ANNA UNIVERSITY: CHENNAI 600 025

NON AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY

REGULATIONS – 2021

M. TECH. PHARMACEUTICAL BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM

I TO IV SEMESTERS CURRICULUM AND SYLLABUS

PROGRAM EDUCATIONAL OUTCOMES (PEOs)

PEO1:	To provide our students with a rigorous postgraduate education that will enable them to flourish in research and career in the field of pharmaceutical biotechnology.
PEO2:	To give students a firm foundation in the principles of engineering, science, and statistics required to address issues relating to biologicals and biopharmaceuticals.
PEO3:	To equip the students with the necessary scientific and technological knowledge to understand, evaluate, design and develop original solutions for health-related issues.
PEO4:	To instill in pupils a sense of professional and scientific ethics, scientific communication abilities, and collaboration abilities, a multidisciplinary strategy, and the capacity to address health-related issues on a larger scale social setting.

PROGRAM OUTCOMES (POS)

PO1:	Acquired in-depth knowledge of Pharmaceutical sciences, Biological sciences and Bioengineering to develop innovative solutions and evaluate new ideas for societal benefits
PO2	Wisdom of fundamentals and advances to practice pharmaceutical biotechnology, interdisciplinary research and entrepreneurship as career of constructive service to society and higher learning.
PO3:	Ability to demonstrate a degree of mastery over the area of Pharmaceutical biotechnology. The mastery should be at a level higher than the requirements in the appropriate bachelor degree program
PO4:	Ability to recognize the need for continuous learning and will prepare oneself to create, select, learn and apply appropriate techniques, resources, and modern instrumentation to solve complex biotechnological activities.
PO5:	Acquired the scientific or technological knowledge in the domain of Pharmaceutical Biotechnology and recognize opportunities to demonstrate a capacity for teamwork, effective communication, decision-making based on open-mindedness and rational analysis in order to achieve common goals.
PO6:	Ability to demonstrate knowledge of Pharmaceutical biotechnology and management principles and apply to manage projects efficiently and economically with intellectual integrity and ethics for sustainable development of society.

MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

YEAR	SEM	COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Analytical techniques in Pharmaceutical Biotechnology	3	3	3	2	1	1
		Pharmaceutical Microbiology	3	3	2	3	3	1
		Industrial Fermentation	2	1	1	2		
		Research Methodology and IPR						
		Drug Regulatory Affairs	2	1	1		1	2
		Professional Elective I						
		Professional Elective II						
		Audit Course*						
		Analytical techniques in Pharmaceutical Biotechnology Laboratory	3	3	3	3	2	
	SEMESTER II	Protein and Protein Formulations	2	2	2	2	2	1
		Immunotechnology	2	2	1	2	2	2
		Techniques in Molecular Biology and Genetic Engineering	2	2	1	2	2	
		Professional Elective III						
		Professional Elective IV						
		Open elective						
		Audit Course II*						
		Immunotechnology Laboratory	2	3	2	3	3	2
		Drug Discovery Laboratory	3	2	2	2	2	
YEAR II	SEMESTER III	Protein and Protein Formulations Laboratory	2	2	1	2	1	2
		Bioinformatics and computational biology laboratory	2	2	1	2	2	2
		Project Work I	2	1	2	1	2	1
		Summer Internship***	1	1	1	2	3	2
	SEMESTER IV	Project Work II	3	2	3	2	3	2

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M.TECH. PHARMACEUTICAL BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM

I TO IV SEMESTERS (FULL TIME) CURRICULA AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PB4101	Analytical techniques in Pharmaceutical Biotechnology	PCC	3	0	0	3	3
2.	PB4102	Pharmaceutical Microbiology	PCC	3	0	0	3	3
3.	PB4103	Industrial Fermentation	PCC	3	0	0	3	3
4.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
5.	PB4104	DrugRegulatory Affairs	PCC	3	0	0	3	3
6.		Professional Elective I	PEC	3	0	0	3	3
7.		Professional Elective II	PEC	3	0	0	3	3
8.		Audit Course*	AC	2	0	0	2	0
PRACTICALS								
9.	PB4111	Analytical techniques in Pharmaceutical Biotechnology Laboratory	PCC	0	0	6	6	3
			TOTAL	**22**	**0**	**6**	**28**	**23**

*Audit Course is Optional

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PB4201	Protein and Protein Formulations	PCC	3	0	0	3	3
2.	PB4202	Immunotechnology	PCC	3	0	0	3	3
3.	BO4004	Techniques in Molecular Biology and Genetic Engineering	PEC	3	0	0	3	3
4.		Professional Elective III	PEC	3	0	0	3	3
5.		Professional Elective IV	PEC	3	0	0	3	3
6.		Open elective	OEC	3	0	0	3	3
7.		Audit Course II*	AC	2	0	0	2	0
PRACTICALS								
8.	PB4211	Immunotechnology Laboratory	PCC	0	0	6	6	3
9.	PB4212	Drug Discovery Laboratory	PCC	0	0	6	6	3
			TOTAL	**20**	**0**	**12**	**32**	**24**

*Audit Course is Optional

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	PB4311	Protein and Protein Formulations Laboratory	PCC	0	0	6	6	3
2.	PB4312	Bioinformatics and computational biology laboratory	PCC	0	0	6	6	3
3.	PB4313	Project Work I	EEC	0	0	12	12	6
4.	PB4314	Summer Internship***	EEC	0	0	0	0	2
		TOTAL		**0**	**0**	**24**	**24**	**14**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	PB4411	Project Work II	EEC	0	0	24	24	12
		TOTAL		**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS: 73

