



ARUNAI ENGINEERING COLLEGE
(AUTONOMOUS)
TIRUVANNAMALAI
REGULATIONS 2024



CHOICE BASED CREDIT SYSTEM

M.TECH BIOTECHNOLOGY

CURRICULUM AND SYLLABI FOR I TO IV SEMESTERS

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA24102	Applied Statistics for Biotechnologists	FCC	4	0	0	4	4
2.	BY24101	Advanced Molecular Biology and Genetic Engineering	PCC	3	0	0	3	3
3.	BY24102	Bioprocess Technology	PCC	3	0	0	3	3
4.	BY24103	Advanced Immunology	PCC	3	0	0	3	3
5.	RM24101	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.	BY24111	Immuno-technology Laboratory	PCC	0	0	6	6	3
TOTAL				20	0	6	26	21

* Audit Course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	BY24201	Bio Separation Technology	PCC	3	0	0	3	3
2.	BY24202	Computational Biology	PCC	3	1	0	4	4
3.	BY24203	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.	BY24211	Preparative and Analytical Techniques In Biotechnology	PCC	0	0	6	6	3
TOTAL				23	1	6	30	25

* Audit Course is optional

HoD/BOS Chairman

[Signature]

[Signature]
Principal

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
RACTICALS								
1.	BY24311	Advanced Genetic Engineering Laboratory	PCC	0	0	6	6	3
2.	BY24312	Bioprocess and Downstream Processing Laboratory	PCC	0	0	6	6	3
3.	BY24313	Project Work I	EEC	0	0	12	12	6
TOTAL				0	0	24	24	12

SEMESTER IV

SEMESTER IV								
S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	BY24411	Project Work II	EEC	0	0	24	24	12
			TOTAL	0	0	24	24	12

TOTAL CREDITS: 70

S.No	Subject Area	Credits per Semester				Total Credits
		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
6	RMC	2	-	-	-	2
7	Total	21	25	12	12	70
8	Audit courses (Non Credit)	*	*			


HoD/BOS Chairman


Principal

PROFESSIONAL ELECTIVE COURSES – I , SEMESTER I								
S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BY24001	Advances in Animal Biotechnology	PEC	3	0	0	3	3
2.	BY24002	Plant Genetic Engineering and Biotechnology	PEC	3	0	0	3	3
3.	BY24003	Advances in Cancer Biology	PEC	3	0	0	3	3
4.	BY24004	Phytochemistry	PEC	3	0	0	3	3
5.	BY24005	Advances in Molecular Pathogenesis	PEC	3	0	0	3	3
PROFESSIONAL ELECTIVE COURSES – II SEMESTER II								
6.	BY24006	Enzyme Engineering and Technology	PEC	3	0	0	3	3
7.	BY24007	Bio reactor Design and Control	PEC	3	0	0	3	3
8.	BY24008	Thermodynamics for Biological Systems	PEC	3	0	0	3	3
9.	BY24009	Biotechnology in Food Processing	PEC	3	0	0	3	3
10.	BY24010	Bioprocess Modelling and Simulation	PEC	3	0	0	3	3
11.	BY24011	Biofuels and Platform Chemicals	PEC	3	0	0	3	3
PROFESSIONAL ELECTIVE COURSES – III, SEMESTER II								
12.	BY24012	Molecular Medicine	PEC	3	0	0	3	3
13.	BY24013	Biomaterials and Tissue Engineering	PEC	3	0	0	3	3
14.	BY24014	Biopharmaceuticals and Biosimilars	PEC	3	0	0	3	3
15.	BY24015	Bio Nanotechnology	PEC	3	0	0	3	3
PROFESSIONAL ELECTIVE COURSES – IV, SEMESTER II								
16.	BY24016	Advanced Genomics and Proteomics	PEC	3	0	0	3	3
17.	BY24017	IPR, Biosafety and Entrepreneurship	PEC	3	0	0	3	3
18.	BY24018	Protein Structure Analysis	PEC	3	0	0	3	3
19.	BY24019	Computer Aided Learning of Structure and Function of Proteins	PEC	3	0	0	3	3
20.	BY24020	Computational Methods in Fluid Dynamics	PEC	3	0	0	3	3


HoD/BOS Chairman


Principal

OPEN ELECTIVES

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCE24001	Integrated Water Resources Management	OEC	3	0	0	3	3
2.	OCE24002	Water, Sanitation and Health	OEC	3	0	0	3	3
3.	OCE24003	Principles of Sustainable Development	OEC	3	0	0	3	3
4.	OCE24004	Environmental Impact Assessment	OEC	3	0	0	3	3
5.	OIC24001	Blockchain Technologies	OEC	3	0	0	3	3
6.	OIC24002	Deep Learning	OEC	3	0	0	3	3
7.	OME24001	Vibration and Noise Control Strategies	OEC	3	0	0	3	3
8.	OME24002	Energy Conservation and Management in Domestic Sectors	OEC	3	0	0	3	3
9.	OME24003	Additive Manufacturing	OEC	3	0	0	3	3
10.	OME24004	Electric Vehicle Technology	OEC	3	0	0	3	3
11.	OME24005	New Product Development	OEC	3	0	0	3	3
12.	OBA24001	Sustainable Management	OEC	3	0	0	3	3
13.	OBA24002	Micro and Small Business Management	OEC	3	0	0	3	3
14.	OBA24003	Intellectual Property Rights	OEC	3	0	0	3	3
15.	OBA24004	Ethical Management	OEC	3	0	0	3	3
16.	ET24003	IoT for Smart Systems	OEC	3	0	0	3	3
17.	ET24004	Machine Learning and Deep Learning	OEC	3	0	0	3	3
18.	PX24010	Renewable Energy Technology	OEC	3	0	0	3	3
19.	PS24003	Smart Grid	OEC	3	0	0	3	3
20.	CP24007	Security Practices	OEC	3	0	0	3	3
21.	MP24002	Cloud Computing Technologies	OEC	3	0	0	3	3
22.	IF24001	Design Thinking	OEC	3	0	0	3	3
23.	MU24001	Principles of Multimedia	OEC	3	0	0	3	3
24.	DS24001	Big Data Analytics	OEC	3	0	0	3	3
25.	NC24001	Internet of Things and Cloud	OEC	3	0	0	3	3
26.	MX24001	Medical Robotics	OEC	3	0	0	3	3
27.	VE24001	Embedded Automation	OEC	3	0	0	3	3


