DEPARTMENT OF BIOTECHNOLOGY

REGULATIONS 2021

M. Tech. BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM

VISION AND MISSION OF THE DEPARTMENT

Vision of the Department

- To provide a world class department to facilitate learning, training and research in Biotechnology by providing infrastructural facilities and competent faculty leading to technological innovations to serve the global society.

Mission of the Department

- The Mission of the Department is to provide quality education to students and to produce competent Biotechnologists to meet the challenges faced by industry and mankind.
- To inculcate high moral, ethical & professional standards among our students.
- To develop overall personality of the students.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. To provide students with solid fundamentals and strong foundation in statistical, scientific and engineering subjects required to create and innovate in the field of biotechnology.
II. To train students with good scientific and technical knowledge so as to comprehend, analyze, design, and create novel products and solutions for developing novel therapeutics and enzymes.
III. To prepare students to excel and succeed in Biotechnology research or industry through the latest state-of-art post graduate education.
IV. To sensitize students about scientific temper and the necessity of bioethics, social responsibility and awareness of the environment.
V. This course enables the student to develop good communication and leadership skills, respect for authority, loyalty and the life-long learning needed for a successful scientific and professional career.

PROGRAMME OUTCOMES (POs):

On successful completion of the Masters in Biotechnology graduates will be able to

1. Acquire in depth knowledge of Biological science and Bioengineering for gaining ability to develop and evaluate new ideas
2. Demonstrate Scientific and technological skills to design and perform research through modern techniques for the development of high throughput process and products.
3. Analyze Biotechnological problems and formulate intellectual and innovative vistas for research and development.
4. Provide potential solutions for solving technological problems in various domains of Biotechnology considering the societal, public health, cultural environmental factors.
5. Examine the outcomes of Biotechnological issues critically and gain knowledge for composing suitable corrective measures.
6. Create and apply modern engineering tools for the prediction and modeling of complex bioengineering activities.
7. Possess self-management and team work skills towards collaborative, multidisciplinary scientific endeavors in order to achieve common goals.
8. Develop entrepreneurial and managerial skills for the implementation of multidisciplinary projects.
9. Demonstrate adherence to accepted standards of professional bioethics and social responsibilities.
10. Possess the attitude necessary for lifelong and acquire communication skills relevant to professional positions

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Our Biotech graduates shall possess strong knowledge in the field of biotechnology and applied sciences.
2. Our Biotech graduates shall be able to design and conduct experiments in biotechnology as well as analyze and interpret data.
3. Our Biotech graduates shall be able to use current techniques, skills and modern tools necessary for modelling and design of bioprocesses.

Mapping of Programme Educational Objectives (PEOs) with Programme Outcomes (POs)and Programme Specific Outcomes (PSOs)

PEOs	POs										PSOs		
	1	2	3	4	5	6	7	8	9	10	1	2	3
I	✓	✓		✓							✓	✓	✓
II			✓		✓	✓	✓				✓	✓	✓
III				✓	✓	✓	✓				✓	✓	✓
IV							✓	✓	✓		✓	✓	✓
V		✓	✓						✓	✓	✓	✓	✓

REGULATIONS 2021

I TO IV SEMESTERS CURRICULUM AND SYLLABUS (FULL TIME)

M.TECH. BIOTECHNOLOGY

SEMESTER I

S.No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	MA1155	Applied Statistical Techniques	4	0	0	4
2	BY1101	Advanced Genetic Engineering	3	0	0	3
3	BY1102	Enzyme Technology and Fermentation Technology	3	0	0	3
4	BY1103	Bioinformatics and Applications	3	0	0	3
5		Professional Elective 1	3	0	0	3
6		Professional Elective 2	3	0	0	3
7		Professional Elective 3	3	0	0	3
PRACTICAL						
8	BY1108	Preparative and Analytical Techniques in Biotechnology Lab	0	0	4	2
		TOTAL	**22**	**0**	**4**	**24**

SEMESTER II

S.No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	BY1201	Bioseparation Technology	3	0	0	3
2	BY1202	Bioprocess Engineering	3	0	0	3
3	BY1203	Bioreactor Design and Analysis	3	0	0	3
4	BY1204	Immunotechnology	3	0	0	3
5	BY1205	Advanced Genomics and Proteomics	3	0	0	3
6		Professional Elective 4	3	0	0	3
7		Professional Elective 5	3	0	0	3
PRACTICAL						
8	BY1208	Immunotechnology Lab	0	0	6	3
		TOTAL	**21**	**0**	**6**	**24**

SEMESTER III

S.No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1		Open Elective*	3	0	0	3
		Online Course*	0	0	0	
2		Audit Course**	2	0	0	0
PRACTICAL						
3	BY1308	Advanced Molecular Biology and Genetic Engineering Lab	0	0	6	3
4	BY1309	Bioprocess and Downstream Processing Lab	0	0	6	3
PROJECT						
5	BY1310	Project Phase – I	0	0	12	6
		TOTAL	**5**	**0**	**24**	**15**

*Any one, out of two can be opted

SEMESTER IV

S.No	COURSE CODE	COURSE TITLE	L	T	P	C
PROJECT						
1	BY1410	Project Phase – II	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

Total No. of Credits : 75

PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVES I

S.No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	BY1001	Molecular concepts in Biotechnology (For Engineering Stream)	3	0	0	3
2	BY1002	Principles of Chemical Engineering (For Science Stream)	3	0	0	3
3	BY1003	Metabolic Process and Engineering (For Biotechnology Stream)	3	0	0	3

PROFESSIONAL ELECTIVES II

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	BY1004	Animal Biotechnology	3	0	0	3
2	BY1005	Computer Aided Learning of Structure and Function of Proteins	2	2	0	3
3	BY1006	Analytical Techniques in Biotechnology	3	0	0	3
4	BY1007	Bio thermodynamics	3	0	0	3
5	BY1008	Plant Biotechnology	3	0	0	3

PROFESSIONAL ELECTIVES III

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	BY1009	Environmental Biotechnology	3	0	0	3
2	BY1010	Cancer Biology	3	0	0	3
3	BY1011	Technology Management	3	0	0	3
4	BY1012	Computational Fluid Dynamics	3	0	0	3
5	BY1013	Biotechnology in Food Processing	3	0	0	3

PROFESSIONAL ELECTIVES IV

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	BY1014	Bio nanotechnology	3	0	0	3
2	BY1015	Phytochemistry	3	0	0	3
3	BY1016	Advances in Molecular Pathogenesis	3	0	0	3
4	BY1017	Spectroscopy for Biotechnologists	3	0	0	3
5	BY1018	IPR and Bio safety	3	0	0	3

PROFESSIONAL ELECTIVES V

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	BY1019	Biopharmaceuticals and Bio similars	3	0	0	3
2	BY1020	Bioprocess Modelling and Simulation	3	0	0	3
3	BY1021	Tissue Engineering	3	0	0	3
4	BY1022	Research Methodology in Biotechnology	3	0	0	3
5	BY1023	Bio fuels and Platform Chemicals	3	0	0	3

OPEN ELECTIVES COURSES (OEC)

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	OCP101	Business Data Analytics	3	0	0	3
2	OMF101	Industrial Safety	3	0	0	3
3	OPE101	Renewable Sources of Electrical Energy	3	0	0	3
4	OMB103	Cost Management of Engineering Projects	3	0	0	3
5	OMF102	Composite Materials	3	0	0	3
6	OCH105	Waste to Energy	3	0	0	3

*(Out of six Courses, one Course must be selected)

AUDIT COURSES (AC)

S.No.	COURSE CODE	COURSE TITLE		L	T	P	C
THEORY							
1	AX1001	English for Research Paper Writing		2	0	0	0
2	AX1002	Disaster Management		2	0	0	0
3	AX1003	Value Education		2	0	0	0
4	AX1004	Constitution of India		2	0	0	0
5	AX1005	Pedagogy Studies		2	0	0	0
6	AX1006	Stress Management by Yoga		2	0	0	0
7	AX1007	Personality Development Through Life Enlightenment Skills		2	0	0	0
8	AX1008	Unnat Bharat Abhiyan		2	0	0	0

Registration for any of these courses is optional to students

SUBJECT AREA WISE DETAILS

FOUNDATION COURSE (FC)

S.No	COURSE CODE	COURSE TITLE	L	T	P	C
1	MA1155	Applied Statistical Techniques	3	2	0	4

PROFESSIONAL CORE (PC)

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C
1	BY1101	Advanced Genetic Engineering	3	0	0	3
2	BY1102	Enzyme Technology and Fermentation Technology	3	0	0	3
3	BY1103	Bioinformatics and Applications	3	0	0	3
4	BY1201	Bioseparation Technology	3	0	0	3
5	BY1202	Bioprocess Engineering	3	0	0	3
6	BY1203	Bioreactor Design and Analysis	3	0	0	3
7	BY1204	Immunotechnology	3	0	0	3
8	BY1205	Advanced Genomics and Proteomics	3	0	0	3
9	BY1108	Preparative and Analytical Techniques in Biotechnology Lab	0	0	4	2
10	BY1208	Immunotechnology Lab	0	0	6	3
11	BY1308	Advanced Molecular Biology and Genetic Engineering Lab	0	0	6	3
12	BY1309	Bioprocess and Downstream processing Lab	0	0	6	3

EMPLOYABILITY ENHANCEMENT COURSE (EEC)

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C
1	BY1310	Project Phase – I	0	0	12	6
2	BY1410	Project Phase – II	0	0	24	12

SUMMARY OF CREDITS

S. No.	SUBJECT AREA	CREDITS PER SEMESTER				TOTAL CREDITS
		I	II	III	IV	
1	**FC**	4	-	-	-	04
2	**PC**	11	18	6	-	35
3	**PE**	9	6	-	-	15
4	**OE**	-	-	3	-	03
5	**AC**	-	-	-	-	-
6	**EEC**	-	-	6	12	18
Total		**24**	**24**	**15**	**12**	**75**

SEMESTER I

MA1155	APPLIED STATISTICAL TECHNIQUES	L	P	T	C
		4	0	0	4

OBJECTIVES

- This course is designed to provide a solid foundation on topics in statistics that can be useful for the biotechnologists to conduct research on different types of data arising in public health and clinical studies. It is framed to address the issues in biotechnology using the concepts on probability, regression, sampling, testing of hypothesis and design an analysis of experiments.

UNITI RANDOM VARIABLE AND PROBABILITY DISTRIBUTION 12

Discrete random variable– Probability mass function–Properties– Continuous random variable – Probability density function – Properties – Moments : Mean and variance with properties– Special distributions: Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, and Normal–Properties-Simple roblems. **CO1**

UNITII JOINT PROBABILITY DISTRIBUTION 12

Bivariate distribution- conditional and marginal distribution - Correlation coefficient, properties-problems- Regression equations-problems-curve fitting by the method of least squares - fitting curves oftheformax+b,ax^2+bx+c,ab^xandax^b **CO2**

UNIT III TESTING OF HYPOTHESIS 12

Sampling distributions – Type I and Type II errors – Tests based on Normal, t,χ^2 and F-distributions for testing of mean, difference between two means, proportion, difference between two proportions, variance, ratio of two variances – Independence of attributes(rxc contingency table)-Goodness of fit. **CO3**

UNITIV NON-PARAMETRIC STATISTICS 12

One sample sign test–Sign test for paired samples–Signed rank test–Rank sum test: The U-test–Rank-sum test: The H-test– Test based on runs. **CO4**

UNITV DESIGN OF EXPERIMENTS 12

Basic principles of experimentation - Analysis of variance - one-way, Two-way classifications - Randomized block design, Latin square design - problems. **CO5**

TOTAL: 60 PERIODS

REFERENCE BOOKS

1. Devore, J.L., “Probability and Statistics for Engineering and Sciences”, 8th Edition, Cengage Learning Pvt. Ltd., New Delhi, 2014.
2. Freund, J.E., “Mathematical Statistics”, 5th Edition, Prentice Hall of India, 2001.
3. Gupta, S.C. and Kapoor, V. K, “Fundamentals of Mathematical Statistics”, Sultan Chand and Sons, 14th Edition, 2016.

4. Johnson, R.A and Gupta C. B., “Miller and Freund’s Probability and Statistics for Engineers”, Pearson Education Int., Asia, 8th Edition, 2011.
5. Libschutz, S. “Probability and Statistics”, 4th Edition, McGraw Hill, New Delhi, 2010.
6. Miller, I. and Miller, “Mathematical Statistics”, 7th Edition, Pearson Education Inc. (10th impression), 2012.
7. Dr.S.P.Gupta., “ Statistical Methods”,46th Edition”, Sultan Chand and Sons,2021.

COURSEOUTCOMES

Upon completion of the course, students will be able to

CO1 Understand the fundamental concepts of probability and gain knowledge on standard distributions which can describe real life phenomenon.

CO2 Understand the basic concepts of one and two dimensional random variables, curve fitting and apply the techniques in research and on different types of data analysis.

CO3 Apply the concept of testing of hypothesis for small and large samples in real life problems

CO4 Understand the need of non parametric methods and to apply in data analysis without any assumptions about specific population.

CO5 Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	1	2	1	-	-	3	2	3
CO2	3	2	2	3	2	-	2	-	-	-	3	2	3
CO3	3	2	2	3	3	1	2	-	-	-	3	3	3
CO4	2	2	1	3	3	2	2	-	-	-	3	3	2
CO5	2	2	2	3	3	-	2	1	-	-	3	3	3

BY1101 ADVANCED GENETIC ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the gene cloning methods, tools and techniques involved in genecloning, genome analysis and genomics.
- To explain the heterologous expression of cloned genes in different hosts, production of recombinant proteins and PCR techniques.
- To understand comparative genomics and proteomics.

UNIT I: CLONING WITH SPECIALIST-PURPOSE VECTORS 9

M13 based vectors, production of RNA probes and interfering RNA - controllable promoters for maximal expression of cloned gene – λPL, trc, T7 and pBAD - factors affecting the expression of cloned genes - purification tags for purification of cloned gene product – vectors for solubilization of expressed proteins

- gateway system of transferring DNA fragments to vectors.

UNIT II: cDNA LIBRARY CONSTRUCTION 9

OligodT priming, self priming and its limitations. Full length cDNA cloning – CAPture method and Oligo capping. Screening strategies – Hybridization, PCR, Immunoscreening, South-western and North-Western. Functional cloning – Functional complementation and gain of function. Difference cloning: Differential screening, Subtracted DNA library, differential display by PCR.

UNIT III: MUTAGENESIS AND ALTERED PROTEIN SYNTHESIS 9

Random mutagenesis - Error-prone PCR, Rolling circle error-prone PCR, use of mutator strains, temporary mutator strains, Insertion mutagenesis, ethyl methanesulfonate, DNA Shuffling, signature tagged mutagenesis and transposon mutagenesis. Incorporation of unnatural amino acids into proteins – Phage and cell-surface display for selection of mutant peptides.

UNIT IV: GENOME ENGINEERING 9

DNA damage – sources and types - DNA double stranded break repair mechanisms - Engineered nucleases in genome engineering - meganucleases, ZFNs, TALEN and CRISPR-Cas system – Mechanisms and applications – Benefits of genome engineering – targeted gene mutation, creating chromosome rearrangement, studying gene function with stem cells, transgenic animals, endogenous gene labelling and targeted transgene addition – genome engineering -prospects and limitations.

UNIT V: GENETIC MANIPULATION OF CELLS AND ANIMALS 9

Overview - principle of gene transfer - methods of gene transfer to animal cell culture - selectable markers for animal cells - Isolation and manipulation of mammalian embryonic stem cells - Using gene transfer to study gene expression and function - creating disease models using gene transfer and gene targeting technology - potential of animal for modelling human disease.

TOTAL PERIODS: 45

TEXT BOOKS:

1.Primrose, S.B., and Twyman., “Principles of Gene Manipulation and Genomics”, 7th Edition,Blackwell Science, 2006.

REFERENCES:

1. Benjamin Lewin, “Gene IX”, Oxford University Press, Cambridge, U.K. 2011.
2. Brown, T.A., “Gene cloning and DNA analysis: An introduction”, 6th Edition, Wiley-Blackwell, 2010.
3. Glick, B.R. and Pasternak J.J., “Molecular Biotechnology: Principles and Applications of Recombinant DNA”, 3rd Edition, ASM Press, 2003.
4. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vol 1-3, CSHL,2001.
5. Winnacker, E.L., “Frome Genes to Clones: Introduction to Gene Technology”, Wiley-Blackwell, 2006.
6. Yamamoto, Takashi (Ed.). “Targeted Genome Editing Using Site-Specific Nucleases”,Springer, Japan, 2015.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Cloning, expression and purification of commercially important genes.

CO2 Library creation and screening techniques involved for recombinant clones

CO3 Mutagenesis and importance of creating altered protein synthesis

CO4 Application of Engineered nucleases in genome engineering

CO5 Gene transfer principles and methods adapted for animal cell culture inorder to create disease models.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	1	1	3	1	-	-	3	-	2	2	3
CO2	3	3	1	1	2	-	-	-	1	-	2	2	2
CO3	3	2	3	1	2	-	-	-	3	-	3	2	2
CO4	0	2	2	1	1	3	-	-	-	-	3	1	2
CO5	3	2	3	1	2	-	-	-	3	-	3	2	2

BY1102 ENZYME TECHNOLOGY & FERMENTATION TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

The course will enable the students

- To gain advanced knowledge about the sterilisation methods, media formulation and use of fermentation processes.
- To have knowledge on operational modes of reactors and selection of process for enzyme production and about immobilisation of enzymes and their applicatons.
- To acquire knowledge involved in the isolation, processing, production and purification of enzymes, organic acids, alcohols and secondary metabolites.
- To understand the theoritical and practical aspects of kinetics and its applicability in research.
- To study the importance of enzymes and its applications in various fields food, pharma and chemical industries etc including research.

UNIT - I FUNDAMENTALS OF FERMENTATION 9

Overview of fermentation – Microbial biomass – Microbial Enzymes – Microbial Metabolites – Types of fermentation – Media for industrial fermentations — Medium sterilization—Development of inoculum for industrial fermentation -Medium optimization – Oxygen requirements of industrial fermentation – Mass transfer in fermentation – Determination of KLa values – Factors affecting KLavalues in fermentation.

UNIT - II INDUSTRIAL FERMENTATION PROCESSES 9

Aerobic and anaerobic fermentations – Batch culture, continuous culture, fed batch culture –Comparison of batch and continuous culture – Submerged and solid state fermentation for the production of enzymes – Immobilization of enzymes and techniques for enzyme immobilization –Biocatalysis in organic media using enzymes – Biotransformation with crude enzymes and whole cells.

UNIT - III PRODUCTION OF ENZYMES AND METABOLITES 9

Production of Proteases, Cellulases, Lipase, Amylase, Glucose isomerase, Pectinase, Peroxidase, Production of primary metabolites– organic acids (Citric acid, Lactic acid), amino acids (Glutamic acid, Lysine),alcohols (ethanol, butanol). Production of secondary metabolites – aminoacids, (Glutamic acid, Lysine), antibiotics (Penicillin, streptomycin), Vitamins (Vitamin B12, Riboflavin).