LIST OF PROFESSIONAL ELECTIVE COURSES

SEMESTER I, ELECTIVES I

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PB4001	Nanobiotechnology	PEC	3	0	0	3	3
2.	BY4008	Thermodynamics for Biological Systems	PEC	3	0	0	3	3
3.	BY4006	Enzyme Engineering and Technology	PEC	3	0	0	3	3
4.	BY4251	Metabolic Process and Engineering	PEC	3	0	0	3	3

SEMESTER I, ELECTIVES II

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PB4002	Applied Biopharmaceutics and Pharmacokinetics	PEC	3	0	0	3	3
2.	PB4003	Molecular Medicine	PEC	3	0	0	3	3
3.	BO4003	Biogenerics and Biopharmaceuticals	PEC	3	0	0	3	3
4.	PB4004	Environmental Biotechnology	PEC	3	0	0	3	3

SEMESTER II, ELECTIVES III

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PB4005	Bioinformatics and Computational Biology	PEC	3	0	0	3	3
2.	PB4006	Bioprocess Engineering and Technology	PEC	3	0	0	3	3
3.	BO4103	Molecular Pharmacology	PEC	3	0	0	3	3
4.	PB4007	Bioconjugate Technology	PEC	3	0	0	3	3

SEMESTER II, ELECTIVES IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PB4008	Pharmacogenomics	PEC	3	0	0	3	3
2.	PB4009	Bio-entrepreneurship	PEC	3	0	0	3	3
3.	PB4010	Biomaterials and Tissue Engineering	PEC	3	0	0	3	3
4.	BO4005	Advances in Omics Sciences and Technology	PEC	3	0	0	3	3

PROFESSIONAL CORE (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	PB4101	Analytical techniques in Pharmaceutical	3	0	0	3	3
2.	PB4102	Pharmaceutical Microbiology	3	0	0	3	3
3.	PB4103	Industrial Fermentation	3	0	0	3	3
4.	PB4104	Drug Regulatory Affairs	3	0	0	3	3
5.	PB4201	Protein and Protein Formulations	3	0	0	3	3
6.	PB4202	Immunotechnology	3	0	0	3	3
7.	PB4111	Analytical techniques in Pharmaceutical Biotechnology Laboratory	0	0	6	6	3
8.	PB4211	Immunotechnology Laboratory	0	0	6	6	3
9.	PB4212	Drug Discovery Laboratory	0	0	6	6	3
10.	PB4311	Protein and Protein Formulations Laboratory	0	0	6	6	3
11.	PB4312	Bioinformatics and computational biology laboratory	0	0	6	6	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	PB4314	Summer internship***	0	0	0	0	2
2.	PB4313	Project Work I	0	0	12	12	6
3.	PB4411	Project Work II	0	0	24	24	12

RESEARCH METHODOLOGY AND IPR (RMC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	RM4151	Research Methodology and IPR	2	0	0	2	2

AUDIT COURSES

REGISTRATION FOR ANY OF THESE COURSES IS OPTIONAL TO STUDENTS

Sl. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AX4091	English for Research Paper Writing	AC	2	0	0	0	0
2.	AX4092	Disaster Management	AC	2	0	0	0	0
3.	AX4093	Constitution of India	AC	2	0	0	0	0
4.	AX4094	நற்றமிழ்இலக்கியம்	AC	2	0	0	0	0

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3
7.	OME431	Vibration and Noise Control Strategies	3	0	0	3
8.	OME432	Energy Conservation and Management in Domestic Sectors	3	0	0	3
9.	OME433	Additive Manufacturing	3	0	0	3
10.	OME434	Electric Vehicle Technology	3	0	0	3
11.	OME435	New Product Development	3	0	0	3

12.	OBA431	Sustainable Management	3	0	0	3
13.	OBA432	Micro and Small Business Management	3	0	0	3
14.	OBA433	Intellectual Property Rights	3	0	0	3
15.	OBA434	Ethical Management	3	0	0	3
16.	ET4251	IoT for Smart Systems	3	0	0	3
17.	ET4072	Machine Learning and Deep Learning	3	0	0	3
18.	PX4012	Renewable Energy Technology	3	0	0	3
19.	PS4093	Smart Grid	3	0	0	3
20.	CP4391	Security Practices	3	0	0	3
21.	MP4251	Cloud Computing Technologies	3	0	0	3
22.	IF4072	Design Thinking	3	0	0	3
23.	MU4153	Principles of Multimedia	3	0	0	3
24.	DS4015	Big Data Analytics	3	0	0	3
25.	NC4201	Internet of Things and Cloud	3	0	0	3
26.	MX4073	Medical Robotics	3	0	0	3
27.	VE4202	Embedded Automation	3	0	0	3

SUMMARY

S. NO.	Subject Area	CREDITS PER SEMESTER				TOTAL CREDITS
		I	II	III	IV	
1.	RMC	2	0	0	0	2
2.	PCC	15	12	6	0	33
3.	PEC	6	9	0	0	15
4.	OEC	0	3	0	0	3
5.	EEC	0	0	8	12	20
6.	Non Credit/Audit Course	✓	✓	0	0	
	TOTAL	**23**	**24**	**14**	**12**	**73**

PB4101 ANALYTICAL TECHNIQUES IN PHARMACEUTICAL BIOTECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To enable the students To have a fundamental knowledge about the molecular spectroscopy, NMR and Mass spectroscopy
- To acquire knowledge on different chromatographic methods for separation of pharmaceutical and biotechnological products.
- To acquire knowledge about the principles and operations of various modern analytical instruments.