HoD/BOS Chairman


Principal

AUDIT COURSES

REGISTRATION FOR ANY OF THESE COURSES IS OPTIONAL TO STUDENTS

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AX24091	English for Research Paper Writing	AC	2	0	0	2	0
2.	AX24092	Disaster Management	AC	2	0	0	2	0
3.	AX24093	Constitution of India	AC	2	0	0	2	0
4.	AX24094	நற்றமிழ் இலக்கியம்	AC	2	0	0	2	0



HoD/BOS Chairman



Principal

Subject Code	Subject Name	Category	L	T	P	C
MA24102	APPLIED STATISTICS FOR BIOTECHNOLOGISTS	FCC	4	0	0	4

Course Objectives:

- 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 Contact Hours : 60

Course Outcomes:	Upon completion of the course students should 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


HoD/BOS Chairman


Principal

	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

Reference books/other materials/webresources:

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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1:	1	1	1	-	-	-
CO2:	2	1	2	-	-	-
CO3:	2	1	2	-	-	-
CO4:	2	1	3	-	-	-
CO5:	2	1	3	-	-	-
Average:	1.8	1	2.2	-	-	-


HoD/BOS Chairman


Principal

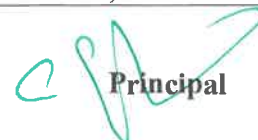
Subject Code	Subject Name	Category	L	T	P	C
BY24101	ADVANCED MOLECULAR BIOLOGY AND GENETIC ENGINEERING	PCC	3	0	0	3

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 transgenic 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 microarray		
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		


HoD/BOS Chairman


Principal

resistance, enhanced nutritional value, Viral vectors, Engineering siRNA mediated gene knock downs (shRNA).

Total Contact Hours : 45

Course Outcomes:	Upon completion of the course students should 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 transgenic animals and plants.

Reference books/other materials/webresources:

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. "From 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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1:	1	1	1	-	-	-
CO2:	2	1	2	-	-	-
CO3:	2	1	2	-	-	-
CO4:	2	1	3	-	-	-
CO5:	2	1	3	-	-	-
Average:	1.8	1	2.2	-	-	-


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24102	BIOPROCESS TECHNOLOGY	PCC	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 Contact Hours : 45

Course Outcomes:	Upon completion of the course students should 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


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:	
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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1:	1	1	1	-	-	-
CO2:	2	1	2	-	-	-
CO3:	2	1	2	-	-	-
CO4:	2	1	3	-	-	-
CO5:	2	1	3	-	-	-
Average:	1.8	1	2.2	-	-	-


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24103	ADVANCED IMMUNOLOGY	PCC	3	0	0	3
Course Objectives:						
- To understand the structure, functions and integration of immune system - To explain the antigen-antibody interactions that offers defense 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,Fluorochromes; 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, dendritic cell vaccines. DNA vaccines, cell based therapeutics.		
		Total Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should 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 develop
CO4:	Understand the importance of various techniques of therapeutically significant monoclonal and engineered antibodies production
CO5:	Gain knowledge in Immunotherapeutics development for Clinical Applications

Reference books/other materials/webresources:	
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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
RM24101	RESEARCH METHODOLOGY AND IPR	RMC	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-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents						
						Total Contact Hours : 30

Course Outcomes:	Upon completion of the course students should be able to:
CO1:	Develop the ability to identify, formulate, review literature for, and analyze complex problems to reach substantiated conclusions using fundamental principles
CO2:	Familiarize with scientific methodology and research processes, understanding various research types, objectives, designs, and sampling techniques
CO3:	Acquire knowledge of data sources for literature reviews and data collection, and develop the ability to analyze and interpret data in relation to the research process.
CO4:	Gain the aptitude to independently carry out research, investigations, and development work to solve practical problems.
CO5:	Understand IPR Basics: Demonstrate a foundational understanding of Intellectual Property Rights and their significance

Reference books/other materials/webresources:	
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.


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24111	IMMUNO-TECHNOLOGY LABORATORY	PCC	0	0	6	3

Course Objectives:

- To give practical exposure in the clinical diagnosis.
- To give laboratory training in different immune technological techniques
- 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
Total Contact Hours : 90

* Approval of IAEC is mandatory for experiments involving Live animal

LIST OF EQUIPMENTS REQUIRED

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

Course Outcomes:	Upon completion of the course students should be able to:
CO1:	Understand the clinical diagnosis methods and its importance.
CO2:	Gain training in different immunotechnological techniques
CO3:	Gain hands on training in cell staining, separation and identification

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1:	3	1	2	1	2	
CO2:	3	1	2	1	2	
CO3:	3	1	2	1	2	
Average	3	1	2	1	2	


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24201	BIO SEPARATION TECHNOLOGY	PCC	3	0	0	3

Course Objectives:

- To enable the students to understand the methods to obtain pure proteins, enzymes and in general about product development R & D
- To gain depth knowledge and hands on experience on Downstream processes to commercial therapeutically important proteins.
- To educate the principle involved in membrane separations and enrichment operations
- To promote the applicability of chromatographic techniques in Biological products separation
- 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should 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 therapeutically 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.

