation and Drug delivery processes (12L) Introduction, Drug discovery and development; steps of drug discovery; Patenting, Drug manufacturing processes, biochemical Product formulation processes; Delivery of biopharmaceuticals as drugs: Parenteral delivery systems, Oral

delivery systems, Pulmonary delivery, Nasal delivery, Ophthalmic delivery, transmucosal and transdermal delivery systems. Current status and future development trends of biopharmaceuticals.

Module II: Drug kinetics and biopharmaceutics (12L)
Mechanism of drug absorption, distribution, metabolism and excretion – factors affecting the
ADME process; Bioequivalence; Pharmacokinetics.

Module III: Principles of drug manufacture (12L)
Liquid dosage forms – solutions, suspensions and emulsions; Topical applications –
ointments, creams, suppositories; Solid dosage forms – powders, granules, capsules, tablets, coating oftablets; Aerosols; Preservation; Packing techniques

Module IV: Biopharmaceuticals (12L)
Understanding principles of pharmacology, pharmacodynamics; Study of a few classes of therapeutics like Recombinant therapeutics, Monoclonal Antibodies, Vaccines, Gene therapy, Antibiotics and Hormones.

References:
1. Lachman, L. *et al*., The Theory and Practice of Industrial Pharmacy, 3rd Edition, VarghesePublishing House, 1987.
2. Aulton, M.E. Pharmaceutics: The Science of Dosage form Design, 2nd Edition, ChurchillLivingstons, 2002.
3. Ansel, H.C. *et. al.,* Pharmaceutical Dosage Forms and Drug Delivery Systems, 7th Edition, Lippincott Williams, Wilkins, 2002.
4. Nogardy Thomas, Medicinal Chemistry: A Molecular and Biochemical Approach, 3rdEdition, OUP, 2005.
5. Rawlins, E.A., Bentley's Textbook of Pharmaceutics, 8th Edition, Baillire, Tindall, 2005.
6. Remington: The Science and Practice of Pharmacy, Vol. I & II, 20th Edition, B.I. Publications /Lippincott Williams & Wilkins, 2000.

Course Code	**PC-MBT291**					
Category	**Laboratory III**					
Course Title	**Bioinformatics Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: II**
	0	**0**	**4**	**2**	**48**	

COURSE OBJECTIVES:

This course emphasizes the hands-on applications of bioinformatics methods to biological problems. Students will gain experience in the application of existing software as well as in combining approaches to answer specific biological questions.

COURSE OUTCOMES:

By the end of the course, students will be able to do the following:

1**. Explain** why bioinformatics approaches are important in understanding and **interpreting** results in many different areas of biological study.
2**. Use** various existing bioinformatics tools in combination to answer complex scientific questions.
3. **Develop** critical analysis and research skills that can be applied to understand and **use** new bioinformatics tools

that are developed in the future.
4**. Access** publicly-available biological databases.
5. **Develop** software tools under good-practice guidelines.

COURSE CONTENT:

1. Introduction to Bioinformatics lab and some useful terminologies. Handling of different primary databases and retrieval of primary data of both protein and nucleotide (Expasy, Entrez) of a particular group or type of an enzyme. Handling of different specialized databases: Pathway-KEGG, Disease databases (cancer and other disease databases), protein folding classification databases-FSSP, different genomic databases.
2. Different approaches of Prediction of Genes: Promoters, splice sites, regulatory regions (Basic principles) application of methods to prokaryotic and eukaryotic genomes and interpretation of results.
3. Sequence based and structure-based approaches to assignment of gene functions, e.g. sequence comparison, structure analysis (especially active sites, binding sites) and comparison, pattern identification, etc.
4. Different approaches of Identification of Disease Genes: Based on some specialized general databases and specific disease databases.
5. Use of various derived databases in structure and function assignment, gene expression profiling.
6. Different approaches for analysis of ligand-protein and protein- protein interactions.
7. Study to find out potential drug targets for cardio vascular, neurological diseases etc. using proprietary and public domain softwares (eg. VEGAZZ) (ligand design, optimization and improvement).

References:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis, 2nd Edition ,CSHL Press, 2004.
2. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss,2003.
3. Zhumur Ghosh, Bibekananda Mallick. Bioinformatics Principles and Applications: OXFORD University Press
4. A. Baxevanis and F. B. F. Ouellette, Bioinformatics: a practical guide to the analysis ofgenes and proteins, 2nd Edition, John Wiley, 2001.
5. P. E. Bourne and H. Weissig. Structural Bioinformatics. Wiley. 2003.
6. C. Branden and J. Tooze, Introduction to Protein Structure, 2nd, Edition, Garland Publishing, 1999.
7. W.B. Pratt and P. Taylor, Principles of Drug Action, Churchill Livingston
8. Andrew Leach, Molecular Modelling: Principles and Applications, Pearson Education
9. Scolnick.J.; Drug Discovery and Design, Academic Press, London,2001
10. N. R. Cohen, Editor, Guidebook on Molecular Modeling in Drug Design. Academic Press, San Diego, 1996.

Course Code	PC-MBT292					
Category	Laboratory IV					
Course Title	Animal Cell Culture Lab					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: II
	0	0	4	2	48	

COURSE OBJECTIVE:

The objective of the course is:

The laboratory emphasizes the principles and practices of initiation, cultivation, maintenance, and the preservation techniques of cell lines.