UNIT I MOLECULAR SPECTROSCOPY 9

UV-Visible spectroscopy- Theory, Laws, Instrumentation, and applications; IR spectroscopy: Theory, Molecular vibrations, Sample handling, Instrumentation of Dispersive and Fourier - Transform IR Spectrometer and Applications; Spectroflourimetry: Theory of Fluorescence, Factors affecting fluorescence, Quenchers, Instrumentation and Applications Atomic absorption spectroscopy: Principle, Instrumentation, Interferences and Applications, Case studies on applications of molecular spectroscopy.

UNIT II NMR SPECTROSCOPY 9

Quantum numbers and their role in NMR, Principle, Instrumentation, Solvent requirement in NMR, Chemical shift, Factors influencing chemical shift, Spin-Spin coupling, Coupling constant, Nuclear magnetic double resonance, Principles of 1H-NMR and 13C NMR. Pharmaceutical and biological applications of NMR spectroscopy.

UNIT III MASS SPECTROSCOPY 9

Principle, Theory, Instrumentation, Types of ionization like electron impact, chemical, field, FAB and MALDI, APCI, ESI, APPI, Analyzers of Quadrupole and Time of Flight, Mass fragmentation and its rules, Meta stable ions, Isotopic peaks and Pharmaceutical and biological applications of Mass spectroscopy, Case studies on biological applications of mass spectroscopy.

UNIT IV CHROMATOGRAPHY 9

Analytical & Preparative concepts of - Principle, instrumentation, chromatographic parameters, factors affecting resolution and applications of High-performance Thin Layer chromatography, Ion exchange chromatography, Column, Gas, High Performance Liquid chromatography and Affinity chromatography, Case studies on usage of ion exchange, HPLC and affinity chromatography in industrial applications.

UNIT V ELECTROPHORESIS & IMMUNOASSAYS 9

Principle, Instrumentation, working conditions, factors affecting separation and applications of the following: Gel electrophoresis, Capillary electrophoresis, Zone electrophoresis, Iso electric focusing; RIA (Radio immuno assay), ELISA and Bioluminescence assays; Analysis of host cell protein (HCP) and host cell DNAs (HCD) in biopharmaceuticals, viable cell analysis, measurement of energy metabolism of live cell, metabolic analyzer – principle and instrumentation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, students will able to

1. Understand the fundamental principles and applications of UV-visible, IR, flame emission, atomic absorption, NMR and Mass spectroscopy
2. Demonstrate the principles and applications of chromatographic and electrophoretic separation techniques
3. Recognize the importance of modern instruments in the pharmaceutical analysis
4. Apply the theoretical knowledge of instruments for new analytical method development in screening of various pharmaceutical agents.

5. Develop ability to involve in chemical and biological standardization of pharmaceutical products.
6. Assess appropriate techniques for the analysis of various pharmaceuticals and biotechnological products.

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	1	1	1
CO2	3	3	3	1	1	1
CO3	3	3	3	2	1	
CO4	3	3	3	3	1	
CO5	3	3	3	2	1	
CO6	3	3	3	3	1	
Average	3	3	3	2	1	1

(1, 2and3arecorrelationlevelswithweightingsasSlight (Low), Moderate(Medium)andSubstantial (High) respectively)

REFERENCES:

1. Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004.
2. Principles of Instrumental Analysis - Doglas A Skoog, F. James Holler, Timothy A. Nieman, 5th edition, Eastern press, Bangalore, 1998.
3. Instrumental methods of analysis – Willards, 7th edition, CBS publishers. 4. Practical Pharmaceutical Chemistry – Beckett and Stenlake, Vol II, 4thedition, CBS Publishers, New Delhi, 1997.
4. Organic Spectroscopy - William Kemp, 3rd edition, ELBS, 1991.
5. Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, 3rd Edition, CBS Publishers, New Delhi, 1997.
6. Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, Marcel Dekker Series

PB4102 PHARMACEUTICAL MICROBIOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

Upon successful completion of this course the student will be able to

- Understand the mechanism of action of chemotherapeutic and antibiotic resistence.
- Identify the microorganisms of relevance to healthcare and the pharmaceutical industry and their sources.
- obtain the knowledge on microbial contamination/product spoilage and antimicrobial preservation in pharmaceutical formulations

UNIT I CHEMOTHERAPEUTIC AGENTS 9

Introduction to chemotherapeutic agents: History and development of chemotherapeutic agent, Properties of antimicrobial agents, Types of chemotherapeutic agents – Synthetic, Semisynthetic, Natural. Antibiotics: Types of antibiotics with their mode of action; antibacterial, antifungal, antiviral, antiprotozoal

UNIT II ANTIBIOTIC RESISTANCE AND DEVELOPMENT OF NEW THERAPEUTICS 9

Antibiotic resistance: Development of antibiotic resistance amongst pathogens Mechanism of antibiotic resistance, Disease management methods. Antimicrobial Peptides: History,

properties, sources, mode of action, application. Plant based therapeutic agents. Different prophylactic and therapeutic methods in control of infections.Introduction to virology.

UNIT III CLEAN ROOM TECHNOLOGY AND BIOSAFETY REGULATIONS 9

Microbial contamination spoilage and hazard Sources of contamination, factors affecting survival and growth. Methods of sterilizations: Steam, dry heat, Radiation, Gaseous and Filtration. Clean room technology and its regulatory aspects. Principles of sterilizations with respect to pharmaceutical industries.Biosafety regulations- BSL-1, BSL-2, BSL-3 and BSL-4.

UNIT IV PRESERVATION OF PHARMACEUTICAL PRODUCTS 9

Principles of preservation: objectives of preservation, the ideal preservative, rational development of a product preservative system etc. Antimicrobial preservatives and their properties: antimicrobial activity, factors affecting antimicrobial activity, preservative monographs. Preservative stability and efficacy.Evaluation methods of Preservative and testing.