UNIT - IV ENZYME KINETICS 9

Overview of enzyme and its action – Time course of enzymatic reactions – Effects of substrate concentration on velocity – Rapid equilibrium model of enzyme kinetics – Steady state model of enzyme kinetics – Significance of *kcat*and *Km* – Experimental Measurement of *kcat*and *Km* – Linear transformations of enzyme kinetic data – Bi Bi reaction mechanisms – Modes of reversible inhibition- Allosteric regulation of enzymes.

UNIT V APPLICATIONS OF ENZYMES 9

Enzymes in organic synthesis – Enzymes as biosensors – Enzymes for food, pharmaceutical, tannery, textile, paper and pulp industries – Enzyme for environmental applications- Enzymes for analytical and diagnostic applications – Enzymes for molecular biology research.

TOTAL PERIODS: 45

TEXT BOOKS:

1. Palmer, T., Bonner, P., “Enzymes Biochemistry, Biotechnology, Clinical chemistry”, 2nd edition, WoodHead Publishing, 2007.
2. Peter Stanbury, Allan Whitaker, Stephen Hall., "Principles of Fermentation Technology", 3rd edition, Elsevier, 2016
3. McNeil, B., Harvey, L., “Practical Fermentation Technology”, John Wiley & Sons, 2008.
4. Buchholz, K., Kasche, V. and Bornscheuer, U., “Biocatalysts and Enzyme Technology”, Completely revised and enlarged edition, WILEY–VCH, 2012.

REFERENCES:

1. Mansi, E.M.T.EL., Bryce, C.F.A., Dahhou, B., Sanchez, S., Demain, A.L. and Allman, A.R., “Fermentation Microbiology and Biotechnology”, 3rd Edition, Taylor and Francis, 2012.
2. Copeland, R. A., “Enzymes- A Practical Introduction to Structure, Mechanism and data analyses” 2nd Edition, WILEY–VCH, 2012.

COURSE OUTCOMES

Upon completion of the course, the students will be able

CO1 To design media and choose a suitable fermentation process for the production of a bio product.

CO2 To select an immobilisation method and explore the possibility of choice of a bioreactor for the production of enzyme.

CO3 To apply the various steps involved in the isolation, processing, production and purification of enzymes, organic acids, alcohols and secondary metabolites.

CO4 To apply the knowledge gained on the theoretical and practical aspects of kinetics for the economical production of the enzyme.

CO5 To understand the importance of enzymes and its applications in various fields like including research.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	1	1	1	-	-	-	1	1	2	1
CO2	1	3	2	1	2	2	1	1	1	2	1	3	2
CO3	-	3	3	2	2	3	1	1	1	2	1	2	2
CO4	1	2	2	2	1	3	1	-	1	1	1	2	2
CO5	1	1	2	2	1	-	1	-	2	1	-	1	3

BY1103 BIOINFORMATICS AND APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To improve the programming skills of the student in the field of Biological research
- To let the students know the recent evolution in biological databank usage
- To train the students to analyse the genome of an organism
- To equip the students in protein modelling and visualization
- To familiarise the students in the drug designing domain using in-silico tools

UNIT I: LINUX OS AND PERL **9+3**

Introduction to Operating systems, Linux commands, File transfer protocols ftp and telnet, Introduction to Bioinformatics and Computational Biology, Programming in PERL: Name conventions – Variables – Operators – Functions – Control structures – File input and output.

UNIT II: BIOLOGICAL SEQUENCES AND DATABANKS 9+3

Introduction to Biological sequences and methods of sequencing, Biological databases: Primary, Secondary and Composite databanks - Scoring matrices: PAM, BLOSUM - Data lifecycle.

UNIT III: SEQUENCE ANALYSIS 9+3

Pairwise Sequence alignment: Dynamic Programming Algorithms, Needleman-Wunch Algorithm, Smith-Waterman Algorithm, FASTA, BLAST – Multiple sequence alignment: Progressive methods, Iterative methods, Applications – Motif representation- PSSM - Gene finding-Artificial Neural Network – Hidden Markov Model

UNIT IV: DATA ANALYSIS AND PHYLOGENETIC METHODS 9+3

Analysis of gene expression, Analysis of mutations in cancer using High-throughput techniques - Microarray analysis, High volume scatter plots and Heat maps. Structural genomics - Plotting along genomic coordinates and Mapping analysis. Introduction to phylogenetics - Distance based and character based trees, tree evaluation.

UNIT V: PROTEIN STRUCTURE ANALYSIS AND DRUG DESIGNING 9+3

Protein structure prediction methods - Homology modeling, abinitio approaches. Protein structure visualization: Pymol, Rasmol. Threading, Critical Assessment of Structure Prediction and RNA structure prediction. Introduction to Systems Biology and Synthetic Biology, DNA computing, Bioinformatics approaches for drug discovery- Rosetta, protein-ligand docking – QSAR analysis, protein-protein interaction, Peptide mass fingerprinting.

TOTAL PERIODS: 60

TEXT BOOKS:

1. Introduction to Bioinformatics by Arthur K. Lesk , Oxford University Press.
2. Algorithms on Strings, Trees and Sequences by DanGusfield, Cambridge University Press.
3. Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by R.Durbin, S.Eddy, A.Krogh, G.Mitchison.
4. Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press.
5. Beginning Perl for Bioinformatics: An introduction to Perl for Biologists by James Tindall, O'Reilley Media

REFERENCES:

1. 1. Baldi, P. and Brunak, S., "Bioinformatics: The Machine Learning Approach" 2nd Edition, MIT Press, 2001.
2. Gentleman, R., "Bioinformatics and Computational Biology Solutions using R and Bioconductor", Springer Science and Business media Inc., 2005.
3. Lesk, A. K., "Introduction to Bioinformatics", 4th Edition, Oxford University Press, 2013 13
4. Liebler, "Introduction to Proteomics" Humana Press, 2002.
5. Mount, D.W., "Bioinformatics Sequence and Genome Analysis" 2nd Edition, Cold Spring Harbor Laboratory Press, 2004
6. Rastogi, S.C., "Bioinformatics Concepts, Skills & Applications", 2nd Edition, CBS Publishers, 2009.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Understand the fundamentals of operating system and gain knowledge in programming language and to develop bioinformatics related tools with programming skils.

CO2 Gain knowledge about the biological sequences and sequence databases.

CO3 Understand the sequence alignment programs and its importance in Bioinformatics.

CO4 Modelling the structure of proteins.

CO5 Screen drug likeliness of molecules using in-silico techniques.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	3	2	2	1	1	2	2	2
CO2	3	3	2	2	2	1	1	1	2	1	2	2	2
CO3	2	1	2	1	2	2	1	2	2	2	2	2	2
CO4	2	2	2	3	3	2	2	2	2	2	2	3	2
CO5	3	3	2	2	3	3	2	2	2	2	3	3	3

BY1108 PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

L	T	P	C
0	0	4	2

OBJECTIVES:

· To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules and laboratory analysis of the same in the body fluids
· To have a practical hands on experience on Absorption Spectroscopic methods and to validate spectrometric and microscopic techniques
· To acquire experience in the purification by performing chromatography
· To design processes for the recovery and subsequent purification of target biological products.

LIST OF EXPERIMENTS

1. Estimation of amino acids by ninhydrin method
2. Estimation of total sugars by phenol sulphuric acid method
3. Estimations of carbohydrates – reducing vs non-reducing, polymeric vs oligomeric, hexose vs pentose.
4. Estimation of protein concentration using Lowry's and Bradford method.
5. DNA determination by UV-visible spectrophotometer – hyperchromic effect.
6. Separation of amino acids and lipids by TLC.
7. Enzyme kinetics: Determination of Km, Vmax and Kcat, Kcat/ Km.
8. Restriction enzyme – Enrichment and unit calculation.

9. Ion-exchange chromatography – Purification of IgG and Albumin.
10. Gel filtration – Size based separation of proteins.
11. Affinity chromatography – IMAC purification of His-tagged recombinant protein.
12. Extraction and characterization of photochemical using UV-visible spectrophotometer.
13. Separation of compounds using Column chromatography.

Requirements:

UV-visible spectrophotometer, Hot air oven, Incubator, Chromatography column, required glasswares, chemicals & kits

TOTAL PERIODS: 60

REFERENCES:

1. Pingoud, A., Urbanke, C., Hoggett, J. and Jeltsch, A., "Biochemical Methods: A ConciseGuide for Students and Researchers", Wiley-VCH, 2002.
2. Segel, I.H., "Biochemical Calculations: How to Solve Mathematical Problems in GeneralBiochemistry", 2nd Edition, John Wiley & Sons, 2004.
3. Wilson, K. and Walker, J., "Principles and Techniques of Biochemistry and MolecularBiology", 7th Edition, Cambridge University Press, 2010.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules and laboratory analysis of the same in the body fluids.

CO2 To have a practical hands on experience on Absorption Spectroscopic methods and to validate spectrometric and microscopic techniques.

CO3 To acquire experience in the purification by performing chromatography.

CO4 To have hands-on experience on the study of enzyme kinetics.

CO5 To design processes for the recovery and subsequent purification of target biological. products.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	-	1	-	-	1	-	-	-	1	1	2	1	1
CO2	1	2	-	-	1	-	-	-	1	1	2	2	1
CO3	1	2	1	2	2	-	-	-	1	1	2	2	2
CO4	1	2	-	1	1	-	-	-	1	1	2	2	1
CO5	1	2	1	2	2	-	-	-	1	1	2	2	2

SEMESTER II

BY1201	BIOSEPARATION TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

To enable the students to

- Understand the methods to obtain pure proteins, enzymes and bioproducts in general.
- Have depth knowledge on downstream processes required in multi-factorial manufacturing environment in a structured and logical fashion.

UNIT I: DOWNSTREAM PROCESSING IN BIOTECHNOLOGY 9

Role and importance of downstream processing in biotechnological processes – Problems and requirements of bioproduct purification – Economics of downstream processing in Biotechnology, cost-cutting strategies – Separation characteristics of proteins and enzymes – size, stability, properties – Flocculation and conditioning of broth – Process design criteria for various classes of bioproducts (high volume, low value products and low volume, high value products) – Upstream production methods affect downstream purification strategies. Purification of inclusion bodies.

UNIT II: PHYSICO-CHEMICAL BASIS OF BIO-SEPARATION PROCESSES 9

Cell disruption methods for intracellular products – Physical, chemical, mechanical – Removal of insoluble, biomass and particulate debris separation techniques – Filtration at constant pressure and at constant rate – Empirical equations for batch and continuous filtration – Types of filtration - Centrifugal and cross – flow filtration – Types of filtration equipments – Centrifugation – Basic principles, design characteristics – Types of centrifuges and applications.

UNIT III: MEMBRANE SEPARATIONS AND ENRICHMENT OPERATIONS 9

Theory, Design consideration and configuration of membrane separation processes – Types membrane separation processes - Reverse osmosis, microfiltration, ultrafiltration, dialysis – Membrane modules – Enrichment Operations – Extraction–equipment for extraction – Aqueous two-phase extraction process –Adsorption isotherms and techniques – Protein precipitation – Methods of precipitation.

UNIT IV: MECHANISM AND MODES OF CHROMATOGRAPHIC SEPARATION 9

Chromatography – Classification of chromatographic techniques – General description of column chromatography – Chromatographic terms and parameters – Practice of chromatography – adsorption, Partition, normal-phase, reversed-phase, size exclusion, ion exchange, hydrophobic, affinity chromatography – Scale-up of chromatography.

UNIT V: FINISHING OPERATIONS AND FORMULATIONS 9

Drying – Mechanism, methods and applications, Types of dryers – Tray, spray, rotary, belt – Crystallization – Nucleation , growth – Types of crystallizers – Tank, Oslo, Circulating-magma evaporator – Freeze drying – Principle, process, applications – Case studies - Purification of Citric acid, Penicillin, Cephalosporin, Recombinant Streptokinase, and Interferon.

TOTAL PERIODS: 60PERIODS

TEXT BOOKS:

1. Belter, P.A., E.L. Cussler and Wei-Houhu “Bioseparations – Downstream Processing for Biotechnology”, John Wiley, 1988.
2. Sivasankar, B. “Bioseparations: Principles and Techniques”. PHI, 2005.
3. Asenjo, Juan A. “Separation Processes in Biotechnology”. CRC / Taylor & Francis, 1990.

REFERENCE BOOKS:

1. Forciniti, D., “Industrial Bioseparation: Principles & Practice”, Blackwell, 2008.
2. Ghosh, R., “Principles of Bioseparations Engineering”, World Scientific Publishers, 2006.
3. Ladisch, M.R., “Bioseparations Engineering: Principles, Practice, and Economics”, John Wiley & Sons, 2001.4. Roger, H., “Bioseparations Science and Engineering”, Oxford University Press, 2006.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1	The product recovery, unit operations involved and factors affecting bioseparation of bioproducts and recombinant products.
CO2	Selection and design of cell disruption methods, filtration and centrifugation operation for bioseparation.
CO3	To identify a suitable unit operation for isolation and concentration for the given bioproduct.
CO4	To select a suitable chromatographic operation for purification of given bioproducts.
CO5	Design various bioproducts polishing methods and purification of various bioproducts/recombinant products.

COs	**PROGRAM OUTCOMES(POs)**										**PROGRAMSPECIFIC OUCOMES**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	3	2	1	2	1	-	-	2	2	3
CO2	3	2	2	3	2	-	2	-	-	-	2	2	3
CO3	3	2	2	3	3	1	2	-	-	-	2	2	3
CO4	2	2	1	3	3	2	2	-	-	-	3	2	3
CO5	2	2	2	3	3	-	2	1	-	-	3	2	3

BY1202	**BIOPROCESS ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To impart knowledge on design and operation of fermentation processes with all its prerequisites
- To endow the students with the basics of microbial kinetics, metabolic stoichiometry and energetics
- To develop bioengineering skills for the production of biochemical products using integrated biochemical processes.

UNIT I: METABOLIC STOICHIOMETRY AND ENERGETICS 9

Outline of Stoichiometry and energetics – Growth yields, Growth yields based on total energy andATP generation – Conservation of mass principles - Carbon and oxygen balances, ATP generation during growth – Relationship between substrate consumption, growth, respiration and noncellular products – Growth energetics of aerobic and anaerobic process – Case studies on mass and energy balance for Embden–Meyerhoff–Parnas pathway, continuous ethanol fermentation,penicillin production.

UNIT II: MICROBIAL GROWTH, KINETICS, MAINTENANCE AND PRODUCT FORMATION 9

Establishment of growth kinetic equations for batch, fed batch and continuous culture – Basic unstructured kinetic models of growth and product substrate utilization – Negative biokinetic rates– Multisubstrate kinetics – Mixed population kinetics - Kinetic models for microbial product formation - Kinetic model equations for inhibition by substrates and products.

UNIT III: STRUCTURED MODELS 9

Structured models for growth and product formation – Compartmental and metabolic models – Mechanistic models - Product formation kinetics – Gaden's and Deindoerfer's classifications – Chemically and genetically structured models – Kinetics models of heterogeneous bioprocesses – Biofilm kinetics, Unstructured models of pellet growth – Considerations for the production of r-DNA products.

UNIT IV: MASS TRANSFER IN BIOLOGICAL SYSTEMS 9

Interphase Gas-Liquid mass transfer – General oxygen balances for Gas-Liquid transfer – Models for oxygen transfer in large scale bioreactors – Case studies for large scale bioreactors – Model for oxygen gradients in a bubble column bioreactor, air lift bioreactor – Model for a multiple impeller fermenter – Gas-liquid mass transfer of components other than oxygen.

UNIT V: 9

DIFFUSION AND BIOLOGICAL REACTION IN IMMOBILIZED BIOCATALYST

External mass transfer – Internal diffusion and reaction within biocatalysts – Derivation of finite difference model for diffusion – Reaction systems – Dimensionless parameters from diffusion – Reaction models – Effectiveness factor concept – Case study for diffusion with biological reaction– Estimation of oxygen diffusion effects in a biofilm.

TOTAL PERIODS: 45

TEXT BOOKS:

1. Moser, Anton., "Bioprocess technology: kinetics and reactors", Springer Science & BusinessMedia, 2012.

REFERENCES:

1. Blakebrough, N., T. K. Ghose, and A. Fiechter, eds. “Advances in biochemical engineering”.Springer-Verlag, volume 3, 2013.
2. Dunn, I.J., Heinzle, E., Ingham, J. and Prenosil, J.E., “Biological Reaction Engineering:Dynamic Modelling Fundamentals with simulation examples”, 3rd Revised Edition, WILEYVCHpublications, 2016.
3. Najafpour, G.D., “Biochemical Engineering & Biotechnology”, 2 nd Edition, Elsevier, 2015.
4. Truskey, G.A., Yuan, F. and Katz, D.F., “Transport Phenomena in Biological Systems”,Pearson Prentice Hall, 2007.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 The principles behind the metabolic stoichiometry and its importance in the designing of engineered microorganisms.

CO2 The kinetics of living cells and to develop a strategy to solve the issues emerging during fermentation processes.

CO3 The develop new biochemical models in optimizing the production of biochemical products

CO4 The models derived for external factors supporting fermentation process (Mass transfer - internal & external)

CO5 The engineering principles to systems containing biological catalysts to meet the needs of the society.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	-	-	-	-	3	3	3
CO2	3	3	2	2	2	1	-	-	-	-	3	3	3
CO3	3	3	2	2	3	1	-	-	-	-	3	3	3
CO4	3	3	3	2	3	1	-	-	-	-	3	3	3
CO5	3	3	3	2	3	1	-	-	-	-	3	3	3

BY1203 BIOREACTOR DESIGN & ANALYSIS L T P C

3 0 0 3

OBJECTIVES:

The course will enable the students

- To understand and develop mathematical models for batch, fedbatch and Continuous reactors.
- To apply the transport phenomena principles to bioreactoR
- To frame the requirements for the design of a reactor.
- To apply the sterilisation principles, the techniques in scale up and scale down of a process.
- To understand the importance of instrumentation, measure and control of process variables involved in the process.

UNIT - I BASIC BIOREACTOR CONCEPTS 12

Bioreactor Operation – Batch operation, semi-continuous and fed-batch operation, Continuous Operation – Chemostat, turbidostat – Microbiological reactors, enzyme reactors – Tank-type, Column-type biological reactors – Case studies – Continuous Fermentation with Biomass Recycle, residence time distribution, Tanks-in-series, Tubular plug flow bioreactors.