COURSE OUTCOME:

After completion of the course students will be able to:

1. **Understand** the basic requirements for growing mammalian cells in culture.
2. **Explain, design, analyze** and **perform** successful assess cell viability, growth and maintenance of adherent and suspension cell cultures without contamination.
3. **Understand** methods commonly used to transform and select cells, assess cell viability, freeze viable cells and recover these cells for future assays.

COURSE CONTENT:

1. Basic sterilization techniques for animal cell culture.
2. Preparation of complete medium.
3. Trypsinization, freezing, thawing of cells.
4. Suspension Culture.
5. Attached Culture.
6. Serum starvation study.
7. Toxicity study by MTT/Trypan Blue assay.
8. Transfection.
7. Proliferation assay.

References

1. Freshney R. Ian, "Culture of animal cells: A manual of Basic Technique", Willey-Liss Publisher, 5th edition (2005).
2. Morgan, Animal Cell Culture-Biotol Series,1993
3. Davis.J.M Basic Cell Culture Second Edition, Oxford University Press. (First Indian Edition, 2005)
4. Jenkins N, ed., "Animal Cell Biotechnology: Methods and Protocol", Humana Press (1999).
5. Minuth W.W., Strehl R., Schumacher K., "Tissue Engineering: Essential for Daily Laboratory Works", Willey Publisher (2005).
6. Butler, M "Mammalian Cell Biotechnology- A Practical Approach," IRL Oxford University Press (1991).

Course Code	PC-MBT293					
Category	Laboratory IV					
Course Title	Bioprocess Engineering Lab					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: II
	0	0	4	2	48	

COURSE OBJECTIVE:

The objective of the course is:

To enhance skill of the students in the area of Biochemical engineering, Bioprocess equipment design, analysis along with introductory skills used in the biotechnology industry.

COURSE OUTCOME:

After completion of the course students will be able to:

1. **Understand, define** and **recall** the different parts of Bioreactor and its live operation.
2. **Understand** the kinetics of different fermentation process.
3. **Determine** the volumetric mass transfer co-efficient (K_{La}) and mixing time of a reactor.

COURSE CONTENT:

PART B:

1. Demonstration of different parts of Bioreactor (NBS-BIOFLO-110).
2. Demonstration and real time operation of different parts of Bioreactor (BIOSTAT-A).
3. Study of the growth kinetics of *E. coli*in Bioreactor
4. Substrate utilization kinetics of *S. cerevisiae* in Bioreactor.
5. Determination of volumetric mass transfer co-efficient (K_{La})
6. Determination of mixing time of a reactor.

References

1. Bioprocess Engineering: Basic Concepts (2nd Edition), Shuler and Kargi, Prentice Hall International.
2. Bioprocess Engineering Principles, Pauline M. Doran, Elsevier Science & Technology Books
3. BIOPROCESS ENGINEERING: Kinetics, Sustainability, and Reactor Design, second edition, Shijie Liu, Elsevier

SESSIONAL

Subject Code : SE-MBT281	**Category : Mini Project**
Subject Name : Mini Project with Seminar	**Semester : II**
L-T-P :0-0-4	**Credit:2**

Mini Project would be to do some preliminary works that would lead to the detailed project work spanning over Semester III and IV. Related to the same, the Seminar would be based on literature review on some emerging areas related to this course and the preliminary works done on the mini project.
Seminar presentation would be made by an individual student, and a report would have to be submitted by each student separately.

AUDIT COURSES (1 and 2)

Course Code	**AC-MBT101A / AC-MBT201A**					
Category	**AUDIT COURSE1 & 2**					
Course Title	**ENGLISH FOR RESEARCH PAPER WRITING**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: I or II**
	2	**0**	**0**	**0**	**24**	

COURSE OBJECTIVES:

Students will be able to:
1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
Ensure the good quality of paper at very first-time submission

COURSE CONTENTS:

Module 1: 4 Hours
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Module 2: 4 Hours
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Module 3: 4 Hours
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Module 4: 4 Hours
key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Module 5: 4 Hours
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, and skills are needed when writing the Conclusions.

Module 6: 4 Hours
useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Suggested Studies:
1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)Model Curriculum of Engineering & Technology PG Courses [Volume-I]
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Course Code	**AC-MBT101B/ AC-MBT201B**					
Category	**AUDIT COURSE 1 & 2**					
Course Title	**PEDAGOGY STUDIES**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: I or II**
	2	**0**	**0**	**0**	**16**	

COURSE OBJECTIVES:

Students will be able to:
1. Review existing evidence on the review topic to inform programme design and policymaking undertaken by the DFID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

COURSE OUTCOMES:

Students will be able to understand:
1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

COURSE CONTENTS:

Module 1: 4 Hours

- **Introduction and Methodology:**
- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions**.**

- Overview of methodology and Searching.

Module 2: 2 Hours

- Thematic overview: Pedagogical practices are being used by teachersin formal and informal classrooms in developing countries.
- Curriculum, Teacher education.

