ANNA UNIVERSITY: CHENNAI 600 025
NON AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
REGULATIONS – 2021
M. TECH. BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULUM AND SYLLABUS

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

I.	To provide students with strong fundamentals with good scientific and technical knowledge so as to comprehend, analyze, design, and create novel products and solutions for developing novel therapeutics and enzymes.
II.	To prepare students to excel and succeed in Biotechnology research or industry through the latest state-of-art post graduate education
III.	To sensitize students about scientific temper and the necessity of bioethics, social responsibility and awareness of the environment
IV.	To enable 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

PROGRAM OUTCOMES (POs)

PO	**PROGRAMME OUTCOMES**
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.	Provide potential solutions for solving technological problems in various domains of Biotechnology considering the societal, public health, cultural environmental factors.
4.	Create and apply modern engineering tools for the prediction and modeling of complex bioengineering activities
5.	Analyze Biotechnological problems and formulate intellectual and innovative vistas for research and development with self-management and team work skills towards collaborative, multidisciplinary scientific endeavors in order to achieve common goals.
6.	Demonstrate adherence to accepted standards of professional bioethics and social responsibilities with entrepreneurial and managerial skills for the implementation of multidisciplinary projects

PEO / PO Mapping:

PEO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
I.	✓	✓	✓	✓		
II.	✓	✓		✓	✓	
III.	✓		✓		✓	✓
IV.		✓	✓		✓	✓

MAPPING OF M.TECH. BIOTECHNOLOGY

YEAR	SEMESTER	COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Applied Statistics for Biotechnologists	3	2	2	1	2	2
		Advanced Molecular Biology and Genetic Engineering	3	2	2	2	3	2
		Bioprocess Technology	3	3	1	3	2	1
		Advanced Immunology	3	2	1	2	1	1
		Research Methodology and IPR	3	-	1	-	2	2
		Audit Course - I *						
		Immuno-technology Laboratory	3	1	2	1	2	-
	SEMESTER II	Bio Separation Technology	2	1	1	1	1	1
		Computational Biology	2	2	2	2	2	1
		Metabolic Process and Engineering	3	2	3	2	3	2
		Preparative And Analytical Techniques In Biotechnology	2	2	2	2	2	2
YEAR II	SEMESTER III	Advanced Genetic Engineering Laboratory	2	3	1	2	2	1
		Bioprocess and Downstream Processing Laboratory	2	2	2	1	3	1
		Project Work I	2	1	2	1	2	1
	SEMESTER IV	Project Work II	3	2	3	2	3	2

YEAR	SEMESTER	COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
PROFESSIONAL ELECTIVE	PROFESSIONAL ELECTIVE I	Advances in Animal Biotechnology	2	2	2	2	3	3
		Plant Genetic Engineering and Biotechnology	3	3	3	2	2	2
		Advances in Cancer Biology	2	2	2	2	2	2
		Phytochemistry	2	2	2	2	2	2
		Advances in Molecular Pathogenesis	2	3	3	1	2	2
	PROFESSIONAL ELECTIVE II	Enzyme Engineering and Technology	2	2	2	1	2	1
		Bio reactor Design and Control	2	3	3	3	2	2
		Environmental Engineering and Biotechnology	3	2	3	2	2	2
		Thermodynamics for Biological Systems	2	2	2	3	3	2
		Biotechnology in Food Processing	2	2	2	1	2	2
		Bioprocess Modelling and Simulation	2	1	2	2	2	2
		Biofuels and Platform Chemicals	2	2	2	2	2	1
	PROFESSIONAL ELECTIVE III	Molecular Medicine	3	1	2	1	2	1
		Biomaterials and Tissue Engineering	3	2	2	2	2	2
		Biopharmaceuticals and Biosimilars	3	2	2	1	3	2
		Bio Nanotechnology	3	3	2	3	2	2
	PROFESSIONAL ELECTIVE IV	Advanced Genomics and Proteomics	2	2	2	2	1	1
		IPR, Biosafety and Entrepreneurship	1	1	2	1	1	2
		Protein Structure Analysis	2	1	2	1	2	1
		Computer Aided Learning of Structure and Function of Proteins	1	1	2	1	2	1
		Computational Methods in Fluid Dynamics	2	1	1	2	2	2

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SEMESTER I

SL. NO.	COURSE CODE	COURSE NAME	CATE GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4110	Applied Statistics for Biotechnologists	FCC	4	0	0	4	4
2.	BY4101	Advanced Molecular Biology and Genetic Engineering	PCC	3	0	0	3	3
3.	BY4102	Bioprocess Technology	PCC	3	0	0	3	3
4.	BY4103	Advanced Immunology	PCC	3	0	0	3	3
5.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Professional Elective I	PEC	3	0	0	3	3
7.		Audit Course - I *	AC	2	0	0	2	0
PRACTICALS								
8.	BY4111	Immuno-technology Laboratory	PCC	0	0	6	6	3
			TOTAL	**20**	**0**	**6**	**26**	**21**

* Audit Course is optional

SEMESTER II

SL. NO.	COURSE CODE	COURSE NAME	CATE GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	BY4201	Bio Separation Technology	PCC	3	0	0	3	3
2.	BY4202	Computational Biology	PCC	3	1	0	4	4
3.	BY4251	Metabolic Process and Engineering	PCC	3	0	0	3	3
4.		Professional Elective II	PEC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
6.		Professional Elective IV	PEC	3	0	0	3	3
7.		Open Elective	OEC	3	0	0	3	3
8.		Audit Course - II *	AC	2	0	0	2	0
PRACTICALS								
9.	BY4211	Preparative and Analytical Techniques In Biotechnology	PCC	0	0	6	6	3
			TOTAL	**23**	**1**	**6**	**30**	**25**

* Audit Course is optional

SEMESTER III

SL. NO.	COURSE CODE	COURSE NAME	CATE GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	BY4311	Advanced Genetic Engineering Laboratory	PCC	0	0	6	6	3
2.	BY4312	Bioprocess and Downstream Processing Laboratory	PCC	0	0	6	6	3
3.	BY4313	Project Work I	EEC	0	0	12	12	6
			TOTAL	**0**	**0**	**24**	**24**	**12**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE NAME	CATE GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	BY4411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 70

LIST OF PROFESSIONAL ELECTIVES

SEMESTER I, ELECTIVE I

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BY4001	Advances in Animal Biotechnology	PEC	3	0	0	3	3
2.	BY4002	Plant Genetic Engineering and Biotechnology	PEC	3	0	0	3	3
3.	BY4003	Advances in Cancer Biology	PEC	3	0	0	3	3
4.	BY4004	Phytochemistry	PEC	3	0	0	3	3
5.	BY4005	Advances in Molecular Pathogenesis	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BY4006	Enzyme Engineering and Technology	PEC	3	0	0	3	3
2.	BY4007	Bio reactor Design and Control	PEC	3	0	0	3	3
3.	BY4008	Thermodynamics for Biological Systems	PEC	3	0	0	3	3
4.	BY4009	Biotechnology in Food Processing	PEC	3	0	0	3	3
5.	BY4010	Bioprocess Modelling and Simulation	PEC	3	0	0	3	3
6.	BY4011	Biofuels and Platform Chemicals	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE III

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BY4012	Molecular Medicine	PEC	3	0	0	3	3
2.	BY4071	Biomaterials and Tissue Engineering	PEC	3	0	0	3	3
3.	BY4013	Biopharmaceuticals and Biosimilars	PEC	3	0	0	3	3
4.	BY4014	Bio Nanotechnology	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BY4015	Advanced Genomics and Proteomics	PEC	3	0	0	3	3
2.	BY4016	IPR, Biosafety and Entrepreneurship	PEC	3	0	0	3	3
3.	BY4017	Protein Structure Analysis	PEC	3	0	0	3	3
4.	BY4018	Computer Aided Learning of Structure and Function of Proteins	PEC	3	0	0	3	3
5.	BY4019	Computational Methods in Fluid Dynamics	PEC	3	0	0	3	3

AUDIT COURSES - I

REGISTRATION FOR ANY OF THESE COURSES IS OPTIONAL TO STUDENTS

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

FOUNDATION COURSE (FC)

SL. NO.	COURSE CODE	COURSE NAME	CATE GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	MA4110	Applied Statistics For Biotechnologists	FCC	4	0	0	4	4

PROFESSIONAL CORE (PCC)

SL. NO.	COURSE CODE	COURSE NAME	CATE GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BY4101	Advanced Molecular Biology Genetic Engineering	PCC	3	0	0	3	3
2.	BY4102	Bioprocess Technology	PCC	3	0	0	3	3
3.	BY4103	Advanced Immunology	PCC	3	0	0	3	3
4.	BY4201	Bio Separation Technology	PCC	3	0	0	3	3
5.	BY4202	Computational Biology	PCC	3	1	0	4	4
6.	BY4251	Metabolic Process & Engineering	PCC	3	0	0	3	3
7.	BY4111	Immuno technology Laboratory	PCC	0	0	6	6	3
8.	BY4211	Preparative and Analytical Techniques in Biotechnology Laboratory	PCC	0	0	6	6	3
9.	BY4311	Advanced Genetic Engineering Laboratory	PCC	0	0	6	6	3
10.	BY4312	Bioprocess and Downstream Processing Laboratory	PCC	0	0	6	6	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE NAME	CATE GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	BY4313	Project Work I	EEC	0	0	12	12	6
2.	BY4411	Project Work II	EEC	0	0	24	24	12

RESEARCH METHODOLOGY AND IPR (RMC)

SL. NO.	COURSE CODE	COURSE NAME	CATE GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3
7.	OME431	Vibration and Noise Control Strategies	3	0	0	3
8.	OME432	Energy Conservation and Management in Domestic Sectors	3	0	0	3
9.	OME433	Additive Manufacturing	3	0	0	3
10.	OME434	Electric Vehicle Technology	3	0	0	3
11.	OME435	New Product Development	3	0	0	3
12.	OBA431	Sustainable Management	3	0	0	3
13.	OBA432	Micro and Small Business Management	3	0	0	3
14.	OBA433	Intellectual Property Rights	3	0	0	3
15.	OBA434	Ethical Management	3	0	0	3
16.	ET4251	IoT for Smart Systems	3	0	0	3
17.	ET4072	Machine Learning and Deep Learning	3	0	0	3
18.	PX4012	Renewable Energy Technology	3	0	0	3
19.	PS4093	Smart Grid	3	0	0	3
20.	CP4391	Security Practices	3	0	0	3
21.	MP4251	Cloud Computing Technologies	3	0	0	3
22.	IF4072	Design Thinking	3	0	0	3
23.	MU4153	Principles of Multimedia	3	0	0	3
24.	DS4015	Big Data Analytics	3	0	0	3
25.	NC4201	Internet of Things and Cloud	3	0	0	3
26.	MX4073	Medical Robotics	3	0	0	3
27.	VE4202	Embedded Automation	3	0	0	3

SUMMARY

S.NO.	Subject Area	Credits per Semester				Credits Total
		I	II	III	IV	
1	FC	4	-	-	-	4
2	PCC	12	13	6	-	31
3	PEC	3	9	-	-	12
4	OEC	-	3	-	-	3
5	EEC	-	-	6	12	18
	RMC	2	-	-	-	2
	Total	**21**	**25**	**12**	**12**	**70**
	Audit courses (Non Credit)	*	*			

MA4110 APPLIED STATISTICS FOR BIOTECHNOLOGISTS L T P C
4 0 0 4

OBJECTIVES:

This course will help the students to

- Study the mathematical aspects of probability, determination of probability and moments.
- Study the distributions of discrete and continuous random variables and their properties.
- Obtain the covariance and correlation between jointly distributed random variables, interpret simple linear regression and fitting of curves by least square method.
- Study concepts and methods of sampling and various statistical tests in testing hypothesis on data.
- Analyze one-way, two-way and three-way classifications of analysis of variance and problems using them.

UNIT I PROBABILITY AND RANDOM VARIABLES 12

Sample spaces - Events - Axiomatic approach to probability - Conditional probability - Additional theorem - Multiplication theorem - Baye's theorem – Random variables : Continuous and discrete random variables - Distribution function - Expectation with properties - Moments, mean, variance problems - Continuous and discrete distributions.

UNIT II STANDARD DISTRIBUTIONS 12

Bivariate distribution - Conditional and marginal distribution - Discrete distributions - Binomial, Poisson, Geometric distributions - Continuous distributions - Normal, Exponential and Negative exponential, Gamma distributions - Simple problems - Properties.

UNIT III CORRELATION AND REGRESSION 12

Correlation coefficient - Properties - Problems - Rank correlation - Regression equations - Problems - Curve fitting by the method of least squares - Fitting curves of the form ax+b , ax^2+bx+c , ab^x and ax^b - Bivariate correlation application to biological problems.

UNIT IV SAMPLING AND TESTING OF HYPOTHESIS 12

Concept of sampling - Methods of sampling - Sampling distributions and standard error - Small samples and large samples - Test of hypothesis - Type I & Type II Errors - Critical region - Large sample tests for proportion, mean - Exact test based on normal , t , F and Chi - square distribution problems - Test of goodness of fit.

UNIT V ANALYSIS OF VARIANCE 12

Basic principles of experimentation - Analysis of variance - One - way, Two - way classifications - Randomized block design - Latin square design - Problems.

TOTAL: 60 PERIODS

COURSE OUTCOMES

After completion of the course the students will be able to

CO1 Mathematical basis and foundations of probability and statistics, computation of probability and moments, standard distributions of discrete and continuous random variables and standard distributions and their properties

CO2 Compute the covariance and correlation between jointly distributed variables.

CO3 Compute and interpret simple linear regression and least square methods between two variables.

CO4 Methods of sampling and application of various statistical tests in testing hypotheses on data

CO5 One-way and two-way classifications of analysis of variance, properties and assumptions, randomized block design and Latin square design problems

REFERENCES:

1. Devore, J. L., "Probability and Statistics for Engineering & Sciences", 8th Edition, Cengage Learning, 2014.
2. Gupta. S.C and Kapoor, V.K,. "Fundamentals of Mathematical Statistics", 12th Edition, Sultan Chand and Sons, New Delhi, 2020.
3. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", 9th Edition, Pearson Education, Asia, 2016.
4. Rice, J. A., "Mathematical Statistics and Data Analysis", 3rd Edition, Cengage Learning, 2013.
5. Ross, S. M., "Introduction to Probability and Statistics for Engineers and Scientists", 6th Edition, Elsevier, 2020.

CO – PO MAPPING

	PO01	PO02	PO03	PO04	PO05	PO06
CO1	1	1	1	-	-	-
CO2	2	1	2	-	-	-
CO3	2	1	2	-	-	-
CO4	2	1	3	-	-	-
CO5	2	1	3	-	-	-
Avg.	1.8	1	2.2	-	-	-

BY4101 ADVANCED MOLECULAR BIOLOGY AND GENETIC ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the gene cloning methods and the tools and techniques involved in gene
- cloning and 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.
- To provide extensive knowledge about Gene Regulation and Genome Editing in Genetic engineering applications.
- To explain the principles involved the creation of trangenic animals and plants.