Reference books/other materials/webresources:

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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24202	COMPUTATIONAL BIOLOGY	PCC	3	1	0	4
Course Objectives:						
To improve the programming skills of the student in the field of Biological research						
Make students know the recent sequence analysis methods						
To educate the students about recent advancements involved in drug delivery systems						
To develop depth knowledge in Molecular Dynamics and Molecular Modeling						
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 Contact Hours : 45+15 = 60


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should 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

Reference books/other materials/webresources:

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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24203	METABOLIC PROCESS AND ENGINEERING	PCC	3	0	0	3

Course 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should be able to:
CO1:	To learn stoichiometry and energetics of metabolism.
CO2:	To apply practical applications of metabolic engineering in chemical, energy, medical and environmental fields.
CO3:	To have a clear understanding on metabolic control analysis
CO4:	To gain experience in the development of genome scale metabolic modelling
CO5:	To integrate modern biology with engineering process to meet desired needs

Reference books/other materials/webresources:	
1.	Christiana D. Smolke, "The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.
2.	Cortossa, S., Aon, M.A., Iglesias, A.A. and Lloyd.D., "An Introduction to Metabolic and Cellular 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 - Principles and Methodologies", Elsevier Science, 2001.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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
CO5:	2	3	2	3	3	2
Average:	2	2	2	2	2	1


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24211	PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY	PCC	0	0	6	3
Course Objectives:						
To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules						
To gain hands-on experience in spectroscopic methods						
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 Chromatography – 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 Contact Hours : 90

Course Outcomes:	Upon completion of the course students should 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


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:	
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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24311	ADVANCED GENETIC ENGINEERING LABORATORY	PCC	0	0	6	3
Course Objectives:						
• Provide hands-on experience in performing basic recombinant DNA techniques.						
• To understand the principle behind each techniques and applications of each methodology in applied biological research.						
• 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	
	Total Contact Hours : 90

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


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should 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

Reference books/other materials/webresources:	
1.	Sambrook, J. and Russel, D.W., "Molecular cloning – A laboratory manual", Third edition, Cold Spring Harbor Laboratory Press, Cold Spring harbor, New York, USA, 2001

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24312	BIOPROCESS AND DOWNSTREAM PROCESSING LABORATORY	PCC	0	0	6	3
Course Objectives:						
The course applies earlier learned knowledge about mass transfer in bio reactors and sterilization kinetics.						
To provide hands on training in Downstream processing through simple experimentations in the laboratory.						
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, kLa determination, residence time distribution.	
7. Cell separation methods-Centrifugation and microfiltration	
8. Cell disruption methods- ultrasonicator, homogeniser.	
9. Aqueous two phase extraction of biologicals.	
10. Protein precipitation by salting –out method (ammonium sulphate).	
11. Protein purification method- Column chromatography.	
12. Product polishing- dryers, crystallizers.	
Total Contact Hours : 90	

LIST OF EQUIPMENTS REQUIRED

Centrifuge,


HoD/BOS Chairman


Principal

Column for purification

Ultrasonicator

Homogeniser

Microfiltration capsule

Hot air oven, Incubator

Laminar air flow chamber

HPLC,

Course Outcomes:	Upon completion of the course students should 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.

Reference books/other materials/webresources:

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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24313	PROJECT WORK I	EEC	0	0	12	6
Course Objectives:						
- 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						

WORKPLAN	
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.	
	Total Contact Hours : 180

Course Outcomes:	Upon completion of the course students should 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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1:	2	1	1		2	1
CO2:	2	1	1	1	2	1
CO3:	2	1	1		2	1
CO4:	2	1	1	1	2	1
Average	2	1	1	1	2	1


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24411	PROJECT WORK II	EEC	0	0	24	12
Course Objectives:						
- 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 .						

WORKPLAN	
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.	
	Total Contact Hours : 360

Course Outcomes:	Upon completion of the course students should 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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

PROFESSIONAL ELECTIVE I

Subject Code	Subject Name	Category	L	T	P	C
BY24001	ADVANCES IN ANIMAL BIOTECHNOLOGY	PEC	3	0	0	3

Course Objectives:

- To educate the students about the scope, regulatory issues and commercially available products produced using of animal biotechnology.
- 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.
- To teach the importance of cell culture study for invitro study purposes and for scaling up the products at commercial level.
- 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?
- To educate the principle behind invitro fertilization and biopharming in order to create transgenic animal of commercial importance.

UNIT – I	INTRODUCTION	9
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	9
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	9
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	9
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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should 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 <i>invitro</i> 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 <i>invitro</i> fertilization and biopharming in order to create transgenic animal of commercial importance.

Reference books/other materials/webresources:

1. Watson, J.D., Gilman, M., Witowski J. 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. Davis J.M. Basic Cell Culture: A Practical Approach, IRL Press, 2nd ed., 2002
4. Lewin, B. Genes VIII, Pearson Prentice Hall, 2004.
5. Freshney R.I. Animal Cell Culture- a practical approach, 6th ed., 2010

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24002	PLANT GENETIC ENGINEERING AND BIOTECHNOLOGY	PEC	3	0	0	3

Course Objectives:

- To impart knowledge on organization of plant genomes and functional characterization of genes.
- To impart knowledge on molecular mechanism of plant-microbe interactions
- To impart knowledge on tissue culture, transformation techniques and transgenic plants
- To impart knowledge on plant genetic engineering and applications
- 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should be able to:
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

Reference books/other materials/webresources:

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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24003	ADVANCES IN CANCER BIOLOGY	PEC	3	0	0	3
Course Objectives:						
- To educate about the basics principles of cancer biology - To educate about the factors involved in development of carcinogenesis. - To understand the basics concepts involved in molecular biology of cancer. - To educate the basic mechanism involved in cancer metastasis. - 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 Contact Hours : 45

Course Outcomes:	Upon completion of the course students should 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.


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:

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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24004	PHYTOCHEMISTRY	PEC	3	0	0	3
Course Objectives:						
- To give the details of plant derived value added compounds and its functions . - To educate the importance of phytocompounds application to fight againsts various microbial infections - To provide knowledge on biotech based production of agro medicines separation techniques - To educate about the basic principles and techniques involved in structure elucidation and Molecular Modeling - 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should be able to:
CO1:	Understand the importance the plant derived value added compounds and its functions .
CO2:	Understand the importance of phytochemicals application to fight against 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

Reference books/other materials/webresources:

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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24005	ADVANCES IN MOLECULAR PATHOGENESIS	PEC	3	0	0	3

Course Objectives:

- To know about the host pathogen interaction and identifying virulence factors involved in viral pathogenesis
- To educate about vaccine development and functional genomic approaches in treatment of fungal pathogenesis
- To provide depth knowledge in clinical significance in bacterial pathogenesis treatments
- To understand about the microbial toxins and modern molecular pathogenesis
- 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 – Persistent 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
Epidemiology 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should 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.