Module 3: 4 Hours

- Evidence on the effectiveness of pedagogical practices
- Methodology for the in depth stage: quality assessment of included studies.
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
- Theory of change.
- Strength and nature of the body of evidence for effective pedagogical practices.
- Pedagogic theory and pedagogical approaches.
- Teachers' attitudes and beliefs and Pedagogic strategies.

Module 4: 4 Hours

- Professional development: alignment with classroom practices and follow-up support
- Peer support
- Support from the head teacher and the community.
- Curriculum and assessment
- Barriers to learning: limited resources and large class sizes

Module 5: 2 Hours

- **Research gaps and future directions**
- Research design
- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact.

SUGGESTED READING

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher educationresearch project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic mathematics and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Code	AC-MBT101C/ AC-MBT201C					
Category	AUDIT COURSE 1& 2					
Course Title	CONSTITUTION OF INDIA					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: I or II
	2	0	0	0	24	

COURSE OBJECTIVES:

Students will be able to:
1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

COURSE OUTCOMES:

Students will be able to:
1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

COURSE CONTENT:

Module 1: 4 Hours

- **History of Making of the Indian Constitution:**
  History

Drafting Committee, (Composition& Working)

Module 2: 4 Hours

- **Philosophy of the Indian Constitution:**

Preamble

Salient Features

Module 3: 4 Hours

- **Contours of Constitutional Rights & Duties:**
- Fundamental Rights
- Right to Equality
- Right to Freedom
- Right against Exploitation

- Right to Freedom of Religion
- Cultural and Educational Rights
- Right to Constitutional Remedies
- Directive Principles of State Policy
- Fundamental Duties.

Module 4: 4 Hours

- **Organs of Governance:**
- Parliament
- Composition
- Qualifications and Disqualifications
- Powers and Functions
- Executive
- President
- Governor
- Council of Ministers
- Judiciary, Appointment and Transfer of Judges, Qualifications
- Powers and Functions

Module 5: 4 Hours

- **Local Administration:**
- District's Administration head: Role and Importance,
- Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.
- Pachayati raj: Introduction, PRI: Zila Pachayat.
- Elected officials and their roles, CEO Zila Pachayat: Position and role.
- Block level: Organizational Hierarchy (Different departments),
- Village level: Role of Elected and Appointed officials,
- Importance of grass root democracy

Module 6: 4 Hours

- **Election Commission:**
- Election Commission: Role and Functioning.
- Chief Election Commissioner and Election Commissioners.
- State Election Commission: Role and Functioning.
- Institute and Bodies for the welfare of SC/ST/OBC and women.

References

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015

Course Code	AC-MBT101D/ AC-MBT201D					
Category	AUDIT COURSE 1 & 2					
Course Title	DISASTER MANAGEMENT					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: I or II
	2	0	0	0	24	

COURSE OBJECTIVES:

Students will be able to:
1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

COURSE CONTENTS:

Module 1: 4 Hours
Introduction
Disaster: Definition, Factors and Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

Module 2: 4 Hours
Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Module 3: 4 Hours
Disaster Prone Areas In India
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic and Coastal Hazards WithSpecial Reference To Tsunami; Post-Disaster Diseases And Epidemics.

Module 4: 4 Hours
Disaster Preparedness And Management
Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

Module 5: 4 Hours
Risk Assessment
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People's Participation In Risk Assessment. Strategies for Survival.

Module 6: 4 Hours
Disaster Mitigation
Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

SUGGESTED READINGS:
1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company. Model Curriculum of Engineering & Technology PG Courses [Volume-I]
2. Sahni, Pardeep Et. Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

Course Code	**AC-MBT101E/ AC-MBT201E**					
Category	**AUDIT COURSE 1& 2**					
Course Title	**VALUE EDUCATION**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: I or II**
	2	**0**	**0**	**0**	**24**	

COURSE OBJECTIVES:

Students will be able to
1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

COURSE OUTCOMES:

Students will be able to
1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

COURSE CONTENTS:

Module 1: 4 *Hours*
- Values and self-development –Social values and individualattitudes. Work ethics, Indian vision of humanism.
- Moral and non- moral valuation. Standards and principles.
- Value judgements

Module 2: 6 *Hours*

- Importance of cultivation of values.
- Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.
- Honesty, Humanity. Power of faith, National Unity.
- Patriotism. Love for nature, Discipline

Module 3: 6 *Hours*

- Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline.
- Punctuality, Love and Kindness.
- Avoid fault Thinking.
- Free from anger, Dignity of labour.
- Universal brotherhood and religious tolerance.
- True friendship.
- Happiness Vs suffering, love for truth.
- Aware of self-destructive habits.
- Association and Cooperation.
- Doing best for saving nature

Module 4: 6 *Hours*

- Character and Competence –Holy books vs Blind faith.
- Self-management and Good health.
- Science of reincarnation.
- Equality, Nonviolence, Humility, Role of Women.
- All religions and same message.
- Mind your Mind, Self-control.
- Honesty, Studying effectively

References

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

Course Code	**AC-MBT101F /AC-MBT201F**					
Category	**AUDIT COURSE 1& 2**					
Course Title	**STRESS MANAGEMENT BY YOGA**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: I or II**
	2	**0**	**0**	**0**	**24**	

COURSE OBJECTIVES:

1. To achieve overall health of body and mind
2. To overcome stress

COURSE OUTCOMES:

Students will be able to:
1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

COURSE CONTENTS:

Module 1:8 Hours

- Definitions of Eight parts of yog. (Ashtanga)

Module 2:8 Hours

- Yam and Niyam.