UNIT I CLONING AND EXPRESSION OF GENES 9

Overview of Restriction and Modification system. Cloning vehicles: Plasmids – Host range, Copy number control, Compatibility. λ phage – Insertional and replacement vectors, in vitro packaging. Single strand DNA vector – M13 Phage. Cosmids, Phasmids, PAC, BAC and YAC. Expression vector – Characteristics, RNA probe synthesis, High level expression of proteins, Protein solubilization, purification and export.

UNIT II CONSTRUCTION OF DNA LIBRARIES 9

DNA library – types and importance. cDNA library: Conventional cloning strategies – Oligod T priming, self-priming and its limitations. Full length cDNA cloning – Capture method and Oligo capping. Strategies for gDNA library construction – Chromosome walking. gDNA and cDNA library. Screening strategy. Hybridization, PCR, Immuno-screening, South-Western and North-Western. Functional cloning – Functional complementation and gain of function. Difference cloning: Differential screening, Subtracted DNA library, differential display by PCR. Microarrays - Applications of microarrays.

UNIT III PCR, MUTAGENESIS AND DNA SEQUENCING 9

Polymerase Chain Reaction (PCR): Principle and applications. Different types of PCR (Hot start, touchdown, multiplex, inverse, nested, AFLP, allele-specific, assembly, Asymmetric, LATE, Colony, in situ, long). Real-time PCR, FRET, SYBR Green assay, Taqman probes, Molecular beacons. Mutagenesis and chimeric protein engineering by PCR, RACE, Kunkels' method of mutagenesis, Phage display and screening methodologies. DNA sequencing. Chemical and Enzymatic methods, Pyrosequencing, Automated sequencing, Genome sequencing methods – top -down approach, bottom- up approach, Next generation gene sequencing.

UNIT IV POST TRANSCRIPTIONAL GENE REGULATION AND GENOME EDITING 9

Role of siRNA, miRNA in gene regulation: siRNA- PTGS, Quelling, origin, components of gene silencing mechanisms, TGS, PTGS, Applications. miRNA- Identification, biogenesis, mechanism of action. Difference between siRNA and miRNA, effect of small RNAs on chromosomal DNA. Genome Editing tools: Genome editing- introduction, zinc finger nucleases, TALENS, CRISPR-Cas9 systems, applications.

UNIT V GENETIC ENGINEERING 9

Introduction of foreign genes into animal cells – Importance, DNA Microinjection, Retroviral vectors, Transfection of Embryonic stem cells, recombination. Transgenic plants –Ti Plasmid, Co integrate and Binary vectors, transgenic plants for disease resistance, abiotic stress resistance, enhanced nutritional value, Viral vectors, Engineering siRNA mediated gene knock downs (shRNA).

TOTAL : 45 PERIODS

COURSE OUTCOMES

After completion of the course the students will be able to

CO1 Gain knowledge in gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.

CO2 Understand the heterologous expression of cloned genes in different hosts, production of recombinant proteins and PCR techniques.

CO3 Gain extensive knowledge in comparative genomics and proteomics.

CO4 Gain extensive knowledge about Gene Regulation and Genome Editing in Genetic engineering applications.

CO5 Understand the principles involved the creation of trangenic animals and plants.

REFERENCES:

1. Primrose S.B., Twyman R.H., and Old R.W. "Principles of Gene Manipulation." 7th Edition. Blackwell Science/Oxford, 2006
2. Winnacker E.L. "Frome Genes to Clones: Introduction to Gene Technology." Panima, 2003.
3. Glick B.R. and Pasternak J.J. "Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3rd Edition. ASM Press, 2003.
4. Lemonie, N.R. and Cooper, D.N. "Gene Therapy." BIOS Scientific, 1996
5. Nelle W. and Hammann C. "Small RNAs: Analysis and Regulatory Functions (Nucleic Acids and Molecular Biology)", 2nd Edition. Springer Verlag Berlin and Heidelberg GmbH & Co. K, 2007
6. Krishnarao Appasani. "Genome Editing and Engineering" Cambridge University press 2018.
7. Raghavachari Nalini, Garcia-Reyero Natàlia. "Gene expression analysis: Methods and protocols" 1st Edition, Humana Press, 2018.

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	2	1	2	3	2
CO2	3	2	1	2	3	2
CO3	3	3	2	2	2	1
CO4	3	2	1	3	3	3
CO5	3	3	3	3	3	3
Average	**3**	**2**	**2**	**2**	**3**	**2**

BY4102 **BIOPROCESS TECHNOLOGY** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on black box stoichiometries principles applicable in Biotechnology
- 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 product using integrated biochemical processes.
- To develop learning and understanding ability in case studies for fermentation derived products

UNIT I BLACK BOX MODEL 9

Yield coefficients, black box stoichiometries, elemental balances, heat balance, degrees of reduction balances, systematic analysis of black box stoichiometries, and identification of gross measurement errors

UNIT II DESIGN OF FERMENTATION PROCESSES 9

Kinetics of substrate utilization, biomass growth and product formation, inhibition of cell growth and product formation. Design and operation of continuous cultures, chemostat in series, batch and fed batch cultures, total cell retention cultivation.

UNIT III MODELING OF VARIOUS FERMENTATION PROCESSES 9

Principles of model building for biotechnological processes, unstructured models on the population level, structured models on the cellular level, morphologically structured model, genetically structured models, cybernetic model, modeling of recombinant systems.

UNIT IV BIOREACTOR DESIGN & CONSTRUCTION 9

Basic design and construction of CSTR, bioreactor design of agitator / agitator motor, power consumption in aerated bioreactor, design of sparger, mixing time estimation, oxygen mass transfer capability in bioreactor, Removal of Heat in bioreactor, Main parameters to be monitored and controlled in fermentation processes.

UNIT V CASE STUDIES IN FERMENTATION DERIVED PRODUCTS 9

Case studies on Production of green chemicals, algal biofuels, recombinant Insulin. Case studies on medium design, reactor design & process optimization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course the students will be able to

CO1	Gain knowledge on black box stoichiometries principles applicable in Biotechnology
CO2	Understand the design and operation of fermentation processes with all its prerequisites.
CO3	Gain knowledge in basics of microbial kinetics, metabolic stoichiometry and energetics.
CO4	Develop bioengineering skills for the production of biochemical product using integrated biochemical processes.
CO5	Develop learning and understanding ability in case studies for fermentation derived products

REFERENCES:

1. Shuler, M.L., Kargi F., “Bioprocess Engineering – Basic Concepts “, Prentice Hall, 2nd Edition, 2015.
2. Pauline D., “Bioprocess Engineering Principles “. Elsevier, 2nd Edition, 2012.
3. Nielsen, J. and Villadsen, J. “Bioreaction Engineering Principles”. Springer, 3rd Edition, 2011.
4. Lydersen B.K., “Bioprocess Engineering Systems, Equipment and Facilities” , Wiley Blackwell, 2nd Edition, 2010.
5. Bailey, J.E. and Ollis, D.F. “Biochemical Engineering Fundamentals", 2nd Edition, McGraw Hill, 2017.
6. Stanbury, P.F., Stephen J.H., Whitaker A., “Principles of Fermentation Technology”, Science & Technology Books, 2nd Edition, 2009.

CO – PO MAPPING

Course outcome	PO					
	1	2	3	4	5	6
CO1	3	2	1	2	1	1
CO2	3	3	1	3	2	
CO3	3	3	1	3	2	
CO4	3	3	1	3	2	
CO5	3	3	1	3	2	
Average	**3**	**3**	**1**	**3**	**2**	**1**

BY4103 ADVANCED IMMUNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the structure, functions and integration of immune system
- To explain the antigen-antibody interactions that offers defence mechanism
- To educate the importance immunoregulation in Immunity development
- To explain various techniques of therapeutically significant monoclonal and engineered
- antibodies production
- To educate the importance of Immunotherapeutics development for Clinical Applications

UNIT I INNATE IMMUNITY 9

Introduction to the Immune system – Various components of the immune system – Innate immune response - Inflammatory response. Cellular and Molecular aspects of the innate immune system- Recognition of pathogens and activation of Toll-like receptors- complement system.

UNIT II ADAPTIVE IMMUNITY 9

Antibody structure and functions – Antibody mediated and cell mediated immunity – components of cell-mediated immunity. Antigen-processing and presentation. MHC – structure and function. Antigen receptors and accessory molecules of T lymphocytes- B- cell development and activation, generation of B-cell diversity – Mechanism of immunoglobulin – gene arrangement and immunoglobulin superfamily. T-cell development – Generation of TCR diversity – Biology of Cytokines.

UNIT III IMMUNOREGULATION 9

Helper and suppressor cells, mechanism in immunity. Inflammation – mechanism and significance. Transplantation immunology- graft rejection and HLA antigens. Role of MHC and T cells. Prevention of graft rejection. Hypersensitivity- immediate and delayed types; mechanism and reactions. Vaccines – types, production and uses. Immunity to virus, bacteria and parasites- genetic control of immune response. Immunosuppression.

UNIT IV IMMUNOLOGICAL TECHNIQUES 9

PBMC separation from the blood; Isolation of monocytes/macrophages. Macrophage culture. Isolation of dendritic cells. Identification of lymphocytes based on CD markers; Production of monoclonal antibodies and Polyclonal antibodies. Principle and applications of immunoassays: RIA, ELISA, IRMA, ELFIA, ECLIA, DELFIA, TRIFMA, SLFIA, and western blot. Precipitation reaction – immunodiffusion, immune-electrophoresis, precipitin ring test. Agglutination tests –hemagglutination, febrile and latex agglutination- applications. Tumor Cell imaging Techniques- In vitro and In vivo cell tracking techniques; Immuno-electron microscopy, Immunofluorescence microscopy,

Flurochromes; Staining techniques for live cell imaging and fixed cells; Flow cytometry

UNIT V IMMUNOTHERAPEUTICS **9**

Recombinant Antibodies, Bispecific Antibodies, catalytic antibodies, humanized antibodies, monoclonal antibodies: Antibody-drug conjugates (ADCs), radiolabeled antibodies, immunotoxins, cancer vaccines (tumor cell vaccines), Antigen vaccines, dentritic cell vaccines. DNA vaccines, cell based therapeutics.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of the course the students will be able to

- **CO1** Understand the structure, functions and integration of immune system
- **CO2** Understand the antigen-antibody interactions that offers defence mechanism
- **CO3** Gain knowledge in importance of learning immunoregulation in Immunity development
- **CO4** Understand the importance of various techniques of therapeutically significant monoclonal and engineered antibodies production
- **CO5** Gain knowlege in Immunotherapeutics development for Clinical Applications

REFERENCES

1. Peter J. Delves., Seamus J. Martin., Dennis R. Burton., Ivan M. Roitt., "Essential Immunology", Wiley-Blackwell; 13th Edition, 2017.
2. Kuby J., "Immunology", WH Freeman & Co., 8th Edition, 2018.
3. Abbas, K.A., Litchman, A.H., Pober, J.S., "Cellular and Molecular Immunology", Elsevier., 9th Edition, 2017.
4. Wilson K and Walker J., "Practical Biochemistry" , Cambridge University Press. 8th Edition, 2018
5. Weir, D.N, "Handbook of Experimental Immunology", Wiley-Blackwell Publishers, 5th Edition 1997

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3		1			
CO2	3		1			
CO3	3		1			
CO4	3	3	1	3	1	2
CO5	3	3	1	3	1	2
Average	**3**	**2**	**1**	**2**	**1**	**1**

RM4151 RESEARCH METHODOLOGY AND IPR **LT P C 2 0 0 2**

UNIT I RESEARCH DESIGN **6**

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES **6**

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data

- Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL :30 PERIODS

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

BY4111 IMMUNOTECHNOLOGY LABORATORY L T P C

0 0 6 3

COURSE OBJECTIVES

1. To give practical exposure in the clinical diagnosis.
2. To give laboratory training in different immune technological techniques.
3. To give hands on training in cell staining, separation and identification

LIST OF EXPERIMENTS

1. *Preparation of antigen and Routes of immunization (Intraperitoneal, Sub-cutaneous, Intramuscular, Intra- nasal, Oral – VIRTUAL DEMO)
2. *Methods of bleeding (Tail bleeding, Intravenous, intraorbital - VIRTUAL DEMO)
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 semidry 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 splenocytes and proliferation against mitogens

*** Approval of IAEC is mandatory for experiments involving Live animals**

TOTAL : 90 PERIODS

LIST OF EQUIPMENTS REQUIRED

Microscopes,
Purification columns,
Microplate reader,
UV spectrometer,
PAGE apparatus,
Western blot apparatus,
Centrifuge,
Haemocytometer,

COURSE OUTCOMES

After completion of the course the students will be able to

1. Understand the clinical diagnosis methods and its importance.
2. Gain training in different immunotechnological techniques.
3. Gain hands on training in cell staining, separation and identification

CO – PO MAPPING

Course outcome	PO					
	1	2	3	4	5	6
CO1	3	1	2	1	2	
CO2	3	1	2	1	2	
CO3	3	1	2	1	2	
Average	3	1	2	1	2	

SEMESTER II

BY4201 BIO SEPARATION TECHNOLOGY L T P C

3 0 0 3

COURSE OBJECTIVES

1 To enable the students to understand the methods to obtain pure proteins, enzymes and in general about product development R & D
2 To gain depth knowledge and hands on experience on Downstream processes to commercial therapeuticaly important proteins.
3 To educate the principle involved in membrane separations and enrichment operations
4 To promote the applicability of chromatographic techniques in Biological products separation
5 To educate about the finishing operations and formulations of commercial applications.

UNIT I DOWNSTREAM PROCESSING IN BIOTECHNOLOGY 9

Role and importance of downstream processing in biotechnological processes – Problems and requirements of bio product 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

bio products (high volume, low value products and low volume, high value products) – Upstream production methods affect downstream purification strategies.

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 ccentrifuges and applications – Sedimentation

UNIT III MEMBRANE SEPARATIONS AND ENRICHMENT OPERATIONS 9

Theory, Design consideration and configuration of membrane separation processes – Reverse osmosis, microfiltration, ultra filtration, dialysis and pervaporation – Structure and characteristics of membranes – Membrane modules – Enrichment Operations – Extraction–equipment for extraction – Aqueous two-phase extraction process – Evaporators – Types of evaporators – 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 – Partition, normal-phase, displacement, reversed-phase, size exclusion, ion exchange, hydrophobic, affinity chromatography – Scale-up of chromatography – Process considerations in Preparative liquid chromatography and HPLC .