Reference books/other materials/webresources:

1. Flint, J., Enquist, L.W., Krug, "Principles of Virology: Molecular iology, Pathogenesis and Control", American Society of Microbiology, 2003.
2. Groisman, 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. Mettenleiter, 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. Salyers, Abigail A. "Bacterial Pathogenesis: A Molecular Approach", 3rd ed., 2010
7. Madigan, Michael T. "Biology of Microorganisms", 15th ed., 2017

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

PROFESSIONAL ELECTIVE II

Subject Code	Subject Name	Category	L	T	P	C
BY24006	ENZYME ENGINEERING AND TECHNOLOGY	PEC	3	0	0	3
Course Objectives:						
• To become acquainted with the classification and mechanism of enzymes						
• To provide basic concepts of the kinetics of enzyme action						
• To impart knowledge about the immobilization of the enzymes						
• To understand the role of enzymes involved in biotransformation						
• 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 of rate 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 of immobilized 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 Contact Hours : 45

Course Outcomes:	Upon completion of the course students should be able to:
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


 HoD/BOS Chairman


 Principal

Reference books/other materials/webresources:

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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24007	BIO REACTOR DESIGN AND CONTROL	PEC	3	0	0	3

Course Objectives:

- To familiarize various reactor types and modes of operations.
- To incorporate mass transfer engineering into bioprocess system
- To impart knowledge on the selection and design of bioprocess equipment
- To integrate the engineering concepts in to scale up and scale down of bioreactor
- 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 $k_L a$ 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should be able to:
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

Reference books/other materials/webresources:

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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24008	THERMODYNAMICS FOR BIOLOGICAL SYSTEMS	PEC	3	0	0	3

Course Objectives:

- To give the concepts of energy, laws of thermodynamics to applications that require quantitative knowledge of thermodynamic properties at macroscopic level.
- To educate the thermodynamics of phase equilibria typically encountered in design of chemical processes such as separation operations
- To educate the theoretical results used to physical systems that convert matter and energy in terms of the laws of thermodynamics
- To educate the various phase equilibrium models in practical situations
- To provide knowledge in the area of thermodynamics principles to various chemical engineering processes

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	PHYTOMEDICINE	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	SEPARATION TECHNIQUES AND STRUCTURE ELUCIDATION	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 equilibria- SLE/LLE/VLLE		
UNIT – V	SECONDARY METABOLITE	9
Criteria of chemical reaction equilibrium in thermodynamic systems, Homogeneous gas and liquid phase reactions, heterogeneous reactions – phase and chemical equilibrium		
		Total Contact Hours : 45

Course Outcomes:	Upon completion of the course students should 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


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:	
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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


 HoD/BOS Chairman


 Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24009	BIOTECHNOLOGY IN FOOD PROCESSING	PEC	3	0	0	3

Course Objectives:

- To know different techniques used for the preservation of foods.
- To educate the importance of fermentation principles involved in converting waste to values.
- To educate the importance of Biotechnological approaches to improve nutritional quality through fermented foods.
- To gain knowledge about the microorganisms, food spoilage diseases.
- 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should 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.

Reference books/other materials/webresources:

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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24010	BIOPROCESS MODELLING AND SIMULATION	PEC	3	0	0	3

Course Objectives:

- To impart knowledge on the fundamental and empirical models for dynamic process
- To provide knowledge to be able to develop kinetic models for biological process
- To impart knowledge on the model and design the bioreactors
- To impart knowledge on the parameters involved in bioprocess
- 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 using models from literature sources		
		Total Contact Hours : 45

Course Outcomes:	Upon completion of the course students should be able to:
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


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:

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, Bwer 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. Thomas E.M., "Process Control: Designing Processes and Control Systems for Dynamic Performance", McGraw Hill, 1st edition, 2000.
7. Smith C.A., Corripio A.B., "Principles and Practice of Automatic Process Control", Wiley, New York, 3rd edition, 2005.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24011	BIOFUELS AND PLATFORM CHEMICALS	PEC	3	0	0	3

Course Objectives:

- To impart the knowledge various forms of biofuels and production of platform chemicals using the microorganisms and various sources for the production of biofuels
- To impart basic knowledge on the production aspects of ethanol
- To impart basic knowledge on the production aspects of biodiesel.
- To impart understanding on the production of other important biofuels and their significance.
- 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 Contact Hours : 45

Course Outcomes:	Upon completion of the course students should be able to:
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


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:	
1.	Lee, Sunggyu; Shah, Y.T. "Biofuels and Bioenergy". CRC / Taylor & Francis, 2013.
2.	Aye D., John N., Terry W., "Biofuels Engineering Process Technology", McGraw Hill, 1st Edition, 2008.
3.	Ayhan Demirbas , "Biofuels Securing the Planet's Future Energy Needs", springer, 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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


 HoD/BOS Chairman


 Principal

PROFESSIONAL ELECTIVE III

Subject Code	Subject Name	Category	L	T	P	C
BY24012	MOLECULAR MEDICINE	PEC	3	0	0	3
Course Objectives:						
- To impart knowledge on the fundamental technologies at a molecular level - To provide basic biology involved in technology - To impart knowledge on the molecular diagnostics using immunological and molecular approaches. - To impart knowledge on the nucleic acid and protein therapeutic agents - 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 Contact Hours : 45

Course Outcomes:	Upon completion of the course students should be able to:
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


 HoD/BOS Chairman


 Principal

Reference books/other materials/webresources:

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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24013	BIOMATERIALS AND TISSUE ENGINEERING	PEC	3	0	0	3

Course Objectives:

- To learn the fundamentals of tissue engineering and tissue repairing
- To educate the role of Biomaterials in Tissue engineering applications
- To acquire knowledge of applicability of molecular agents in drug delivery systems which promote tissue engineering principles.
- To acquire knowledge on clinical applications of tissue engineering
- 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should 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

Reference books/other materials/webresources:	
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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24014	BIOPHARMACEUTICALS AND BIOSIMILARS	PEC	3	0	0	3

Course Objectives:

- To provide knowledge in core responsibilities for the development and monitoring of the drug and the preparation of medicines according to the norms.
- To gain knowledge in physicochemical properties, pharmacology and the formulation of commonly used biopharmaceuticals.
- To educate about the recent advancements in drug delivery systems.
- To educate about the biosimilars medicine and its future prospects
- 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 – GM-CSF – Blood clotting Factors – Tissue plasminogen activator – Monoclonal antibodies and engineered antibodies.		
		Total Contact Hours : 45

Course Outcomes:	Upon completion of the course students should 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.