Do`s and Don't's in life.
i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Module 3:8 Hours

- Asan and Pranayam

i) Various yog poses and their benefits for mind & body
ii)Regularization of breathing techniques and its effects-Types of pranayam

References

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami YogabhyasiMandal, Nagpur

2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama(Publication Department), Kolkata

Course Code	**AC-MBT101G/ AC-MBT201G**					
Category	**AUDIT COURSE 1 & 2**					
Course Title	**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: I or II**
	2	**0**	**0**	**0**	**24**	

COURSE OBJECTIVES:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

COURSE OUTCOMES:

Students will be able to
1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

COURSE CONTENTS:

Module 1: 8 Hours
Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)

- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

Module 2: 8 Hours

- Approach to day to day work and duties.
- Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

Module 3: 8 Hours

- Statements of basic knowledge.
- ShrimadBhagwadGeeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Personality of Role model. ShrimadBhagwadGeeta:Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

SUGGESTED READING

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,
3. Rashtriya Sanskrit Sansthanam, New Delhi.

Course Code	**AC-MBT101H/ AC-MBT201H**					
Category	**AUDIT COURSE 1& 2**					
Course Title	**SANSKRIT FOR TECHNICAL KNOWLEDGE**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: I or II**
	2	**0**	**0**	**0**	**24**	

COURSE OBJECTIVES:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
5. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

COURSE OUTCOMES:

Students will be able to
1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

COURSE CONTENTS:

Module 1: 8 *Hours*

- Alphabets in Sanskrit,
- Past/Present/Future Tense,
- Simple Sentences

Module 2: 8 *Hours*

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

Module 3: 8 *Hours*

- Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

References

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

THIRD SEMESTER

Course Code	**PE-MBT301A**					
Category	**Program Elective V**					
Course Title	**Biostatistics and Design of Experiments**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	3	**0**	**0**	**3**	**48**	

COURSE OBJECTIVE:

The objectives of the course are:

1. To provide students with the foundations of probabilistic and statistical analysis.
2. To collect data and analyze problems in a critical manner.
3. To understand the exact method of data analysis and experimental design construction.
4. To learn the formal application of probability theory.

COURSE OUTCOME (CO):

After successful completion of this course, the student will be able to:

1. Apply basic statistical concepts commonly used in Biotechnology.
2. Use basic analytical techniques to generate results.
3. Demonstrate the design and analysis of statistical methods.
4. Demonstrate and understand the central concepts of modern statistical theory and their probabilistic foundation.
5. Design experiments to deal with real-life problems.

COURSE CONTENT:

Module I: [8 Lectures]
Preliminary concept: Characteristics and limitation of statistics, Application of Biostatistics
Data: Types of data, Frequency distributions, Cumulative frequency distribution, Graphical presentation of data
Central tendency: Arithmetic mean, Geometric mean, median, mode, Other measures of central tendency
Measures of variation: The range, Dispersion measured with quantiles, Mean deviation, Variance, Standard deviation, Coefficient of variance

Module II: [5 Lectures]
Skewness, Kurtosis and Moments Correlation and Regression, Curve fitting, Nonlinear data fitting, Confidence intervals

Module III: [10 Lectures]
Probabilities: Concept of Probability: introduction and basics counting principle, Permutations and Combinations, Conditional probability and Random variables, Probability mass function and Probability density function, Variance and Covariance, Expectation, Binomial random variables and Moment generating function

Probability distribution: Poisson distribution, Uniform distribution, Normal distribution, Exponential distribution, Sampling distributions and Central limit theorem,

Module IV: [15 Lectures]
Test of Hypothesis (1 tailed and 2 tailed Test of Hypothesis, p-value), Test of Hypothesis (Type -1 and Type -2 error), 1 tailed and 2 tailed T-distribution, Chi-square test, Analysis of variances (ANOVA)

Module V: [10 Lectures]
Design of experiments (DOE)
DOE introduction, Factorial design, Full factorial design, Fractional factorial design, Real life problem analysis by DOE, Concept of Orthogonal array, Taguchi DOE Method

Reference books:

1. Biostatistical Analysis - Jerrold H. Zar
2. Introduction to Probability & Statistics - Medenhall, Beaver, Beaver
3. Bernard Rosner, Fundamentals of Biostatistics, Thomson Brooks/Cole.
4. Richard A. Johnson, Probability and Statistics for Engineers, Prentice Hall.
5. Morris H. De Groot, Mark J. Schervish, Probability and Statistics, Addison-Wesley.

Web Reference:
http://nptel.ac.in/courses/102106051/
https://nptel.ac.in/courses/110/105/110105087/

Course Code	PE-MBT301B					
Category	Program Elective V					
Course Title	Modeling and Simulation in Bioprocess					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: III
	3	0	0	3	48	

COURSE OBJECTIVE:

The objectives of the course are:

To introduce the different aspects of modeling in bioprocess system and to familiarize the simulation of bioprocess modeling.

COURSE OUTCOMES:

After completion of course, students would be able to:

1. Learn about the principles of bioprocess modeling and simulation.
2. Understand the mathematical models in biochemical engineering systems.
3. Familiar simulation software's in different states.
4. Apply numerical methods in simulations.