UNIT V FINISHING OPERATIONS AND FORMULATIONS 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES

After completion of the course the students will be able to

CO1 Understand the methods to obtain pure proteins, enzymes and in general about product development R & D

CO2 Gain depth knowledge and hands on experience on Downstream processes to commercial therapeuticaly important proteins.

CO3 Understand the principle involved in membrane separations and enrichment operations

CO4 Understand the applicability of chromatographic techniques in Biological products separation

CO5 Understand the importance of finishing operations and formulations of commercial applications..

REFERENCES

1. Belter, P.A., Gussler, E.L. and Hu, W.S., “Bio-separation: Downstream Processing for Biotechnology”, John Wiley and Sons, 2011.
2. Forciniti, D., “Industrial Bio-separation: Principles & Practice”, Blackwell, 2008.
3. Ghosh, R., “Principles of Bio-separations Engineering”, World Scientific Publishers, 2006.
4. Ladisch, M.R., “Bioseparations Engineering: Principles, Practice, and Economics”, John Wiley & Sons, 2001.
5. Roger, H., “Bio-separations Science and Engineering”, Oxford University Press, 2006.

CO – PO MAPPING

Course outcome	PO					
	1	2	3	4	5	6
CO1	2	3				1
CO2	2		1`	2	2	
CO3	1		1			
CO4				1	1	
CO5	1	2	2			
Average	2	1	1	1	1	1

BY4202 COMPUTATIONAL BIOLOGY LT P C
3 1 0 4

COURSE OBJECTIVE:

1. To improve the programming skills of the student in the field of Biological research
2. Make students know the recent sequence analysis methods
3. To educate the students about recent advancements involved in drug delivery systems
4. To develop depth knowledge in Molecular Dynamics and Molecular Modeling
5. To develop depth knowledge in Systems Biology Networks

UNIT I ALGORITHMS 9

Dynamic Programming Algorithms: Needleman-Wunsch, Smith-Watermann – Heuristic Algorithms: FASTA, BLAST; statistical and Biological significance; Clustering: Hierarchical Clustering, k-Means Clustering; Phylogeny; Tree Construction: Distance-based (Neighbour-Joining, Unweighted Pair Group Method with Arithmetic Mean) and Character-based methods (small and large parsimony algorithm).

UNIT II SEQUENCE ANALYSIS 9

Nucleic acid: Reading frames, Codon Usage analysis, Translational and transcriptional signals, Splice site identification, Gene prediction methods, RNA fold analysis; Protein: Compositional analysis, Hydrophobicity profiles, Amphiphilicity detection, Moment analysis, Transmembrane prediction methods, Secondary structure prediction methods.

UNIT III COMPUTER AIDED DRUG DESIGN 9

Drug discovery process: Target identification and validation, lead optimization and validation. Analog-Based drug design: Pharmacophores (3D database searching, conformation searches, deriving and using 3D Pharmacophore, constrained systematic search, Genetic Algorithm, clique detection techniques, maximum likelihood method) and QSAR; Structure-based drug design: Docking, De Novo Drug Design (Fragment Placements, Connection Methods, Sequential Grow), Virtual screening.

UNIT IV MOLECULAR DYNAMICS AND MACHINE LEARNING 9

Molecular Dynamics & Simulation: Molecular Modeling (QM / MM and Mixed), thermodynamic and chemical transformations, classical force-field, bonds, bond Angles, degrees of freedom, solvation, molecular surfaces, equations of motion, properties of simulations, applications of MD simulations. Hidden Markov Models: Hidden Markov Models, Machine learning techniques, Profile HMMs, Hidden Markov Models for gene finding, Artificial Neural Networks: Historic evolution – Perceptron, NN Architecture, supervised and unsupervised learning, Viterbi Algorithm, Artificial Neural Networks in protein secondary structure prediction; Decision trees, Support Vector Machines.

UNIT V SYSTEMS BIOLOGY **9**

Systems Biology Networks - basics of computer networks, Biological uses and Integration. Micro array – definition, Applications of Micro Arrays in systems biology. Self- organizing maps and Connectivity maps - definition and its uses. Networks and Pathways – Types and methods. Metabolic networks.

TOTAL : 45+15 = 60 PERIODS

COURSE OUTCOMES

After completion of the course the students will be able to

CO1 Gain depth knowledge in programming skills of the student in the field of Biological research
CO2 Learn the current trends developed in sequence analysis methods
CO3 Gain depth knowledge about recent advancements involved in drug delivery systems
CO4 Gain depth knowledge in Molecular Dynamics and Molecular Modeling
CO5 Gain depth knowledge in Systems Biology Networks

REFERENCES

1. Gusfield D. et al., "Algorithms on Strings Trees and Sequences." Cambridge University Press, 1st Edition, 1997.
2. Mount, David W. "Bioinformatics: Sequence and Genome Analysis", CBS, 2nd Edition, 2004.
3. Lesk, Arthur M., "Introduction to Bioinformatics", Oxford University Press, 2nd Edition, 2010.
4. Leach A. R., "Molecular Modeling Principles and Applications", Pearson, 2nd Edition, 2010.
5. Madsen, U. "Textbook of Drug Design and Discovery", Taylor & Francis, 3rd Edition, 2002.
6. Baldi P., Brunak S., "Bioinformatics: The Machine Learning Approach." East West Press, 2nd Edition, 2003
7. Baxevanis A.D., Oullette, B.F.F., A Practical Guide to the Analysis of Genes and Proteins" John Wiley, 2nd Edition, 2002.
8. Durbin R. Eddy S., Krogh A., Mitchison G., "Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids", Cambridge University Press, 1st Edition, 1998.
9. Alon, U., "An Introduction to Systems Biology: Design Principles of Biological Circuits.", Chapman & Hall/CRC, 1st Edition, 2006.

Extensive Reading:

1. "https://journals.plos.org/ploscompbiol", Public Library of Science.
2. "https://academic.oup.com/bioinformatics" , Oxford University Press

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	2	1			
CO2	2	2		3		
CO3	1		3		2	3
CO4				3	2	
CO5		2	2		2	
Average	**2**	**2**	**2**	**2**	**2**	**1**

BY4251 METABOLIC PROCESS AND ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To familiarize the students with a quantitative basis, for the analysis of cellular metabolism
- To understand the metabolic networks in single cells and at the organ level
- To enable the students to use organisms to produce valuable substances on an industrialscale in cost effective manner
- To know how to optimize strategy for directed genetic changes in microbes for better strain production

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 aminoacids - Biosynthesis of aminoacids, 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 – Metabolic pathway 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, over-determined and under-determined systems –Sensitivity analysis – Direct flux determination from fractional label enrichment – Applications involving complete enumeration of metabolite isotopomers – Carbon metabolite balances-GC-MS for metabolic flux analysis – genome wide technologies

UNIT IV GENOME BASED METABOLIC MODEL DEVELOPMENT 9

Development of Genomic scale metabolic model, Insilico Cells:studying genotype-phenotype relationships using constraint-based models, case studies in E. coli, S.cerevisiae metabolic network reconstruction methods, optimization of metabolic network, Identification of targets for metabolic engineering; software and databases for genome scale modeling

UNIT V ANALYSIS OF METABOLIC CONTROL AND INDUSTRIAL CASE STUDIES 9

Fundamental of Metabolic Control Analysis (MCA), MFA, and MPA and their application, Multi-substrate enzyme kinetics, Metabolic engineering examples for bio-fuel, bio-plastic and green chemical synthesis , Study of genome scale model in various systems for the production of green chemicals using software tools

TOTAL: 45 PERIODS

OUTCOMES:

After completion of metabolic engineering, students will be able

- To learn stoichiometry and energetics of metabolism.
- To apply practical applications of metabolic engineering in chemical, energy, medical andenvironmental fields.
- To have a clear understanding on metabolic control analysis
- To gain experience in the development of genome scale metabolic modelling
- To integrate modern biology with engineering process to meet desired needs

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 andCellular Engineering", 2nd Edition,World Scientific Publishing Co, 2011
3. Curran, C.P., "Metabolic Processes and Energy Transfers - An Anthology of Current Thought", 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 - Principlesand Methodologies", Elsevier Science, 2001.

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	1	-	1	-
CO2	2	3	1	3	2	2
CO3	3	1	2	1	2	1
CO4	1	2	3	3	3	1
CO 5	2	3	2	3	3	2
Average	**2**	**2**	**2**	**2**	**2**	**1**

BY4211 PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY L T P C
0 0 6 3

COURSE OBJECTIVES

1 To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules

2 To gain hands-on experience in spectroscopic methods

3 To acquire practical experience by performing chromatography for the recovery and subsequent purification of target biological products.

LIST OF EXPERIMENTS

1. Preparation of Acetate, Tris and Phosphate Buffer. Validation of HendersonHasselbach equation.
2. Reactions of amino acids – Ninhydrin, Pthalaldehyde, Dansyl chloride – measurement using colorimetric and fluorimetric methods.
3. Differential estimations of carbohydrates – reducing vs non-reducing, polymeric vs 13 oligomeric, hexose vs pentose.
4. Estimation of protein concentration using Lowrys' method, Dye-binding method.
5. DNA determination by UV-Vis Spectrophotometer – hyperchromic effect. Separation of lipids by TLC.
6. Enzyme Kinetics: Direct and indirect assays – determination of Km, Vmax and Kcat, Kcat/ Km.
7. Restriction enzyme – Enrichment and unit calculation.
8. Ion-exchange Chromatagraphy – Purification of IgG and Albumin
9. Gel filtration – Size based separation of proteins
10. Affinity chromatography – IMAC purification of His-tagged recombinant protein

11. .Assessing purity by SDS-PAGE Gel Electrophoresis
12. Chemical modification of proteins – PITC modification of IgG and Protein Immobilization

TOTAL: 90 PERIODS

COURSE OUTCOMES

After completion of the course the students will be able to

CO1 To learn about the principles of buffer preparation, the reactions of amino acids and DNA determination
CO2 To understand the principles of quantitative estimation of carbohydrates using the spectroscopic method
CO3 To gain knowledge about principles and practical experience in the estimation of protein concentration
CO4 To know the principles of determining the kinetic parameters of an enzymatic reaction using direct and indirect assays
CO5 To acquire hands-on experience on purification processes through chromatography and to design processes for the recovery of target biological products

REFERENCES:

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

CO – PO MAPPINGii

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	1	-	1	1
CO2	2	3	2	2	2	2
CO3	3	3	2	2	2	2
CO4	3	2	2	3	2	1
CO5	3	3	3	2	2	2
Average	**3**	**3**	**2**	**2**	**2**	**2**

SEMESTER - III

BY4311 ADVANCED GENETIC ENGINEERING LABORATORY L T P C
0 0 6 3

COURSE OBJECTIVES:

1 Provide hands-on experience in performing basic recombinant DNA techniques.
2 To understand the principle behind each techniques and applications of each methodology in applied biological research.
3 To provide in depth knowledge in creation of recombinant DNA and production of recombinant protein

LIST OF EXPERIMENTS

1. Isolation of vector Eg. Plasmid and Isolation of vector Eg. Genomic DNA
2. Electroporation to Yeast/ Bacteria
3. Isolation of RNA and cDNA synthesis
4. Primer designing and Calculation of Annealing Temperature
5. Demo on Real-time PCR/ Gradient PCR
6. Plasmid isolation and confirming recombinant by PCR and RE digestion.
7. Confirmation of the presence of insert by colony PCR
8. Induction and expression of recombinant protein
9. Western blot with ECL detection
10. Site directed mutagenesis using PCR
11. Southern blot (Non-radioactive)
12. RFLP analysis of the recombinant DNA
13. SDS-PAGE analysis of recombinant protein expression
14. Quantification of expressed recombinant protein by ELISA

LIST OF EQUIPMENTS REQUIRED

- Microscopes
- PCR
- Purification columns
- Microplate reader
- UV spectrometer
- PAGE apparatus,
- Western blot apparatus (dry/semi-dry/wet),
- Southern blot apparatus,
- centrifuge,
- Hemocytometer,

CHEMICALS : required stains, chemicals, enzymes & consumables

TOTAL : 90 PERIODS

COURSE OUTCOMES

After completion of the course the students will be able to

CO1 Gain hands-on experience in performing basic recombinant DNA techniques.

CO2 Understand the principle behind each techniques and applications of each methodology in applied biological research.

CO3 Gain depth knowledge in creation of recombinant DNA and production of recombinant protein

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

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	3	1	2	1	1
CO2	3	3	1	2	1	1
CO3	1	3	1	3	2	2
Average	**2**	**3**	**1**	**2**	**2**	**1**

BY4312 BIOPROCESS AND DOWNSTREAM PROCESSING LABORATORY L T P C
0 0 6 3

COURSE OBJECTIVES:

1 The course applies earlier learned knowledge about mass transfer in bio reactors and sterilization kinetics.
2 To provide hands on training in Downstream processing through simple experimentations in the laboratory.
3 To understand the nature of the end product, its concentration, stability and degree of purification required for targeted biological products.

LIST OF EXPERIMENTS

1. Enzyme immobilization studies – Gel entrapment, adsorption and cross linking immobilization.
2. Batch cultivation – *E.coli* – growth rate, substrate utilization kinetics, product analysis after induction, metabolite analysis by HPLC.
3. Fed batch cultivation - *E.coli* - growth rate, substrate utilization kinetics, product analysis after induction, metabolite analysis by HPLC.
4. Continuous cultivation – x - D construction, kinetic parameter evaluation, gas analysis, carbon balancing.
5. Optimization techniques – Plackett Burman, Response surface methodology.
6. Bioreactor studies: Sterilization kinetics, k_La 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.

LIST OF EQUIPMENTS REQUIRED

- Centrifuge,
- Column for purification
- Ultrasonicator
- Homogeniser
- Microfiltration capsule
- Hot air oven, Incubator
- Laminar air flow chamber

- HPLC,

CHEMICALS All required chemicals & stains.

TOTAL : 90 PERIODS

OUTCOMES:

After completion of the course the students will be able to

CO1 Gain ability to investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems.

CO2 Acquire knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.

CO3 Learn the basic principles and techniques of chromatography to purify the biological products and formulate the products for different end uses.

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.

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	2	3	1	3	1
CO2	2	1	2		3	1
CO3	3	2	1	1	3	2
Average	**2**	**2**	**2**	**1**	**3**	**1**

SEMESTER III

BY4313 PROJECT WORK I L T P C

0 0 12 6

OBJECTIVES

The course aims to enable the students to

- identify the problem/process relevant to their field of interest that can be carried out
- search databases and journals to collect and analyze relevant data
- plan, learn and perform experiments to find the solution
- prepare project report

TOTAL : 180 PERIODS

Individual students will identify a problem relevant to his/her field of study, collect and analyze literature, design, and carryout experiment, collect data, interpret the result and prepare the project report.