UNIT - II AERATION & AGITATION IN BIOPROCESS SYSTEMS 12

Mass transfer in agitated tanks – Effect of agitation on dissolved oxygen - Correlations with kLa in Newtonian and non Newtonian liquid – Power number, Power requirement for mixing in aerated and non aerated tanks for Newtonian and non Newtonian liquids – Agitation rate studies - Mixing time in agitated reactor,– Shear damage, bubble damage, Methods of minimizing cell damage – Laminar and Turbulent flow in stirred tank bioreactors.

UNIT - III SELECTION & DESIGN OF BIOPROCESS EQUIPMENT 12

Materials of construction for bioprocess plants – Design considerations for maintaining sterility of process streams processing equipments, selection, specification – Design of heat and mass transfer equipment used in bioprocess industries – Requirements, design and operation of bioreactor for microbial, plant cell and animal cell.

UNIT - IV SCALE UP AND SCALE DOWN ISSUES 12

Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development,nutrient availability and supply – Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer co-efficients – Scale up of downstream processes – Adsorption (LUB method), Chromatography (constant resolution etc.), Filtration (constant resistance etc.), Centrifugation (equivalent times etc.), Extractors (geometry based rules) – Scale–down related aspects.

UNIT V BIOREACTOR INSTRUMENTATION AND CONTROL 12

Bioreactor controlling probes – Characteristics of bioreactor sensors - Methods of measuring process variables –Temperature – Flow measurement and control – Pressure measurement and control – Agitation – shaft power, rate of stirring – Detection and prevention of foam –
Measurement of Microbial biomass – Measurement and control of Dissolved oxygen – Inlet and outlet gas analysis – pH measurement and control - Biosensors.

TOTAL PERIODS: 60

TEXT BOOKS:

1. Mann, U., “Principles of Chemical Reactors Analysis & Design: New tools for Industrial Chemical Reactor Operations”, Willey–VCH, 2009.
2. Mansi, E.M.T.EL., Bryce, C.F.A., Demain, A.L. and Allman, A.R., “Fermentation Microbiology and Biotechnology”, 3 rd edition Taylor and Francis, 2012.

REFERENCES:

1. Impre, J.F.M.V., Vanrolleghem, P.A. and Iserentant, D.M., “Advanced Instrumentation, Data Interpretation and Control of Biotechnological Processes”, Kluwer Academic Publishers, 2010.
2. Towler, G. and Sinnott, R., “Chemical Engineering Design: Principles, Practice, Economics of Plant and Process Design”, 2 nd edition, Butterworth – Heinemann ltd., Elsevier, 2012.

COURSE OUTCOMES

Upon completion of the course, the students will be able

CO1 To select appropriate bioreactor configuration and operation mode based on the nature of bioproduct and cell lines and other process criteria.

CO2 To apply the knowledge of transport phenomena in the design of reactors.

CO3 To frame the requirements for the design of a reactor.

CO4 To analyse the techniques involved in the scale up and scale down of a process.

CO5 Integrate research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	2	-	1	-	-	3	2	2
CO2	2	2	1	-	1	1	1	-	-	-	2	3	2
CO3	3	2	2	1	1	1	1	-	-	-	3	2	2
CO4	1	2	1	-	-	-	1	-	-	1	1	2	2
CO5	2	2	2	1	-	1	1	1	-	1	2	2	2

BY1204 IMMUNOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To understand the structure, functions and integration of immune system.
- To explain the antigen-antibody interactions that offers defence mechanism
- To explain various techniques of therapeutically significant monoclonal and engineered antibodies production

UNIT I: IMMUNE SYSTEM AND ITS RESPONSE 9

Cells of the immune system and their development – Primary and secondary lymphoid organs – Humoral immune response – Cell mediated immune responses – T lymphocyte and B lymphocyteTolerance – Homeostasis in immune system – Complement.

UNIT II: ANTIGEN AND ANTIBODY 9

Production of antibodies – Polyclonal, monoclonal – Hybridoma technology – Antibody – Isolationand identification – Validation and their use – Agglutination and precipitation tests – Coomb's test– ELISA types – ELISPOT– Plaque forming cell assay, Epitope mapping, Antigen detection assay,SDS-PAGE-immunoblotting and immunoprecipitation – Immunofluorescence andimmunohistochemistry – Measurement of Ag-Ab interaction.

UNIT III: CELLULAR IMMUNOLOGICAL TECHNIQUES 9

PBMC separation from the blood – Ficoll-hypaque method – Identification of lymphocytes basedon CD markers – FACS – Lymphoproliferation assay – Cr5I release assay – Macrophage culturesdetection assays – Rosette assay – Cytokine bioassays: IL2, IFNγ, TNFα – Mixed lymphocytereaction – HLA typing.

UNIT IV: VACCINE TECHNOLOGY 9

Principles in vaccine development – Adjuvant, Immunization (Active and Passive immunization) – Vaccine validation – Protein based vaccines – DNA vaccines – Plant based vaccines – Ediblevaccine – Recombinant antigens as vaccines – Multivalent subunit vaccine – Reverse vaccinology– New Types of Replicating vaccines.

UNIT V: IMMUNOTHERAPEUTICS 9

Engineered antibodies – Catalytic antibodies, idiotypic antibodies, plantibodies – Combinatoriallibraries for antibody isolation. Cancer immunotheraphy and Immunosuprressive therapy –Cytokine therapy – Immunoglobulin therapy: Replacement and immunomodulators – Genetransfer techniques for immunological diseases.

TOTAL PERIODS: 45

REFERENCE:

1. Emily P. Wen, Ronald Ellis and Narahari S. Pujar, "Vaccine Development andManufacturing" Wiley, 1st Edition, 2014.
2. Gerd-Rudiger Burmester, Antonio Pezzutto and Jurgen Wirth, "Color Atlas of Immunology",Thieme Medical Publishers, 1st Edition, 2003.
3. Judith A. Owen, Jenni Punt and Sharon Stranford, "Kuby Immunology", W.H. Freeman andCompany, 7th Edition, 2013.
4. Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt, "Roitt's EssentialImmunology" Wiley-Blackwell Publication, 12th Edition, 2011.
5. Robert R. Rich, Thomas A Fleisher, William T. Shearer, Harry Schroeder, Anthony J. Frewand Cornelia M. Weyand, "Clinical Immunology-Principles and Practice" Elsevier, 4th Edition, 2013.

COURSE OUTCOMES

Upon completion of the course,

CO1 Students would have a fundamental knowledge about the various organs involving in immune response, immune resopones and complement systems.

CO2 Students would have developed knowledge about the production and application of producing monoclonal antibodies and will have knowledge in various immunological techniques.

CO3 Students would have gained knowledge in the separation and identification of lymphocytes and various CD markers. They also gain knowledge in cytokine assay.

CO4 After completing this course, students get familiar about the basic principles and application of various vaccine development

CO5 At the end of the course the student would acquire knowledge on development aspects in engineering antibodies and gain knowledge in combinational libraries for antibody isolation.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	-	-	-	-	-	2	1	-
CO2	1	1	1	-	-	-	-	-	-	-	1	3	3
CO3	1	2	1	1	-	1	-	-	-	-	1	2	3
CO4	1	2	2	1	1	2	1	-	1	-	1	2	1
CO5	1	2	2	1	1	3	1	-	1	-	1	1	3

BY1205 ADVANCED GENOMICS AND PROTEOMICS L T P C

3 0 0 3

OBJECTIVES:

- To understand the gene cloning methods, tools and techniques involved in gene cloning, genome analysis and genomics.
- To explain the heterologous expression of cloned genes in different hosts, production of recombinant proteins and PCR techniques.
- To identify the importance of protein bio molecules and the structure-function relationships in proteins.
- To understand comparative genomics and proteomics

UNIT I: GENE AND GENOME ANALYSIS 9

Gene prediction in prokaryotes and eukaryotes - Genome-wide association (GWA) analysis - Massively parallel Signature sequencing (MPSS), Whole genome Shotgun sequencing, Next Generation Sequencing (NGS) - Cytogenetic and physical mapping - GDB, NCBI, OMIM, NGI/MGD - Structural annotation - Functional annotation - Limitation of genomics

UNIT II: GENOME INFORMATICS 9

Functional genomics: Developmental biology and Differential gene expression, Microarray analysis - Epigenomics: Histone modification assays-ChIP-Chip and ChIP-Seq, DNA Methylation assays-DNA hybridization technique - Metagenomics: *de novo* transcriptome assembly

UNIT III: GENOMIC DIVERSITY 9

Study systems: Cyanobacteria, Plasmodium, Yeast, Virus, *Arabidopsis thaliana*, *Homo sapiens*, Worm, Zebra fish - Comparative databases: COG, KEGG, MBGD, PEDANT, Organism Specific databases

UNIT IV: PROTEOME INFORMATICS 9

2D Electrophoresis - Spot visualization and picking - Database for 2D gel - Tryptic digestion of protein - Peptide fingerprinting - Data analysis: Mass spectrometry; ion source (MALDI, spray sources); analyzer (ToF, quadrupole, quadrupole ion trap) and detectors - Ramachandran plot - Post-translational modifications of proteins - Limitation of proteomics

UNIT V: APPLICATIONS OF GENOMICS AND PROTEOMICS 9

Genomic Medicine - Synthetic biology and bioengineering - Conservation genomics - Interaction proteomics - Protein networks - Expression proteomics – Biomarkers - Proteogenomics.

TOTAL PERIODS: 45

REFERENCES:

1. Benjamin Lewin, “Gene IX”, Oxford University Press, Cambridge, U.K. 2011.
2. Brown, T.A., “Gene cloning and DNA analysis: An introduction”, 6th Edition, Wiley-Blackwell, 2010.
3. Glick, B.R. and Pasternak J.J., “Molecular Biotechnology: Principles and Applications of Recombinant DNA”, 3rd Edition, ASM Press, 2003.
4. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vol 1-3, CSHL,2001.
5. Winnacker, E.L., “Frome Genes to Clones: Introduction to Gene Technology”, Wiley-Blackwell, 2006.
6. Yamamoto, Takashi (Ed.). “Targeted Genome Editing Using Site-Specific Nucleases”,Springer, Japan, 2015.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Genome sequencing techniques currently used for gene and genome analysis.

CO2 Microarrays, Analysis of Gene expression and proteomics.

CO3 Genomic diversity and organism specific databases

CO4 2D Gel electrophoresis and Mass spectrometry analysis for any proteome

CO5 Applications of Genomics and proteomics in Biomedicine

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	1	1	3	1	-	-	-	-	2	2	3
CO2	3	3	1	1	2	-	-	-	-	-	2	2	2
CO3	3	2	3	1	2	-	-	-	-	-	3	2	2
CO4	3	2	2	1	1	3	-	-	-	-	3	1	2
CO5	3	2	3	1	2	-	-	-	-	-	3	2	2

BY1208 IMMUNOTECHNOLOGY LABORATORY L T P C

0 0 6 3

OBJECTIVES:

- To give practical exposure in the clinical diagnosis.
- To give laboratory training in different immunotechnological techniques.

EXPERIMENTS

1. Preparation of antigen and Routes of immunization (Intra-peritonial, Sub-cutaneous,Intramuscular, Intra- nasal, Oral)
2. Methods of bleeding (Eg. Tail bleeding, Intravenous, intraorbital)
3. Collection of serum, storage and purification of total IgG (salt precipitation).
4. Evaluation of Antibody titre by direct ELISA
5. Evaluation of Antigen by Sandwich ELISA
6. Characterization of antigens by native and SDS-PAGE
7. Characterizations of antigens by Western blot analysis – Wet and semi dry transfer
8. Conjugation of Immunoglobins (Streptavidin, colloidal gold)
9. Methods for prototype development of Immunodiagnostics (ICT card)
10. Blood smear identification of leucocytes by Giemsa stain
11. Separation of mononuclear cells by Ficoll-Hypaque
12. Separation of spleenocytes and proliferation against mitogens

TOTAL PERIODS: 90

Equipment Needed

Microscopes, restainer (mouse, rat, rabbit), Restrainers, purification columns, microplate reader, UV spectrometer, PAGE apparatus, Western blot apparatus (dry/semi-dry/wet), centrifuge, Haemocytometer, required strains & consumables

REFERENCE:

1.Antibodies: A Laboratory Manual, Edward A. Greenfield, Cold Spring Harbor Laboratory Press, 2nd Edition, 2014
2.Current protocols in immunology / editorial board John E. Coligan.et al,. 2003, New York :Wiley Interscience, 2003.
3.Practical Immunology Frank C. Hay and Olwyn M.R. Westwood, Blackwell Science Ltd., 4th ed, 2002

COURSE OUTCOMES

Upon completion of the course, the students will

CO1 Handle animals for immunological experiments, prepare and isolate antigens from animals.

CO2 Prepare, quantify and purify antibodies.

CO3 Evaluate antigens and antibodies using ELISA, Blotting and characterise protein by SDS-PAGE.

CO4 Perform experiments to identify and isolate different cells in a blood sample.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	1	2	2	3	1	1	2	2
CO2	2	2	2	2	2	2	2	2	2	1	2	2	2
CO3	2	2	2	2	3	2	2	2	2	1	2	2	3
CO4	2	1	2	2	2	2	2	2	2	1	2	2	2

SEMESTER III

BY1308	ADVANCED MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB	L	T	P	C
		0	0	6	3

OBJECTIVES:

- Provide hands-on experience in performing basic recombinant DNA techniques
- To understand the principle behind each techniques and applications of each methodology in applied biological research.

LIST OF EXPERIMENTS

1.Isolation of DNA
2. Electroporation to Yeast
3. Isolation of RNA
4. cDNA synthesis
5. Primer designing
6. Real-time PCR
7. Plasmid isolation and confirming recombinant by PCR and RE digestion.
8. Confirmation of the presence of insert by colony PCR
9. Induction and expression of recombinant protein
10. Western blot with ECL detection
11. Site directed mutagenesis
12. Southern blot (Non-radioactive)
13. RFLP analysis of the recombinant DNA

Required Equipments:

PCR, purification columns, micro plate reader, UV spectrometer, SDS- PAGE apparatus, Western blot apparatus (dry/semi-dry/wet), Southern blot apparatus, Cooling centrifuge, Haemocytometer, Gel Documentation, Gel rocker

TOTAL PERIODS: 90

REFERENCES:

1.Sambrook, J. and Russsel, D.W., “Molecular cloning – A laboratory manual”, Third edition, Cold Spring Harbor Laboratory Press, Cold Spring harbor, New York, USA, 2001.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Describe the main principles, methods for preparation and cloning of DNA in various organisms.

CO2 Express clearly about the gene amplification and methods for analysis of DNA such as hybridization, restriction analysis and gene expressions.

CO3 Use genetic and biotechnological techniques to manipulate genetic materials and develops new and improved living organisms.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	1	1	3	1	-	-	3	-	2	2	3
CO2	3	3	1	1	2	-	-	-	-	-	2	2	2
CO3	3	2	3	1	2	-	-	-	3	-	3	2	3

BY1309	BIOPROCESS AND DOWNSTREAM PROCESSING LABORATORY	L	T	P	C
		0	0	6	3

OBJECTIVES:

The course applies earlier learned knowledge on bioreactors and sterilization kinetics.

- To provide hands-on training in downstream processing through simple experimentation in the laboratory.
- To understand the nature of the end product, its concentration, stability and degree of purification required for targeted biological products.
- Skills and knowledge gained are useful by analogy when solving problems typical for the bioindustry or for research.

LIST OF EXPERIMENTS:

1. Enzyme immobilization studies – Gel entrapment, adsorption and cross linking immobilisation.
2. Batch cultivation – *E.coli*– growth rate, substrate utilization kinetics, product analysis.
3. Fed batch cultivation - *E.coli*- growth rate, substrate utilization kinetics, product analysis.
4. Continuous cultivation – x - D construction, kinetic parameter evaluation, gas analysis, carbon balancing.
5. Optimization techniques – PlackettBurman, Response surface methodology.
6. Bioreactor studies: Sterilization kinetics, kLa determination, residence time distribution.
7. Cell separation methods-Centrifugation and microfiltration
8. Cell disruption methods- ultrasonicator, homogeniser.
9. Aqueous two phase extraction of biologicals.

10. Protein precipitation by salting-out method (ammonium sulphate).
11. Protein purification method- Column chromatography.
12. Product polishing- dryers, crystallizers.

TOTAL PERIODS: 90

REQUIRED EQUIPMENTS:

Centrifuge, Column for purification, Ultrasonicator, Homogeniser, Microfiltration,Hot air oven, Incubator, Laminar air flow chamber, freeze dryer, required chemicals & strains

REFERENCES:

1. J.C. Janson – Protein Purification – Principles, High Resolution Methods And Applications, 3rd Edition, Wiley, 2011.
2. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications
3. Shuler and Kargi, “Bioprocess Engineering “, 3rd Edition, Prentice Hall, 2017.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

CO1 Describe the main principles, methods for preparation and cloning of DNA in various organisms.

CO2 Express clearly about the gene amplification and methods for analysis of DNA such as hybridization, restriction analysis and gene expressions.

CO3 Use genetic and biotechnological techniques to manipulate genetic materials and develops new and improved living organisms.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	3	3	3	3	2	-	-	-	-	2	3	3
CO2	2	3	3	3	3	2	-	-	-	-	2	3	3
CO3	2	3	3	3	3	2	-	-	-	-	2	3	3

PROFESSIONAL ELECTIVES I

BY1001	MOLECULAR CONCEPTS IN BIOTECHNOLOGY (FOR ENGINEERING STREAM)	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. Familiarize students with the cell and molecular biology of both Prokaryotes and Eukaryotes
2. By doing this course students wil lacquire basic fundamental knowledge and explore skills in molecular biology and become aware of the complexity of the cells.
3. This course will emphasize the molecular mechanism of DNA replication, repair, transcription, protein synthesis and gene regulation in various organisms.

UNIT I DNA, RNA AND PROTEIN SYNTHESIS 9

Concept and organization of genetic materials – Types of DNA & RNA – DNA replication, Decoding genetic information – Regulation of gene expression – Protein synthesis, Transcription and translation. Regulation of transcription in bacteria and eukaryotes – Non-coding RNAs – DNA repair mechanism

UNIT II MANIPULATION OF GENE EXPRESSION IN PROKARYOTE 9

Prokaryotic genome organization - Regulatable promoters, fusion proteins – Construction, cleavage and use of fusion proteins – Unidirectional tandem gene arrays and translation expression vectors – Protein stability – Oxygen limitation, protease deficient host strains, bacterial hemoglobin *Vitreoscill* sp. – Increased protein secretion – Factor Xa and bacteriocin

UNIT III DIRECTED MUTAGENESIS AND PROTEIN ENGINEERING 9

Directed mutagenesis – Oligonucleotide-directed mutagenesis with M13 virus and plasmid DNA – PCR amplified oligonucleotide directed mutagenesis – Protein thermostability – Addition of disulfide bonds, reduction in free sulfhydryl residues – Increasing enzyme activity – Modifying the substrate binding specificity, modifying metal cofactor requirements – Restriction modification enzymes – Zinc finger proteins.