UNIT V MICROBIAL FERMENTATIONS 9

Industrial importance of microbes in the production of Enzymes- Amylase, Invertase, Proteolytic.Vaccines -Recombinant and Synthetic Vaccines.Organic acids-citric acid, acetic acid, and α- keto glutaric acid.Bio-insecticides-Bacillus sp., Baculovirus.Antibiotics-Penicillin, Bacitracin, Streptomycin.Vitamins-Vitamin B12, Vitamin A, Riboflavin.

SELF STUDY TOPICS (NOT FOR EXAMINATIONS): Role of microbes in the degradation of pollutants / toxic compounds, Microbial waste products in the market.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO 1	Describe the structure and types of antimicrobial chemotherapeutic agents and their mode of action
CO 2	Apply the knowledge of biochemical and genetic basis for antibiotic resistance and its control mechanism
CO 3	Explain the various sterilization techniques and evaluate the sterility testing of pharmaceuticals.
CO 4	Earn about various antimicrobial preservatives used in Pharmaceuticals and its evaluation methods
CO 5	Illustratethe principle in fermentation process and techniques for antibiotics, enzymes and vitamin production.
CO 6	Identify the microorganisms of relevance to healthcare and the pharmaceutical industry and microbial production and evaluation of pharmaceuticals

CO-PO Mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3			3	1
CO 2	3	3	2		3	
CO 3	3	3		2	3	
CO 4	3	3	2	3	3	
CO 5	3	3	2	3	3	
CO 6	3	3	2	3	3	1
Average	3	3	2	3	3	1

REFERENCES:

1. Hugo, WB and Russell, AD. Pharmaceutical Microbiology, (2003). Blackwell Science, Oxford, UK.
2. Geoffrey Hanlon and Norman Hodges. Essential Microbiology for pharmacy and pharmaceutical science. (2013).Wiley Blackwell.
3. S. P. Vyas & V. K. Dixit. Pharmaceutical Biotechnology. (2003) CBS Publishers & Distributors, New Delhi.
4. Prescott's Microbiology 8th Edition by Willey, Joanne, Sherwood, Linda, Woolverton,Chris.
5. Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S. Microbiology. (1990). Harper and Row Publishers, Singapore.
6. L.E. Casida, Industrial microbiology, New Age International Publishers.2005

PB4103 INDUSTRIAL FERMENTATION L T P C
3 0 0 3

COURSE OBJECTIVES:

- To enable the students to understand the concepts of fermentation technology applied to industrial processes for making products: fermenters, reaction kinetics, media formulation, utilization of microbial cultures, design aspects of bioreactors.

UNITI INTRODUCTIONTOBIOREACTORDESIGNANDCONSTRUCTION 9

Bioreactor selection criteria and classification, Parameters for control, Design of ideal reactors, Single (Batch, Flow) and multiple reactors, Non-Ideal flow, RTD studies, Modelling of Non-ideal flow reactors, Design and operation of various bioreactors, viz CSTF, fed batch systems, air-lift bioreactors, fluidized bed bioreactors, Scale-up studies.

UNITII MICROBIALKINETICSANDDESIGNOFVARIOUSCULTIVATION PROCESSES 9

Immobilized and solid state cultivation; Kinetics of growth in batch continuous and fedbatch culture. Specific growth rate, doubling time, growth yield, metabolic quotient; stoichiometry-balance equation, carbon- nitrogen balance, oxidation - reduction principles, product formation. Biomass productivity, comparison with batch cultures, residual time distribution, test of validity; product formation, total cell retention cultivation, .Effect of inhibitors and activators on growth.

UNITIII MODELING OF RECOMBINANT CULTIVATION ANIMAL AND PLANT CELLCULTIVATIONSYSTEMSFORTHERAPEUTICPROTEINS 9

Structuredmodelsofmetabolismandgrowth,modelsofgeneexpressionandregulation,agenerali zed model of plasmid replication, Genetic instability, predicting host-vector interactions andgeneticinstability.Processconsiderationsforutilizinggeneticallyengineeredstrains.Media,a eration in cell culture systems, Bioreactors for plant/animal suspension culture, cell immobilizationandorganizedtissue,bioreactorconsiderationsforanimal/plantcellcultureforprod uctionofpharmaceuticals,TherapeuticproteinsandMonoclonalantibodies.Industrialapplication softhebioreactorsas cellcultivationsystems.Introduction to cell banking and storage - .mammalian, insects, stem cells and Microbes.

UNITIV DOWNSTREAMPROCESSING ANDSEPARATIONTECHNIQUES 9

Characteristicsofbiologicalmaterials:Recoveryandpurificationoffermentationproducts;pretreat ment methods; Separation of cell mass: centrifugation, clarification and filtration; removal of host cells proteins (HCP) and viral plasmids proteins, viral inactivation. Moderntechniques:Electrophoresis;Chromatographicmethods;Membraneprocesses-

Ultrafiltration;Reverse osmosis; Cross flow filtration; Microfiltration; Isoelectric focusing; Affinity based separations.Advantagesand disadvantagesoftheabovemethods.

UNITV CASESTUDIESINFERMENTATIONDERIVEDPRODUCTS 9

Case studies on Whole cell immobilization and their industrial application. Production of penicillin, recombinant Insulin, amino acids-lysine and glutamic acid. Enzymes -amylase and protease. Case studies should deal with strainimprovement,medium design,reactordesign andprocessoptimizationetc.

SELF STUDY TOPICS (NOT FOR EXAMINATIONS): Drying, Drying curve, Batch and continuous dryers, Case studies for the separation of intracellular and extracellular products, Evaporation and crystallization.