OUTCOMES:

At the end of the course the students will be able to

CO1 Identify the research/industrial problems
CO2 Collect and analyze the relevant literature
CO3 Design, conduct experiment and analyse the data
CO4 Prepare project report

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	1		2	1
CO2	2	1	2	1	2	1
Average	**2**	**1**	**2**	**1**	**2**	**1**

SEMESTER IV

BY4411 **PROJECT WORK II** **L T P C**

0 0 24 12

OBJECTIVES

The course aims to

- train students to analyze the problem/ think innovatively to develop new methods/product /process
- make them understand how to find solutions/ create products economically and in an environmentally sustainable way
- enable them to acquire technical and experimental skills to conduct experiment, analyze the results and prepare project report
- enable them to effectively think about strategies to commercialize the product .

TOTAL : 360 PERIODS

Individual students will identify a problem relevant to his/her field of study, collect and analyze literature, design, and carryout experiment, collect data, interpret the result and prepare the project report.

COURSE OUTCOMES

At the end of the project the student will be able to

CO1 Formulate and analyze problems for developing new methods/solutions/processes.
CO2 Plan and conduct experiments to find solutions in a logical manner
CO3 Analyze the results, interpret and prepare project report/know the strategies for commercialization

CO – PO MAPPING

Course outcome	PO					
	1	2	3	4	5	6
CO1	2	2	3	2	3	1
CO2	3	1	3	2	3	2
CO3	3	2	2	2	3	3
Average	3	2	3	2	3	2

PROFESSIONAL ELECTIVE I

BY4001 ADVANCES IN ANIMAL BIOTECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVE:

1. To educate the students about the scope, regulatory issues and commercially available products produced using of animal biotechnology.
2. To provide depth knowledge about the available viral vectors that can be used to create recombinant DNA for gene therapy purposes so that they can undertake research /project work related to biopharming.
3. To teach the importance of cell culture study for invitro study purposes and for scaling up the products at commercial level.
4. To provide depth knowledge about creaion of recombinant products for gene therapy purpose and the importance of molecular probe which is an important tool for medical and forensic studies.
5. To educate the principle behind invitro fertilization and biopharming in order to create transgenic animal of commercial importance.

UNIT I INTRODUCTION 6

Scope of Animal Biotechnology, Animal Biotechnology for production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins.

UNIT II MOLECULAR BIOLOGY 9

Biology of animal viral vectors- SV40, adeno virus, retrovirus, vaccinia virus, herpes virus, adeno associated virus and baculo virus. Applications of commercially available viral vectors and their pros and cons

UNIT III CELL CULTURE TECHNOLOGY 10

Culturing of cells, primary and secondary cell lines, 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, hemostat/Turbidostat; High technology vaccines; Hybridoma technology; Cell lines and their applications

UNIT IV GENETIC ENGINEERING 10

Gene therapy-prospects and problems, Recent advancements in Gene therapy; 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.Recent advancements in diagnostic tool development and its diagnostic procedure

UNIT V ADVANCEMENTS AND APPLICATIONS 10

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

After completion of the course the students will be able to:

CO1 Understand the scope, regulatory issues and commercially available products produced using of animal biotechnology.

CO2 Gain knowledge about the available viral vectors that can be used to create recombinant DNA for gene therapy purposes so that they can undertake research /project work related to biopharming.

CO3 Understand the importance of cell culture study for *invitro* study purposes and for scaling up the products at commercial level.

CO4 Gain knowledge in creating recombinant products for gene therapy purpose and the importance of molecular probe which is an important tool for medical and forensic studies.

CO5 Understand the principle behind *invitro* fertilization and biopharming in order to create transgenic animal of commercial importance.

REFERENCES:

1. Watson, J.D., Gilman, M., WitowskiJ. and Zoller, M. Recombinant DNA, 3rd ed., Scientific American Books, 2007
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, 2nd ed., 2002
5. Freshney R.I. Animal Cell Culture- a practical approach, 6th ed., 2010

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1		2		2	3
CO2	2	2	2		3	3
CO3	2	2		2	3	3
CO4	3	1	1		2	3
CO5	3	2	2	2	3	3
Average	**2**	**2**	**2**	**2**	**3**	**3**

BY4002 PLANT GENETIC ENGINEERING AND BIOTECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

1 To impart knowledge on organization of plant genomes and functional characterization of genes.

2 To impart knowledge on molecular mechanism of plant-microbe interactions

3 To impart knowledge on tissue culture, transformation techniques and transgenic plants

4 To impart knowledge on plant genetic engineering and applications

5 To impart knowledge on plant functional genomics and genome editing

UNIT I PLANT GENOME AND GENE EXPRESSION 9

Plant genome organization – Arabidopsis and Rice nuclear genome, Endosymbiotic theory - Chloroplast and mitochondrial genome organization, Cytoplasmic male sterility; RNA editing, Regulation of gene expression, epigenetic regulations, protein targeting

UNIT II TISSUE CULTURE TECHNIQUES 9

Introduction to plant tissue culture, tissue culture media; Micropropagation; production of artificial seeds; Double haploid production by androgenesis and gynogenesis; triploid production by endosperm culture; Cell Suspension cultures; protoplast isolation and regeneration, somatic hybridization and cybridization; clonal variation for crop improvement; Cryopreservation; Hairy root cultures, synthetic seed technology

UNIT III PLANT MICROBE INTERACTIONS 9

Types of plant microbe interactions- Pathogens, endophytes and symbionts: Molecular basis of plant pathogen interactions, gene-for-gene interactions, mechanism of pathogenesis in plants (Bacterial and fungal pathogens) – Pathogen effector molecules, Overview of plant immunity and defense-Plant defense mechanisms- preformed defense, induced defense, Plant resistant proteins, PR- proteins. Agrobacterium biology –Ti plasmid and T-DNA transfer, Symbiotic nitrogen fixation in legumes by Rhizobia- Molecular biology and biochemistry of nitrogen fixation, nif, nod genes, nitrogenase function

UNIT IV PLANT GENETIC ENGINEERING 9

Methods of transformation- Microprojectile bombardment, Agrobacterium mediated transformation, cointegrate and binary vectors, Plant selectable markers, reporter genes, marker-free plants, transgenic plants for crop improvement-disease resistance, insect resistance, herbicide resistance, FlavrSavr Tomato, Golden rice, Bt. cotton, Roundup- ready crops, metabolic engineering and molecular pharming (Edible vaccines).

UNIT V PLANT FUNCTIONAL GENOMICS AND GENOME EDITING 9

Plant functional genomics-Reverse genetics technique, Forward Genetics-T-DNA tagging, Transposon tagging, Activation tagging, Entrapment tagging, RNAi, gene targeting by homologous recombination in plants, Targeted genome engineering Zinc Finger Nucleases, TALENS, CrispR Cas9 system

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able

CO1 To acquire basic knowledge on organization of plant genome and regulation of gene expression

CO2 Be able to explain the molecular basis of plant microbe interactions

CO3 Get acquainted with the principles and practice of tissue culture techniques

CO4 Become proficient in designing experiments for development of transgenic plants to increase the yield

CO5 Gain knowledge on high throughput functional genomics and genome editing tools

REFERENCES:

1. Slater A., Nigel W.S., “Plant Biotechnology: The Genetic Manipulation of Plants”, Oxford University Press, 2nd Edition, 2008.
2. Mantell S.H., Mathews J.A., Mickee R.A., “Principles of Plant Biotechnology: An Introduction to Genetic Engineering in Plants” Blackwell Scientific Publication, 1st Edition, 1985.

3. Dodds J.H., “Plant Genetic Engineering”, Cambridge University Press, 1st Edition, 2012.
4. Gamburg O.L., Philips G.C., “Plant Tissue & Organ Culture fundamental Methods”, Narosa Publications, 2000.
5. Buchanan B., Gruissem W., Jones R., “Biochemistry & Molecular Biology of Plants”, Wiley Blackwell, 2nd Edition, 2015.
6. Heldt H.W., Piechulla B., “Plant Biochemistry”, Oxford University Press, 3rd Edition, 2007.
7. Robert H. Smith, “Plant tissue culture: Techniques and Experiments”, Academic Press Inc;3rd edition, 2013

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1		1	2	1
CO2	2		2	1	2	2
CO3	3	3	2		2	2
CO4	3	3	2	3	3	3
CO5	3	3	3	2	3	3
Average	**3**	**3**	**3**	**2**	**2**	**2**

BY4003 ADVANCES IN CANCER BIOLOGY L T P C
3 0 0 3

COURSE OBJECTIVE:

1 To educate about the basics principles of cancer biology
2 To educate about the factors involved in development of carcinogenesis.
3 To understand the basics concepts involved in molecular biology of cancer.
4 To educate the basic mechanism involved in cancer metastasis.
5 To educate the importance of various therapies involved in cancer treatments.

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 –Growth factors, 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 carcinogenes is: x-ray radiation – mechanisms of radiation carcinogenesis – Stages of cancer: initiation, promotion, progression.

UNIT III MOLECULAR ASPECTS OF CANCER AND ITS METASTASIS 9

Transformation – Activation of Kinases – Oncogenes – Mechanism of oncogene activation – Retroviruses and oncogenes – Detection of Oncogenes – Oncogenes/proto-oncogene activity – Tumor Suppressor Genes: – Telomerases –- Clinical significances of Invasion –— Metastatic cascade– Recent approach to identify key factors controlling Metastasis.

UNIT IV CANCER SCREENING-DIAGNOSIS AND PREVENTION MODALITIES 9

Life Style, Dietary Factors and Complementary Medicines (Yoga, Meditation, Acupuncture, Exercise & Probiotics) and their Pathways, Screening Principles, Developing and Evaluating a Cancer Screening Program, Various Screening Modalities for specific types of Cancer, Genetic Counselling, Biomarkers in Tumour Clinical Practice, Circulating and Cellular Tumour Markers, In vivo Tumour Imaging, Advances in Cancer Detection - Detection of Metastasis and Micro metastasis.

UNIT V CANCER THERAPY 9

Therapy forms – Surgery, Chemotherapy, Radiation therapy - Detection of Cancers – Prediction of Aggressiveness of Cancer —New approaches of Cancer therapy – Cancer Immuno therapy - Monoclonal antibodies and Cancer Treatment, Gene therapy, Cancer Stem cell Targeted Therapy – Introduction to Personalized Medicine, Therapeutic and Preventive Vaccines. Cancer Clinical Trials - Ethical and Regulatory Affairs. Bio-Nanotechnology based product treatments and Targeted drug delivery systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course the students will be able to

CO1 Understand the basics principles of cancer biology.

CO2 Understand the factors involved in development of carcinogenesis.

CO3 Understand the basics concepts involved in molecular biology of cancer.

CO4 Understand the basic mechanism involved in cancer metastasis.

CO5 Understand the importance of various therapies involved in cancer treatments.

REFERENCES:

1. Fialho, A. and Chakrabarty, A., “Emerging Cancer Therapy: Microbial Approaches and Biotechnological Tools” 1 st Edition, Wiley, 2010.
2. Pelengaris, S. and Khan, M., “The Molecular Biology of Cancer”, Blackwell Publishing, 2006.
3. Ruddon, R.W., “Cancer Biology”, 2nd Edition, Oxford University Press, 2007
4. Schulz, W.S., “Molecular Biology of Human Cancers – An Advanced Students Text Book”, Springer, 2005.
5. Weinberg, R.A., “The Biology of Cancer”, Taylor & Francis, Garland Science, 2007
6. Molecular Biology of Cancer: Mechanisms, Targets and Therapeutics, Lauren Pecorina, Oxford University Press,2008.
7. The Cell; A Molecular Approach, Geoffrey M Cooper, ASM Press, 2013

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3		2		1	
CO2	2	2			1	
CO3	2		2		1	
CO4	2	2		1		
CO5	2	2	2	3	3	2
Average	**2**	**2**	**2**	**2**	**2**	**2**

BY4004 **PHYTOCHEMISTRY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1 To give the details of plant derived value added compounds and its functions .
2 To educate the importance of phytocompounds application to fight againts various microbial infections
3 To provide knowledge on biotech based production of agro medicines separation techniques
4 To educate about the basic principles and techniques involved in structure elucidation and Molecular Modeling
5 To provide knowledge on secondary metabolites and its role in development of herbal therapeutics

UNIT I INTRODUCTION TO PHYTOCHEMISTRY 9

Phytochemicals and their classification–Phytochemical screening –Physiochemical tests – Macroscopic and microscopic techniques –Traditional plant and Herbal remedies —- Herbal drugs WHO guidelines–Standardization of Herbal Drugs Derivatives with Special Reference to Brazilian Regulations

UNIT II PHYTOCOMPOUNDS 9

Plant extract used to Bacterial, Fungal and Parasitic infection – Biological and Toxicology Properties of plant extract –Anti-MRSA and Anti-VRE activities of Phytoalexins and Phytoncides– Anti microbial and targeted screening of Plant extract – Plant derived compound against drug resistant microorganisms – Antioxidant and antitumor Plant metabolites (fruits and vegetables)– Bioactive compounds as food

UNIT III PHYTOMEDICINE 9

Medicinal Plants for Development of Phytomedicine and Use in Primary Health Care– Immunostimulants and adaptogen from Plants –Polyphenols for Atherosclerosis and Ischemic Heart disease –Cancer Chemopreventive agents –Lipidoxidation nitrogen Radicals– Phytochemicals in oilseeds – Flavonoids in Cardiovascular disease – Bioengineering and Breeding approaches in improving phytochemical content of plants.