UNIT IV TRANSGENIC ANIMALS 9

Concept of genetic engineering – Techniques in genetic engineering - Transgenic animals – Gene transfer methods – Retroviral vector method, DNA microinjection, engineered embryonic stem cell, nuclear transfer, YAC –Applications of transgenic animals – Transgenic livestock – Production of donor organs, pharmaceuticals, disease resistant livestock – Improving milk quality and animal production traits

UNIT V HUMAN MOLECULAR GENETICS 9

Genetic linkage and gene mapping – Genetic polymorphism, RFLP, SNP, STRP – Physical mapping of the human genome – Sequence tagged site (STS) for constructing physical maps from YAC, BAC or PAC – Genomic libraries – Transcriptional mapping – Cloning human disease genes and methods – Human Genome Project.

Total Periods 45

REFERENCES

1. Glick, B.R., Pasternak, J.J. and Cheryl L. Patten., "Molecular Biotechnology – Principles and Applications of Recombinant DNA", 4th Edition, ASM Press, 2009.
2. Wink, M., "An Introduction to Molecular Biotechnology – Molecular Fundamentals, Methods and Applications in Modern Biotechnology", Wiley-VCH Verlag, 2006.
1. Clark, D.P. and Pazdernik, N.J., "Biotechnology – Applying the Genetic Revolution", Elsevier Inc., 2009.
4. Kun, L.U., "Microbial Biotechnology – Principles and Applications", 2nd Edition, World Scientific Publishing Co. Pte. Ltd., 2006.
2. Walker, J.M. and Rapley, R., "Molecular Biology and Biotechnology", 5th Edition, RSC publishing, 2009.
3. Ajoy Paul: Cell and Molecular Biology, 4th Ed., Books and Allied (P) Ltd., Kolkata, 2015.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

CO1 Describe the Molecular mechanism of DNA Replication,Repair,Transcription, Protein synthesis and gene regulation in various organisms

CO2 Understand and Manipulation of Gene Expression in Prokaryote

CO3 Understand and Perform Directed Mutagenesis and Protein Engineering

CO4 Get Detailed Knowledge on Transgenic Animals and Its Applications

CO5 Understand The Overall View on Human Molecular Genetics

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	1	1	2	1	1
CO2	3	2	-	-	-	-	-	-	1	1	2	1	1
CO3	3	2	-	-	-	-	-	-	1	1	2	1	1
CO4	3	2	-	-	-	1	-	-	2	1	2	1	1
CO5	3	2	-	2	-	1	-	-	3	1	2	1	1

BY1002 **PRINCIPLES OF CHEMICAL ENGINEERING (for Science Stream)** **L T P C**

OBJECTIVES: **3 0 0 3**

The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics. The objectives are to enable the students

- To perform calculations pertaining to processes and operations.
- To apply fluid mechanics principles to applied problems

UNIT I **FUNDAMENTALS OF CHEMICAL ENGINEERING** **9**

Concepts of unit operation and unit process with examples – Units and dimensions, conversion factors, dimensional analysis – Presentation and analysis of data – Mole, density, Specific gravity – Mass fraction, Mole fraction – Analysis of multicomponent system – Concentration.

UNIT II **MATERIAL AND ENERGY BALANCES** **9**

Overall and component material balances – Material balances without chemical reactions – Chemical reactions, stoichiometry, conversion and yield – Material balance calculations with chemical reactions – Combustion calculations – Recycle operations – Energy balances – Entropy, latent heat – Concepts of chemical thermodynamics – Relation to VLE, solution thermodynamics and reaction thermodynamics.

UNIT III **FLUID MECHANICS** **9**

Laminar and turbulent flow – Basic equations of fluid flow, continuity equations and Bernoulli's equation – Shear – Stress relationships – Non-Newtonian fluids, friction factor and its calculation in laminar and turbulent flow – Operational principles of different types of pumps, compressors and valves – Measurement of fluid flow using venturimeters, orifice meters – Rotameters, pivot tube.

UNIT IV **MASS TRANSFER** **9**

Fick's law of diffusion – Analogy with momentum and heat transfer, diffusivities of gases and liquids, diffusion in binary mixtures, Interphase mass transfer – Film theory of mass transfer, determination of volumetric mass transfer coefficient – Overview of separation operations with examples, ideal stage concept – Mass transfer equipment – Distillation, liquid extraction, gas absorption, drying

Total periods 45

COURSE OUTCOMES

Upon completion of the course, the students will be able to

CO1	Solve problems related to units and conversions and fit the given data using the methodologies
CO2	Solve problems related to material and energy balance concepts and design reactors for biochemical processes
CO3	Understand Fluid Mechanics principles in biotechnology
CO4	Apply their knowledge in the field of biochemical engineering from the principles of thermodynamics.
CO5	Apply their knowledge in the field of biochemical engineering from the principles of conservation of mass

COs	PROGRAM OUTCOMES (POs)										PROGRAM SPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	1	-	-	2	-	1	-	1	3	1	1
CO2	3	3	1	-	-	2	-	1	-	1	3	1	1
CO3	3	3	1	-	-	2	-	1	-	1	3	1	1
CO4	3	3	1	-	-	2	-	1	-	1	3	1	1
CO5	3	3	1	-	-	2	-	1	-	1	3	1	1

BY1003 **METABOLIC PROCESS AND ENGINEERING (for Biotechnology Stream)**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide a quantitative basis, enzyme kinetics, for the understanding of metabolic networks in single cells and at the organ level
- To enable the students to use organisms to produce valuable substances on an industrial scale in cost effective manner

UNIT I: CELLULAR METABOLISM **9**

Transport Processes – Fueling reactions – Glycolysis, fermentative pathways – TCA cycle and oxidative phosphorylation, anaplerotic pathways –Catabolism of fats, organic acids, and amino acids - Biosynthesis of amino acids, nucleic acids, and fatty acids – Polymerization – Growth Energetics.

UNIT II: REGULATION, MANIPULATION AND SYNTHESIS OF METABOLIC PATHWAY **9**

Regulation of enzyme activity – Regulation of enzyme concentration – Regulation of metabolic networks – Regulation at the whole cell level – Metabolic pathway manipulations – Enhancement of Product yield and productivity – Extension of substrate range, product spectrum and novel products (Antibiotics, Polyketides, Vitamins) – Improvement of cellular properties – Metabolicpathway synthesis algorithm – Lysine biosynthesis.

UNIT III: ANALYSIS AND METHODS FOR THE METABOLIC FLUX **9**

Metabolic flux map – Fluxes through the catabolic pathways in microbes– Metabolic flux analysis for determined, overdetermined and under-determined systems –Sensitivity analysis – Direct flux determination from fractional label enrichment – Applications involving complete enumeration of metabolite isotopomers – Carbon metabolite balances.

UNIT IV: APPLICATION OF METABOLIC FLUX ANALYSIS 9

Amino acid production – Biochemistry and regulation– Metabolic flux analysis of lysine biosynthetic network and specific deletion mutants – Metabolic fluxes in mammalian cell cultures –Intracellular fluxes, validation of flux estimates by ^{13}C labeling studies – Design of cell culture media.

UNIT V: ANALYSIS OF METABOLIC CONTROL AND INDUSTRIAL CASE STUDIES 9

Fundamental of Metabolic Control Analysis (MCA), MFA, and MPA and their application, relating system variables to enzyme kinetics, Multi-substrate enzyme kinetics, Metabolic engineering examples for bio-fuel, bio-plastic and green chemical synthesis and industrial case studies.

TOTAL PERIODS: 45

REFERENCES:

1. Christiana D. Smolke, “The Metabolic Pathway Engineering Handbook Fundamentals”,CRC Press Taylor & Francis Group, 2010.
2. Cortossa, S., Aon, M.A., Iglesias, A.A. and Lloyd.D., “An Introduction to Metabolic and CellularEngineering", 2nd Edition,World Scientific Publishing Co, 2011
3. Curran, C.P., “Metabolic Processes and Energy Transfers - An Anthology of CurrentThought”, The Rosen Publishing group, Inc., 2006.
4. Nielsen, J., Villadsen, J. and Liden, G., “Bioreaction Engineering Principles”,3rd Edition,Springer, 2011
5. Stephanopoulos, G.N., Aristidou, A.A. and Nielsen.J., “Metabolic Engineering – Principles And Methodologies”, Elsevier Science, 2001.

COURSE OUTCOMES

Upon completion of the course,

CO1 Students would have a fundamental knowledge about the cellular metabolism and biosynthesis and catabolism of various biomolecules.

CO2 Students would have gained knowledge on regulation, manipulation and synthesis of metabolic pathways

CO3 Students would have developed knowledge about analysis and methods for the metabolic flux

CO4 After completing this course, students get familiar with the application of metabolic flux analysis.

CO5 At the end of the course the student would acquire knowledge in analysis of metabolic control and industrial case studies

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	1	-	2	-	-	-	-	2	2	1
CO2	1	1	2	2	2	2	-	-	-	-	2	2	1
CO3	2	1	3	2	2	1	-	-	-	-	2	2	1
CO4	2	1	3	2	2	2	-	-	-	-	2	2	1
CO5	2	1	2	2	2	1	-	-	-	-	2	-	1

PROFESSIONAL ELECTIVES II

BY1004	ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide the fundamentals of animal cell culture,diseases and therapy
- To offer the knowledge about the micromanipulation and transgenic animals

UNIT I INTRODUCTION 4

cope of Animal Biotechnology, Animal Biotechnology for production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins – Significance of animal based products.

UNIT II MOLECULAR BIOLOGY 9

Biology of animal viral vectors- SV40, adeno virus, retrovirus, vaccinia virus, herpes virus, adeno associated virus and baculo virus.

UNIT III CELL CULTURE TECHNOLOGY 11

Culturing of cells, primary and secondary cell lines, Analysis of cell energitics - Cell culture - Scaling up of animal cell culture-monolayer culture, suspension culture; Various bio-reactors used for animal cell culture-Roller bottle culture; Bioreactor process control, stirred animal cell culture, Air-lift fermentor, Chemostat/Turbidostat; High technology vaccines: Hybridoma technology; Cell lines and their applications

UNIT IV GENETIC ENGINEERING 11

Gene therapy-prospects and problems; Knock out mice and mice model for human genetic disorder; Baculo virus in biocontrol; Enzymes technology, Somatic manipulation of DNA, Nucleic acid hybridization and probes in diagnosis- preparation of probes, evaluation and applications.

UNIT V APPLICATIONS 10

Rumen manipulation- probiotics embryo transfer technology, invitro fertilization, transgenesis- methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods; Biopharming - Transgenic animals (Mice, Cows, Pigs, Sheep, Goat, Birds and Insects); Artificial insemination and embryo transfer.

TOTAL PERIODS: 45

REFERENCES:

1. Watson, J.D., Gilman, M., Witowski J.and Zoller, M. Recombinant DNA, 2nd ed., Scientific American Books, 1983
2. Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003
3. Lewin, B. Genes VIII , Pearson Prentice Hall, 2004
4. Davis J.M. Basic Cell Culture: A Practical Approach, IRL Press, 1998 5. Freshney R.I. Animal Cell Culture- a practical approach, 1987.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Fundamentals And Applications Of To Animal Biotechnology

CO2 Molecular Biology Aspects Of Animal Biotechnological Operations

CO3 Various Techniques To Be Adopted In Cell Culture

CO4 Concepts Of Micromanipulation Technology And Transgenic Animal technology

CO5 Applications In Transgenic Animal Breeding

COs	PROGRAM OUTCOMES(POs)										PROGRAM SPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	2	1	2	1	2
CO2	3	2	2	-	-	-	-	-	2	1	2	1	2
CO3	3	2	3	-	-	-	-	-	2	1	2	1	2
CO4	3	2	2	1	-	-	-	-	2	1	2	1	2
CO5	3	2	3	1	2	-	-	-	2	1	2	1	2

BY1005 COMPUTER AIDED LEARNING OF STRUCTURE AND FUNCTION OF PROTEINS

L	T	P	C
2	2	0	3

OBJECTIVES:

To enable the students

- To identify the importance of protein biomolecules.
- To realize the structure-function relationships in proteins

UNIT I AMINO ACIDS AND 3D STRUCTURE **9**

Amino acids – Acid-base properties – Stereo chemical representations – Chemical and Physical properties – Primary structure – Secondary structure and motifs – Tertiary structures and domains – Quaternary structures – Classifications – CATH, SCOP – Protein Data Base analysis.

UNIT II FIBROUS AND MEMBRANE PROTEINS **9**

Amino acid composition and organization of fibrous proteins – Keratins – Fibroin – Collagen – Molecular organization of membranes – Bacteriorhodopsin – Structure of the Bacterial reaction centre – Oxygenic photosynthesis – Membrane proteins based on transmembrane beta barrels – Structure of ATP synthetase.

UNIT III FUNCTION AND CONTROL OF FUNCTION **9**

Protein flexibility – Hydrogen exchange – Rotations of side chains – Enzyme Catalysis – Steady state kinetics – Transition state stabilization – Allostery – Multiple binding sites and interactions – Allosteric properties of Hemoglobin – Negative Cooperativity.

UNIT IV BIOSYNTHESIS AND DEGRADATION **9**

Post translational covalent modifications – Proteolytic processing – Alteration of the chain Termini – Glycosylation – Lipid attachment – Hydroxylation – Phosporylation – Disulphide bond formation – Chemical aging – Factors determine the rate of degradation – Proteases – Lysosomes – Ubiquitin

mediated pathway.

UNIT V DETERMINATION AND PREDICTION OF 3D STRUCTURE 9

Experimental physical methods – X-Ray crystallography, NMR, Cryo-EM, Neutron diffraction – Vibrational spectroscopy – Raman spectroscopy – Computational methods – Homology modeling – Fold recognition and Threading.

TOTAL PERIODS: 45

TEXT BOOKS

1. Whitford, D.,"Proteins: Structure and Function", John Wiley & Sons Ltd., 2005.
2. Creighton. TE., "Proteins: Structures and Molecular Properties", 2nd Edition, W. H. Freeman and Company, New York, 1993.

REFERENCES:

1. Rastogi, S.C., "Bioinformatics Concepts, Skills & Applications", 2nd Edition, CBS publishers, 2009.
2. Petsko, G.A. and Ringe, D., "Protein Structure and Function", 2004.
3. Bujnicki, J.M., "Prediction of Protein Structures, Functions, and Interactions", John Wiley & Sons Ltd., 2009.

COURSE OUTCOMES

Upon completion of the course, the students will be able to gain knowledge on

CO1 Various Interactions In Protein Makeup.

CO2 Different Levels Of Protein Structure.

CO3 Role Of Functional Proteins In Various Field Of Study.

CO4 Biosynthesis And Degradation of Proteolytic Process

CO5 Latest Application Of Protein Science In Their Research

COs	PROGRAM OUTCOMES(POs)										PROGRAM SPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	1	-	1	-	1	-	-	1	1	2	1	1
CO2	2	1	-	1	-	1	-	-	1	1	2	1	1
CO3	2	1	1	1	-	1	-	-	1	1	2	1	1
CO4	2	1	-	1	-	-	-	1	1	1	2	1	1
CO5	2	1	1	1	-	-	-	1	1	1	2	1	1

BY1006	ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

To enable the students

- To have a fundamental knowledge about the Light spectrum, Absorption, Fluorescence, NMR, Mass spectroscopy
- To acquire knowledge on the different chromatographic methods for separation of biological products.
- Understand the methods to obtain pure proteins, enzymes and in general about product development R & D

UNIT I: PROTEIN CRYSTALLOGRAPHY 9

Biological macromolecules – Principle of protein crystallization – Method – Testing – Cryotechniques – Influence of heterogeneity on crystallization – Progress in structural genomics – Micro crystallization – Utility of micro fluidics for crystallization.

UNIT II: PROTEIN AND PEPTIDE PURIFICATION 9

Chromatographic methods for protein and peptide purification – Multidimensional chromatography – High throughput screening of soluble recombinant proteins – Immunoprecipitation – Affinity chromatography for antibody purification – Role of reverse phase HPLC in proteomic research.

UNIT III: ELECTROPHORETIC TECHNIQUES 9

Strategies – Separation of proteins using 2D gel electrophoresis – Electrophoresis method for purifying proteins – *in situ* enzyme detection – Staining method – Separation of peptide mixture – Pulse field gel electrophoresis – Denaturing gradient gel electrophoresis.

UNIT IV: MICROSCOPY 9

Microscopy with light and electrons – Electrons and their interaction with the specimen – Electron diffraction – Instrument, specimen preparation and application of TEM and SEM – Fluorescence microscopy – Laser confocal microscopy – Phase contrast – Video microscopy – Scanning probe microscopy.

UNIT V: SPECTROSCOPY 9

Methods for characterizing purified proteins – IR absorption process, IR spectrometer and sample preparation – Instrumentation and applications of UV – Overview of mass spectrometry, ionization methods, mass analysis, detection and quantitation – Circular dichroism (CD) spectroscopy – NMR – Fourier transform infrared spectroscopy (FTIR).

TOTAL PERIODS: 45

REFERENCES:

1. Babine, R.E. and Abdel-Meguid, S.S., “Protein Crystallography in Drug Discovery”, Willy-VCH Verlag GmbH& Co., 2004.
2. Bhowmik, G. and Bose, S., “Analytical Techniques in Biotechnology”, Tata McGraw-Hill Publishers, 2011.
3. Chandler, D. and Roberso, R.W., “Bioimaging: Current Techniques in Light & Electron Microscopy”, Jones and Bartlett publishers, 2008.
4. Pavia, D.L., Lampman, G.M., Kriz, G.S. and Vyvyan, J.R., “Introduction to Spectroscopy”, 4th Edition, Brooks/Cole Cengage Learning, 2008.
5. Simpson, R.J., “Purifying Proteins for Proteomics”, Cold Spring Harbor Lab Press, 2004.

COURSE OUTCOMES

Upon completion of the course,

CO1 Students would have a fundamental knowledge about the various methods to obtain pure proteins and protein crystallization.

CO2 Students would have gained knowledge on the different chromatographic methods for separation of biological products.

CO3 Students would have developed knowledge about electrophoretic techniques for the separation of proteins.

CO4 Students get familiar with the Microscopic techniques.

CO5 Students would have acquired knowledge about the light spectrum, Absorption, Fluorescence, NMR, Mass spectroscopy.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	-	1	-	-	-	-	-	-	2	2	1
CO2	2	1	-	2	2	-	-	-	-	-	2	2	1
CO3	2	1	-	2	2	-	-	-	-	-	2	2	1
CO4	2	1	-	2	2	-	-	-	-	-	2	2	1
CO5	2	1	-	2	2	-	-	-	-	-	2	-	1

BY1007 BIOTHERMODYNAMICS L T P C

3 0 0 3

OBJECTIVES:

- To enable the students to learn about basic concepts of classical and statistical thermodynamics
- To demonstrate the capability to analyze the energy conversion performance in a variety of modern applications in biological systems.