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:

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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24015	BIO NANOTECHNOLOGY	PEC	3	0	0	3
Course Objectives:						
• Provide concepts of nanotechnology • Have knowledge on the synthesis and characterization of nanomaterials • Have knowledge on the nanobiology and its application • 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should be able to:
CO1	understand fundamental concepts of nanotechnology and nanomaterials
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

Reference books/other materials/webresources:

1. Gazit, E., and Mitraki, A., "Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology", 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 Vs Organic 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 the Future", Humana Press, 2008.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

PROFESSIONAL ELECTIVE IV

Subject Code	Subject Name	Category	L	T	P	C
BY24016	ADVANCED GENOMICS AND PROTEOMICS	PEC	3	0	0	3
Course Objectives:						
To impart knowledge on the organization and structure of genomes						
To provide knowledge on the techniques in mapping of genome						
To impart knowledge on sequencing strategies for genome analysis.						
To impart knowledge on the comparative and functional genomics						
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 & 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		


HoD/BOS Chairman


Principal

Denisovans; Woolly Mammoth; Barley; Mycobacterium tuberculosis	
Total Contact Hours : 45	
Course Outcomes:	Upon completion of the course students should be able to:
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 and learned the evolutionary significance of paleogenomics

Reference books/other materials/webresources:	
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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24017	IPR, BIOSAFETY AND ENTREPRENEURSHIP	PEC	3	0	0	3
Course Objectives:						
To impart knowledge and to create awareness on IPR						
To impart knowledge in patent filing procedures, agreements and treaties						
To impart knowledge on biosafety and guidelines						
To impart knowledge on genetically modified organisms and related guidelines						
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 Cartagena 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should be able to:
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

Reference books/other materials/webresources:

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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24018	PROTEIN STRUCTURE ANALYSIS	PEC	3	0	0	3

Course Objectives:

- To impart knowledge on the strategies for identification and analysis of proteins.
- To provide knowledge on the types of ionization and mass spectrometry in proteomics
- To impart knowledge on separation and processing of proteins in proteomic analysis
- To impart knowledge on the comparative proteomic analysis.
- 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 Ion detectors		
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 chromatography in 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 and in-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 Protein microarrays.		
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 Contact Hours : 45

Course Outcomes:	Upon completion of the course students should be able to:
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


HoD/BOS Chairman


Principal

	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

Reference books/other materials/webresources:

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.	Siuzdak G. "Mass Spectrometry for Biotechnology." Academic Press, 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., McLafferty 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.

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24019	COMPUTER AIDED LEARNING OF STRUCTURE AND FUNCTION OF PROTEINS	PEC	3	0	0	3
Course Objectives:						
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 Contact Hours : 45				

Course Outcomes:	Upon completion of the course students should 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

Reference books/other materials/webresources:	
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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
BY24020	COMPUTATIONAL METHODS IN FLUID DYNAMICS	PEC	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 Contact Hours : 45

Course Outcomes:	Upon completion of the course students should 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.


HoD/BOS Chairman


Principal

CO5	Apply the principles involved in Finite Element formulation methods.
------------	--

Reference books/other materials/webresources:

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

PO & PSO / CO	CO-PO Mapping					
	PO1	PO2	PO3	PO4	PO5	PO6
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


HoD/BOS Chairman


Principal

AUDIT COURSES

Subject Code	Subject Name	Category	L	T	P	C
AX24091	ENGLISH FOR RESEARCH PAPER WRITING	AC	2	0	0	0

Course 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 Contact Hours : 30

Course Outcomes:	Upon completion of the course students should be able to:
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

Reference books/other materials/webresources:

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.


 HoD/BOS Chairman


 Principal

Subject Code	Subject Name	Category	L	T	P	C
AX24092	DISASTER MANAGEMENT	AC	2	0	0	0
Course 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 Contact Hours : 30

Course Outcomes:	Upon completion of the course students should be able to:
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


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:

- | | |
|----|--|
| 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 Of India, New Delhi,2001. |


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
AX24093	CONSTITUTION OF INDIA	AC	2	0	0	0
Course Objectives:						
Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.						
To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional						
Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.						
To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.						

UNIT – I	HISTORY OF MAKING OF THE INDIAN CONSTITUTION	5
History, Drafting Committee, (Composition & Working)		
UNIT – II	PHILOSOPHY OF THE INDIAN CONSTITUTION	5
Preamble, Salient Features		
UNIT – III	CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES	5
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	5
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	5
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	5
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.		
		Total Contact Hours : 30

Course Outcomes:	Upon completion of the course students should be able to:
CO1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
CO3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO4	Discuss the passage of the Hindu Code Bill of 1956


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:	
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
AX24094	நற்றமிழ் இலக்கியம்	AC	2	0	0	0