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 - QSAR and Molecular Modeling

UNIT V SECONDARY METABOLITE 9

Secondary metabolite production through cell culture system–Hairy root induction–Methods of gene transfer–Chemical methods– PEG – dextran–Physical method– Electroporation– Microinjection– Lipofection delivery for herbal therapeutics–Quality Control –Germplasm improvement.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course the students will be able to

CO1 Understand the importance the plant derived value added compounds and its functions .
CO2 Understand the importance of phytocompounds application to fight againts various microbial infections
CO3 Develop depth knowledge on biotech based production of agro medicines separation techniques
CO4 Understand the basic principles and techniques involved in structure elucidation and Molecular Modeling
CO5 Develop depth knowledge on secondary metabolites and its role in development of herbal therapeutics

REFERENCES

1. Ahamed, I., Aqil, F. and Owais, M.“Modern Phytomedicine”, Turning medicinal Plants into drugs. WILEY VCH, Verlag GmbH & Co, KGaA, Weinheim. 2006.
2. Arnason, J.T., Arnason, J.E. and Arnason, J.T.,“Phytochemistry of Medicinal Plants”, Kluwer Academic Publishers, 1995.
3. Bidlack, W.R., Omaye, S.T., Meskin, M.S.and Topham, D.K.W.,” Phytochemicals as Bioactive

Agents", 1St Edition, CRC Press, 2000.
4. Meskin, M.S., Bidlack, W.R., Davies, A.J. and Omaye, S.T., "Phytochemicals in Nutrition and Health", CRC Press, 2002.
5. Rasooli, I, "Bioactive compounds in Phytomedicine" , Intech Open access Publishers , 1st Edition, 2011
6. Durgesh Nandini Chauhan and Kamal Shah ,"Phytopharmaceuticals Potential Therapeutic Applications",Scrivener publishing,Wiley,2021

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3		2		3	2
CO2	2	2	2		2	2
CO3	2	3	3	1	3	2
CO4	3	2		3	2	1
CO5	2	2	2	1	2	3
Average	**2**	**2**	**2**	**2**	**2**	**2**

BY4005 ADVANCES IN MOLECULAR PATHOGENESIS L T P C
3 0 0 3

COURSE OBJECTIVES:

1 To know about the host pathogen interaction and identifying virulence factors involved in viral pathogenesis
2 To educate about vaccine development and functional genomic approaches in treatment of fungal pathogenesis
3 To provide depth knowledge in clinical significance in bacterial pathogenesis treatments
4 To understand about the microbial toxins and modern molecular pathogenesis
5 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: 45 PERIODS

COURSE OUTCOMES:

After completion of the course the students will be able to

CO1 Understand the host pathogen interaction and identifying virulence factors involved in viral pathogenesis

CO2 Gain about vaccine development and functional genomic approaches in treatment of fungal pathogenesis

CO3 Gain depth knowledge in clinical significance in bacterial pathogenesis treatments

CO4 Understand about the microbial toxins and modern molecular pathogenesis

CO5 Understand the methods involved in control of pathogens by modern approaches.

REFERENCES:

1. Flint, J., Enquist, L.W., Krug, "Principles of Virology: Molecular Biology, Pathogenesis and Control", American Society of Microbiology, 2003.
2. Groismen, E.A., "Principles of Bacterial Pathogenesis", Academic Press, 2001.
3. Gyles, C.L., Prescott, J.F., Songer, J.G. and Thoen C.O., "Pathogenesis of Bacterial Infections in Animals", 3rd Edition, Wiley-Blackwell, 2004.
4. Mettenleitter, T.C. and Sobrino, F.,"Animal Viruses: Molecular Biology", Caister Academic Press, 2008.
5. Norkin, L.C., "Virology: Molecular Biology and Pathogenesis", ASM Press, 2009.
6. Madigan, Michael T. "Biology of Microorganisms", 15th ed., 2017
7. Salyers, Abigail A. "Bacterial Pathogenesis: A Molecular Approach", 3rd ed., 2010

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2		1			
CO2	2	3	2	1	3	2
CO3	3		2		2	
CO4	2	2	1	`1		1
CO5	3	3	2	2	2	2
Average	**2**	**3**	**3**	**1**	**2**	**2**

PROFESSIONAL ELECTIVE II

BY4006	ENZYME ENGINEERING AND TECHNOLOGY	LT P C 3 0 0 3

COURSE OBJECTIVES

1. To become acquainted with the classification and mechanism of enzymes
2. To provide basic concepts of the kinetics of enzyme action
3. To impart knowledge about the immobilization of the enzymes
4. To understand the role of enzymes involved in biotransformation
5. To gain knowledge about the processes involved in enzymatic applications

UNIT I INTRODUCTION 9

Introduction to enzymes, Classification, Sources, Mechanism of enzyme action. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes, Enzymes of biological importance - Acetyl cholinesterase, angiotensin converting enzyme (ACE), ACE Inhibitors, HMG Co A reductase inhibitors, pseudo cholinesterase, 5'-nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD), Isoforms, immunoreactivetrypsinogen (IRT) and chymotrypsin; amylase isoenzymes

UNIT II KINETICS OF ENZYME ACTION 9

Methods for investigating the kinetics of enzyme catalyzed reactions – Initial velocity Studies, Estimation of Michaelis Menten parameters, Effect of pH and temperature on enzyme activity, kinetics of inhibition. Modeling ofrate equations for single and multiple substrate reactions

UNIT III IMMOBILIZED ENZYMES 9

Techniques of enzyme immobilization; kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, design and configuration of immobilized enzyme reactors; applications ofimmobilized enzyme technology, Economic argument for immobilization

UNIT IV ENZYMES IN FUNCTIONAL GROUP TRANSFORMATION 9

Functional group interconversion using enzymes (hydrolysis reaction, oxidation/reduction reactions, C-C bond formations), Retrosynthetic biocatalysis, Chemoenzymatic synthesis of natural products. Industrial process using enzymes for production of drugs, fine chemicals and chiral intermediates, Catalytic antibodies, The design and construction of novel enzymes, artificial enzymes, Biotransformation of drugs (hydroxylation of Steroids).

UNIT V APPLICATIONS OF ENZYMES 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able

CO1	To learn the classification, importance and mechanism of enzymes
CO2	To understand the methods for investigating the kinetics of enzyme action
CO3	To gain knowledge about the immobilization of enzymes and its applications
CO4	To develop the processes involved in functional group transformation using enzymes.
CO5	To impart knowledge on the processes involved in enzymatic applications

REFERENCES:

1. Bailey J.E., Ollis D.F. "Biochemical Engineering Fundamentals.". McGraw Hill, 2nd Edition

1986.
2. Faber, Kurt “Biotransformations in Organic Chemistry: A Textbook.”, 5th Edition. Springer, 2008.
3. Palmer, Trevor. “Enzymes: Biochemistry, Biotechnology, Clinical Chemistry.” 2nd Edition, East West Press, 2008.
4. Blanch H.W., Clark D. S., “Biochemical Engineering”, Marcel Dekker, Inc. 2nd Edition, 1997.
5. Lee, James M., “Biochemical Engineering.” PHI, 1st Edition, 1992.
   Yeh W.K., Yang H.C., James R.M., “Enzyme Technologies: Metagenomics, Biocatalysis and Biosynsthesis”, Wiley- Blackwell, 1st Edition, 2010

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	1	1	1	
CO2	2	3	3	3	3	2
CO3	3	2	2	1	1	3
CO4	3	3	3	2	2	2
CO5	3	1	3	2	2	3
Average	**3**	**3**	**3**	**2**	**2**	**3**

BY4007 BIO REACTOR DESIGN AND CONTROL LT P C
3 0 0 3

COURSE OBJECTIVES

1 To familiarize various reactor types and modes of operations.

2 To incorporate mass transfer engineering into bioprocess system

3 To impart knowledge on the selection and design of bioprocess equipment

4 To integrate the engineering concepts in to scale up and scale down of bioreactor

5 To impart knowledge on the bioreactor instrumentation and control

UNIT I BASIC BIOREACTOR CONCEPTS 9

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, Tanks-in-series, Tubular plug flow bioreactors.

UNIT II AERATION AND AGITATION IN BIOPROCESS SYSTEMS 9

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, residence time distribution – Shear damage, bubble damage, Methods of minimizing cell damage – Laminar and Turbulent flow in stirred tank bioreactors.

UNIT III SELECTION AND DESIGN OF BIOPROCESS EQUIPMENT 9

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 9

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 9

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: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able

CO1 To select appropriate bioreactor configurations and operation modes based upon the nature of bio products and cell lines and other process criteria.

CO2 To understand the aeration and agitation in bioprocess systems

CO3 To understand the selection and design of bioprocess equipment

CO4 To apply modelling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems

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

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. Mann, U., “Principles of Chemical Reactors Analysis & Design: New tools for Industrial Chemical Reactor Operations”, Willey–VCH, 2009.
3. 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.
4. Towler, G. and Sinnott, R., “Chemical Engineering Design: Principles, Practice, Economics of Plant and Process Design”, 2 nd edition, Butterworth – Heinemann ltd., Elsevier, 2012.

CO – PO MAPPING

Course outcome	PO					
	1	2	3	4	5	6
CO1	2	3	2	3	2	2
CO2	3	3	3	3	2	1
CO3	3	3	3	3	2	1
CO4	2	2	3	2	2	1

CO5	1	2	3	2	3	3
Average	**2**	**3**	**3**	**3**	**2**	**2**

BY4008 THERMODYNAMICS FOR BIOLOGICAL SYSTEMS L T P C
3 0 0 3

OBJECTIVE

This course helps the students to be expert in applying thermodynamic principles to various chemical engineering processes involving energy flow, phase and reaction equilibrium.

UNIT I THERMODYNAMIC LAWS 9

Basic thermodynamic concepts, Energy and first Law; Reversibility and second Law; Review of Basic Postulates, equation of state and its applications, corresponding states, equilibrium criteria, Legendre Transformation and Maxwell's relations

UNIT II GIBBS PHASE RULE 9

Phase rule, Stability of thermodynamic systems, first order phase transitions and critical phenomenon, single component phase diagrams, thermodynamic properties from volumetric and thermal data

UNIT III SOLUTION THERMODYNAMICS 9

Partial molar properties, Gibbs-Duhem equation, fugacities in gas and liquid mixtures, activity coefficients, Ideal and Non-ideal solutions, azeotropes, Wilson, NRTL, and UNIQUAC equations, UNIFAC method.

UNIT IV PHASE EQUILIBRIA 9

Vapour Liquid Equilibrium involving low pressure, high pressures and multi component systems,VLE in ideal and non- ideal solutions, Henry's Law, Other phase equilibriums- SLE/LLE/VLLE.

UNIT V CHEMICAL EQUILIBRIA 9

Criteria of chemical reaction equilibrium in thermodynamic systems, Homogeneous gas and liquid phase reactions, heterogeneous reactions – phase and chemical equilibrium

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Associate the concepts of energy, laws of thermodynamics to applications that require quantitative knowledge of thermodynamic properties at macroscopic level.

CO2: Understand the thermodynamics of phase equilibria typically encountered in design of chemical processes such as separation operations.

CO3: Relate the theoretical results used to physical systems that convert matter and energy in terms of the laws of thermodynamics.

CO4: Analyze many of the thermodynamic properties of dilute solutions can be derived analytically from statistical formulations.

CO5: Apply the various phase equilibrium models in practical situations

CO6: Apply in the area of thermodynamics principles to various chemical engineering processes

REFERENCES

1. M. Smith, H. C. Van Ness and M. M. Abbott; Introduction to Chemical Engineering Thermodynamics, Tata-McGraw Hill (2003).
2. I. Sandler; Chemical, Biochemical, and Engineering Thermodynamics, John Wiley &Sons, New Delhi (2007).
3. Koretsky, M. D.; Engineering and Chemical Thermodynamics, John Wiley and Sons, New Delhi (2004).
4. Callen, H. B. Thermodynamics and an Introduction to Thermostatistics; John Wiley and Sons: New York (1985).
5. Tester, J. W., Modell, M., Thermodynamics and its Applications, Prentice-Hall, New Jersey

(1996).
6. Rao., Y.V.C., Chemical Engineering Thermodynamics, University Press, Hyderabad,2005
7. Narayanan K.V"A Text Book of Chemical Engineering Thermodynamics "Prentice Hall of India Pvt.Ltd.2001.

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	2	2	2	2	1
CO2	2	2	1	2	3	1
CO3	2	2	3	1	3	1
CO4	2	2	2	1	3	1
CO5	2	2	3	1	2	3
CO6	2	2	1	2	2	2
Average	**2**	**2**	**2**	**3**	**3**	**2**

BY4009 BIOTECHNOLOGY IN FOOD PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES

1 To know different techniques used for the preservation of foods.
2 To educate the importance of fermentation principles involved in converting waste to values.
3 To educate the importance of Biotechnological approaches to improve nutritional quality through fermented foods.
4 To gain knowledge about the microorganisms, food spoilage diseases.
5 To know about the constituents and additives present in the food in order to improve the quality of food.

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: 45 PERIODS

COURSE OUTCOMES:

After completion of the course the students will be able to

CO1 Unit operations in modern food processing and impact of the process on food quality
CO2 Principles and different preservations techniques of food can also be known.
CO3 Understand the importance of Biotechnological approaches to improve nutritional quality through fermented foods.
CO4 Different constituents present in food and microorganism involved in processing of food.
CO5 Understand the methods and control involved in improving the quality of food.

REFERENCES

1. Adams M., Adams M. R. and Robert Nout M. J., "Fermentation and food safety", Springer, 2001.
2. Da-Wen S., "Emerging Technologies for Food Processing", Academic Press, 2005.
3. Fellows, P.J., "Food Processing Technology: Principles and Practice", 3rd Edition, CRC Press, 2009.
4. Hutkins R. W., "Microbiology and Technology of Fermented Foods", IFT Press series, Volume 32 of Institute of Food Technologists Series, Wiley-Blackwell, 2006.
5. Pometto A, Shetty K, Paliyath G and Levin R. E., "Food Biotechnology", 2nd Edition , CRC press, 2005.
6. Zeuthen P. and Bogh-Sorensen, L., "Food Preservation Techniques", 1st Edition, CRC Press, 2003

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	3	2	2	2	2
CO2	2	2	2		2	2
CO3	2	1	2		2	1
CO4	3	1	2		2	1
CO5	2	2	3	1	3	2
Average	**2**	**2**	**2**	**1**	**2**	**2**

BY4010 BIOPROCESS MODELLING AND SIMULATION L T P C
3 0 0 3

COURSE OBJECTIVES

1 To impart knowledge on the fundamental and empirical models for dynamic process
2 To provide knowledge to be able to develop kinetic models for biological process
3 To impart knowledge on the model and design the bioreactors
4 To impart knowledge on the parameters involved in bioprocess

5 To impart knowledge to simulate bioprocess with the help of computation tools

UNIT I INTRODUCTION TO MODELING 9

Use of mathematical models, principles of formulation, fundamental laws, continuity equations, energy equations, equations of motions, transport equations, equation state, equilibrium, basic chemical kinetics

UNIT II KINETICS AND BIOREACTOR MODELS 9

Enzyme kinetics- Microbial kinetics-Structured kinetic model-batch, fed Batch and continuous operation-Modeling of non-ideal behavior in bioreactors – Tanks-in-series, dispersion and compartment models

UNIT III DESIGN OF BIOREACTORS 9

Immobilized enzyme Bioreactors; Mass transfer in immobilized bio catalytic systems-Analysis of film and pore diffusion resistances and their effect on overall reaction kinetics; Mass transfer in biological reactors-Inter phase gas-liquid mass transfer, General oxygen balances for gas-liquid transfer- Models for oxygen transfer in large scale bioreactors-Design and analysis of packed bed and membrane bioreactors

UNIT IV MONITORING AND CONTROL OF BIOPROCESSES 9

Elements of feedback control- types of controller action- Proportional Controller- Proportional Integral Controller – Proportional Derivative Controller- Proportional Integral Derivative Controller-Advanced control strategies- Cascade Control - Feed Forward Control- Bioprocess adaptive control - Bioprocess control using Artificial Intelligence

UNIT V SIMULATION OF BIOPROCESSES 9

Problem Structuring, Process Analysis, and Process Scheme - Implementation and Simulation-Uncertainty Analysis- Software packages for simulation of bioprocesses – MATLAB-SIMULINK, ISIM; Simulation of bioprocesses usingmodels from literature sources

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able

CO1 To understand the fundamental and empirical models for dynamic process
CO2 To develop kinetic models for biological process
CO3 To model and design the bioreactors
CO4 To understand the parameters involved in bioprocess
CO5 To simulate bioprocess with the help of computation tools

REFERENCES

1. Dunn I.J., “Biological Reaction Engineering: Dynamic Modeling Fundamentals with Simulation Examples”, Wiley-VCH, 1st Edition, 2003.
2. Luyben W.L., “Process Modeling, Simulation and control for Chemical Engineers”, McGraw Hill, 2nd Edition,2013.
3. Bailey J.A and Ollis D.F., “Biochemical Engineering Fundamentals”, McGraw Hill (New York), 2nd Edition, 2010.
4. Heinzle E, Biwer A.P, Cooney C.L., “Development of Sustainable Bioprocesses: Modeling and Assessment”,John Wiley and sons, 2007.
5. Marlin, T.E., “Process Control”, 2nd edition, McGraw Hill, New York, 2000.
6. Smith C.A., Corripio A.B., “Principles and Practice of Automatic Process Control”, Wiley, New York, 3rd edition,2005.
7. Thomas E.M., “Process Control: Designing Processes and Control Systems for Dynamic Performance”, McGraw Hill, 1st edition, 2000.