UNIT I CONCEPTS AND LAWS OF THERMODYNAMICS 9

Basic concepts of thermodynamics – First Law of Thermodynamics – Second law of thermodynamics – Zeroth Law and Third Law of thermodynamics – Laws of thermodynamics and biology – Thermodynamics of equilibrium – Behavior of systems far from equilibrium – Dissipative structures in non-equilibrium systems – Thermodynamic features of small systems – Thermodynamics of macromolecular processes in cells – Thermodynamics of energy interactions in ecosystems – Conservation of energy.

UNIT II ENERGY TRANSFORMATION AND BIOENERGETICS 9

Distribution of energy – Carbon, energy and life – Molecular level energy storage – Biothermodynamics of energy use by plant and animals – Methods for measuring the thermodynamic stability of membrane proteins – Protein folding – Modeling the native state ensemble of proteins using statistical thermodynamics – Energetic profiles of proteins derived from thermodynamics of the native state ensemble – Principle of components analysis of energetic profile space – Energetic profiles are conserved between homologus proteins

UNIT II GIBB'S FREE ENERGY AND ITS APPLICATIONS 9

Theory and derivation of Gibbs free energy – Free energy of reactions –Lipid membrane phase transitions – Thermodynamics of cellular metabolism – Sugar metabolism – Energy transport in ATP and NAD – Substrate recycling – Donnan Equilibrium – Enzyme-substrate interaction – Free energy of transfer of amino acids – Differences between heat engines and biological energy processes – Temperature regulation in organisms – Humidity and temperature effects on organisms – Non-equilibrium thermodynamics and life.

UNIT IV STASTICAL THERMODYNAMICS AND BINDING EQUILIBRIA 9

Diffusion – Boltzman distribution – Partition function – Analysis of thermodynamic data – Multi-state equlibria – Protein heat capacity functions – Cooperative transitions – Interaction free energy – Helix coil transition theory – Binding equlibria – Single site model – Multiple independent sites – Oxygen transport – Scatchard plots and Hill plots – Ligand binding in macromolecules.

UNIT V REACTION KINETICS TO BIOLOGICAL SYSTEM 9

Free energy analysis of chemical reactions – Chemical coupling to drive reactions in biological systems – First order and second order reactions – Collision theory – Transition state theory – Free energy of activation – Arrhenius rate constant equation – Applications – Temperature and concentration effects on enzyme kinetics – Reaction mechanism of lysozyme – Kinetic identification of reaction intermediates – Sequential enzyme reactions in metabolism and analysis.

TOTAL PERIODS: 60

Text Books

1. Haynie, D.T., "Biological Thermodynamics", Second Edition, Cambridge University Press, 2008.
2. Hammes, G.G., "Thermodynamics and Kinetics for the Biological Sciences for Biological System", Wiley, 2000.

REFERENCES:

1. Cengel, Y.A. and Boles, M.A., "Thermodynamics, an Engineering Approach", McGraw Hill, Sixth Edition, 2006.
Timasheff, S.N., "Protein Hydration, Thermodynamic Binding, and Preferential Hydration, Biochemistry", 13473-13482, 2002.
Johnson, M.L., Holt, J.M. and Ackers, G.K., "Biothermodynamics", Part 1, Academic Press, 2009.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

CO1 Explain the theoretical concepts of thermodynamics and how it applies to energy

CO2 Understand Conversion in technological applications and biological systems.

CO3 Design and carryout bioprocess engineering experiments, and analyze and Interpret fundamental data to do the design and operationof bioprocesses.

CO4 Describe the criteria when two phases coexist in equilibrium and the vapour liquid equilibrium calculations, microbial growth and productformation.

CO5 Gain knowledge on Chemical reaction kinetics to biological system

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	2	-	-	1	2	2	1	2
CO2	3	2	2	1	1	2	-	-	1	2	2	1	2
CO3	3	2	2	1	1	2	-	-	1	2	2	1	2
CO4	3	2	2	1	1	2	-	-	1	2	2	1	2
CO5	3	2	2	1	1	2	-	-	1	2	2	1	2

BY1008 **PLANT BIOTECHNOLOGY** **L T P C**

3 0 0 3

OBJECTIVES:

- To give the details of plant cells and its functions
- To provide the basics of agro bacterium and applications of plant biotechnology

UNIT I **PLANT TISSUE CULTURE** **9**

Concept of cellular totipotency– Cytodifferentiation– Organogenic differentiation – Nutritional requirements – Seed culture, embryo culture, Protoplast culture, Micropropagation, Cell suspension –*Invitro* production of haploids–Somaclonal variation –Germplasm storage and cryopreservation.

UNIT II **CHLOROPLAST AND MITOCHONDRIA** **9**

Structure, function –Light and dark reaction and genetic material –Rubisco synthesis and assembly, coordination, regulation and transport of proteins– Mitochondria: Genome – Cytoplasmic male sterility and import of proteins – Comparison and differences between mitochondrial and chloroplast genome – Chloroplast transformation.

UNIT III PLANT METABOLISM AND METABOLIC ENGINEERING 9

Nitrogen fixation – Nitrogenase activity – Nod genes, nif genes, bacteroids – Plant nodulins. Production of secondary metabolites – Flavanoid synthesis and metabolic engineering.

UNIT IV GENE TRANSFER IN PLANTS 9

Tranisent and stable gene expression –Marker genes –Vector mediated gene transfer, *Agrobacterium* mediated DNA transformation–Tumor inducing principle, Ti plasmid – TDNA transfer – Transformation techniques using *Agrobacterium,*importance in genetic engineering–Agrobacterium vectors – Viruses mediated gene transfer, status and expression of transferred genes.

UNIT V TRANSGENICS IN CROP IMPROVEMENT 9

Resistance to biotic stresses and abiotic stresses – Herbicide resistance –Transgenics for quality – Transgenics plants as bioreactors – commercial transgenic crops and impact of recombinant DNA technology–Molecular Pharming – Therapeutic products –Transgene silencing and ethical issues.

TOTAL PERIODS: 45

REFERENCES:

1. Adrian, Scott, Nigel W., Fowler, Mark R.Plant Biotechnology: The Genetic Manipulation of Plants by Slater 2nd Edition Oxford University Press, 2008
2. Chawla, H.S, Introduction to Plant Biotechnology, 2nd edition, 2007
3. Gamburg ,O.L., and Philips G.C. Plant Tissue & Organ Culture: Fundamental Methods. Narosa Publishing House,2005
4. Grierson D. and Covey, S.N. Plant Molecular Biology, 2nd Edition, Blackie,1988
5. Heldt, Hans-Walter, Plant Biochemistry & Molecular Biology, 1stEditionOxford University Press,1997

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 The fundamentals of plant cells, structure and functions.

CO2 The regulation and transport of proteins.

CO3 The Nitrogen fixation mechanism and significance of viral vectors.

CO4 Plant tissue culture and transgenic plants

CO5 Transgenic crops and development of therapeutic products.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	-	-	-	2	2	3	1	1
CO2	3	2	1	2	1	-	-	-	2	2	3	1	1
CO3	3	2	1	2	1	-	-	-	2	2	3	1	1
CO4	3	2	1	2	1	-	-	-	2	2	3	1	1
CO5	3	2	1	2	1	-	-	-	2	2	3	1	1

PROFESSIONAL ELECTIVES III

BY1009	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

The proposed course is designed

- To understand the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments
- To replace of conventional treatment methodologies by molecular biology and genetic engineering strategies
- To seek the way for the alternate sources of energy to avoid environmental issues

UNIT I: BIODEGRADATION AND BIOREMEDIATION 9

Bioremediation technologies – Biostimulation, Bioaugmentation, Bioventing, biosparging and Phytoremediation – Bioleaching, bioprecipitation, bioaccumulation and biosorption of heavy metals. Aerobic and Anaerobic degradation of aliphatic and aromatic compounds – Biodegradation of herbicides and pesticides.

UNIT II: MICROBIAL METABOLISM IN WASTEWATER TREATMENT 9

Decomposition of organic compounds in natural ecosystems – Co-metabolic degradation of organo-pollutants - Hydrolysis of biopolymers by aerobic and anaerobic microorganisms – Anaerobic degradation of carbohydrates, proteins, lipids – Nitrogen removal – Ammonification, nitrification, denitrification

UNIT III: BIOLOGICAL TREATMENT OF WASTEWATER 9

Physico-chemical characteristics of wastewater – Overview of aerobic and anaerobic treatment processes, Process design of aerobic and anaerobic system – Activated sludge process – Trickling filter – Rotating biological contactors – Fluidized bed reactor – Upflow anaerobic sludge blanket reactor (UASB) – Membrane bioreactors – Algal photosynthesis in wastewater treatment.

UNIT IV: BIOTECHNOLOGY FOR AIR POLLUTION AND WASTE MANAGEMENT 9

Biotechnology for treating Air pollutants – Biofilters and Bioscrubbers – Biotechnology for the management of agricultural, plastic, dairy, paper and pulp, textile, leather, hospital and pharmaceutical industrial wastes.

UNIT V: BIOPRODUCTS FROM RENEWABLE SOURCES 9

Overview of renewable sources, Production of vermicompost, Production of biofertilizers and biopesticides, Production of biomethane, bioethanol, biohydrogen, biodiesel – Production of bioplastics and biopolymers – Bioelectricity generation and value added products from renewable sources

TOTAL PERIODS: 45

TEXT BOOKS:

1. Chakrabarty K.D., Omen G.S., Biotechnology And Biodegradation, Advances In Applied Biotechnology Series , Vol.1, Gulf Publications Co., London, 1989.
2. Evans, G.G. and Furlong, J., Environmental Biotechnology: Theory and Application, 2nd Edition, John Wiley & Sons, 2011.

REFERENCES:

1. Henze, M., Harremoes, P., Jansen, J.C. and Arvin, E., “Wastewater Treatment: Biological and

Chemical Processes", 2nd Edition, Springer, 2013.
2. Jordening, H.J. and Winter, J., "Environmental Biotechnology: Concepts and Application", Wiley-VCH Verlag GmbH & Co., 2005.
3. Wong J.W-C., Tyagi R.D., and Pandey. A., "Current Developments in Biotechnology and Bioengineering Solid waste" Elsevier, 2016.
4. Zarook, S. and Ajay,S., Biotechnology for Odor and Air Pollution Control, Springer, 2005.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1	Understand the scientific & engineering principles of microbial technologies to clean up polluted ecosystems
CO2	Replace of conventional treatment methodologies by molecular biology and genetic engineering strategies
CO3	Improve the sources of energy for aerobic and anaerobic treatment methods
CO4	Design Scientific solutions and participation can be served for the environmental Protection.
CO5	Seek the way for alternate sources of energy to avoid environmental issues.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	1	-	-	-	-	-	-	3	2	1
CO2	1	2	2	2	1	-	-	1	-	-	2	3	-
CO3	-	-	1	3	-	1	-	-	3	-	1	2	1
CO4	-	-	-	-	1	2	-	2	3	-	-	1	2
CO5	-	-	-	-	-	-	-	1	2	3	-	1	3

BY1010 CANCER BIOLOGY L T P C

3 0 0 3

OBJECTIVES:

To enable the students to understand

- Basic biology of cancer
- Impact of antibodies against cancer in the human body leading to more effective treatments
- Enhanced immunology based detection methods and imaging techniques
- Development of cell based and cytokine based immunotherapy against cancer

UNIT I PRINCIPLES OF CANCER BIOLOGY 9

Cancer: Definition, causes, properties, classification, clonal nature – Cell Cycle: Regulation of cell cycle, cell proliferation and apoptosis – Signal transduction pathways – Apoptosis: apoptotic pathways, signal

molecules, effects on receptor, signal switches – Modulation of cell cycle in cancer – Mechanism of spread.

UNIT II PRINCIPLES OF CARCINOGENESIS 9

Cancer risk factors – Theory of carcinogenesis – Chemical carcinogenesis – Physical carcinogenesis: x-ray radiation – mechanisms of radiation carcinogenesis – Stages of cancer: initiation, promotion, progression.

UNIT III MOLECULAR BIOLOGY OF CANCER 9

Signal targets and cancer – Growth factors – Transformation – Activation of kinases – Oncogenes: c-Myc, Ras, Bcl-2 family – Mechanism of oncogene activation – Retroviruses and oncogenes – Detection of oncogenes – Oncogenes/proto oncogene activity – Tumor suppressor genes: Rb, p53, APC, BRCA paradigms – Telomerases

UNIT IV CANCER METASTASIS 9

Clinical significances of invasion – Heterogeneity of metastatic phenotype – Metastatic cascade: basement membrane disruption, invasion – Recent approach to identify key factors controlling metastasis – Angiogenesis

UNIT V CANCER THERAPY 9

Therapy forms – Surgery, chemotherapy, radiation therapy - Detection of cancers – Prediction of aggressiveness of cancer – Advances in cancer detection – Tumor markers; New approaches of cancer therapy – mAbs, vaccines, gene therapy, stem cell therapy.

TOTAL PERIODS: 45

Text Books

1. Ruddon, R.W., “Cancer Biology”, 2nd Edition, Oxford University Press, 2007
2. Weinberg, R.A., “The Biology of Cancer”, Taylor & Francis, Garland Science, 2007

REFERENCES:

1. Schulz, W.S., “Molecular Biology of Human Cancers – An Advanced Students Text Book”, Springer, 2005.
2. Pelengaris, S. and Khan, M., “The Molecular Biology of Cancer”, Blackwell Publishing, 2006.
3. Fialho, A. and Chakrabarty, A., “Emerging Cancer Therapy: Microbial Approaches and Biotechnological Tools” 1st Edition, Wiley, 2010.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Concepts of cell cycle, cell regulation, proliferation & apoptosis.

CO2 Principles of carcinogenesis and stages of cancer.

CO3 Signal targets, growth factors & Mechanism of oncogene activation and detection.

CO4 Cancer metastatis, clinical significances and factors that can control metastatis.

CO5 Detection of cancer & Advancements in cancer detection.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	1	1	-	2	2	3	1	1
CO2	3	3	3	2	2	1	1	-	2	2	3	1	1
CO3	3	3	3	2	2	1	1	-	2	2	3	1	1
CO4	3	3	3	2	2	1	1	-	2	2	3	1	1
CO5	3	3	3	2	2	1	1	-	2	2	3	1	1

BY1011 TECHNOLOGY MANAGEMENT L T P C

3 0 0 3

OBJECTIVES:

- To impart the knowledge of various aspects of Creativity, Innovation and New Product Development

UNIT I TECHNOLOGY MANAGEMENT 9

Concept and meaning of technology – Evolution and growth of technology – Role and significance of management of technology – Impact of technology on society and business – Process and product technology. Competitive advantages through new technologies: product development from scientific breakthrough to marketable product – Role of Government in Technology Development – Managing Intellectual Property

UNIT II TECHNOLOGICAL FORECASTING & ASSESSMENT 9

Intuitive – Extrapolation – Growth Curves – Technology Monitoring. Normative: Relevance Tree – Morphological Analysis – Mission Flow Diagram - Technology Choice –Technological Leadership and Followership – Technology Acquisition. Meaning of Innovation and creativity – Innovation management

UNIT III TECHNOLOGY STRATEGY 9

Strategy concept – Types – Key principles – Framework for formulating technology strategy - Technology forecasting: techniques and application – Technology diffusion and absorption: Rate of Diffusion – Innovation Time and Innovation Cost – Speed of Diffusion – Project management in adoption and implementation of new technologies

UNIT IV TECHNOLOGY TRANSFER MANAGEMENT 9

Technology transfer process – Outsourcing strategic issues – Joint ventures – Technology sourcing. Integration of People and Technology – Organizational and Psychological Factors –Organizational Structure – Social Issues in Technology Management: Technological Change and Industrial Relations – Technology Assessment – Environmental Impact Analysis.

UNIT V TECHNOLOGY TRANSFER AND ACQUISITION 9

Import regulations – Implications of "Uruguay Round" and WTO – Bargaining process –Transfer option – MOU. Adopting technology – Human interactions – Organizational redesign and re-engineering – Technology productivity. Technology Absorption and Innovation: present status in India – Need for new

outlook – Absorption strategies for acquired technology – Creating new/improved technologies – Innovations – Technology Measurement – Technology Audit

TOTAL PERIODS: 45

Text Books

1. Khalli,T., "Management of Technology", McGraw-Hill, 2009.
2. Schilling, M.A., "Strategic Management of Technological Innovation", McGraw-Hill, 2008.

REFERENCES:

1. Narayanan,V.K., "Managing Technology and Innovation for Competitive Advantage" Pearson Education, 2007.
2. Sullivan, N., "Technology Transfer", Cambridge University, 1995.
3. Thamhain, H.J., "Management of Technology: Managing Effectively in Technology-Intensive Organizations", 2nd Edition, Wiley, 2005

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Evolution , significance & impact of technology on society & business.

CO2 Morphological analysis, mission flow diagram leading to innovation & creativity.

CO3 Principles, framework in formulating a strategy- its adoption & implementation

CO4 Technology assessment & environment impact analysis.

CO5 Human interaction, organisational design leading to productivity.

COs	PROGRAM OUTCOMES(POs)										PROGRAM SPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	2	1	3	1	1	2	1	1	1	1
CO2	1	2	2	2	1	3	1	1	2	1	1	1	1
CO3	1	2	2	2	1	3	1	1	2	1	1	1	1
CO4	1	2	2	2	1	3	1	1	2	1	1	1	1
CO5	1	2	2	2	1	3	1	1	2	1	1	1	1

BY1012 COMPUTATIONAL FLUID DYNAMICS L T P C

3 0 0 3

OBJECTIVES:

The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics. The objectives are to enable the students

- To perform calculations pertaining to processes and operations.
- To apply fluid mechanics principles to applied problems

UNIT I GOVERNING EQUATIONS 9

Fluid flow and its mathematical descriptions; conservation laws – Continuity equations – Momentum equation, energy equation – Navier-Stokes equations – Boundary conditions, Solutions of Governing Equations – Finite difference method, Finite element method, Finite Volume Method, Euler's Equations – Non-Newtonian Constitutive Equations – Curvilinear coordinates and Transformed equations – CFD as Research tool and Design tool – Validation Strategies.

UNIT II NUMERICAL ANALYSIS 9

Solving System of Algebraic equations – Gauss Elimination, Gauss-Seidel – LU-Decomposition – Jacobi – Simpson Rule – Laplace solution – Euler's method – R-K method – Fourier analysis of first and second upwind

UNIT III COMPRESSIBLE FLOW COMPUTATION 9

Euler equations – Conservative and non-conservative from thermodynamics of compressible flow – Scalar conservations laws – Conservation – Weak solutions – Non-uniqueness – Entropy conditions – Godunov methods – Flux vector splitting Method – Reconstruction of dependent variables – Fluxes – Preconditioning of low speed Flows – Projection methods

UNIT IV TURBULENT FLOW COMPUTATION 9

Physical Considerations – Survey of theory and models – Relation of High – Resolution Methods and Flow Physics – Large Eddy Simulation – Standard and Implicit – Numerical Analysis of Sub grid Models – ILES Analysis – Explicit Modeling – Implicit Modeling – Limiters – Energy Analysis – Computational Examples – Burgers' Turbulence – Convective Planetary Boundary Layer.