UNIT – I	சங்க இலக்கியம்	6
1. தமிழின் துவக்கநூல் தொல்கொப்பியம் – எழுத்து, சொல், பொருள் 2. அகநானூறு (82) – இயற்கை இன்னிசை அரங்கம் 3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி 4. புறநானூறு (95,195) – போரை நிறுத்திய ஓளவையார்		
UNIT – II	அறநெறித் தமிழ்	6
1. அறநெறி வகுத்த திருவள்ளுவர் அறம் வலியுறுத்தல், அன்புடைமை ஒப்புரவறிதல் அறிதல், ஈகை, புகழ் 2. பிறஅறநூல்கள் - இலக்கியமருந்து – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசரகோவை (தூய்மையை வலியுறுத்தும் நூல்)		
UNIT – III	இரட்டைக் காப்பியங்கள்	6
1. கண்ணகியின் புரட்சி – சிலப்பதிகார வழக்குரை காதை 2. சமூகசேவை இலக்கியம் மணிமேகலை – சிறைக்கோட்டம் அறக்கோட்டமக்கிய காதை		
UNIT – IV	அருள்நெறித் தமிழ்	6
1. சிறுபாணாற்றுப்படை – பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஓளவைக்கு நல்லிக்கனி கொடுத்தது, அரசர் பண்புகள் 2. நற்றிணை- அன்னைக்குரிய புன்னை சிறப்பு 3. திருமந்திரம் (617, 618) – இயமம் நியமம் விதிகள் 4. தர்மசாலையை நிறுவிய வள்ளலார் 5. புறநானூறு – சிறுவனே வள்ளலானான் 6. அகநொனூறு (4) – வண்டு நற்றிணை(11) – நண்டு கலித்தொகை (11) – யானை, புறா ஐந்திணை 50 (27) – மான் ஆகியவை பற்றிய செய்திகள்.		


HoD/BOS Chairman


Principal

UNIT - V	நவீன தமிழ் இலக்கியம்	6
1. உரைநடைத் தமிழ், - தமிழின் முதல் புதினம், - தமிழின் முதல் சிறுகதை, - கட்டுரை இலக்கியம், - பயண இலக்கியம், - நாடகம், 2. நாட்டு விடுதலைப் போரட்டமும் தமிழ்இலக்கியமும், 3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும், பெண்விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும், 5. அறிவியல்தமிழ், 6. இணையத்தில் தமிழ், 7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.		
		Total Contact Hours : 30

Reference books/other materials/web resources:	
1.	தமிழ் இணையக் கல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org
2.	தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) - https://ta.wikipedia.org
3.	தர்மபுர ஆதீன வெளியீடு
4.	வாழ்வியல் களஞ்சியம் - தமிழ்ப்பல்கலைக் கழகம், தஞ்சாவூர்
5.	தமிழ்கலை களஞ்சியம் - தமிழ்வளர்ச்சித் துறை (thamilvalarchithurai.com)
6.	அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலை கழகம், தஞ்சாவூர்.


HoD/BOS Chairman


Principal

OPEN ELECTIVES

Subject Code	Subject Name	Category	L	T	P	C
OCE24001	INTEGRATED WATER RESOURCES MANAGEMENT	OEC	3	0	0	3

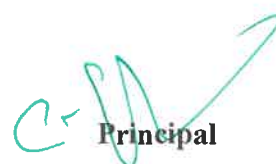
Course Objectives:

- 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 Contact Hours : 45

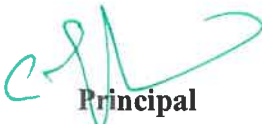
Course Outcomes:	On completion of the course, the student is expected to be able to
CO1	Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management
CO2	Select the best economic option among the alternatives; illustrate the pros and cons of PPP through 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


 HoD/BOS Chairman


 Principal

Reference books/other materials/webresources:	
1.	Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2.	Mollinga .P. etal “ Integrated Water Resources Management”, Water in South Asia Volume I, Sage Publications, 2006.
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.


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
OCE24002	WATER, SANITATION AND HEALTH	OEC	3	0	0	3
Course 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 Contact Hours : 45

Course Outcomes:	On completion of the course, the student is expected to be able to
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.


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:

- | | |
|----|---|
| 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.83 Improving the Environment for learning: An Expanded Agenda |
| 3. | National Research Council. <i>Global Issues in Water, Sanitation, and Health: Workshop Summary</i> . Washington, DC: The National Academies Press, 2009 |
| 4. | Sen, Amartya 1997. On Economic Inequality. Enlarged edition, with annex by James Foster and Amartya Sen, Oxford: Clarendon Press, 1997 |
| 5. | Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers |
| 6. | Third World Network.org (www.twn.org). |


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
OCE24003	PRINCIPLES OF SUSTAINABLE DEVELOPMENT	OEC	3	0	0	3

Course 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 CHALLENGES	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–		


HoD/BOS Chairman


Principal

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 Contact Hours : 45

Course 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

Reference books/other materials/webresources:

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, Roulledge Taylor and Francis, 2017
4.	The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - <i>George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla</i> , 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.


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
OCE24004	ENVIRONMENTAL IMPACT ASSESSMENT	OEC	3	0	0	3
Course 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 IDENTIFICATION 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course 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

Reference books/other materials/webresources:

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.


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
OIC24001	BLOCKCHAIN TECHNOLOGIES	OEC	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 Contact Hours : 45

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


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:

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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
OIC24002	DEEP LEARNING	OEC	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 – IV	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		
		Total Contact Hours : 45


HoD/BOS Chairman


Principal

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

Reference books/other materials/webresources:	
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
OME24001	VIBRATION AND NOISE CONTROL STRATEGIES	OEC	3	0	0	3

Course 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of this course, the students will be able to:
CO1	apply the basic concepts of vibration in damped and undamped systems
CO2	apply the basic concepts of noise and to understand its effects on systems
CO3	select the instruments required for vibration measurement and its analysis
CO4	select the instruments required for noise measurement and its analysis
CO5	recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

Reference books/other materials/webresources:	
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.


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
OME24002	ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS	OEC	3	0	0	3

Course Objectives:

- To learn the present energy scenario and the need for energy conservation.
- To understand the different measures for energy conservation in utilities.
- Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings
- To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
- 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 Contact Hours : 45

Course Outcomes:	Upon completion of this course, the students will be able to:
CO1	Understand technical aspects of energy conservation scenario
CO2	Energy audit in any type for domestic buildings and suggest the conservation measures.
CO3	Perform building load estimates and design the energy efficient landscape system.
CO4	Gain knowledge to utilize an appliance/device sustainably.
CO5	Understand the status and current technological advancement in energy storage field.