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	1	2		1	
CO2	2	2	2	2	2	1
CO3	2	2	2	2	2	1
CO4	2		2	2	2	2
CO5	2	2	2	2	3	2
Average	**2**	**1**	**2**	**2**	**2**	**2**

BY4011 BIOFUELS AND PLATFORM CHEMICALS L T P C
3 0 0 3

COURSE OBJECTIVES:

1 To impart the knowledge various forms of biofuels and production of platform chemicals using the microorganisms and various sources for the production of biofuels
2 To impart basic knowledge on the production aspects of ethanol
3 To impart basic knowledge on the production aspects of biodiesel.
4 To impart understanding on the production of other important biofuels and their significance.
5 To impart knowledge on the production of platform chemicals using microorganisms

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: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, students will have gained knowledge and will be able

CO1 To know the importance of biofuels and platform chemicals
CO2 To optimize or Screen the organisms for the production of these from renewable sources..
CO3 To utilize the biosources of ethanol and their production
CO4 To develop the design for biodiesel production
CO5 To produce platform chemicals from microorganisms

REFERENCES

1. Lee, Sunggyu; Shah, Y.T. "Biofuels and Bioenergy". CRC / Taylor & Francis, 2013.
2. Ayhan Demirbas , "Biofuels Securing the Planet's Future Energy Needs", springer, 2008.
3. Aye D., John N., Terry W., "Biofuels Engineering Process Technology", McGraw Hill, 1st Edition, 2008.
4. Wim S., Erik V., "Biofuels", Wiley, 1st Edition, 2009.
5. Chinnappan Baskar et al, "Biomass Conversion: The Interface of Biotechnology, Chemistry and Materials Science" Springer, 2012.
6. Satinder Kaur Brar et al, "Platform Chemical Biorefinery: Future Green Chemistry" 2016.

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3		1		1	
CO2	3	1	3	1	2	2
CO3	2	1	2	1	2	1
CO4	2	3	2	3	2	2
CO5	2	3	2	3	2	2
Average	**2**	**2**	**2**	**2**	**2**	**1**

PROFESSIONAL ELECTIVE III

BY4012 MOLECULAR MEDICINE L T P C
3 0 0 3

COURSE OBJECTIVES:

1 To impart knowledge on the fundamental technologies at a molecular level
2 To provide basic biology involved in technology
3 To impart knowledge on the molecular diagnostics using immunological and molecular approaches.
4 To impart knowledge on the nucleic acid and protein therapeutic agents
5 To provide knowledge on the types and evaluation of vaccines

UNIT I FUNDAMENTAL TECHNOLOGIES 9

Molecular cloning, Genomic Libraries, Amplification of DNA Using PCR, DNA Sequencing Technologies, Sequencing Whole Genomes, Genomics- proteomics, transcriptomics, metabolomics.

UNIT II BIOLOGY BEHIND THE TECHNOLOGY **9**

Fundamental Concepts in Immunology: Immune response, Innate Immunity, Adaptive Immunity, Cells and tissues of the Immune System Types of Antibodies, Immunological Techniques, Genetic Basis of Disease: Chromosomal Disorders and Gene Mapping, Single-Gene Disorders, Polygenic Disorders and Gene Clustering, Immune Pathogenesis: Models of Immune System Lesions, Immune Hypersensitivity Disorders, Immunodeficiency Disorders, Microbial Pathogenesis : Bacterial Infections Viral Infections.

UNIT III MOLECULAR DIAGNOSTICS **9**

Immunological Approaches To Detect Protein Biomarkers of Disease.: Enzyme-Linked Immunosorbent Assays, Immunoassays for Infectious Disease, Protein Arrays To Detect Polygenic Diseases, DNA-Based Approaches to Disease Diagnosis: Hybridization Probes, Padlock Probes, Allele-Specific PCR, TaqMan PCR, Real-Time PCR To Detect Infectious Disease Detection of Epigenetic Markers and SNP. Detecting RNA Signatures of Disease

UNIT IV NUCLEIC ACID AND PROTEIN THERAPEUTICS **9**

Nucleic Acid Therapeutic Agents: Targeting Specific mRNAs and DNAs, Viral Delivery Systems, Non-viral Nucleic Acid Delivery Systems, Protein Therapeutics: Pharmaceuticals, Recombinant Antibodies, Enzymes.

UNIT V VACCINES **9**

Overview on vaccination, Subunit Vaccines, Peptide Vaccines, Dendritic Cell Vaccines, DNA Vaccines, Attenuated Vaccines, Vector Vaccines, Systems Biology and Evaluation of Vaccines

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, students will be able

CO1 To learn and comprehend the fundamental technologies at a molecular level
CO2 To understand the basic biology involved in technology
CO3 To understand the molecular diagnostics using immunological and molecular approaches.
CO4 To understand the nucleic acid and protein therapeutic agents
CO5 To have understanding and knowledge on the types and evaluation of vaccines

REFERENCES

1. Bernard R. Glick, Cheryl L. Patten, Terry L. Delovitch, “Medical Biotechnology”, American Society of Microbiology Press, 1st Edition, 2013.
2. Albert S., “Medical Biotechnology- Achievements, prospects and perceptions”, United nations University Press, 1st Edition, 2005.
3. Godbey W. T., “An Introduction to Biotechnology: The Science, Technology and Medical Applications”, Woodhead Publishing, 1st Edition, 2014.
4. Firdos A. K., “Biotechnology in Medical Sciences”, Taylor and Francis, CRC Press, 1st Edition, 2014.

CO – PO MAPPING

Course outcome	PO					
	1	2	3	4	5	6
CO1	3		1		2	
CO2	3	2	2		2	
CO3	3	1	2	1	2	1
CO4	2	2	3	1	2	1
CO5	2	2	3	1	2	3

Average	**3**	**1**	**2**	**1**	**2**	**1**

BY4071 BIOMATERIALS AND TISSUE ENGINEERING LT P C
3 0 0 3

COURSE OBJECTIVES:

1 To learn the fundamentals of tissue engineering and tissue repairing
2 To educate the role of Biomaterials in Tissue engineering applications
3 To acquire knowledge of applicability of molecular agents in drug delivery systems which promote tissue engineering principles.
4 To acquire knowledge on clinical applications of tissue engineering
5 To understand the basic concept behind tissue engineering focusing on the stem cells.

UNIT I FUNDAMENTAL OF TISSUE ENGINEERING 9

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.

UNIT II BIOMATERIALS FOR TISSUE ENGINEERING 9

Introduction to Biomaterials - classification- significance.in tissue engineering based therapies, Modifications of Biomaterials, 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 BIOMATERIALS AND CONTROLLED DRUG DELIVERY 9

Biomaterials: Properties of biomaterials ,Surface, bulk, mechanical and biological properties .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, Recent advancements of Nanotechnology based biomaterials in targeted and controlled drug delivery .

UNIT V BIOPOLYMER- BASED BIOMATERIALS AS SCAFFOLDS AND STEM CELLS 9

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. Applications of macro, micro and nano sized commercially available biomaterials for stem cell therapy.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course the students will be able to

CO1 Understand the components of the tissue architecture .
CO2 Gain depth knowledge about the role of Biomaterials in Tissue engineering applications
CO3 Awareness about the properties and broad applications of biomaterials.
CO4 Understand stem cell characteristics and their relevance in Medicine.
CO5 Overall exposure to the role of tissue engineering and stem cell therapy in organogenesis

REFERENCES

1. Pallua, N. and Suscheck, C.V., "Tissue Engineering: From Lab to Clinic" Springer, 2010
2. Palsson, B., Hubbell, J.A., Plonsey, R. and Bronzino, J.D., "Tissue Engineering", CRC Press, 2003.
3. Palsson, B.O. and Bhatia, S., "Tissue Engineering", Pearson Prentice Hall, 2004.
4. Saltzman, W.M., "Tissue Engineering", Oxford University Press, 2004.
5. Scheper, T., Lee, K. and Kaplan, D., "Advances in Biochemical Engineering / Biotechnology – Tissue Engineering I", Volume 102, Springer-Verlag Berlin Heidelberg, 2006.

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	1	1		2	
CO2	3	2	2	2	2	2
CO3	3	2	2	2	2	2
CO4	3	2	3	2	2	3
CO5	3	3	3	3	3	3
Average	**3**	**2**	**2**	**2**	**2**	**2**

BY4013 BIOPHARMACEUTICALS AND BIOSIMILARS L T P C
3 0 0 3

COURSE OBJECTIVES:

1 To provide knowlege in core responsibilities for the development and monitoring of the drug and the preparation of medicines according to the norms.
2 To gain knowledge in physicochemical properties, pharmacology and the formulation of commonly used biopharmaceuticals.
3 To educate about the recent advancements in drug delivery systems.
4 To educate about the biosimilars medicine and its future prospects
5 To provide the applications of biopharmaceuticals in respect to clinical aspects.

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 – GMCSF – Blood clotting Factors – Tissue plasminogen activator – Monoclonal antibodies and engineered antibodies.

TOTAL: 45 PERIODS

OUTCOMES:

After completion of the course the students will be able to

CO1 Understand the legal steps involved in progressing a new drug to market. Grasping the current regulatory acts and safety norms of the modern pharmaceutical industries.

CO2 Acquire knowledge on novel biotechnological and pharmaceutical products, current medicines and their applications in therapeutic and diagnostic fields.

CO3 Have depth knowledge and understanding of current topical and newly emerging aspects of pharmaceutical biotechnology

CO4 Understand the biosimilars medicine and its future prospects

CO5 Understand the Pharmaceutical parameters for the current and future biotechnology related products on the market.

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.

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3		3		3	3
CO2	2		2		2	2
CO3	3	3	1	2	3	1
CO4	3	3	1	3	3	1
CO5	2	2	2	2	2	2
Average	**3**	**2**	**2**	**1**	**3**	**2**

BY4014 **BIO NANOTECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

The course aims to

- Provide concepts of nanotechnology
- Have knowledge on the synthesis and characterization of nanomaterials
- Have an idea of the potential applications of nano technology in various fields including nanomedicine

UNIT I NANOSCALE PROCESSES AND NANOMATERIALS 9

Overview of nanoscale processes and characterization 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 9

Biomolecular structure and stability – Protein folding – Self-assembly – Self-organization – Molecular recognition – Flexibility – Information-Driven nanoassembly – Energetics – Chemical transformation – Regulation – Biomaterials – Biomolecular motors – Traffic across membranes – Biomolecular sensing – Self-replication – Machine-phase bionanotechnology.

UNIT III PROPERTIES AND MEASUREMENT OF NANOMATERIALS 9

Optical Properties: Absorption, Fluorescence, and Resonance; Methods for the measurement of nanomaterials; Microscopy measurements: SEM, TEM, AFM and STM. Confocal and TIRF imaging

UNIT IV NANOBIOLOGY AND BIOCONJUGATION OF NANOMATERIALS 9

Properties of DNA and motor proteins; Lessons from nature on making nanodevices; Reactive groups on biomolecules (DNA & Proteins); Surface modification and conjugation to nanomaterials. Fabrication and application of DNA nanowires; Nanofluidics to solve biological problems

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 – Nano- Sized 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: 45 PERIODS

OUTCOMES:

Upon completing this course, the students

CO1 understand fundamental concepts of nanotechnology and anomaterials
CO2 have knowledge on the fabrication and characterization of nanomaterials
CO3 understand nanobiology and modification of nanomaterials
CO4 know nano-based drug delivery and nanomedicine

REFERENCES

1. Gazit, E., and Mitraki, A., “Plenty of Room for Biology at the Bottom: An Introduction toBionanotechnology”, Imperial College Press, 2013.
2. Goodsell, D.S., “Bionanotechnology”, John Wiley and Sons, 2004.
3. Jesus M. de la Fuente and Grazu, V., “Nanobiotechnology: Inorganic Nanoparticles VsOrganic Nanoparticles” Elsevier, 2012.
4. Niemeyer, C.M. and Mirkin, C.A., “Nanobiotechnology: Concepts, Applications and Perspectives”, Wiley- VCH, 2006.

5. Shoseyov, O. and Levy I., “Nanobiotechnology: Bioinspired Devices and Materials of theFuture”, Humana Press, 2008.

CO – PO MAPPING

Course outcome	PO					
	1	2	3	4	5	6
CO1	3	2	2	2	2	1
CO2	3	3	2	3	2	1
CO3	3	3	2	3	2	1
CO4	3	3	3	3	3	3
Average	**3**	**3**	**2**	**3**	**2**	**2**

PROFESSIONAL ELECTIVE IV

BY4015 ADVANCED GENOMICS AND PROTEOMICS L T P C
3 0 0 3

COURSE OBJECTIVES

1 To impart knowledge on the organization and structure of genomes

2 To provide knowledge on the techniques in mapping of genome

3 To impart knowledge on sequencing strategies for genome analysis.

4 To impart knowledge on the comparative and functional genomics

5 To impart knowledge on the metagenomics, pharmacogenomics and paleogenomics

UNIT I ORGANIZATION AND STRUCTURE OF GENOMES 9

Introduction to genome organization, size and complexity - Bacterial genomes – Circular - E.coli, Linear - Streptomyces coelicolor and Agrobacterium tumefaciens, and multipartite – Borrelia burgdorferi. Eukaryotic organelle genomes – Chloroplast and mitochondria. Eukaryotic nuclear genomes: Plant – Arabidopsis and Rice; Animal: Human and mice; Fungi: Aspergillus nidulans and Baker’s yeast. C-value paradox, coding and Non-coding sequences, dynamic components of genomes. Genome sequencing projects.