TOTAL:45PERIODS

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

1. Apply the knowledge of fermentation technology in industrial processes
2. Handle and utilize microbial systems for biological reactions for making products
3. Design and use of reactor systems for bioprocesses.
4. Analyse kinetics of cell and product formation in batch, continuous and fed-batch cultures
5. Differentiate the rheological changes during fermentation process
6. Detail the downstream process of fermentation of important microbial products**.**

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1			
CO2	2	1	1			
CO3				2		
CO4	2	1		2		
CO5	2	1	1	2		
CO6	2			2		
Average	2	1	1	2		

REFERENCES

1. Stanbury,Stephen.P.F.,Hall,J.andWhitaker,A.“Principlesoffermentationtechnology”Elsevier3rdedition.
2. Bailey, J.E. and Ollis, D.F. “Biochemical Engineering Fundamentals” 2nd Edition.,McGrawHill,1986.
3. B.Sivashankar,“Bioseparationprinciplesandtechniques”.PrenticeHallofIndiaPvtLtd2007
4Blanch,H.WandClarkD.S.,“BiochemicalEngineering”,MarcelDekker,1997
5. Doran,PaulineM,“BioprocessEngineeringPrinciples”.AcademicPress,1995
6. Nielsen,J.andVilladsen,J.“BioreactionEngineeringPrinciples”.Springer,2007.
7. Shuler,M.L.and Kargi,F. “Bioprocess Engineering:Basic Concepts”. 2nd Edition,Prentice-Hall,2002.

RM4151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

UNIT I RESEARCH DESIGN 6

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

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods.Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

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

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

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

UNIT V PATENTS 6

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

TOTAL : 30 PERIODS

REFERENCES

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

PB4104 DRUGREGULATORYAFFAIRS L T P C
3 0 0 3

COURSE OBJECTIVES:

The course aims to,

- Enable the students to learn about the drug regulatory laws and the agencies in India and at International level.
- Acquire knowledge of quality drug standards and drug development approval processes
- Attain the knowledge of product safety management.

UNITI INTRODUCTIONTODRUGREGULATORYLAWS 9

History,Organization and functions ofUSFDA, EMEA, Australia TGA, U.K. MHRA, WHO, ICH and ISO.Indian drug regulatory authorities, Central and State regulatory bodies.Need for pharmaceutical regulations**-** Drugs and Cosmetics Act and Rules 1940 with latest

Amendments, Special emphasis – Schedule M and Y. The Drugs (Price Control) Order 2013 with itsamendments, The drugs and Magic Remedies (Objectionable advertisements) Act 1954,Guidelinesforevaluationofnanopharmaceuticals inIndia.

UNITII PHARMACOPOEIA 6

Purpose of Pharmacopoeias- Descriptions & Monographs; Standards and Specifications; Testing of Drugs ;Various CountriesPharmacopoeias; Indian,British,U.S,European, Japanese and International pharmacopoeia.

UNITIII cGMPs&REGULATORY RECORDS 10

cGMPconcepts — Introduction, US cGMP Part 210 and Part 211.EC Principles of GMP (Directive 91/356/EEC) Article 6 to Article 14 and WHO cGMP guidelines GAMP-5; Medical device and IVDs Global Harmonization Task Force(GHTF) Guidance docs.Introduction, Organizational Structure, Purpose and Functions, Regulatory Guidelines, Working Groups, Summary Technical Document (STED), Global Medical Device Nomenclature (GMDN).Drugdossiercontents-CTD(CMCsection)&data.cGMP& ICH guidelines for Accelerated stability Testing.

UNITIV DRUGDEVELOPMENTAPPROVAL PROCESS/CLINICALTRIALS 10

Drugdevelopmentstages,FDAguidelinesonIND,NDA,ANDAapprovals.Europeanregulatoryagency: types of filing process (Centralized, decentralized, RMS countries), Regulation of preclinicalstudies, Schedule-Y, Introduction to animal ethics; Animal rights and use of animalsin the advancement of medical technology; Introduction to laws and regulations regarding the use ofanimalsinresearch.Good Clinical Practice (ICHGCP) guidelines,History and Idea behind GLP, Areas of Application of GLP, GMP compliance audit

UNITV QUALITY MANAGEMENT SYSTEMS 10

Introduction to GDP, data management and integrity, Concept of Quality, Total Quality Management, Quality by design, Six Sigma concept, Out of Specifications (OOS), Change control. Validation: Types of Validation, Types of Qualification, Validation master plan (VMP), Analytical Method Validation. Validation of utilities, [Compressed air, steam, water systems, Heat Ventilation and Air conditioning (HVAC)]and Cleaning Validation. The International Conference on Harmonization (ICH) process, ICH guidelines to establish quality, safety and efficacy of drug substances and products, ISO 13485, Sch MIII and other relevant CDSCO regulatory guidance documents.

TOTAL:45PERIODS

COURSE OUTCOMES:

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

- Apply the knowledge of drug regulatory laws.
- Acquire the knowledge of pharmacopoeia standards.
- Know the quality guidelines and the drug regulating authorities in different countries.
- Have an insight about drug regulatory approval process and clinical trials in pharmaceutical industry.
- Assure the learning of product safety management concepts in pharmaceutical industry.
- Acquire the knowledge of drug regulatory, quality and safety management in pharmaceutical industry

CO– PO mapping

Course outcome		Programme Outcomes (PO)					
		1	2	3	4	5	6
CO 1	Apply the knowledge of drug regulatory laws.	2		1			2
CO 2	Acquire the knowledge of pharmacopoeia standards	2					2
CO 3	Know the quality guidelines and the drug regulating	2					

	authorities in different countries						
CO 4	Have an insight about drug regulatory approval process and clinical trials in pharmaceutical industry.	2	1	1		1	2
CO 5	Assure the learning of product safety management concepts in pharmaceutical industry.	2					2
CO 6	Acquire the knowledge of drug regulatory, quality and safety management in pharmaceutical industry	2	1	1		1	2
Average		2	1	1		1	2