COURSE CONTENT:

MODULE I: Approach to Modeling

Significance of modeling and simulation, kinetic models on different approaches; Deterministic and stochastic, structured and unstructured, segregated and unsegregated; examples of each. Compartmental models (two and four); product formation model; genetically structured models, modeling of extra cellular enzyme production.

MODULE II: Modeling of Bioprocess

Modeling of continuous sterilization of medium; modeling of activated sludge process with a control system; model for anaerobic digestion, model for SCP production form spent sulfite liquor. Models for external mass transfer, internal diffusion and reaction within biocatalysts, model for antibiotic formation; modeling of therapeutic protein production with recombinant cells.

MODULE III: Simulation Techniques (Software)

continuous system simulators (CSMP, INT, LEANS, MIDAS, MIMIC);dynamic process simulators (DYFLO, DYNSIS, PRODYC, REMUS); steady state material and energy balance programs(PACER, FLOWTRAN, CHESS);some aspects of INT and DYFLO programs; General arrangement of main program using INT subroutines.

MODULE IV: Simulation techniques (Numerical Methods)

Programs based on numerical methods like algebraic equations, Newton Raphson method for algebraic convergence, interpolation, arbitrary function generation (FUN1, FUN2 subroutines). Programs based on solution of differential equations: Eular method for 1st and 2nd order integration, subroutines INT and INTI; Fourth order Runga–Kutta method: stability of numerical integration variable slip size method.

MODULE V: Case Studies
Case studies, Numerical problems.

References:
1. Bailey, J.E and D.F ollis , Biochemical Engineering fundamentals , 2nd ed. McGraw Hill Book Co. , 1988
2. Blanch, H.W and I.J. Dunn ,"Modeling and Simulation in Biochemical Engg" in advances in biochemical engg. Vol-3 edited by T.K. Ghosh, A. Fiechler and N. Blakebrngh.
3. R.G.E Franks, " Modeling and Simulation in chemical engineering ", Wiley International 1972.
4. Kleinstreur ,C. and T. Powegha, " Modeling and Simulation of Bioreactor Process Dynamics " in Advances in Biochemical Engg./ Biotechnology , vol.30 , edited by A. Fiechler springer verlag , Berlin , Heidelberg,1984.

Course Code	**PE-MBT301C**					
Category	**Program Elective V**					
Course Title	**Problem Solving Through Programming in C**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	3	**0**	**0**	**3**	**48**	

COURSE OBJECTIVE:

The objectives of the course are:
1. To provide exposure to problem-solving through programming.
2. To train the student to the basic concepts of the C-programming language.

This course involves a lab component which is designed to give the student hands-on experience with the concepts.

COURSE OUTCOMES:
After completion of course, students would be able to:
1. Illustrate the flowchart and design an algorithm for a given problem and to develop C programs using operators
2. Develop conditional and iterative statements to write C programs
3. Exercise user defined functions to solve real time problems
4. Inscribe C programs that use Pointers to access arrays, strings and functions.
5. Exercise user defined data types including structures and unions to solve problems.
6. Inscribe C programs using pointers and to allocate memory using dynamic memory management functions.

COURSE CONTENT:

MODULE 1: 4L
Introduction to Problem Solving through programs, Flowcharts/Pseudo codes, the compilation process, Syntax and Semantic errors, Variables and Data Types.

MODULE 2: 7L
Arithmetic expressions, Relational Operations, Logical expressions; Introduction to Conditional Branching. Conditional Branching and Iterative Loops.

MODULE 3: 7L
Arranging things : Arrays 2-D arrays, Character Arrays and Strings

MODULE 4:4L
Basic Algorithms including Numerical Algorithms

MODULE 5: 7L
Functions and Parameter Passing by Value Passing Arrays to Functions, Call by Reference

MODULE 6: 14L
Recursion Structures and Pointers Self-Referential Structures and Introductions to Lists Advanced Topics

MODULE 7: 5L
Handling biological problems through programming in C.

Reference Books
1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

Course Code	**PE-MBT301D**					
Category	**Program Elective V**					
Course Title	**Big Data Analytics**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	3	**0**	**0**	**3**	**48**	
Pre-requisites	**Data Structure, Computer Architecture and Organization**					

COURSE OBJECTIVE:

The objectives of the course are:

Understand big data for business intelligence. Learn business case studies for big data analytics. Understand nosql big data management. Perform map-reduce analytics using Hadoop and related tools.

COURSE OUTCOMES:

After completion of course, students would be able to:

1. Describe big data and use cases from selected business domains
2. Explain NoSQL big data management
3. Install, configure, and run Hadoop and HDFS
4. Perform map-reduce analytics using Hadoop
5. Use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.

COURSE CONTENT:

MODULE 1: 7L

What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics.

MODULE 2: 8L

Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schemaless databases, materialized views, distribution models, sharding, master-slave replication, peerpeer replication, sharding and replication, consistency, relaxing consistency, version stamps, map-reduce, partitioning and combining, composing map-reduce calculations.

MODULE 3: 8L

Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures

MODULE 4: 9L

MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy of Map Reduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats

MODULE 5: 7L

Hbase, data model and implementations, Hbase clients, Hbase examples, praxis. Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration.