UNIT II GENOME MAPPING 9

Fragmentation with restriction enzymes –separating large fragments: PFGE, Isolation of chromosomes by FACS, and chromosome microdissection. YAC, BAC and P1 phage based genomic libraries. Genetic Mapping – gene markers, DNA markers – RFLP, SSLP, SNP, Linkage analysis; genetic mapping in bacteria and mapping by pedigree analysis in humans. Physical Mapping – Restriction mapping, FISH and GISH, STS mapping – ESTs, SSLPs and random genomic sequences. Mapping reagents, Chromosome walking, mapping without cloning - Radiation hybrids, Happy mapping. Integration of mapping methods

UNIT III SEQUENCING OF GENOMES 9

Basic DNA sequencing – Sanger Dideoxy sequencing – Slab gel and capillary electrophoresis, Automated DNA sequencing. Sequencing strategies – Single-end sequencing, paired-end sequencing, Mate-paired sequencing. Next- generation sequencing methodologies – Sequencing by synthesis: illumina, 454-pyrosequencing, Pacific Biosciences, ion-semiconductor sequencing; Sequencing by ligation – ABI-Solid sequencing - Generation of polony array; Single molecule sequencing – Heliscope and nanopore-sequencing. Base calling and sequence accuracy, Closing

sequence gaps

UNIT IV COMPARATIVE AND FUNCTIONAL GENOMICS 9

Comparative genomics: Orthologues, paralogues and gene displacement, comparative genomics of prokaryotes, eukaryotes and organelle genomes. Phylogenetic footprinting and other applications of comparative genomics. Functional Genomics: understanding genome function at the DNA level – Epistasis and ENCODE project. Transcriptomics: Microarrays, SAGE, MPSS and RNA-Seq; Loss-of-function techniques: mutagenesis, RNAi and gene knockout. Understanding genome function at protein level – Protein-protein interaction, AP/MS.

UNIT V METAGENOMICS, PHARMACOGENOMICS AND PALEOGENOMICS 9

Metagenomics: Approaches for metagenomic analysis, Functional Metagenomics; Pharmacogenomics; Genetic variability in drug response; Clinical Applications and challenges in Pharmacogenomics; Impact of Pharmacogenomics on future drug development. Paleogenomics: Ancient DNA Extraction, Genomic analysis of aDNA, Paleogenomics Applications – case studies - insights from genomes of archaic hominins - Neanderthals and Denisovans; Woolly Mammoth; Barley; Mycobacterium tuberculosis

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able

CO1 To differentiate the structure and organization of genomes of bacteria, plants, animals and fungi

CO2 To develop mapping and sequencing strategies for genome analysis.

CO3 To compare the various genomes and delineate the differences and similarities in them

CO4 To be able to develop strategies to determine the function of the genomes as a whole

CO5 To develop strategies for the analysis of metagenome, determine the interaction of genomes and drugs andlearned the evolutionary significance of paleogenomics

REFERENCES

1. Hunt S.P., Livesey, F.L., “Functional genomics”, Oxford University Press, 2000.
2. Primrose S.B., Twyman R., “Principles of Genome Analysis and Genomics”. Blackwell Publishers, 3rd Edition, 2007.
3. T. A. Brown., Genomes, Garland Science T&F group, 2006
4. Arthur M. Lesk. Introduction to genomics, Oxford University Press, 2012.
5. Cantor, C.R, Smith, C.L., “Genomics”, John Wiley & Sons, 1st Edition, 1999.
6. Sandor S., “Genomics and Proteomics: Functional and Computational Aspects”. Springer, 1s Edition reprint

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1		1			
CO2	1	2	2	2		
CO3	2	2	1			
CO4	2	2	2	3	3	2
CO5	2	1	2	3	2	2
Average	**2**	**2**	**2**	**2**	**1**	**1**

BY4016 IPR, BIOSAFETY AND ENTREPRENEURSHIP L T P C
3 0 0 3

COURSE OBJECTIVES:

1 To impart knowledge and to create awareness on IPR
2 To impart knowledge in patent filing procedures, agreements and treaties
3 To impart knowledge on biosafety and guidelines
4 To impart knowledge on genetically modified organisms and related guidelines
5 To impart knowledge on entrepreneurship and scales of operation

UNIT I 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 II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – 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,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc 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 III 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 IV 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.

UNIT V ENTREPRENEURSHIP DEVELOPMENT 9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS

OUTCOMES:

On completion of the course, students will have gained knowledge and will be able

CO1 To understand the fundamentals and areas of IPR
CO2 To have learnt patent filing procedures, agreements and treaties
CO3 To understand biosafety and relevant guidelines
CO4 To understand genetically modified organisms and related guidelines
CO5 To understand entrepreneurship and scales of operation

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. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., “Intellectual Property Rights for Engineers”, 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., “Patent Law”, 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. 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.
6. S.S Khanka, “Entrepreneurial Development”, S.Chand & Company LTD, New Delhi, 2007.

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2		1		2	2
CO2	2	2	1			1
CO3	2		2	2	1	1
CO4	1	2	1		2	2
CO5		1	3	3	2	2
Average	**1**	**1**	**2**	**1**	**1**	**2**

BY4017 **PROTEIN STRUCTURE ANALYSIS** **LT P C**
3 0 0 3

COURSE OBJECTIVES

1 To impart knowledge on the strategies for identification and analysis of proteins.

2 To provide knowledge on the types of ionization and mass spectrometry in proteomics

3 To impart knowledge on separation and processing of proteins in proteomic analysis

4 To impart knowledge on the comparative proteomic analysis.

5 To impart knowledge on the techniques involved in proteomics

UNIT I PROTEOMICS AND BIOLOGICAL MASS- SPECTROMETRY 9

Over- view of strategies used for the identification and analysis of proteins; Basics of Mass-spectrometry (MS) and bimolecular analysis; One- dimensional (1-D) polyacrylamide gel electrophoresis (PAGE) of proteins; Enzymatic cleavage of proteins in solution; In-gel digestion of protein bands; Electrophoretic transfer of proteins on to membranes (PVDF).

UNIT II MASS-SPECTROMETRY IN PROTEOMICS 9

Common ionization methods for peptide/protein analysis (MALDI and ESI); Principles of Time of Flight (TOF), Ion Trap (IT), Quadrupole (Q), Fourier Transform-Ion cyclotron Resonance (FT-ICR), and Orbitrap mass analyzers; Collision-Induced Dissociation (CID) of peptides; Introduction to Iondetectors.

UNIT III SEPARATION AND PROCESSING OF PROTEINS FOR PROTEOMICS ANALYSIS 9

Protein extraction from biological samples (Mammalian Tissues, Yeast, Bacteria, and Plant Tissues); 2-DE of proteins for proteome analysis; Difference in-gel electrophoresis (DIGE); Liquid chromatography separations in proteomics (Affinity, Ion Exchange, Reversed-phase,and size exclusion); Strategies for multidimensional liquid chromatographyin proteomics; Analysis of complex protein mixtures using Nano-liquid chromatography (Nano-LC) coupled to Mass-spectrometry analysis.

UNIT IV COMPARATIVE AND QUANTITATIVE PROTEOMICS 9

Rapid identification of Bacteria based on spectral patterns using MALDI- TOF- MS. Comparative proteomics based on global in-vitro andin-vivo labeling of proteins/peptides followed by Mass-spectrometry analysis: ICAT, iTRAQ, SILAC. Analysis of Post-translational modification (PTM) of proteins; Enrichment and analysis of phospho- and glyco- proteins; Characterization of protein interactions using yeast two-hybrid system, Co- immunoprecipitation followed by MS, and Proteinmicroarrays.

UNIT V PROTEOMICS INFORMATICS 9

Identification of proteins by PMF and MS/MS data; Database search engines for MS data analysis (Mascot, Sequest,and others); Proteomics informatics strategies for biomarker discovery, analysis of protein functions and pathways. Applications of proteomics (Disease diagnosis,drug development, and plant biotechnology)

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able

CO1 To gain knowledge on various areas of proteomics including gel-based and non-gel based separation of proteins,strategies for protein labeling and analysis of post-translational modifications of proteins

CO2 To gain knowledge on mass-spectrometry based sequencing and identification..

CO3 To gain knowledge on proteomic techniques

CO4 To gain skills in performing comparative and proteomics analyses.

CO5 To gain skills on proteomics informatics

REFERENCES

1. Simpson R.J., “Proteins and Proteomics: A Laboratory Manual.” I.K. International Pvt. Ltd, 1st Edition,2003.
2. Pennington S. R., Dunn M.J., “Proteomics: From Protein Sequence to Function.” Viva Books, 1st Edition,2002.
3. Twyman R. M., “Principles of Proteomics.” Taylor & Francis, 1st Edition,2004.
4. O’Connor C. D. and Hames B. D. “Proteomics” Scion Publishing, 1st Edition,2008.
5. Dassanayake R. S., Gunawardene Y.I.N. S.” Genomic and Proteomic Techniques.” Narosa, 1st Edition,2011.
6. SiuzdakG.“MassSpectrometryforBiotechnology.”AcademicPress, 1st Edition, 1996.
7. Hoffman E. D., Stroobant V., “Mass Spectrometry – Principles and Applications”, John Wiley& Sons, 1st Edition,2007.
8. Chapman J.R., “Mass Spectrometry of Proteins and Peptides”, (Methods in Molecular Biology Series Vol 146),Humana, 1st Edition, 2000.
9. Rosenberg I. M. “Protein analysis and Purification – Benchtop Techniques.”, Springer, 1st Edition, 2005.
10. Scopes R. K.,” Protein Purification: Principles and Practice.”, Springer, 1st Edition, 1994
11. Chibbal D., LMcLafertty L., Schena M., “Protein Microarrays.”, Jones and Bartlett, 1st Edition, 2005.
12. Smejkal G. B. and Lazarev A. V. “Separation methods in Proteomics.” CRC Press, 1st Edition, 2006.

CO – PO MAPPING

Course outcome	PO					
	1	2	3	4	5	6
CO1	3		2		2	
CO2	2	2	1		2	
CO3	2	1	1	2	3	1
CO4	2	2	2	2	2	2
CO5	1	2	3	3	3	2
Average	**2**	**1**	**2**	**1**	**2**	**1**

BY4018 COMPUTER AIDED LEARNING OF STRUCTURE AND FUNCTION OF PROTEINS **L T P C 3 0 0 3**

COURSE OBJECTIVES

1. To provide fundamental knowledge on the existence of various structures of proteins
2. To make the students aware of the databases available and also know how the structure affects the function of proteins
3. To know the various classes of proteins
4. To learn to use the databases and do phylogenetic studies
5. To know how protein modification influence the function of proteins

UNIT I COMPONENTS OF PROTEIN STRUCTURE **9**

Introduction to Proteins, structure and properties of amino acids, the building blocks of Proteins, Molecular Interactions and their roles in protein structure and function, Primary Structure – methods to determine and synthesis

UNIT II PROTEIN BIOINFORMATICS **9**

Protein sequence and structural databases, Multiple sequence alignment, Secondary, Tertiary and Quaternary Structure of Proteins; Sequence and Structural Motifs; Protein Folding

UNIT III OVERVIEW OF STRUCTURAL AND FUNCTIONAL PROTEINS **9**

Classes of Proteins and their Structure Function Relationships – alpha, beta, alpha/beta proteins, DNA-binding proteins, Enzymes, IgG, membrane proteins

UNIT IV PROTEIN STRUCTURAL CLASSIFICATION DATABASES **9**

SCOP and CATH. Evolutionary relationships and Phylogenetic Studies

UNIT V PROTEIN MODIFICATIONS **9**

Post translational modifications, Engineering of proteins, Site directed mutagenesis, Fusion Proteins, Chemical derivatization.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

After completion of the course the students will be able to

CO1 Have knowledge on the fundamental structure of proteins

CO2 Analyse how the tertiary and quaternary structures as well as folding patterns influence protein function
CO3 Have knowledge about the the different classes of proteins and their function
CO4 Use databases and do phylogenetic studies
CO5 Understand how protein modifications influence their function

REFERENCES

1. Biochemistry, 3rd Edition by Donald J. Voet, Judith G. Voet, 2004 John Wiley & Sons Publishers, Inc
2. Introduction to Protein Structure, 2nd Edition, Carl Branden and John Tooze, 1999, Garland Publications, New York
3. Proteins – Structures and Molecular Properties, 2nd Edition, Thomas E. Creighton, W. H. Freeman and Company, New York

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1		1			
CO2	2	2	2	2	2	1
CO3	1		2			
CO4	1	1	2	1	2	2
CO5		2	2		2	
Average	**1**	**1**	**2**	**1**	**2**	**1**

BY4019 COMPUTATIONAL METHODS IN FLUID DYNAMICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To educate the importance of performing calculations pertaining to processes and operations. To apply fluid mechanics principles to applied problems.
- To apply Thermodynamics principles involved in flow computation process.
- To educate the importance of turbulent flow computation study
- To apply the principles involved in Finite Element formulation methods.

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: 45 PERIODS

COURSE OUTCOMES:

After 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 Apply their knowledge in the field of biochemical engineering from the principles of thermodynamics.
CO4 Acquire knowledge related to fluid statics and dynamics, agitators and applications of various pumps.
CO5 Apply the principles involved in Finite Element formulation methods.

REFERENCES

1. Blazek, J., "Computational Fluid Dynamics: Principles and Applications", Elsevier Publications, 2005.
2. Cebeci, T., Shao, J.P., Kafyeke, F. and Laurendeau, E., "Computational Fluid Dynamics for Engineers", Springer - Horizons Publishing Inc., 2005.
3. Drikakis, D. and Rider, W.J., "High - Resolution Methods for Incompressible and Low-Speed Flows", Springer-Verlag Berlin Heidelberg, 2005.
4. Knight, D.D., "Elements of Numerical Methods for Compressible Flows Cambridge" University Press, 2006.

CO – PO MAPPING

Course outcome	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1		2		1
CO2	2	2	2	1	2	2
CO3	2		1		2	
CO4	1	2		3		1
CO5	1		1		2	2
Average	**2**	**1**	**1**	**2**	**2**	**2**

AUDIT COURSES

AX4091 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: 30 PERIODS

OUTCOMES

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

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 Press 2006
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 book 1998.

AX4092 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 conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

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 : 30 PERIODS

OUTCOMES

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 illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

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

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.