REFERENCES:

1. NUdupaandKrishnamurthyBhat.AConciseTextbookofDrugRegulatoryAffairs,ManipalUniversityPress,Edition:1, 2015.
2. David M.Bleisner, Establishing a cGMP Laboratory Audit System, A practical Guide, Wiley Publication, 2006.
3. Abraham, John and Smith, H.W. "Regulation of the Pharmaceutical Industry", Palgrave,Macmillan,2003.
4. Weinberg, Sandy "Good Laboratory Practice Regulations" 4th Edition,Marcel Dekker,2007.
5. Gad,Shayne C."DrugSafetyEvaluation",Wiley-Interscience, 3rdEdition,2016.
6. Good Clinical, Laboratory and Manufacturing Practices Techniques for the QA Professional, Edited by PA Carson,and N Dent,, The Royal Society of Chemistry 2007, Published by The Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge CB4 0WF, UK
7. Laboratory Auditing for Quality and Regulatory compliance bu Donald C. Singer, Drugs and the Pharmaceutical Sciences, Vol.150. 2005.
8. Berry,IraR.andHarpaz,Daniel"ValidationofActivePharmaceuticalIngredients",2ndEdition, CRCPress, 2001
9. BritishPharmacopoeia,Andesite Press, 2021.
10. United States Pharmacopoeia,2020
11. https://cdsco.gov.in/opencms/opencms/en/Home/
12. https://www.fda.gov/drugs/pharmaceutical-quality-resources/current-good-manufacturing-practice-cgmp-regulations

PB4111 ANALYTICAL TECHNIQUES IN PHARMACEUTICAL BIOTECHNOLOGY LABORATORY

L T P C
0 0 6 3

COURSE OBJECTIVES:

- carry out analytical experiments related to spectroscopic and chromatographic techniques.
- enable students to learn the principles of analysis for pharmaceutical and biotechnological applications
- provide students of various analytical skills, in relevance of pharmaceutical dosage forms and analytical instrumentation,

LIST OF EXPERIMENTS

1. UV/Visible Spectroscopy
   i) Calibration of UV spectrophotometer
   ii) Effect of solvent on wavelength maxima of drugs.
   iii) Validation of Beers lambert laws.

iv) Standard calibration curve by UV spectroscopy at λ max, λ max + 10 nm and λ max – 10 nm
v) Determination of pKa by U.V. spectroscopy.
vi) Multicomponent analysis by UV-Spectrophotometry by different methods
vii) Analysis of drugs from formulations focusing on separation of drug from the formulation excipients.

2. Fluorescence spectroscopy:
   i) Excitation and emission spectra for the fluorescent dye fluorescein.
   ii) Effect of concentration and instrumental bandwidth on the fluorescent signal.
3. IR Spectroscopy
   i) Calibration of IR spectrophotometer
   ii) Sample preparation for I.R. spectroscopy (solid/liquids) and interpretation of IR bands for important functional groups.
4. Chromatography:
   i) HPLC calibration of HPLC column and determination of response factor by HPLC
   ii) Separation of components by HPTLC and column chromatography.
5. Structural Interpretation by Spectroscopy:
   i) Basic interpretations of simple Mass spectra and NMR.
   ii) Structural elucidation workshop: Interpretation of 1H NMR, 13C NMR, IR and Mass spectrometry of simple compounds.

TOTAL: 90 PERIODS

COURSE OUTCOMES:

At the end of the course, the student able to

- Operate spectroscopic and chromatographic instruments.
- Assess sources of error in instrumental analysis and perform calibration of instruments.
- Conduct the chromatographic separation and spectroscopic analysis of drugs.
- Interpret the structure of the organic compounds with the given spectral data.
- Develop ability to involve in qualitative and quantitative analysis of drugs and biologics.
- Appreciate the importance of modern instruments in the quality control and research

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3		
CO2	3	3	3	3	2	
CO3	3	3	3	3		
CO4	3	3	3	3		
CO5	3	3	3	3		
CO6	3	3	3	3	2	
Average	3	3	3	3	2	

REFERENCES:

1. Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004.
2. Loyd V. Allen Jr, “Remington: The Science and Practice of Pharmacy”. Vol. I & II, 22nd Edition, Pharmaceutical Press;, 2012.
3. Kenneth A. Connors, “Textbook of Pharmaceutical Analysis”, 3rd Edition, John wiley and sons, New York, 2007.

4. Siddiqui, Anees A, “Pharmaceutical Analysis”. Vol.I & II, 3rd edition, CBS Publishers, 2014.
5. Takeru Higuchi, Einar Brochmann, Hanffen Hanssen, Hamffen Hanssen, “Pharmaceutical Analysis” 1st Edition, CBS Publishers, 2005.

SEMESTER II

PB4201 PROTEIN AND PROTEIN FORMULATIONS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide the basic concepts of protein and protein formulations.
- To instill the principles of protein formulation and design
- To impart knowledge and skills necessary for knowing fundamental aspects of proteins and their formulations

UNIT I PROTEIN ENGINEERING 9

Concepts for protein engineering. Isolation and purification of proteins, Stability and activity based approaches of protein engineering, Chemical and Physical Considerations in Protein and Peptide Stability.

UNIT II PEPTIDOMIMETICS 9

Introduction, classification; Conformationally restricted peptides, design, pseudopeptides, peptidomimetics and transition state analogs; Biologically active template; Amino acid replacements; Peptidomimetics and rational drug design.