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:	
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.


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
OME24003	ADDITIVE MANUFACTURING	OEC	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 Contact Hours : 45


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:

- | | |
|----|--|
| 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. |

**HOD/BOS Chairman****Principal**

Subject Code	Subject Name	Category	L	T	P	C
OME24004	ELECTRIC VEHICLE TECHNOLOGY	OEC	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 ARCHITECTURE	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 Contact Hours : 45

Reference books/other materials/webresources:	
1.	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2 nd 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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
OME24005	NEW PRODUCT DEVELOPMENT	OEC	3	0	0	3
Course Objectives:						
Applying the principles of generic development process ;and understanding the organization structure for new product design and development.						
Identifying opportunity and planning for new product design and development.						
Conducting customer need analysis; and setting product specification for new product design and development.						
Generating, selecting ,and testing the concepts for new product design and development.						
Applying the principles of Industrial design and prototype for new product design and development.						

UNIT I	INTRODUCTION TO PRODUCT DESIGN & 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 IDENTIFICATION & 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 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	INDUSTRIAL DESIGN & PROTOTYPING	9
Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping–Prototyping Technologies–Planning for Prototypes		
		Total Contact Hours :45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of this course, the students will be able to:
CO1:	Apply the principles of generic development process; and understand the organization structure for new product design and development.
CO2:	Identify opportunity and plan for new product design and development.
CO3:	Conduct customer need analysis; and set product specification for new product design and development.
CO4:	Generate, select, and test the concepts for new product design and development.
CO5:	Apply the principles of Industrial design and prototype for design and develop new products

Reference books/other materials/web resources:	
1.	Belz A., 36-Hour Course: "Product Development" McGraw-Hill, 2010.
2.	Rosenthal S., "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3.	Pugh S., "Total Design Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, 1991, ISBN 0-202-41639-5.
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


 HoD/BOS Chairman


 Principal

Subject Code	Subject Name	Category	L	T	P	C
OBA24001	SUSTAINABLE MANAGEMENT	OEC	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. Organizations.		
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 Procurements		
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 Contact Hours :45

Course Outcomes:	Upon completion of this course, the students will be able to:
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 sustainability performances.
CO4:	Knowledge of innovative practices in sustainable business and community management
CO5:	Deep understanding of sustainable management of resources and commodities


HoD/BOS Chairman


Principal

Reference books/other materials/web resources:	
1.	Daddi,T.,Iraldo,F.,Testa, Environmental Certification for Organizations and Products: Management, 2015
2.	ChristianN.Madu,HandbookofSustainabilityManagement2012
3.	PetraMolthan-Hill,TheBusinessStudent'sGuidetoSustainableManagement: Principles and Practice, 2014
4.	MargaretRobertson,SustainabilityPrinciplesandPractice,2014
5.	PeterRogers,AnIntroductiontoSustainableDevelopment,2006


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
OBA24002	MICRO AND SMALL BUSINESS MANAGEMENT	OEC	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
Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.		
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 Contact Hours :45

Course Outcomes:	Upon completion of this course, the students will be able to:
CO1:	Familiarize the students with the concept to 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
CO4:	Business evaluation for buying and selling of small firms
CO5:	Familiarize the students with the concept to small business


HoD/BOS Chairman


Principal

Reference books/other materials/web resources:

- | | |
|----|--|
| 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. |


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
OBA24003	INTELLECTUAL PROPERTY RIGHTS	OEC	3	0	0	3

Course Objectives:

- 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 Contact Hours :45

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


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:	
1.	V.Sople Vinod, Managing Intellectual Property by (Prentice Hall of India Pvt. Ltd), 2006.
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. Intellectual Property rights and copyrights 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 Handbook.


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
OBA24004	ETHICAL MANAGEMENT	OEC	3	0	0	3
Course Objectives: 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	STRATEGIES IN INTELLECTUAL PROPERTY	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 Contact Hours :45

Course Outcomes:	Upon completion of this course, the students will be able to:
CO1:	Role modelling and influencing the ethical and cultural context.
CO2:	Respond to ethical crises and proactively address potential crisis situations. Understand and implement stakeholder management decisions.
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


HoD/BOS Chairman


Principal

Reference books/other materials/web resources:	
1.	BradAgle,AaronMiller,BillO'Rourke,TheBusinessEthicsFieldGuide:theessential companion to leading your career and your company, 2016.
2.	Steiner&Steiner,Business,Government&Society:AmanagerialPerspective,2011.
3.	Lawrence&Weber,BusinessandSociety:Stakeholders,Ethics,PublicPolicy,2020.


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
ET24003	IoT FOR SMART SYSTEMS	OEC	3	0	0	3
Course Objectives:						
To study about Internet of things technologies and its role in real time applications.						
To introduce the infrastructure required for Io T						
To familiarize the accessories and communication techniques for Io T.						
To provide insight about the embedded processor and sensors required for IoT						
To familiarize the different platforms and Attributes for Io T						

UNIT I	INTRODUCTION TO INTERNET OF THINGS	9
Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical Io T applications, Trends and implications.		
UNIT II	IOT ARCHITECTURE	9
Io T reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, Io T standards, Cloud computing for Io T, Bluetooth, Bluetooth Low Energy beacons		
UNIT III	PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT	9
PROTOCOLS: NFC, SCADA and RFID, Zig bee MIPI, M-PHY, Uni Pro, SPMI, SPL, M-P CI e 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 RASPBERRY 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 Contact Hours :45

Course Outcomes:	Upon completion of this course, the students will be able 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
CO4:	Analyze the big data analytic and programming of Io T
CO5:	Implement Io T solutions for smart applications

Reference books/other materials/web resources:


HoD/BOS Chairman


Principal

Reference books/other materials/web resources:	
1.	Arshdeep Bahga and Vijai Madisetti : 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 Kaufmann Publishers, 2010.
6.	Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.