UNIT V FINITE ELEMENT METHOD 9

Finite Element formulation – Errors, Solutions of Finite difference equations – Elliptic equations – Parabolic Equations – Hyperbolic Equations – Burger's Equations – Nonlinear Wave equation (Convection Equation) – Primitive Variable method for Incompressible viscous flows; Taylor-Galerkin Method and Pertov-Galerkin Method for Compressible Flows.

TOTAL PERIODS: 45

Text Books

1. Drikakis, D. and Rider, W.J., "High - Resolution Methods for Incompressible and Low-Speed Flows", Springer-Verlag Berlin Heidelberg, 2005.
2. Blazek, J., "Computational Fluid Dynamics: Principles and Applications", Elsevier Publications, 2005.

REFERENCES:

1. Knight, D.D., "Elements of Numerical Methods for Compressible Flows Cambridge" University Press, 2006.
2. Cebeci, T., Shao, J.P., Kafyeke, F. and Laurendeau, E., "Computational Fluid Dynamics for Engineers", Springer - Horizons Publishing Inc., 2005.
3. Warsi, Z.U.A., "Fluid dynamics: Theoretical and Computational approaches", CRC Press, 1999.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Solving problems related to units and conversions and fit the given data using the methodologies

CO2 Solving problems related to material & energy balance, application of algebraic expressions, Laplace & Fourier analysis

CO3 Application of knowledge from the principles of thermodynamics to biochemical engg.

CO4 Computational modelling methods and its application in fluid dynamics.

CO5 Fluid statics & dynamics and the application of finite element methods.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	1	1	1	3	-	-	1	2	2	2	1
CO2	2	2	1	1	1	3	-	-	1	2	2	2	1
CO3	2	2	1	1	1	3	-	-	1	2	2	2	1
CO4	2	2	1	1	1	3	-	-	1	2	2	2	1
CO5	2	2	1	1	1	3	-	-	1	2	2	2	1

BY1013 BIOTECHNOLOGY IN FOOD PROCESSING L T P C

3 0 0 3

OBJECTIVES:

To enable the students

- To know about the constituents and additives present in the food.
- To gain knowledge about the microorganisms,foodspoilage diseases.
- To know different techniques used for the preservation of foods.

UNIT I FOOD PROCESSING 9

Heat Processing using steam or water (Blanching, Pasteurization) – Heat sterilization (Evaporation and distillation) – Heat processing using hot air (Dehydration, baking and roasting) – Heat processing using hot oils – Processing by the removal of heat (chilling , Freezing) – High pressure processing of foods – Pulsed electric field processing of liquids and beverages – Non-thermal processing by radiofrequency electric fields

UNIT II FOOD FERMENTATION 9

Fermentative production of foods – Single cell protein (yeast, mushroom) – Microorganisms responsible for production of fermented foods – Enzyme in bakery and cereal products – Enzymes in fat/oil industries – Protease in cheese making and beverage production – Production of Pectinases and Utilization in Food Processing – Food Flavour Production – Utilization of food waste for production of valuables.

UNIT III FERMENTED FOODS 9

Overview of fermented foods – Bean-based – Grain-based – Vegetable-based – Fruit-based – Honey-based – Dairy-based – Fish-based – Meat-based – Tea-based – Advantages of fermented foods Health benefits of fermented foods – Nutritive value of fermented food – Biotechnological approaches to improve

nutritional quality – Microbial changes in fermented food.

UNIT IV FOOD PRESERVATION TECHNIQUES 9

Spoilage of food - Microbiology of water, meat, milk, vegetables – Food poisoning – Cold preservation – Heat conservation – Ionizing radiation – High pressure – Electric field – Chemical food preservation – Combination of techniques for food preservation – Natural antioxidants – Antimicrobial enzymes – Edible coatings – Control of pH and water activity.

UNIT V FOOD QUALITY AND CONTROL 9

Analysis of food – Major ingredients present in different product – Food additives, vitamins – Analysis of heavy metal, fungal toxins, pesticide and herbicide contamination in food – Microbial safety of food products – Chemical safety of food products – Good manufacturing practice

TOTAL PERIODS: 45

Text Books

1. Fellows, P.J., "Food Processing Technology: Principles and Practice", 3rd Edition, CRC Press, 2009.
2. Pometto A, Shetty K, Paliyath G and Levin R. E., "Food Biotechnology", 2nd Edition , CRC press, 2005.

REFERENCES:

1. Hutkins R. W., "Microbiology and Technology of Fermented Foods", IFT Press series, Volume 32 of Institute of Food Technologists Series, Wiley-Blackwell, 2006.
2. Zeuthen P. and Bogh-Sorensen, L., "Food Preservation Techniques", 1st Edition, CRC Press, 2003.
3. Adams M., Adams M. R. and Robert Nout M. J., "Fermentation and food safety", Springer, 2001.
4. Da-Wen S., "Emerging Technologies for Food Processing", Academic Press, 2005.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Sterilisation methods and processing methods of foods & beverages.

CO2 Production of fermented foods and use of food waste for production of value added products

CO3 Nutritive & health benefits of fermented foods.

CO4 Food preservation techniques and edible coatings

CO5 Analysis of contaminants in food, safety and GMP.

COs	PROGRAM OUTCOMES(POs)										PROGRAM SPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	1	-	2	2	3	3	2
CO2	3	3	2	2	2	2	1	-	2	2	3	3	2
CO3	3	3	2	2	2	2	1	-	2	2	3	3	2
CO4	3	3	2	2	2	2	1	-	2	2	3	3	2
CO5	3	3	2	2	2	2	1	-	2	2	3	3	2

PROFESSIONAL ELECTIVES IV

BY1014	BIO NANOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn about basis of nanomaterial science
- To make them ready to prepare nanoparticles in different routes
    - Capable of characterising nano-scale materials
    - Apply nano materials in nano device fabrications
- To equip them in targeted drug design area

UNIT I: NANOSCALE PROCESSES AND NANOMATERIALS 9

Overview of nanoscale processes of nanomaterials – Physicochemical properties of nanomaterials – Concepts in nanotechnology – Natural nanomaterials –Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Polymeric nanoparticles, Buckyballs, Nanotubes) – Interaction between biomolecules and nanoparticle surface –Synthesis and assembly of nanoparticles and nanostructures using bio-derived templates.

UNIT II: STRUCTURAL AND FUNCTIONAL PRINCIPLES OF BIONANOTECHNOLOGY AND CHARACTERISATION 9

Biomolecular structure and stability – Biomolecular Self-assembly – Self-organization – Molecular recognition –Chemical transformation – Regulation – Biomaterials –– Traffic across membranes – Biomolecular sensing – Self-replication – Characterisation techniques - X-ray diffraction technique, Scanning Electron Microscopy, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques AFM, SPM, STM, and VSM.

UNIT III: PROTEIN-BASED NANOTECHNOLOGY 9

Overview of protein nanotechnology – Nanotechnology with S-Layer protein – Engineered nanopores – Bacteriorhodopsin and its potential – Protein assisted synthesis of metal nanoparticles – Synthesis of protein-based nanoparticles – Protein nanopaticle-hybrids – Biomolecular motors and motor proteins - Covalent and non-covalent protein nanoparticle conjugates – Protein-carbon nanotube conjugates.

UNIT IV: DNA-BASED NANOTECHNOLOGY 9

DNA-based nanostructures – Biomimetic fabrication of DNA based metallic nanowires and networks – Self assembling DNA structures – DNA-nanoparticle conjugates – DNA-carbon nanotube conjugates – DNA templated electronics – DNA nanostructures for mechanics and computing – DNA nanomachine.

UNIT V: NANOMEDICINE AND NANOSENSING 9

Promising nanobiotechnologies for applications in medicine – Role of nanotechnology in methods of treatment – Liposomes in nanomedicine – Therapeutic applications of nanomedicine – NanoSized carriers for drug delivery and drug carrier systems – Protein and peptide nanoparticles, DNA based nanoparticles, Lipid matrix nanoparticles for drug delivery – Design and development of bionanosensors using DNA, enzymes – Nanobiosensors for imaging and diagnosis.

TOTAL PERIODS: 45

Text Books

1. Gamburg OL, Philips GC, Plant Tissue & Organ Culture fundamental Methods, Narosa Publications. 1995.
2. Singh BD. Text Book of Biotechnology, Kalyani Publishers. 1998

REFERENCES:

1. Heldt HW. Plant Biochemistry & Molecular Biology, Oxford University Press. 1997.
2. Ignacimuthu .S, Applied Plant Biotechnology, Tata McGraw Hill. 1996.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1	Understand the fundamental concepts, physiochemical properties and the types of nanoscale materials.
CO2	Gain knowledge about the structure and function of different types of nanomaterials and the machines used in bionanotechnology.
CO3	Understand the involvement of protein in bionanotechnology and its role.
CO4	Gain knowledge about the DNA based nano structures and its application various areas of nanobiotechnology.
CO5	Understand the principle behind targeted drug delivery and the usage of nano carriers in nanomedicine.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	2	2	1	1	1	-	-	-	1	1
CO2	1	2	2	2	2	1	2	1	1	-	1	1	2
CO3	2	2	2	2	2	1	2	1	1	-	2	2	3
CO4	2	2	2	2	3	2	2	2	1	1	3	2	3
CO5	2	2	3	3	3	3	2	2	2	2	2	3	3

BY1015 **PHYTOCHEMISTRY** **L T P C**

3 0 0 3

OBJECTIVES:

- To give the details of plant derived value added compounds and its functions
- To provide knowledge on biotech based production of agro medicines

UNIT I **INTRODUCTION OF PHYTOCHEMICALS** 9

Categories of phytochemicals and their classification (carbohydrates, tannins, alkaloids, glycosides, steroids, saponins, terpenoids, flavonoids, coumarins, mucilage's xanthine) – Phytochemical screening: Physiochemical tests – Moisture content, total ash, water-soluble ash, acid-insoluble ash, sulphate ash, alcohol and water-soluble extractive values – Heavy metal detection by atomic spectroscopy. Macroscopic studies –Shape, apex, base, margin, taste and odour Microscopic-stomatal number, stomatal index, vein islet number and vein termination number.

UNIT II THERAPEUTIC EFFECT OF PLANT PRODUCTS 9

Anti-tumor activity – Anti-coagulation – Anti-bacterial – Anti-inflammatory– Anti-MRSA and Anti-VRE activities of Phytoalexins and Phytoncides. Screening of Plant extracts for antiparasitic activity.

UNIT III BIOACTIVITY STUDIES 9

Screening of drugs for biological activity – Antidiabetic, antinflammatory, antihepatotoxic, antifertility, diuretic, anticancer, antihepatotoxic, antimalarial, antihypertensive and hypolipedemic and adoplogenic agents

UNIT IV SEPARATION TECHNIQUES AND STRUCTURE ELUCIDATION 9

Thin layer chromatography – HPTLC – Column chromatography – GC-MS – LC-MS – HPLC – Partition chromatography – Gas chromatography – FT-IR – UV- NMR (1D&2D) – X-ray diffraction.

UNIT V LARGE SCALE PRODUCTION OF BIOACTIVE PRODUCTS 9

Secondary metabolite production through cell culture system – Hairy root induction –Methods of gene transfer – Chemical methods – PEG – dextran – Physical method – Electroporation – Microinjection – Lipofection agrobacterium based vector mediated gene transfer – Particle bombardment.

TOTAL PERIODS: 45

TEXT BOOKS

Ahamed, I., Aqil, F. and Owais, M., “Modern Phytomedicine”, WILEY VCH, Verlag GmbH & Co, KGaA, Weinheim. 2006.
Chawla, H.S., “Introduction to Plant Biotechnology”, Science Publishers, 2004.

REFERENCES:

Meskin, M.S., Bidlack, W.R., Davies, A.J. and Omaye, S.T., “Phytochemicals in Nutrition and Health”, CRC Press, 2002.
Arnason, J.T., Arnason, J.E. and Arnason, J.T., “Phytochemistry of Medicinal Plants”, Kluwer Academic Publishers, 1995.
Bidlack, W.R., Omaye, S.T., Meskin, M.S. and Topham, D.K.W.,” Phytochemicals as Bioactive Agents”, 1St Edition, CRC Press, 2000.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

- **CO1** Category and classification of phytochemicals
- **CO2** Therapeutic effect of plant products.
- **CO3** The screening of drugs for biological activity.
- **CO4** The separation techniques that can be used for plant derived products
- **CO5** The production of various bioactive products

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	1	2	3	2	-	-	-	2	2	3	1	1
CO2	3	1	2	3	2	-	-	-	2	2	3	1	1
CO3	3	1	2	3	2	-	-	-	2	2	3	1	1
CO4	3	1	2	3	2	-	-	-	2	2	3	1	1
CO5	3	1	2	3	2	-	-	-	2	2	3	1	1

BY1016 ADVANCES IN MOLECULAR PATHOGENESIS L T P C

3 0 0 3

OBJECTIVES:

To enable the students

- To understand about the microbial toxins and modern molecular pathogenesis
- To know about the host pathogen interaction and identifying virulence factors
- To control pathogens by modern approaches.

UNIT I VIRAL PATHOGENESIS 9

Various pathogen types and modes of entry – Viral dissemination in the host – Viral virulence – Injury induced by virus – Host susceptibility of viral disease – Pattern of infection - Acute infection – Persistant infection – Latent infection – Slow infection – Methods for the study of pathogenesis – Foot and mouth disease virus, Pestiviruses, Arteriviruses, Blue tongue virus and Animal herpesviruses

UNIT II FUNGAL PATHOGENESIS 9

Innate humoral immunity to fungi – Acquired cellular immunity – Mucosal immunity – Intracellular pathogenesis of *Histoplasma capsulatum* – Facultative intracellular pathogen of *Cryptococcus neoformans* – Fungal interaction with leukocytes – Fungal vaccine development – Host defence against chronic disseminated *Candidiasis* – Study fungal virulence by using Genomics – Functional genomic approaches to fungal pathogenesis.

UNIT III BACTERIAL PATHOGENESIS 9

Epidemology and Clinical disease – Clinical course and basic immunology – *In vitro* models of *Salmonella* virulence – Antibiotic resistant *Salmonella* – *Salmonella* based vaccines – *Shigella* cellular models of infection – Influenza virus – Pathogenic *Escherichia coli* – *Vibrio cholerae* – Streptococcal disease – *Haemophilus influenzae* infection

UNIT IV MANIPULATION OF HOST CELLS AND IMMUNE FUNCTION BY VIRAL PROTEINS 9

Clinical importance of understanding host defence – Interference with cytokine and Chemokine function – impairment of host mediated killing of infected cells – inhibition of apoptosis – Immunological structure of proteins – Class I and II MHC mediated antigen – Evasion from natural killer cells.

UNIT V MOLECULAR APPROACHES TO CONTROL 9

Classical approaches based on serotyping – Modern diagnosis based on highly conserved virulence factors, immune and DNA based techniques – New therapeutic strategies based on recent findings on molecular pathogenesis – Viral Vaccines – Immune modulators – New vaccine technology

TOTAL PERIODS: 45

Text Books

1. Groismen, E.A., "Principles of Bacterial Pathogenesis", Academic Press, 2001.
2. Norkin, L.C., "Virology: Molecular Biology and Pathogenesis", ASM Press, 2009.

REFERENCES:

1. Gyles, C.L., Prescott, J.F., Songer, J.G. and Thoen C.O., "Pathogenesis of Bacterial Infections in Animals", 3rd Edition, Wiley-Blackwell, 2004.
2. Flint, J., Enquist, L.W., Krug, R.M., Racaniello, V.R. and Skalka, A.M., "Principles of Virology: Molecular Biology, Pathogenesis and Control", American Society of Microbiology, 2003.
3. Mettenleitter, T.C. and Sobrino, F.,"Animal Viruses: Molecular Biology", Caister Academic Press, 2008.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Fundamentals of modern molecular pathogenesis of Virus
CO2 Fundamentals of modern molecular pathogenesis of Fungus
CO3 Fundamentals of modern molecular pathogenesis of Bacteria
CO4 Host pathogen interaction and identifying virulence factors
CO5 Control of pathogens by modern approaches

COs	PROGRAM OUTCOMES(POs)										PROGRAM SPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	-	-	3	2	3	2	1
CO2	3	2	2	2	1	1	-	-	3	2	3	2	1
CO3	3	2	2	2	1	1	-	-	3	2	3	2	1
CO4	3	2	2	2	1	1	-	-	3	2	3	2	1
CO5	3	2	2	2	1	1	-	-	3	2	3	2	1

BY1017 SPECTROSCOPY FOR BIOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

To enable the students

- To have a fundamental knowledge about the Light spectrum, Absoprtion, Fluorescence,NMR, Mass spectroscopy

- To deliver the knowledge of spectroscopic techniques and its functions
- To provide the technical information of spectroscopy for biological applications

UNIT I ELECTRONIC SPECTRA 9

Overview of electronic spectra – Absorption spectra – Ultraviolet spectra of proteins – Nucleic acid spectra – Prosthetic groups – Difference spectroscopy – X-ray absorption spectroscopy – Fluorescence and phosphorescence – Helicase activity monitored by fluorescence – Fluorescence energy transfer – Molecular ruler-application of energy transfer to biological systems.

UNIT II CIRCULAR DICHROISM, OPTICAL ROTARY DISPERSION AND FLUORESCENCE POLARIZATION 9

Optical rotary dispersion – Circular dichroism – Optical rotary dispersion and circular dichroism of proteins – Optical rotation and circular dichroism of nucleic acids – Small molecule binding to DNA – Protein folding – Interaction of DNA with zinc finger proteins – Fluorescence polarization – Integration of HIV genome into host genome and alpha – Ketoglutarate.

UNIT III IR AND RAMAN SPECTROSCOPY 9

Infrared spectroscopy – Raman spectroscopy – IR and Raman spectroscopy of biological materials – Structure determination with vibrational spectroscopy – Structure of enzyme-substrate complexes – Biological vibrational spectroscopic imaging – FT-IR and FT-Raman in biomedical research.

UNIT IV NUCLEAR MAGNETIC RESONANCE AND ELECTRON SPIN RESONANCE 9

NMR spectrometers – Chemical shifts – Spin-spin splitting – Relaxation times –Multidimensional NMR – Magnetic resonance imaging – Electron spin resonance – Regulation of DNA transcription – Protein – DNA interactions – Dynamics of protein folding – RNA folding – Lactose permease.