UNIT III PROTEOMICS 9

Protein identification and characterization: Methods/strategies, protein identification, de novo protein characterization, Isotope labelling, N- and C-terminal tags. 2-Dimensional gel electrophoresis Methods including immobilized pH gradients (IPGs), resolution, reproducibility and image analysis, future developments.Purpose of Protein glycosylation-effect of protein glycosylation on the proteome

UNIT IV PROTEIN FORMULATION 9

Different strategies used in the formulation of DNA and proteins, Analytical and biophysical parameters of proteins and DNA in preformulation, Liposomes, PEGylation, Biological Activity, Biophysical Characterization Techniques, Forced degradation studies of protein.

UNIT V METHODS OF PROTEIN SEQUENCING 9

Various methods of protein sequencing, characterisation, Edman degradation, Tryptic and/or Chymotryptic Peptide Mapping.

TOTAL:45PERIODS

COURSE OUTCOMES

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

- Understand the fundamentals of protein engineering.
- Discuss the underlying concepts of peptidomimetics and drug design.
- Demonstrate the characterization techniques for protein molecules.
- Incorporate approaches to formulate stable protein formulation.
- Elicit concepts of the protein sequencing.
- Become expertise in the technology of Protein and Protein Formulations

CO – PO mapping

Course Outcome	ProgrammeOutcomes(PO)					
	1	2	3	4	5	6
CO1	2	2	2	2		
CO2	2	2			2	
CO3	2	2		2	2	
CO4		2	2	2	2	1
CO5	2	2	2			
CO6			2	2	2	1
Average	2	2	2	2	2	1

REFERENCES:

1. Eugene J. McNally, Jayne E. Hastedt Protein Formulation and Delivery, Informa Healthcare USA, Inc 2008
2. Engelbert Buxbaum, Fundamentals of Protein Structure and Function, Springer International Publishing Switzerland 2015
3. Ajay K. Banga Therapeutic Peptides and Proteins Formulation, Processing, and Delivery Systems. 3rd Edition, 2015. CRC Press, Taylor & Francis USA.
4. Sheldon J. Park, Jennifer R. Cochran, Protein Engineering and Design, 1ST Edition, 2009, CRC press. USA
5. Jeffrey L. Cleland, Rober Langer. Formulation and Delivery of Proteins and Peptides. ACS, USA.
6. Robert K. Skopes. Protein purification, principles and practice, springer, New york.
7. David Whitford, Proteins-Structure and Function, 1st Edition, 2005. John Wiley & Sons, USA.
8. Lars Hovgaard, Sven Frokjaer, Marco van de Weert. Pharmaceutical Formulation Development of Peptides and Proteins. 2nd Edition, CRC Press, Taylor & Francis, USA.

PB4202 IMMUNOTECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

The course aims to

- understand the applications of immunology for the development of diagnostics
- understand the basic principles of vaccine development
- make use of the knowledge of immunotechnology for clinical applications and also become aware of the regulatory issues.

UNIT I INTRODUCTION 6

Review on Cells of the immune system and their development; primary and secondary lymphoid organs; humoral immune response; cell mediated immune responses; complement, classification of T cells and B cells, cell markers.

UNIT II ANTIBODIES 11

Development of Monoclonal antibodies, classification and their applications; ELISA – types; IFT (direct and indirect) Agglutination tests; Antigen detection assay; Plaque Forming Cell Assay, Development of rapid immunodiagnostics - Immuno- lateral flow / flow through assays. Diagnosis of immediate and delayed hypersensitivity, anaphylactic reaction, total Ig

and antigen specific IgE antibody assay, assay for hemolytic diseases, assay for immune complex, skin tests for DTH response

UNIT III DEVELOPMENT OF IMMUNOASSAYS 10

PBMC separation from the blood; identification of lymphocytes based on CD markers; FACS; Lympho proliferation assay; Mixed lymphocyte reaction; Cr51 release assay; macrophage cultures; cytokine bioassays- IL2, gamma IFN, TNF alpha.; HLA typing.

UNIT IV VACCINE TECHNOLOGY 10

Principles of vaccine development, types; Development of vaccines for bacterial, viral and parasitic diseases, Regulatory requirements for vaccine development and testing, ethical issues, protein based vaccines; sub-unit vaccines, DNA vaccines; Plant based vaccines; recombinant antigens as vaccines; reverse vaccinology, cancer vaccines, customized therapeutic cancer vaccines, (scFv) antibodies and molecular evolution of scFv for enhanced sensitivity and specificity,

UNIT V DEVELOPMENT OF IMMUNOTHERAPEUTICS 8

Development of effective immuno drug targets for infectious diseases, engineered antibodies;catalytic antibodies; idiotypic antibodies; dendritic cells based immunotherapy, combinatorial
libraries for antibody isolation, CAR T-cell therapy, Immune check point inhibitors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Understand the science of immunotechnology
- Comprehend the concepts of antibodies and its characterization
- Describe the developments in the immunoassays
- Gain the knowledge of vaccine development
- Apply the technology for the development of immunotherapeutics and Diagnosis
- Become an entrepreneur in the field of immunotechnology

CO – PO mapping

Course Outcomes	ProgrammeOutcomes(PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	2	1			
CO2	2	2	1			
CO3				2	2	
CO4	2	2		2	2	
CO5	1	2	1	2	2	
CO6				2	2	2
Average	2	2	1	2	2	2

REFERENCES:

1. Roitt, Ivan. Essential Immunology 9th Edition., Blackwell Scientific, 13th edition, 2017
2. Roitt I., Brostoff J. and Male D. Immunology, 6th ed. Mosby, 2001
3. Goldsby , R.A., Kindt, T.J., Osbome, B.A. and Kerby J. Immunology, 6th ed., W.H.Freeman, 2006
4. Janeway's Immunobiology, Ninth Edition, Kenneth M. Murphy, Casey Weaver, 2017
5. Roitt's Essential Immunology, 13th Edition, Peter J. Delves, Seamus J. Martin, Dennis R.Burton, Ivan M. Roitt, 2017
6. Lippincott Illustrated Reviews: Immunology, 2nd ed., 2012

BO4004 TECHNIQUESINMOLECULARBIOLOGYANDGENETIC ENGINEERING **L T P C 3 0 0 3**

COURSE OBJECTIVES:

- This course is aimed to teach students with different approaches to perform molecular biology, genetic engineering, rDNA technology and their practical applications in biotechnological research as well as in pharmaceutical industries.