AX4093 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 Revolutionin1917and 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 Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- 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.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

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

AX4094 நற்றமிழ் இலக்கியம் **L T P C**
2 0 0 0

UNIT I சங்க இலக்கியம் **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம் – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)

- இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
- போரை நிறுத்திய ஔவையார்

UNIT II **அறநெறித் தமிழ்** **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
- அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
– ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III **இரட்டைக் காப்பியங்கள்** **6**

1. கண்ணகியின் புரட்சி
- சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
- சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV **அருள்நெறித் தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
- பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
- அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
- இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
- சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
நற்றிணை (11) - நண்டு
கலித்தொகை (11) - யானை, புறா
ஐந்திணை 50 (27) - மான்
ஆகியவை பற்றிய செய்திகள்

UNIT V **நவீன தமிழ் இலக்கியம்** **6**

1. உரைநடைத் தமிழ்,
- தமிழின் முதல் புதினம்,
- தமிழின் முதல் சிறுகதை,
- கட்டுரை இலக்கியம்,
- பயண இலக்கியம்,
- நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

<u>தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்</u>

1.தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) -https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம் - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

OCE431 INTEGRATED WATER RESOURCES MANAGEMENT L T P C
3 0 0 3

OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

UNIT I CONTEXT FOR IWRM 9

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II WATER ECONOMICS 9

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS 9

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9

Water for food production: 'blue' versus 'green' water debate – Water foot print - Virtual water trade for achieving global water and food security –- Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

TOTAL: 45 PERIODS

OUTCOMES

- On completion of the course, the student is expected to be able to

CO1 Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
CO2 Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
CO3 Apply law and governance in the context of IWRM.
CO4 Discuss the linkages between water-health; develop a HIA framework.
CO5 Analyse how the virtual water concept pave way to alternate policy options.

REFERENCES:
1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
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3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Effective Water Governance". Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

OCE432 WATER, SANITATION AND HEALTH L T P C
3 0 0 3

OBJECTIVES:

• Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

UNIT I FUNDAMENTALS WASH 9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT 9

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality- Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT 9

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:- Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

UNIT IV GOVERNANCE 9

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)-Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V INITIATIVES 9

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 Capture to fundamental concepts and terms which are to be applied and understood all through the study.

CO2 Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.

CO3 Critically analyse and articulate the underlying common challenges in water, sanitation and health.

CO4 Acquire knowledge on the attributes of governance and its say on water sanitation and health.

CO5 Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R.,Kjellstorm, 2006, "Basic Epidemiology", 2nd Edition, World Health Organization.

2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. New Directions for Teaching and Learning, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda

3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary***.** Washington, DC: The National Academies Press, 2009.

4. Sen, Amartya 1997. On Economic Inequality. Enlarged edition, with annex by JamesFoster and Amartya Sen, Oxford: Claredon Press, 1997.

5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com

6. Third World Network.org (www.twn.org).

OCE433 PRINCIPLES OF SUSTAINABLE DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLEGES 9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development- millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation –climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step- peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation — Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8

Nature of sustainable development strategies and current practice**-** Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.

CO2 Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals

CO3 Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption

CO4 Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.

CO5 Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla,* IIED and UNFPA, Earthscan, UK, 2008
5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
6. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.

OCE434 ENVIRONMENTAL IMPACT ASSESSMENT L T P C

3 0 0 3

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION 9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process-screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT INDENTIFICATION AND PREDICTION 10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological —- cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES 9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to
  - **CO1** Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
  - **CO2** Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
  - **CO3** Understand relationship between social impacts and change in community due to development activities and rehabilitation methods
  - **CO4** Document the EIA findings and prepare environmental management and monitoring plan
  - **CO5** Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

OIC431 **BLOCKCHAIN TECHNOLOGIES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand and explore the working of Blockchain technology
CO2: Analyze the working of Smart Contracts
CO3: Understand and analyze the working of Hyperledger
CO4: Apply the learning of solidity to build de-centralized apps on Ethereum
CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

OIC432 **DEEP LEARNING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS **6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS **9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK **10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT VI NATURAL LANGUAGE PROCESSING USING RNN **10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING **10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data
CO2: Implement Image Segmentation and Instance Segmentation in Images
CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)
CO4: Traffic Information analysis using Twitter Data
CO5: Autoencoder for Classification & Feature Extraction

TOTAL : 45 PERIODS

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018

3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OME431 VIBRATION AND NOISE CONTROL STRATEGIES L T P C
3 0 0 3

OBJECTIVES

- To appreciate the basic concepts of vibration in damped and undamped systems
- To appreciate the basic concepts of noise, its effect on hearing and related terminology
- To use the instruments for measuring and analyzing the vibration levels in a body
- To use the instruments for measuring and analyzing the noise levels in a system
- To learn the standards of vibration and noise levels and their control techniques

UNIT- I BASICS OF VIBRATION 9

Introduction – Sources and causes of Vibration-Mathematical Models - Displacement, velocity and Acceleration - Classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration - Single Degree Freedom Systems - Vibration isolation - Determination of natural frequencies

UNIT- II BASICS OF NOISE 9

Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra -Types of sound fields - Octave band analysis - Loudness.

UNIT- III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9

Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings - Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments -. System Identification from Frequency Response -Testing for resonance and mode shapes

UNIT- IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9

Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

UNIT- V METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL 9

Specification of Vibration Limits – Vibration severity standards - Vibration as condition Monitoring Tool – Case Studies - Vibration Isolation methods - Dynamic Vibration Absorber – Need for Balancing - Static and Dynamic Balancing machines – Field balancing - Major sources of noise - Noise survey techniques – Measurement technique for vehicular noise - Road vehicles Noise standard – Noise due to construction equipment and domestic appliances – Industrial noise sources and its strategies – Noise control at the source – Noise control along the path – Acoustic Barriers – Noise control at the receiver -- Sound transmission through barriers – Noise reduction Vs Transmission loss - Enclosures

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:

1. Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.
2. Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007.

3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000.
4. William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.
5. G.K. Grover, “Mechanical Vibrations”, Nem Chand and Bros.,Roorkee, 2014.
6. A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.
7. David A. Bies and Colin H. Hansen, “Engineering Noise Control – Theory and Practice”, Spon Press, London and New York, 2009.

OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To learn the present energy scenario and the need for energy conservation.
2. To understand the different measures for energy conservation in utilities.
3. Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
4. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
5. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I ENERGY SCENARIO 9

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

UNIT II HEATING, VENTILLATION & AIR CONDITIONING 9

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

UNIT III LIGHTING, COMPUTER, TV 9

Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

UNIT IV ENERGY EFFICIENT BUILDINGS 9

Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

UNIT V ENERGY STORAGE TECHNOLOGIES 9

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Understand technical aspects of energy conservation scenario.
2. Energy audit in any type for domestic buildings and suggest the conservation measures.
3. Perform building load estimates and design the energy efficient landscape system.
4. Gain knowledge to utilize an appliance/device sustainably.
5. Understand the status and current technological advancement in energy storage field.

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment
3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001

4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com)
6. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
7. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
8. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

OME433 ADDITIVE MANUFACTURING L T P C
3 0 0 3

UNIT I INTRODUCTION 9
Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9
CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.

UNIT III VAT POLYMERIZATION 9
Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION 9
Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies

POWDER BASED PROCESS
Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle-– Materials- Application and Limitation - Three Dimensional Printing - Materials -Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters -Materials - Benefits -Applications.

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES 9
Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

TOTAL: 45 PERIODS

REFERENCES:
1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590
4. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

OME434 ELECTRIC VEHICLE TECHNOLOGY L T P C
3 0 0 3

UNIT I NEED FOR ELECTRIC VEHICLES 9

History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

UNIT II ELECTRIC VEHICLE ARCHITECHTURE 9

Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

UNIT III ENERGY STORAGE 9

Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

UNIT IV ELECTRIC DRIVES AND CONTROL 9

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor -drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

UNIT V DESIGN OF ELECTRIC VEHICLES 9

Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

TOTAL: 45 PERIODS

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained - Wiley, 2003.
4. Ehsani, M, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2005

OME435 NEW PRODUCT DEVELOPMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identfying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product design and development.
4. Generating, selecting, and testing the concepts for new product design and development.
5. Appling the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCTDESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of

Product Development – The Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations.

UNIT II OPPORTUNITY DENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs – The Process of Identifying Customer Needs. Product Specifications: Definition – Time of Specifications Establishment – Establishing Target Specifications – Setting the Final Specifications

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

Concept Generation: Activity of Concept Generation – Structured Approach – Five step method of Concept Generation. Concept Selection: Methodology – Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.

UNITV INDUSTRIAL DESIGN & PROTOTYPING 9

Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Apply the principles of generic development process; and understand the organization structure for new product design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and test the concepts for new product design and development.
5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, “Product Design and Development “McGraw-Hill Education; 7 edition, 2020.

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Rosenthal S.,“Effective Product Design and Development”, Business One Orwin,Homewood, 1992,ISBN1-55623-603-4.
3. Pugh.S,“Total Design Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing,1991,ISBN0-202-41639-5.
4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

OBA431 SUSTAINABLE MANAGEMENT LT P C
3 0 0 3

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainabilityperformances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship – evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1. Familiarise the students with the concept of small business
CO2. In depth knowledge on small business opportunities and challenges
CO3. Ability to devise plans for small business by building the right skills and marketing strategies
CO4. Identify the funding source for small start ups
CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.

OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS 9

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES 9

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS 9

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

OBA434 ETHICAL MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVE

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY 9

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS 9

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology- ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Role modelling and influencing the ethical and cultural context.
CO2: Respond to ethical crises and proactively address potential crises situations.
CO3: Understand and implement stakeholder management decisions.
CO4: Develop the ability, knowledge, and skills for ethical management.
CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

ET4251 IoT FOR SMART SYSTEMS LT P C

3 0 0 3

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture**,** IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9

PROTOCOLS:

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS 9

Services/Attributes: Big-Data Analytics for IOT, Dependability,Interoperability, Security, Maintainability.

Embedded processors for IOT :Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES 9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.

CO2: Compare and contrast different platforms and infrastructures available for IoT

CO3: Explain different protocols and communication technologies used in IoT

CO4: Analyze the big data analytic and programming of IoT

CO5: Implement IoT solutions for smart applications

REFERENCES:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.
9. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, “ Smart Grid Technology and Applications”, Wiley, 2015.
13. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

ET4072 MACHINE LEARNING AND DEEP LEARNING L T P C
3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS 9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.
CO2: Compare and contrast the types of neural network architectures, activation functions
CO3: Acquaint with the pattern association using neural networks
CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks
CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:
To impart knowledge on
- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9
Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO_2 Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS 9
Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9
Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9
Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9
Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:
After completion of this course, the student will be able to:
CO1: Demonstrate the need for renewable energy sources.
CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
CO3: Design a stand-alone and Grid connected PV system.
CO4: Analyze the different configurations of the wind energy conversion systems.
CO5: Realize the basic of various available renewable energy sources

REFERENCES:
1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford UniversityPress, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.

5. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006
6. Gray, L. Johnson, “Wind energy system”, prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

PS4093 SMART GRID L T P C
3 0 0 3

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to
CO1: Relate with the smart resources, smart meters and other smart devices.
CO2: Explain the function of Smart Grid.
CO3: Experiment the issues of Power Quality in Smart Grid.
CO4: Analyze the performance of Smart Grid.
CO5**:** Recommend suitable communication networks for smart grid applications

REFERENCES
1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

CP4391 SECURITY PRACTICES L T P C
3 0 0 3

COURSE OBJECTIVES:
- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY 9

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES
1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017

2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, "The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics", Syngress, 2012
6. Cory Altheide and Harlan Carvey, "Digital Forensics with Open Source Tools",2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

MP4251 CLOUD COMPUTING TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS 9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM 9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

UNIT V PROGRAMMING MODEL 9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Employ the concepts of virtualization in the cloud computing
CO2: Identify the architecture, infrastructure and delivery models of cloud computing
CO3: Develop the Cloud Application in AWS platform
CO4: Apply the concepts of Windows Azure to design Cloud Application
CO5: Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner"s Guidell, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072 DESIGN THINKING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I UX LIFECYCLE TEMPLATE 8

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

UNIT II CONTEXTUAL INQUIRY 10

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9

Design-informing models: second span of the bridge . Some general "how to" suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV UX GOALS, METRICS, AND TARGETS 8

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results.

Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:

1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Build UI for user Applications
CO2: Use the UI Interaction behaviors and principles
CO3: Evaluate UX design of any product or application
CO4: Demonstrate UX Skills in product development
CO5: Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153 **PRINCIPLES OF MULTIMEDIA** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION 9

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA 9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS 9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS 9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures –

Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Handle the multimedia elements effectively.
CO2: Articulate the concepts and techniques used in multimedia applications.
CO3: Develop effective strategies to deliver Quality of Experience in multimedia applications.
CO4: Design and implement algorithms and techniques applied to multimedia objects.
CO5: Design and develop multimedia applications following software engineering models.

REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

DS4015 BIG DATA ANALYTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA 9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION 9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies – Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS 9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS 9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE 9

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays - Lists -Data frames -Classes, Input/output, String manipulations

COURSE OUTCOMES:

CO1:understand the basics of big data analytics
CO2: Ability to use Hadoop, Map Reduce Framework.
CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.
CO4:gain knowledge on R language
CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL:45 PERIODS

REFERENCE:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

NC4201 INTERNET OF THINGS AND CLOUD L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT 9

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

UNIT II PROTOCOLS FOR IoT 9

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS 9

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION 9

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT V IoT AND CLOUD 9

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core -Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the various concept of the IoT and their technologies..
CO2: Develop IoT application using different hardware platforms
CO3: Implement the various IoT Protocols
CO4: Understand the basic principles of cloud computing.
CO5: Develop and deploy the IoT application into cloud environment

REFERENCES

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.
4. Simon Walkowiak, “Big Data Analytics with R” PackT Publishers, 2016
5. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2015.

MX4073 MEDICAL ROBOTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS 9

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS 9

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS 9

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS 9

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Describe the configuration, applications of robots and the concept of grippers and actuators
CO2: Explain the functions of manipulators and basic kinematics
CO3: Describe the application of robots in various surgeries
CO4: Design and analyze the robotic systems for rehabilitation
CO5: Design the wearable robots

REFERENCES

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

VE4202 EMBEDDED AUTOMATION L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING 9

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT - II AVR MICROCONTROLLER 9

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT – III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS 9

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT – IV VISION SYSTEM 9

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT – V HOME AUTOMATION 9

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor - Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, students will be able to

CO1: analyze the 8-bit series microcontroller architecture, features and pin details
CO2: write embedded C programs for embedded system application
CO3: design and develop real time systems using AVR microcontrollers
CO4: design and develop the systems based on vision mechanism
CO5: design and develop a real time home automation system

REFERENCES:

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.