MODULE 6: 6L

Pig, Grunt, pig data model, Pig Latin, developing and testing Pig Latin scripts. Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.

MODULE 7: 3L

Application of big data analytics in Biotechnology.

References:

1. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging
2. Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
3. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World ofPolyglot Persistence", Addison-Wesley Professional, 2012.
4. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.
5. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
6. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
7. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
8. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
9. Alan Gates, "Programming Pig", O'Reilley, 2011.

Course Code	PE-MBT301E					
Category	Program Elective II					
Course Title	Nanobiotechnology					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: I
	3	0	0	3	48	

COURSE OBJECTIVE:

The objectives of the course are:

1. Course will deliver a comprehensive knowledge in synthesis and characterization of nanomaterials of various types.
2. Course will cover inter- and multi-disciplinary science and engineering.
3. Course will deliver various applications of nanotechnology in biomedical, food and cosmetics.

COURSE OUTCOME (CO):

After successful completion of this course, the student will be able to:

1. **Describe** and **interpret** the basic of synthesis and characterization of nanomaterials.
2. **Learn** and **analyze** the development of engineered nanomaterials.
3. **Solve** and **understand** scientific problems related to nanotechnological materials.
4. **Evaluate** various applications of nanomaterials in Foods and Cosmetics.
5. **Create** awareness on the toxicity of nanomaterials.

COURSE CONTENT:

Module I:[10 L] Engineered Nanomaterials Nanotechnology

Nanotechnology: Definition of nanoscale with reference to biosystems, Scope (Overview of current industry applications) and future prospects; Cellular Nanostructures, Nanopores, Biomolecular motors; Nanoscale Properties (Electrical, Optical, Chemical); Cellular Nanostructures; Nanopores; Biomolecular motors; Criteria for suitability of nanostructures for biological applications. Nanotechnology and environment.

Module II: [10 L] Basic characterization techniques

Characterization techniques: Electron microscopy; Atomic force microscopy; Photon correlation Spectroscopy; Scanning probe microscopy (AFM, STM), Diffraction techniques (XRD, synchrotron)

Module II: [10 L] Engineered Nanomaterials

Engineered Nanomaterials: Carbon nanomaterials (fullerenes, graphene, nanotubes, nanofibers); Metal nanoparticles (synthesis, properties and applications); Magnetic nanoparticles (synthesis, properties and applications); Quanatum dots, liquid crystals; Nanoporous materials (metalic, zeolite, MOFs)

Module IV: [10 L] Application of Nanotechnology

Health Care Nanotechnology

Nanotechnology in Biomedical and Life Sciences: Criteria for suitability of nanostructures for biological applications, Lipids as nano-bricks, Proteins as nanomolecules, DNA in nanotechnology, Present and future of nanotechnology applications in: a) Molecular biology (e.g. Hairpin Nanoprobes for gene detection, Control of

Biomolecular Activity by Nanoparticle Antennas, Nanofibers and their applications in tissue engineering), b) Medicine (Public acceptance of nanomedicine, nanostructures for drug delivery, concepts, targeting, routes of delivery and advantages).

Foods and Cosmetics

Foods and Cosmetics - Bioavailability and Delivery of Nutraceuticals and Functional Foods Using Nanotechnology - Polymer-Based Nanocomposites for Food Packaging

References:

1. Nanochemistry: A Chemical Approach to Nanomaterials (Hardcover) by Geoff Ozin, A Arsenaultn (Publisher: Royal Society of Chemistry, 1 edition (November 22, 2005) ISBN: 085404664X)
2. Nanoscale Technology in biological systems, Ralph S. Greco, Fritz B. Prinz, R. Lane Smithm CRC Press, 2005
3. Introduction to Nanotechnology, Charles P. Poole, Jr., Frank J. Owens, John Wiley & Sons, 2003, ISBN0471079359
4. Bionanotechnology: Lessons from Nature Author: David S. Goodsell Publisher: Wiley- Liss ISBN:047141719X.
5. Biomedical Nanotechnology Editor: Neelina H. Malsch Publisher: CRC Press, ISBN-10 : 0824725794, ISBN-13 : 978-0824725792

Course Code	**PE-MBT301F**					
Category	**Program Elective III**					
Course Title	**Environmental Biotechnology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: II**
	3	**0**	**0**	**3**	**48**	

COURSE OBJECTIVE:

The objectives of the course are:

1. To gain knowledge on the importance of environmental education and ecosystem.
2. To acquire knowledge about environmental pollution - sources, effects and control measures of environmental pollution.
3. To understand the treatment of wastewater and solid waste management.
4. To generate valuable resources for the human society.

COURSE OUTCOME (CO):

After successful completion of this course, the student will be able to:

1. Understand the concept of environment and elaborate the organization of ecosystem, its components.
2. Identify, understand, and distinguish the different environmental pollution associated to environmental degradation.
3. Describe the principles and techniques supporting the application of Biotechnology to the environment.
4. Design, formulate and develop different control mechanisms, devices to minimize the environmental pollution.
5. Identify, analyze the industrial activities on environmental pollution and its control mechanism.
6. Understand the principles of bioremediation, phytoremediation, biofuel, bioresource.