 HoD/BOS Chairman


 Principal

Subject Code	Subject Name	Category	L	T	P	C
ET24004	MACHINE LEARNING AND DEEP LEARNING	OEC	3	0	0	3
Course Objectives:						
- Understanding about the learning problem and algorithms - Providing in sight about neural networks - Introducing the machine learning fundamentals and significance - Enabling the students to acquire knowledge about pattern recognition. - Motivating the student 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, over fitting, 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, Auto encoders: Convolutional Autoencoders, Denoising auto encoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs		
		Total Contact Hours :45

Course Outcomes:	Upon completion of this course, the students 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 features election and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs


HoD/BOS Chairman


Principal

Reference books/other materials/web resources:	
1.	J. S. R. Jang, C.T. Sun, E.Mizutani, Neuro Fuzzyand Soft Computing – A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2.	Deep Learning, IanGoodfellow , YoshuaBengioand AaronCourville, MIT Press,ISBN: 9780262035613, 2016.
3.	The Elements of Statistical Learning.Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009
4.	PatternRecognitionandMachineLearning.ChristopherBishop.Springer.2006.
5.	Understanding Machine Learning. Shai Shalev-Shwartzand ShaiBen-David. Cambridge University Press. 2017.


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
PX24010	RENEWABLE ENERGY TECHNOLOGY	OEC	3	0	0	3
Course Objectives:						
- Different types of renewable energy technologies - Stand-alone operation, grid connected operation of renewable energy systems						
UNIT I	INTRODUCTION					9
Classification of energy sources —CO ₂ 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 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	PHOTOVOLTAICS 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 energyconversion 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 Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs						
		Total Contact Hours :45				

Course Outcomes:	Upon completion of this course, the students 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:	Designate and 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


HoD/BOS Chairman


Principal

Reference books/other materials/web resources:	
1.	S.N.Bhadra, D. Kasta, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
2.	Rai.G.D,"Nonconventional energysources",Khannapublishes,1993.
3.	Rai.G.D,"Solarenergyutilization",Khannapublishes,1993
4.	Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologiand Applications", PHI Learning Private Limited, 2012
5.	JohnTwideuandTonyWeir,"RenewalEnergyResources"BSPPublications,2006
6.	Gray,L.Johnson,"Windenergysystem",prenticehallofIndia,1995.


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
PS24003	SMARTGRID	OEC	3	0	0	3
Course Objectives:						
To Study about Smart Grid technologies, different smartmeters 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 SMARTGRID	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	SMARTGRID 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 SMARTGRID	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 Contact Hours :45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of this course, the students will be 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.
CO4:	Recommend suitable communication networks for smart grid applications
CO5:	:Relate with the smart resources, smart meters and other smart devices.

Reference books/other materials/web resources:	
1.	Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012
2.	Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, 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.	SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.
5.	Kenneth C. Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
CP24007	SECURITY PRACTICES	OEC	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-Top10 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	CYBERSECURITY 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 Contact Hours :45

Course Outcomes:	Upon completion of this course, the students will be able to:
CO1:	Understand the core fundamentals of system
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.


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:	
1.	JohnR.Vacca, Computer and Information Security Handbook,ThirdEdition,Elsevier2017
2.	MichaelE.Whitman,HerbertJ.Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022.
3.	RichardE.Smith, Elementary Information Security, Third Edition, Jonesand Bartlett Learning, 2019
4.	Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for PenetrationTesting,ExploitDevelopmentandVulnerabilityResearch,Syngress publications,Elsevier, 2007. ISBN : 978-1-59749-074
5.	JohnSammons,“The Basics of Digital Forensics-The Primer for Getting Started in Digital Forensics”, Syngress, 2012
6.	Cory Altheide and HarlanCarvey, “Digital Forensics withOpenSourceTools”,2011 Syngress, ISBN: 9781597495875


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
MP24002	CLOUD COMPUTING TECHNOLOGIES	OEC	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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should be able to:
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.

Reference books/other materials/webresources:	
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 Guidel, 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.


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
IF24001	DESIGN THINKING	OEC	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	9
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	9
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	9
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	9
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.		
		Total Contact Hours : 45

SUGGESTED ACTIVITIES:

1: Hands on Design Thinking process for a product 2: Defining the Look and Feel of any new Project


HoD/BOS Chairman


Principal

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

Course Outcomes:	Upon completion of the course students should be able to:
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

Reference books/other materials/webresources:	
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



HoD/BOS Chairman

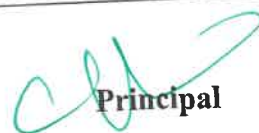


Principal

Subject Code	Subject Name	Category	L	T	P	C
MU24001	PRINCIPLES OF MULTIMEDIA	OEC	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		


HoD/BOS Chairman


Principal

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 Contact Hours : 45

Course Outcomes:	Upon completion of the course students should be able to:
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

Reference books/other materials/webresources:	
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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
DS24001	BIG DATA ANALYTICS	OEC	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		
		Total Contact Hours : 45

Course Outcomes:	Upon completion of the course students should be able to:
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.


HoD/BOS Chairman


Principal

Reference books/other materials/webresources:	
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.
	Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
NC24001-	INTERNET OF THINGS AND CLOUD	OEC	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	CLOUD COMPUTING INTRODUCTION	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	CASE STUDIES/INDUSTRIAL APPLICATIONS	9
Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.		
UNIT – V	PROTOCOLS FOR IoT	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 Contact Hours : 45

Course Outcomes:	Upon completion of the course students should 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

Reference books/other materials/webresources:	
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.	Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.
5.	Simon Walkowiak, "Big Data Analytics with R" PackT Publishers, 2016


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
MX24001	MEDICAL ROBOTICS	OEC	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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should be able to:
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

Reference books/other materials/webresources:

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, 1 st 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


HoD/BOS Chairman


Principal

Subject Code	Subject Name	Category	L	T	P	C
VE24001-	EMBEDDED AUTOMATION	OEC	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 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 – 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 Contact Hours : 45


HoD/BOS Chairman


Principal

Course Outcomes:	Upon completion of the course students should 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

Reference books/other materials/webresources:

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


HoD/BOS Chairman


Principal