UNIT V MASS SPECTROMETRY 9

Mass analysis – Tandem Mass Spectrometry – Ion detectors – Ionization of the sample – Sample preparation/analysis – Proteins and peptides – Protein folding – Mass spectrometry of biomolecules

TOTAL PERIODS: 45

TEXT BOOKS

1. Hammes, G.G., “Spectroscopy for the Biological Sciences”, 1st Edition, Wiley-Inter Science, 2005.
2. Ramamoorthy, A., “NMR Spectroscopy of Biological Solids”, CRC Press, 2005

REFERENCES:

1. Pretsch, E., Bühlmann, P. and Badertscher, M., “Structure Determination of Organic compounds: Tables of Spectral Data”, 4th Edition, Springer, 2009.
2. Gremlich, H. and Yan, B., “Infrared and Raman Spectroscopy of Biological Materials”, CRC Press, 2000.
3. Greve, J., Puppels, G.J. and Otto, C., “Spectroscopy of Biological Molecules: New Directions 1st Edition, Springer”, 1999.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Basics of Electronic spectra and its various biological applications

CO2 Basics of Circular Dichroism, Optical Rotary Dispersion And Fluorescence Polarization and its various biological applications

CO3 Basics of IR And Raman Spectroscopy and its various biological applications

CO4 Basics of NMR and Electron Spin Resonance and its various biological applications

CO5 Basics of Mass Spectrometry and its various biological applications

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	3	3	1	1	1	-	-	-	1	1	2	1
CO2	1	3	3	1	1	1	-	-	-	1	1	2	1
CO3	1	3	3	1	1	1	-	-	-	1	1	2	1
CO4	1	3	3	1	1	1	-	-	-	1	1	2	1
CO5	1	3	3	1	1	1	-	-	-	1	1	2	1

BY1018 **IPR AND BIOSAFETY** **L T P C**

3 0 0 3

OBJECTIVES:

- To create awareness about IPR and engineering ethics
- To follow professional ethics and practices in their careers
- To create awareness and responsibilities about the environment and society

UNIT I AGREEMENTS, TREATIES AND CONCEPT OF PRIOR ACT 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties –Budapest Treaty – PCT – Indian Patent Act 1970 & recent amendments Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,esp@cenet(EPO) – PATENT Scope (WIPO) – IPO, etc.

UNIT II IPR 9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

UNIT III PATENT FILING PROCEDURES 9

National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes. Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT IV BIOSAFETY 9

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended

Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT V GENETICALLY MODIFIED ORGANISMS 9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol

TOTAL PERIODS: 45

TEXT BOOKS

1. Irish, V., "Intellectual Property Rights for Engineers", 2nd Edition, The Institution of Engineering and Technology, 2005.
2. Fleming, D.O. and Hunt, D.L., "Biological Safety: Principles and Practices", 4th Edition, American Society for Microbiology, 2006.
3. BAREACT.IndianPatentAct1970Acts&Rules,UniversalLawPublishingCo.Pvt.Ltd., 2007.
4. Kankanala, C. Genetic Patent Law &Strategy, 1stEd., ManupatraInformation SolutionPvt.Ltd.,2007
5. Kanka, S.S.EntrepreneurshipDevelopment, 1st Ed., S. ChandandCo,1997.

REFERENCES:

1. Bouchoux, D.E., "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal", 3rd Edition, Delmar Cengage Learning, 2008.
2. Young, T., "Genetically Modified Organisms and Biosafety: A Background Paper for Decision-Makers and Others to Assist in Consideration of GMO Issues" 1st Edition, World Conservation Union, 2004.
3. Mueller, M.J., "Patent Law", 3rd Edition, Wolters Kluwer Law & Business, 2009.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Various Laws, Rules and Regulations of Patents
CO2 Various forms of Intellectual Property Rights
CO3 Patent filing procedures and types of infringement
CO4 Different Biosafety Levels and its Guidelines
CO5 Fundamentals of GMO, its regulations and agreements

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	3	3	1	1	-	2	2	1	1	3
CO2	1	2	2	3	3	1	1	-	2	2	1	1	3
CO3	1	2	2	3	3	1	1	-	2	2	1	1	3
CO4	1	2	2	3	3	1	1	-	2	2	1	1	3
CO5	1	2	2	3	3	1	1	-	2	2	1	1	3

PROFESSIONAL ELECTIVE V

BY1019	BIOPHARMACEUTICALS AND BIOSIMILARS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The aim of the course is to give strong foundation and advanced information on

- Core responsibilities for the development and monitoring of the drug and the preparation of medicines according to the no the norms.
- To gain knowledge in physicochemical properties, pharmacology and the formulation of commonly used biopharmaceuticals.

UNIT I: INTRODUCTION **9**

Drug sources – Discovery and Development phases – Drugs and Cosmetics Act and regulatory aspects – Role of patents in the drug industry – Biopharmaceutical classification system – Drug Target – Drug metabolism – Pharmacokinetics – Pharmacodynamics – Bioavailability – Bioequivalence – Toxicity studies – Pharmacogenomics.

UNIT II: DOSAGE FORMS **9**

Classification of dosage forms – Excipients – Formulation – Tablets, Capsules, Emulsion, Suspension, Lotion, Liniments, Ointments, Cream, Paste, Suppositories, Parenterals – Pressurized dosage forms – Packaging techniques.

UNIT III: ADVANCED DRUG DELIVERY SYSTEMS **9**

Controlled release dosage forms – Rationale – Principle and factor influencing – Design and Fabrication – Microencapsulation – Liposomes – Niosomes – Transdermal drug delivery – Ocular, Vaginal and Uterine controlled release.

UNIT IV: BIOSIMILARS **9**

Biosimilar medicine – Importance – INN nomenclature system – Key trends in biosimilar product development – Production of biosimilar products – Difficulties with biosimilar drugs – Non clinical and clinical study – Regulation and approval process – Future prospects.

UNIT V: CASE STUDIES ON BIOPHARMACEUTICALS **9**

Erythropoietin – Insulin – Somatotropin – Interleukin – Interferon – GM-CSF – Blood clotting factors – Tissue plasminogen activator – Monoclonal antibodies and engineered antibodies.

TOTAL PERIODS: 45

REFERENCES:

1. Crommelin Dwan J.A., Robert D. Sindelar and Bernd Meibohm, “Pharmaceutical Biotechnology: Fundamentals and application”, Springer, 4th Edition, 2013.
2. Gary Walsh, “Pharmaceutical Biotechnology-Concepts and Application”, John Wiley and Sons Publishers, 1st Edition, 2007.
3. James Swarbrick, “Encyclopedia of Pharmaceutical Technology”, CRC Press, 4th Edition, 2013.
4. Shayne Cox Gad, “Pharmaceutical Manufacturing Handbook: Production and Processes”, Wiley, 2nd Edition, 2011.
5. Shein-Chung Chow, “Biosimilars: Design and Analysis of Follow-on Biologics”, CRC Press, 3rd Edition, 2013.

COURSE OUTCOMES

Upon completion of the course,

CO1 Students would have a fundamental knowledge about the various phases and the regulatory aspects involved in the drug development and on pharmacokinetics & dynamics.

CO2 Students will get familiar with the preparation of various dosage forms of drug and its quality control.

CO3 Students would have developed knowledge about advanced drug delivery systems.

CO4 Students would have gained knowledge about biosimilars and its regulation and approval process.

CO5 At the end of the course the student would acquire knowledge on different types of biopharmaceuticals.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	2	-	3	-	-	-	2	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	2	-	-	2	-	-
CO4	1	-	-	2	-	-	2	2	1	-	-	2	2
CO5	2	-	2	-	-	-	-	-	-	-	2	-	-

BY1020 BIOPROCESS MODELING AND SIMULATION L T P C

3 0 0 3

OBJECTIVES:

- To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.
- To impart knowledge on design and operation of fermentation processes with all its prerequisites.
- Provide the students with the basics of bioreactor engineering.
- To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

UNIT I CONCEPTS AND PRINCIPLES 9

Introduction to modelling – Systematic approach to model building – Material and energy balance – Classification of models – General form of dynamic models dimensionless models – General form of linear systems of equations nonlinear function – Conservation principles thermodynamic principles of process systems

UNIT II MODELS 9

Structured kinetic models – Compartmental models (two and three) – Product formation Unstructured models – Genetically structured models – Stochastic model for thermal sterilization of the medium –

Modelling for activated sludge process – Model for anaerobic digestion – Models for lactic fermentation and antibiotic production

UNIT III MODELLING OF BIOREACTORS 9

Modelling of non-ideal behaviour in Bioreactors – Tanks-in-series and Dispersion models – Modelling of
PFR and other first order processes – Analysis of packed bed and membrane bioreactors
Recombinant Cell Culture Processes – Plasmid stability in recombinant Cell Culture limits to over-expression

UNIT IV MONITORING OF BIOPROCESSES 9

On-line data analysis for measurement of important physico-chemical and biochemical parameters – State and parameter estimation techniques for biochemical processes – Biochemical reactors-model equations – Steady-state function – Dynamic behaviour – Linearization – Phase plane analysis – Multiple steady state – Bifurcation behaviour

UNIT V SOLUTION STRATEGIES 9

Solution strategies for lumped parameter models – Stiff differential equations – Solution methods for initial value and boundary value problems – Euler's method – R-K method – shooting method – Finite difference methods – Solving the problems using MATLAB/SCILAB –ISIM-Simulation of bioprocesses using models from literature sources.

TOTAL PERIODS: 45

TEXT BOOKS

1. Hangos, K.M. and Cameron, I.T., "Process Modelling and Simulation", 2001.
2. Heinzle, E., Biwer, A.P. and Cooney, C.A.L., "Development of Sustainable Bioprocess: Modeling", Wiley, 2007.

REFERENCES:

1. Boudreau, M.A. and McMillan, G.K.," New Directions in Bioprocess Modelling and Control", ISA, 2006.
2. Bequette, B.W., "Process Control:Modeling, Design & Stimulating", Prentice Hall, 2003.
3. Bailey, J.A. and Ollis, D. F., Fundamentals of Biochemical Engineering", McGraw Hill –1986

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1	Systematic approach to model building & thermodynamic principles of model systems
CO2	Various types of models and its application in bioprocess
CO3	Modelling of non ideal behaviour in reactors
CO4	Measurement of important parameters in bioprocessing operation
CO5	Simulation of bioprocess using various models.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	3	3	1	1	3	-	-	-	1	1	2	1
CO2	2	3	3	1	1	3	-	-	-	1	1	2	1
CO3	2	3	3	1	1	3	-	-	-	1	1	2	1
CO4	2	3	3	1	1	3	-	-	-	1	1	2	1
CO5	2	3	3	1	1	3	-	-	-	1	1	2	1

BY1021 TISSUE ENGINEERING L T P C

3 0 0 3

OBJECTIVES:

To enable the students

- To learn the fundamentals of tissue engineering and tissue repairing
- To acquire knowledge on clinical applications of tissue engineering
- To understand the basic concept behind tissue engineering focusing on the stemcells, biomaterials and its applications

UNIT I FUNDAMENTAL OF TISSUE ENGINEERING 9

Cells and tissue grade organization in living system - Cell cycle – Stem cells – Types, factors influencing stem cells – Mechanical properties of cells and tissues, cell adhesion – Extracellular matrix – Glycans, laminin, fibronectin, collagen, elastin, extracellular matrix functions – Signalling – Mechanics and receptors – Ligand diffusion and binding, trafficking and signal transduction – *In vitro* cell proliferation – Scope of tissue engineering

UNIT II BIOMATERIALS FOR TISSUE ENGINEERING 9

Preparation of biomaterials and their types - Measurement of protein adsorption – Direct and indirect methods, fibrinogen adsorption –Displaceable and non-displaceable – Changes in protein conformation upon adsorption – Vroman effect principle to maximize the amount of fibrinogen adsorption – Devices for tissue engineering transplant cells.

UNIT III DELIVERY OF MOLECULAR AGENTS AND CELL INTERACTIONS WITH POLYMERS 9

Molecular agents in tissue engineering – Controlled released of agents – Methods, in time and space – Future applications of controlled delivery – Microfluidic systems – Microfluidics and microfluidic devices – Cell interactions – Factors influencing cell interactions – Cell interactions with polymer surfaces and suspension – Cell interactions with three-dimensional polymer

UNIT IV POLYMERS AND CONTROLLED DRUG DELIVERY 9

Natural and synthetic biodegradable Polymers – Engineered tissues – Skin regeneration – Nerve

regeneration – Liver, cartilage, bone – Biodegradable polymers in drug delivery –Polymeric drug delivery systems – Applications of biodegradable polymers.

UNIT V BIOPOLYMER-BASED BIOMATERIALS AS SCAFFOLDS AND STEM CELLS

Synthesis of bio polymer - Natural polymers – Structural and chemical properties, scaffold processing, mechanical properties and biodegradability – Biocompatibility and host response – Application of scaffolds in tissue engineering. Use of stem cells in tissue engineering – Embryonic stem cells, mesenchymal stem cells (MSC), adult stem cells, markers for detection of stem cells – Risks with the use of stem cells – Application of stem cells in tissue engineering.

TOTAL PERIODS: 45

TEXT BOOKS

1. Pallua, N. and Suscheck, C.V., “Tissue Engineering: From Lab to Clinic” Springer, 2010
2. Saltzman, W.M., “Tissue Engineering”, Oxford University Press, 2004.

REFERENCES:

1. Palsson, B., Hubbell, J.A., Plonsey, R. and Bronzino, J.D., “Tissue Engineering”, CRC Press, 2003.
2. Palsson, B.O. and Bhatia, S., “Tissue Engineering”, Pearson Prentice Hall, 2004.
3. Scheper, T., Lee, K. and Kaplan, D., “Advances in Biochemical Engineering / Biotechnology – Tissue Engineering I”, Volume 102, Springer-Verlag Berlin Heidelberg, 2006.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Components of tissue architecture

CO2 Preparation of various types of biomaterials

CO3 Delivery of molecular agents and cell interactions with polymers

CO4 Different types of polymers and their role in Drug delivery

CO5 Biopolymer-based biomaterials as scaffolds and Stem cells in organogenesis

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	-	-	2	2	3	2	2
CO2	3	3	2	2	2	1	-	-	2	2	3	2	2
CO3	3	3	2	2	2	1	-	-	2	2	3	2	2
CO4	3	3	2	2	2	1	-	-	2	2	3	2	2
CO5	3	3	2	2	2	1	-	-	2	2	3	2	2

BY1022	RESEARCH METHODOLOGY IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the knowledge of various methods of research strategy
- To understand Biotech research constraints and its analysis
- To emphasise the Creativity, Innovation and New Product Development

UNIT I RESEARCH AND ITS METHODOLOGIES 9

Motivation – Objective and significance of research – Research process – Observation – Axiom – Theory – Experimentation – Types of research (basic, applied, qualitative, quantitative, analytical etc). Features of translational research – Concept of laboratory to market (bench to public) – Industrial R&D.

UNIT II RESEARCH IN BIOTECHNOLOGY 9

Laboratory policy and procedure of academic research – Types of expertise and facilities required. Technology and product transfer research – Grant funding – Sources of literature – Interdisciplinary nature – Collaboration based research.

UNIT III EXPERIMENTAL RESEARCH 9

Research direction – Understanding biotechnology research by experimentation – Strategies for experimentation – Selecting an experimental design – Sample size – Enzymes and enzymatic analysis – Antibodies and immunoassays – Instrumental methods – Bioinformatics and computation

UNIT IV RESULTS AND ANALYSIS 9

Scientific methodology in recording results – Importance of negative results – Ways of recording – Industrial requirement – Artifacts versus true results – Types of analysis (analytical, objective, subjective) and cross verification – Correlation with published results – Discussion – Hypothesis – Concept – Theory and model.

UNIT V PUBLISHING SCIENTIFIC AND TECHNICAL PAPERS 9

Guide to publishing scientific papers – Types of scientific and technical publications in biotechnology – Specifications – Ways to protect intellectual property – Patents – Technical writing skills – Importance of impact factor and citation index.

TOTAL PERIODS: 45

TEXT BOOKS

1. Marczyk, G.R., DeMatteo, D. & Festinger, D. Essentials of Research Design and Methodology, John Wiley & Sons Publishers Inc, 2005.
2. Segel, I.H. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Ed., John Wiley & Sons Publishers Inc, 1976.
3. Korner, A.M. Guide to Publishing a Scientific paper, Bioscript Press, 2004.
4. Marczyk,G.R., DeMatteo, D. and Festinger, D., “Essentials of Research Design and Methodology”, John Wiley & Sons Publishers, Inc., 2005.
5. Korner, A.M., “Guide to Publishing a Scientific paper”, Taylor & Francis group, 2008.

REFERENCES:

1. Kothari, C.R., “Research Methodology: Methods and Techniques”, New Age Publications, 2008.
2. Malinowski, M.J. and Arnold, B.E., “Biotechnology: Law, Business and Regulation”, Aspen Publishers, 2004.
3. Haaland, P.D., “Experimental Design in Biotechnology”, Marcel Dekker, 1989.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Types of research and research process

CO2 Biotechnology research planning and execution and result analysis

CO3 Design and Experimentation of Biochemical assays

CO4 Ways of recording, interpreting and analysing results

CO5 Fundamentals of writing and publishing scientific and technical papers

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	1	-	-	3	1	3	3	1	2	1
CO2	1	2	2	1	-	-	3	1	3	3	1	2	1
CO3	1	2	2	1	-	-	3	1	3	3	1	2	1
CO4	1	2	2	1	-	-	3	1	3	3	1	2	1
CO5	1	2	2	1	-	-	3	1	3	3	1	2	1

BY1023 BIOFUELS AND PLATFORM CHEMICALS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart the knowledge of Bioconversion of renewable lignocelluloses biomass to biofuel and value added products
- To demonstrate a drive towards products benign to natural environment increasing the importance of renewable materials
- To emphasise the development of Biomass an inexpensive feedstock considered sustainable and renewable to replace a wide diversity of fossil based products

UNIT I INTRODUCTION **9**

Cellulosic Biomass availability and its contents. Lignocellulose as a chemical resource. Physical and chemical pretreatment of lignocellulosic biomass. Cellulases and lignin degrading enzymes.

UNIT II ETHANOL **9**

Ethanol as transportation fuel and additive; bioethanol production from carbohydrates; engineering strains for ethanol production from variety of carbon sources to improved productivity.

UNIT III BIODIESEL **9**

Chemistry and Production Processes; Vegetable oils and chemically processed biofuels; Biodiesel composition and production processes; Biodiesel economics; Energetics of biodiesel production and effects on greenhouse gas emissions. Issues of ecotoxicity and sustainability with ; expanding biodiesel production

UNIT IV OTHER BIOFUELS **9**

Biodiesel from microalgae and microbes; biohydrogen production; biorefinery concepts

UNIT V PLATFORM CHEMICALS **9**

Case studies on production of C3 to C6 chemicals such as Hydroxy propionic acid, 1,3 propanediol, propionic acid, succinic acid, glucaric acid, cis-cis muconic acid.