COURSE CONTENT:

Module I: [8 Lectures]

Introduction: Environment; Basic concepts; Role of Biotech in environmental protection; Control and management of biological processes

Ecosystem: Components of ecosystem; Ecosystem management; Genetic, species and ecosystem diversity – bio diversity hot spots; threats to biodiversity; Conservation of bio diversity: in-situ and ex-situ conservations

Module II: [10 Lectures]

Environmental pollution; Source of pollution; Air, water as a source of natural resource;

Hydrocarbons; Oil pollution; Surfactants; Pesticides; Measurement of pollution; Water pollution; Biofilm; Soil pollution; Radioactive pollution; Radiation; Ozone depletion; Global warming and Green house effect; Acid rain, Eutrophication, Land degradation, Biomagnification; Impact of pollutants

Air pollution- control and treatment strategies; Determination of BOD, COD, TDS and trace metals

Module III: [15 Lectures]

Water/Wastewater Quality Enhancement: Wastewater characteristics; Primary, secondary and tertiary treatment; Philosophy of treatment; Physical, chemical and biological Unit operations process.

Physical Unit Processes: Screening; Commutation; Grit Removal; Equilization; Sedimentation;

Chemical Unit Processes: Coagulation-Flocculation; Filtration; Disinfections; Aeration and Gas transfer; Precipitation; Softening; Adsorption and Ion exchange; Membrane processes.

Biological Unit Processes: Aerobic treatment; Suspended growth aerobic treatment processes; Activated sludge process and its modifications; Attached growth aerobic processes; Tricking filters and Rotating biological contactors

Anaerobic: Anaerobic reactors for treatment of waste water- Anaerobic Digesters, Up flow Anaerobic Sludge Blanket Reactor (UASB), Fluidized Bed Biofilm Reactor (FBBR)

Advanced Waste Water Treatment Limitations of conventional treatment, pathogen removal, toxic substances removal, phosphorous and nitrogen removal

Module IV: [15 Lectures]

Solids Disposal: Solids waste disposal - composting, landfill, briquetting / gasification and incineration, Solid waste management.

Bioremediation: Introduction, Types of pollutants, sources of pollutants, magnitude of contamination problem, merits and limitations of bioremediation, bioremediation of organic and inorganic pollutants.

Phytoremediation: phytoextraction, rhizofiltration, phytodegradation, phytovolatilization, rhizoremediation, phytostabilization.

Resources: Non-renewable and renewable energy resources.; Alternate source of energy, Biomass as source of energy, Bioreactors, Rural biotechnology, Biocomposting, Biofertilizers, Vermiculture, Organic farming, Bio-mineralization, Biofuels, Bioethanol and biohydrogen, Bioelectricity through microbial fuel cell, energy management and safety

Reference books:

1. Environmental Engineering, Davis & Cornwel, McGraw Hill.
2. Environmental Pollution Control Engineering, CS Rao, New Age International
3. Ecology and Environment, PD Sharma PD, Rastogi Publications, Delhi

Web Reference:

1. http://nptel.ac.in/courses/103107084/
2. http://nptel.ac.in/courses/105106119/
3. http://nptel.ac.in/courses/105105048/
4. http://nptel.ac.in/courses/103107084/
5. http://nptel.ac.in/courses/105104102/

Course Code	**PE-MBT301G**					
Category	**Program Elective IV**					
Course Title	**Food Biotechnology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: II**
	3	**0**	**0**	**3**	**48**	
Pre-requisites	- **Microbiology**					

COURSE OBJECTIVE:

This course will provide a broad grounding in concepts, techniques and issues involved in food products and their processing.

COURSE OUTCOME (CO):

After completion of course, students would be able to:

1. Realize and identify the biotechnological techniques involved in the improvement of food qualities.
2. Understand the principles involving food preservation and processing.
3. Understand the principles that make a food product safe for consumption.
4. Demonstrate knowledge of major scientific concepts, social, economic and ethical implications in the food sciences.

COURSE CONTENT:

Module I: Food Microbiology - Metabolic Engineering of Bacteria for food ingredients, Metabolic engineering of *Saccharomyces cerevisae*. Probiotics, Encapsulation of probiotic bacteria, Single Cell Protein . Biotechnological Modifications of S. cerevisae and its effect in wine production, genetic Engineering of baker's yeast, Application of Algae in Food, Recombinant Lactic Acid Bacteria.

Module II: **Plant and Animal Food applications and functional food**- Introduction to Nutraceutical and Nutigenomics, Bioavailability and delivery of nutraceuticals using nanotechnology Food and food component preventing cancer, Antiobesity effect of Alleniccarotenoid, fucoxanthin, Improvement in Food Quality- Enzymes & Recombinant lipooxygenases and oxylipin metabolism for food quality, Molecular design of Soybean Protein for improvement in Food Quality, Biotechnological Approaches to improve Nutritional Quality and Shelf life of Fruits and Vegetables, Genetic Modification of peanut as a solution to peanut Allergy.

Module III: Food Safety- DNA & Protein microarray for food Safety, Application of DNA Fingerprinting in Food Biotechnology, Application of Biosensors in food processing industry, antibody based diagnostic system. Food quality management, HACCP.

Module IV: Food Preservation and Processing: Thermal processing of foods, canning operation. Heat transfer in food, microwave operation, Kinetics of chemical reactions in foods, Dehydration of foods, Mass transfer in dehydration, Drying rate curve, Psychrometry, Physical separation processes in foods – filtration operation, membrane filtration, Design of a food processing plant.

References:

1. Food Biotechnology: Kalidas Shetty
2. Fundamental of Food Biotechnology: Lee
3. Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals by Jean Richard Neeser, J. Bruce German, CRC Press.

OPEN ELECTIVES

Course Code	**OE-MBT301A**					
Category	**Open Electives**					
Course Title	**Business Analytics**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	3	**0**	**0**	**3**	**48**	

COURSE OBJECTIVE:

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc..

COURSE OUTCOMES:

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights.

COURSE CONTENT

MODULE I: 9L

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview. 9

MODULE II: 8L

Trendiness and Regression Analysis: Modeling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

MODULE III: 9L

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modeling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modeling, nonlinear Optimization.

MODULE IV: 10L

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

MODULE V: 8L

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making.

MODULE VI: 4L

Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

REFERENCE:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Course Code	OE-MBT301B					
Category	Open Electives					
Course Title	Operations Research					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: III
	3	0	0	3	48	

COURSE OUTCOMES:

At the end of the course, the student should be able to

1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

COURSE CONTENTS:

Module 1:

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Module 2:

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Module 3:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Module 4:

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Module 5:

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Course Code	OE-MBT301C					
Category	Open Electives					
Course Title	Cost Management of Engineering Projects					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: III
	3	0	0	3	48	

COURSE CONTENT:

Module-I:
Introduction and Overview of the Strategic Cost Management Process

Module-II:
Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Module-III:
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

Module-IV:
Cost Behaviour and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

Module-V:
Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Module-VI:
Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

References:
1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Course Code	OE-MBT301D					
Category	Open Electives					
Course Title	Industrial Safety					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: III
	3	0	0	3	48	

COURSE CONTENT:

MODULE-I:
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety colour codes. Fire prevention and fire fighting, equipment and methods.

MODULE-II:
Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

MODULE-III:
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

MODULE-IV:
Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

MODULE-V:
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

References:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Course Code	**OE-MBT301E**					
Category	**Open Electives**					
Course Title	**Composite Materials**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	3	**0**	**0**	**3**	**48**	

COURSE CONTENT:

MODULE-I:

Introduction: Definition – Classification and characteristics of Composite materials .Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

MODULE-II:

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers,Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements.Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

MODULE-III:

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hotisostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

MODULE-IV:

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs –hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

MODULE-V

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

References:

1. Material Science and Technology – Vol 13 – Composites by R.W. Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R.Balasubramaniam, JohnWiley & Sons, NY, Indian edition, 2007.

3. Hand Book of Composite Materials-ed-Lubin.
4. Composite Materials – K.K. Chawla.
5. Composite Materials Science and Applications – Deborah D.L. Chung.
6. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Course Code	**OE-MBT301F**					
Category	**Open Electives**					
Course Title	**Waste to Energy**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	3	**0**	**0**	**3**	**48**	

COURSE CONTENT:

MODULE-I:
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

MODULE-II:
Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases, yields and applications

MODULE-III:
Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

MODULE-IV:
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

MODULE-V:
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status – Bioenergy system - Design and constructional features - Biomass resources and their classification – Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification – pyrolysis and liquefaction - biochemical conversion - anaerobic digestion – Types of biogas Plants – Applications -Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion –Biomass energy programme in India.

References:
1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. Were Ko-Brobby and E. B. Hagan, John Wiley &Sons, 1996.

SESSIONAL

Subject Code : SE-MBT381	**Category :** Major Project
Subject Name : Dissertation-I (Progress)	**Semester** : III
L-T-P : **0-0-20**	**Credit:10**

A Project Dissertation would be of two-semester duration and one project would be allotted to one student. The Progress of project dissertation up to the end of the Third Semester would be evaluated by the concerned supervisor and a panel of examiners through a seminar presentation on the progress of dissertation followed by viva voce. The Progress of project dissertation up to the end of the Third Semester would be presented by the student concerned and viva voce will be conducted by a panel of examiners.

Quality of the project is measured in terms of

- Very clear and concise objectives
- Very clear methodology, articulated using technical terms indicating all steps and tools
- Cites substantial current and good quality literature
- Clarity in design/setting up of experiment.
- Benchmarks used / Assumptions made
- Interpretation of results and justification thereof and validity of the results presented.
- Overall presentation of the report

SESSIONAL

Subject Code : SE-MBT481	**Category :** Major Project
Subject Name : Dissertation-II (Completion)	**Semester** : IV
L-T-P : **0-0-32**	**Credit:16**

Total output of the project work would have to be submitted in form of a bound thesis containing literature review, objective, details of work done, conclusion, reference, etc. The evaluation of the thesis will be done by a panel of examiners.
Final presentation and viva voce of the project will be based on the project thesis submitted to be conducted by a panel of examiners.

Quality of the project is measured in terms of

- Very clear and concise objectives
- Very clear methodology, articulated using technical terms indicating all steps and tools
- Cites substantial current and good quality literature
- Clarity in design/setting up of experiment.
- Benchmarks used / Assumptions made
- Interpretation of results and justification thereof and validity of the results presented.
- Overall presentation of the report.