TOTAL PERIODS: 45

REFERENCES:

1. Lee, Sunggyu; Shah, Y.T. “Biofuels and Bioenergy”. CRC / Taylor & Francis, 2013

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Bioconversion of renewable lignocelluloses biomass to biofuel and value added products

CO2 Production of Biothanol as sustainable and renewable energy

CO3 Production of Biodiesel and its economics

CO4 Other alternate energy sources such as biohydrogen and bio refinery

CO5 Synthesis of various Platform chemicals

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	2	-	-	2	2	3	3	1
CO2	3	3	2	3	2	2	-	-	2	2	3	3	1
CO3	3	3	2	3	2	2	-	-	2	2	3	3	1
CO4	3	3	2	3	2	2	-	-	2	2	3	3	1
CO5	3	3	2	3	2	2	-	-	2	2	3	3	1

OPEN ELECTIVES COURSES (OEC)

OCP101	BUSINESS DATA ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT - I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real–time decision–making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT - II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, Z–Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.
-

UNIT - III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and

- Hypothesis testing.
- Converting real–time decision–making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT - IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map–Reduce: Matrix–Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web–based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT - V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map–Reduce Tasks and Result Projection

TOTAL PERIODS: 45

REFERENCES:

1. Vignesh Prajapati, ‘Big Data Analytics with R and Hadoop’, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, ‘Business Analytics Using R – A Practical Approach’, A press, 2017.
3. Anand Rajaraman, Jeffrey David Ullman, ‘Mining of Massive Datasets’, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, ‘Essentials of Business Analytics’, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, ‘Business Analytics: The Science of Data–Driven Decision Making’, Wiley, 2017.
6. A. Ohri, ‘R for Business Analytics’, Springer, 2012
7. Rui Miguel Forte, ‘Mastering Predictive Analytics with R’, Packt Publication, 2015.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Identify the real–world business problems and model with analytical solutions.

CO2 Solve analytical problem with relevant mathematics background knowledge.

CO3 Convert any real–world decision–making problem to hypothesis and apply suitable statistical testing.

CO4 Write and demonstrate simple applications involving analytics using Hadoop and MapReduce

CO5 Use open–source frameworks for modeling and storing data and apply suitable visualization technique using R for visualizing voluminous data

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	-	1	1	-	2	2	1	1	1	1	2
CO2	1	2	-	1	1	-	2	2	1	1	1	1	2
CO3	1	2	-	1	1	-	2	2	1	1	1	1	2
CO4	1	2	-	1	1	-	2	2	1	1	1	1	2
CO5	1	2	-	1	1	-	2	2	1	1	1	1	2

OMF101 **INDUSTRIAL SAFETY** **L T P C**

3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT - I INTRODUCTION 9

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 color codes. Fire prevention and firefighting, equipment and methods.

UNIT - II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

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

UNIT - III WEAR AND CORROSION AND THEIR PREVENTION 9

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.

UNIT - IV FAULT TRACING 9

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.

UNIT - V PERIODIC AND PREVENTIVE MAINTENANCE 9

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

TOTAL PERIODS: 45

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgraw Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn , Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook, Eighth Edition, 2008

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Basics of industrial safety

CO2 Fundamentals of maintenance engineering and its tools and applications

CO3 Wear and corrosion, its types and preventive methods

CO4 Illustration of fault tracing and its concepts

CO5 Identification of preventive and periodic maintenance of various equipments

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	1	2	-	-	2	2	2	1	1	1	2
CO2	1	2	1	2	-	-	2	2	2	1	1	1	2
CO3	1	2	1	2	-	-	2	2	2	1	1	1	2
CO4	1	2	1	2	-	-	2	2	2	1	1	1	2
CO5	1	2	1	2	-	-	2	2	2	1	1	1	2

OPE101 RENEWABLE SOURCES OF ELECTRICAL ENERGY L T P C

3 0 0 3

OBJECTIVES:

- To understand the energy scenario and various energy sources.
- To learn the solar photovoltaic and solar thermal systems.
- To impart knowledge on wind energy and bio-mass energy conversion systems.
- To provide knowledge about the Geothermal and Ocean energy conversion system.
- To design and implement hybrid energy conversion system.

UNIT I INTRODUCTION 9

Renewable energy sources and its energy scenario - global and Indian; Environmental aspects and impacts of renewable energy generation on environment; Types of Renewable energy sources: solar - wind - Biomass - Ocean - Tidal - Geothermal and Fuel cell.

UNIT II SOLAR ENERGY SYSTEMS 9

Solar radiation at the earth's surface - solar radiation measurements - estimation of average solar radiation - Introduction to Solar photo-voltaic (PV) system and Solar - thermal system; Equivalent circuit of a solar cell, solar array and its sizing. Solar thermal collectors: flat plate collectors - concentrating collectors; solar thermal applications - heating, cooling, desalination, drying, cooking - solar thermal electric power plant.

UNIT III WIND ENERGY AND BIO-MASS ENERGY 9

Wind Sources: horizontal and vertical axis wind turbine - performance characteristics - types of wind turbine generators - Betz criteria; Bio-mass: Principles of Bio-Conversion - Anaerobic/aerobic digestion - types of Bio-gas digesters - gas yield - combustion characteristics of bio-gas - utilization for cooking.

UNIT IV GEOTHERMAL AND OCEAN ENERGY 9

Geothermal: Resources - types of wells - methods of harnessing the energy. Ocean Energy: OTEC-Principles, utilization - setting of OTEC plants - thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques - mini-hydro power plants and their economics.

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 9

Need for Hybrid Systems - Types of Hybrid systems - Case studies of solar and Wind.

TOTAL PERIODS: 45

TEXT BOOKS

1. S. P. Sukhatme, Solar Energy Principle of Thermal Collection and Storage", Tata McGraw Hill, 1990.
2. Rai G.D, "Non-Conventional Energy Sources", Khanna Publishers, 2011.

REFERENCES:

1. G. L. Johnson, Wind energy systems, Prentice Hall Inc. New Jersey.
2. J. M. Kriender, Principles of Solar Engineering", McGraw Hill, 1987.
3. Twidell&Wier, "Renewable Energy Resources", CRC Press (Taylor & Francis), 2011
4. V. S. Mangal, Solar Engineering", Tata McGraw Hill, 1992.
5. N. K. Bansal, Renewable Energy Source and Conversion Technology", Tata McGraw Hill, 1989.
6. P. J. Lunde, Solar Thermal Engineering", John Willey & Sons, New York, 1988.
7. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes", Wiley & Sons, 1990

COURSE OUTCOMES

Upon completion of the course, the students will

CO1 Understand the energy scenario and the various sources of non-conventional energy sources.

CO2 Learn the physics of solar energy and to understand the solar photovoltaic, solar-thermal energy conversion system.

CO3 Acquire knowledge in wind and bio-mass energy conversion system.

CO4 Acquire knowledge in Geothermal and Ocean energy conversion system.

CO5 Design and implement hybrid energy systems.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	2	1	-	1	2	2	2	1
CO2	2	2	2	2	2	2	1	-	1	2	2	2	1
CO3	2	2	2	2	2	2	1	-	1	2	2	2	1
CO4	2	2	2	2	2	2	1	-	1	2	2	2	1
CO5	2	2	2	2	2	2	1	-	1	2	2	2	1

OMB103	COST MANAGEMENT OF ENGINEERING PROJECTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT - I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT - II INTRODUCTION TO PROJECT MANAGEMENT 9

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.

UNIT - III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT - IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity- Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT - V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory

TOTAL PERIODS: 45

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003

5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Understand the costing concepts and their role in decision making

CO2 Understand the project management concepts and their various aspects in selection

CO3 Interpret costing concepts with project execution

CO4 Gain knowledge of costing techniques in service sector and various budgetary control techniques

CO5 Become familiar with quantitative techniques in cost management

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	-	1	-	1	1	1	1	1	1	1	2
CO2	1	2	-	1	-	1	1	1	1	1	1	1	2
CO3	1	2	-	1	-	1	1	1	1	1	1	1	2
CO4	1	2	-	1	-	1	1	1	1	1	1	1	2
CO5	1	2	-	1	-	1	1	1	1	1	1	1	2

OMF102 COMPOSITE MATERIALS L T P C

3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials

UNIT - I INTRODUCTION 9

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.

UNIT - II REINFORCEMENTS 9

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.

UNIT - III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic 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

UNIT - IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method –Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications

UNIT – V STRENGTH 9

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

TOTAL PERIODS: 45

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2010.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

COURSE OUTCOMES

Upon completion of the course, the students will

CO1 Know the characteristics of composite materials and effect of reinforcement in composite materials.

CO2 Know the various reinforcements used in composite materials.

CO3 Understand the manufacturing processes of metal matrix composites.

CO4 Understand the manufacturing processes of polymer matrix composites.

CO5 Analyze the strength of composite materials.

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	1	1	-	-	1	1	1	2
CO2	2	2	2	2	1	1	1	-	-	1	1	1	2
CO3	2	2	2	2	1	1	1	-	-	1	1	1	2
CO4	2	2	2	2	1	1	1	-	-	1	1	1	2
CO5	2	2	2	2	1	1	1	-	-	1	1	1	2

OCH105	WASTE TO ENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT - I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT - II BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT - III BIOMASS GASIFICATION 9

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

UNIT - IV BIOMASS COMBUSTION 9

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.

UNIT - V BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy 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.

TOTAL PERIODS: 45

TEXT BOOKS

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

REFERENCES:

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

COURSE OUTCOMES

Upon completion of the course, the students will be able

CO1 To understand the various types of wastes from which energy can be generated

CO2 To gain knowledge on biomass pyrolysis process and its applications

CO3 To develop knowledge on various types of biomass gasifiers and their operations

CO4 To gain knowledge on biomass combustors and its applications on generating energy

CO5 To understand the principles of bio-energy systems and their features

COs	PROGRAM OUTCOMES(POs)										PROGRAMSPECIFIC OUCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	1	3	-	1	-	-	2	1	2	2	1
CO2	3	2	1	3	-	1	-	-	2	1	2	2	1
CO3	3	2	1	3	-	1	-	-	2	1	2	2	1
CO4	3	2	1	3	-	1	-	-	2	1	2	2	1
CO5	3	2	1	3	-	1	-	-	2	1	2	2	1

AUDIT COURSES

AX1001	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

OBJECTIVES:

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission.

UNIT I: INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT II: PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT III: TITLE WRITING SKILLS 6

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, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV: RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

UNIT V: VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission.

TOTAL PERIODS: 30

REFERENCES:

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London,2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books)2006.
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book1998.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Understand that how to improve your writing skills and level of readability

CO2 Learn about what to write in each section

CO3 Understand the skills needed when writing a Title

CO4 Understand the skills needed when writing the Conclusion

CO5 Ensure the good quality of paper at very first-time submission

AX1002	**DISASTER MANAGEMENT**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

OBJECTIVES:

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflictsituations.
- Develop the strengths and weaknesses of disaster managementapproaches

UNIT I: INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II: REPERCUSSIONS OF DISASTERS AND HAZARDS 6

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.

UNIT III: DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV: DISASTER PREPAREDNESS AND MANAGEMENT 6

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.

UNIT V: RISK ASSESSMENT 6

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.

TOTAL PERIODS: 30

REFERENCES:

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

COURSE OUTCOMES

Upon completion of the course, the students will have an

CO1 Ability to summarize basics of disaster

CO2 Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3 Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO4 Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5 Ability to develop the strengths and weaknesses of disaster management approaches

AX1003	**VALUE EDUCATION**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

OBJECTIVES:

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I:

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II:

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

UNIT III:

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 brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV:

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.

TOTAL PERIODS: 30

REFERENCES:

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

COURSE OUTCOMES

Upon completion of the course, the students will

CO1 Knowledge of self-development.

CO2 Learn the importance of Human values.

CO3 Developing the overall personality

AX1004	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

OBJECTIVES:

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- 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 nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik revolution in 1917and its impact on the initial drafting of the Indian Constitution.

UNIT I: HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working).

UNIT II: PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features.

UNIT III: CONTOURS OF CONSTITUTIONAL RIGHTS AND 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

UNIT IV: 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.

UNIT V: LOCAL ADMINISTRATION

District's Administration head: Role and Importance Municipalities: Introduction, Mayor and role of Elected Representative, CEO, 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.

UNIT VI: ELECTION COMMISSION

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

TOTAL PERIODS 30

REFERENCES:

1. The Constitution of India,1950(Bare Act),GovernmentPublication.
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., LexisNexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis,2015.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

CO2 Discuss the intellectual origins of the framework of argument that informed the conceptualizationof social reforms leading to revolution in India..

CO3 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.

CO4 Discuss the passage of the Hindu Code Bill of 1956.

AX1005	PEDAGOGY STUDIES	L	T	P	C
		2	0	0	0

OBJECTIVES:

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development

UNIT I: INTRODUCTION AND METHODOLOGY 9

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II: THEMATIC OVERVIEW 9

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III: EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES 9

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV: PROFESSIONAL DEVELOPMENT 9

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.

UNIT V: RESEARCH GAPS AND FUTURE DIRECTIONS 9

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL PERIODS: 30

REFERENCES:

1. Ackers J, HardmanF (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 education research project (MUSTER) country report1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths 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: Amass scale, rapid, 'learning to read'campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1	What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
CO2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population oflearners?
CO3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effectivepedagogy?

AX1006	**STRESS MANAGEMENT BY YOGA**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

OBJECTIVES:

- To achieve overall health of body and mind
- To overcome stress

UNIT I: **10**

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II: **10**

Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III: **10**

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL PERIODS: 30

REFERENCES:

1. Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Develop healthy mind in a healthy body thus improving social health

CO2 Also Improve efficiency.

AX1007	**PERSONALITY DEVELOPMENT THROUGHLIFE ENLIGHTENMENT SKILLS**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

OBJECTIVES:

- To learn to achieve the highest goalhappily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom instudents

UNIT I: **10**

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)

UNIT II: **10**

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.

UNIT III: **10**

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68Chapter 12 - Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17,Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63.

TOTAL PERIODS: 30

REFERENCES:

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

COURSE OUTCOMES

Upon completion of the course, the students will gain knowledge on

CO1 Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life

CO2 The person who has studied Geeta will lead the nation and mankind to peace and prosperity

CO3 Study of Neet is hatakam will help in developing versatile personality of students.

AX1008	UNNAT BHARAT ABHIYAN	L	T	P	C
		2	0	0	0

Objectives

- To engage the students in understanding rural realities
- To identify and select existing innovative technologies, enable customization of technologies, or devise implementation method for innovative solutions, as per the local needs.
- To leverage the knowledge base of the institutions to devise processes for effective implementation of various government programmes
- To understand causes for rural distress and poverty and explore solutions for the same
- To apply classroom knowledge of courses to field realities and thereby improve quality of learning

UNIT - I QUALITY OF RURAL LIFE IN VILLAGES AND UNNAT BHARAT ABHIYAN 9

Introduction to Unnat Bharat Abhiyan - concept, scope and objectives, rural life, rural society, cast and gender relations, rural values with respect to community, nature and resources, elaboration of “Soul of India lies in villages” – (Gandhi Ji), Rural infrastructure, problems in rural area.

Assignment: Prepare a map (Physical , visual and digital) of the village you visited and write an essay about inter-family relation in that village.

UNIT - II RURAL ECONOMY AND LIVELIHOOD 9

Agriculture, farming, land ownership pattern, water management, animal husbandry, non-farm livelihoods and artisans, rural entrepreneurs, rural market .

Assignment: Describe your analysis of rural household economy, it’s challenges and possible pathways to address them. Group discussion in class- (4) Field visit 3.

UNIT - III RURAL INSTITUTIONS 9

History of Rural Development, Traditional rural organizations, Self Help Groups, Gram Swaraj and 3- Tier Panchayat Raj Institutions (Gram Sabha, Gram Panchayat, Standing Committee), local civil society, local administration. Introduction to Constitution, Constitutional Amendments in Panchayati Raj – Fundamental Rights and Directive Principles.

Assignment: Panchayati Raj institutions in villages? What would you suggest to improve their effectiveness? Present a case study (written or audio-visual). Field Visit – 4.

UNIT - IV RURAL DEVELOPMENT PROGRAMMES 9

National programmes - Sarva Shiksha Abhiyan, Beti Bachao, Beti Padhao, Ayushman Bharat, Swatchh Bharat, PM Awass Yojana, Skill India, Gram Panchayat Decentralised Planning, NRLM, MNREGA, etc.

Written Assignment: Describe the benefits received and challenges faced in the delivery of one of these programmes in the rural community, give suggestions about improving implementation of the programme for the rural poor.

UNIT - V FIELD WORK **9**

Each student selects one programme for field visit Field based practical activities:

- Interaction with SHG women members, and study of their functions and challenges; planning for their skill building and livelihood activities
- Visit MGNREGS project sites, interact with beneficiaries and interview functionaries at the work site
- Field visit to Swachh Bharat project sites, conduct analysis and initiate problem solving measures
- Conduct Mission Antyodaya surveys to support under Gram Panchayat Development Plan(GPDP)
- Interactive community exercise with local leaders, panchayat functionaries, grass-root officials and local institutions regarding village development plan preparation and resource mobilization
- Visit Rural Schools I mid-day meal centres, study Academic and infrastructural resources and gaps
- Participate in Gram Sabha meetings, and study community participation
- Associate with Social audit exercises at the Gram Panchayat level, and interact with programme beneficiaries
- Attend Parent Teacher Association meetings, and interview school drop outs
- Visit local Anganwadi Centre and observe the services being provided
- Visit local NGOs, civil society organisations and interact with their staff and beneficiaries.
- Organize awareness programmes, health camps, Disability camps and cleanliness camps o Conduct soil health test, drinking water analysis, energy use and fuel efficiency surveys
- Raise understanding of people's impacts of climate change, building up community's disaster preparedness
- Organise orientation programmes for farmers regarding organic cultivation, rational use of irrigation and fertilizers and promotion of traditional species of crops and plants
- Formation of committees for common property resource management, village pond maintenance and fishing.

Total Periods: 45

TEXT BOOKS:

1. Singh, Katar, Rural Development Principles, Policies and Management, Sage Publications, New Delhi, 2015
2. A Hand book on Village Panchayat Administration, Rajiv Gandhi Chair for Panchayati Raj Studies, 2002
3. United Nations, Sustainable Development Goals, 2015 un.org/sdgs

REFERENCE BOOKS:

1. M.P.Boraian, Best Practices in Rural Development, Shanlax Publishers
2. Unnat Bharat Abhiyan Website : www.unnatbharatabhiyan.gov.in

COURSE OUTCOMES

Upon completion of the course, the students will be able to

CO1 Understand of rural life, culture and social realities

CO2 Understand the concept of measurement by comparison or balance of parameters.

CO3 Develop a sense of empathy and bonds of mutuality with local community

CO4 Appreciate significant contributions of local communities to Indian society and economy

CO5 Value the local knowledge and wisdom of the community

CO6 Understand of rural life, culture and social realities