UNIT I VECTOR SYSTEMS **9**

Overview of tools in recombinant DNA technology. Artificial chromosomes — YACs and BACs. Principles for maximizing gene expression — expression vectors, pMal, GST, pET-based vectors. Protein purification — His-tag, GST-tag and MBP-tag. Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and Pichia vectors system, plant based vectors, Ti and Ri plasmids as vectors,yeast vectors and shuttle vectors.

UNIT II ASSAY TECHNIQUES IN MOLECULAR BIOLOGY **9**

Nuclease protection assays, Nuclease S1 mapping, Reporter assays — Mono and dual reporter assays, Electrophoretic mobility shift assay (EMSA) / Gel shift assay, Run-off transcription assay, Phage display, Ribosome display, Gene silencing – siRNAs and Morpholinos.

UNIT III HIGH-THROUGHPUT DNA SEQUENCING **9**

Preparation of Next Generation Sequencing (NGS) libraries: Fragmentation versus tagmentation, end repair, clonal amplification — Bridge PCR and emulsion PCR. Basics and steps involved in NGS platforms: Illumina/Solexa, Roche 454, Ion-torrent and Pacific biosciences. Current status of Oxford nanopore sequencing. Principles of Mate pair sequencing, ChIP-seq, RIP/CLIP-Seq, Methyl seq — Restriction enzyme, enrichment and bisulfite treatment strategies.

UNIT IV GENE EXPRESSION ANALYSIS **9**

Overview of gene expression and its significance. Hybridization methods: Southern and Northern. PCR methods: Reverse transcriptase PCR, End point Vs Real time PCR, Relative quantitation, Absolute quantification — Standard curve method and digital PCR. Endogenous/loading controls. High throughput analysis: Multiplex PCR, Microarray, Serial analysis of gene expression (SAGE) and Small Amplified RNA-SAGE (SAR-SAGE), Total analysis of gene expression (TOGA), Gene calling, RNA-seq and Ribosome profiling.

UNIT V GENOME EDITING TECHNOLOGIES **9**

Basics and applications of genome editing methods - Zinc-finger nuclease (ZFN), Transcription activator-like effector nucleases (TALEN), Mega nucleases, CRISPR-Cas systems — Types and applications, Homing endonucleases, Transposons and Cre/lox P systems. Gene delivery systems – Physicochemical methods and viral vectors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Detail the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.
- Apply concept of genetic engineering techniques in basic and applied experimental biology.
- Possess proficiency in designing and conducting experiments involving genetic manipulation.
- Demonstrate the skills on gene manipulation, gene expression, etc which prepares them for further studies in the area of genetic engineering.
- Illustrate technical know-how on versatile techniques in recombinant DNA

technology.

- describe the genome editing and sequencing and methods for gene therapy..

.CO – PO mapping

Course Outcome	Programme Outcomes(PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	2	1			
CO2	2	2	1			
CO3				2	2	
CO4	2	2		2	2	
CO5	1	2	1	2	2	
CO6				2	2	
Average	2	2	1	2	2	

REFERENCES:

1. Steven R. Head, Phillip Ordoukhanian, Daniel R. Salomon. “Next Generation Sequencing:Methods and protocols” 1st Edition, Humana Press, 2018.
2. Krishnarao Appasani. “Genome Editing and Engineering” Cambridge University press 2018.
3. Raghavachari Nalini, Garcia-ReyeroNatàlia. “Gene expression analysis: Methods andprotocols” 1st Edition, Humana Press, 2018.
4. Primrose SB and Twyman RB. “Principles of Gene manipulation and Genomics”. 7th Edition,Wiley-Blackwell, 2006.
5. Green MR and Sambrook J. “Molecular Cloning: A Laboratory Manual”. 4th Edition, CSHLpress, 2012.

PB4211 IMMUNOTECHNOLOGYLABORATORY L T P C
0 0 6 3

COURSE OBJECTIVES

The course aims to,

- provide hands-on-experience on handling animal for research and various relevantI immunological techniques like ELISA, Flow cytometry etc.
- provide practical experience on performing and understanding immunoassays forevaluating drugs.
- to obtain laboratory training for different Immunotechnological techniques.

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 semi dry transfer

8. Conjugation of Immunoglobins (Streptavidin, colloidal gold)

9. Methods for prototype development of Immunodiagnostics (ICT card)

10. Blood smear identification of leucocytes by Giemsa stain 16

11. Separation of mononuclear cells by Ficoll-Hypaque

12. Separation of splenocytes and proliferation against mitogens
13. Primer design using softwares.
14. Gene DNA amplification by random / specific primers.
15. Western Blotting
16. Gene amplification by PCR.

TOTAL: 90 PERIODS

LIST OF EQUIPMENTS REQUIRED

Microscopes
Purification columns
Microplate reader
UV spectrometer
PAGE apparatus
Western blot apparatus
Centrifuge
Haemocytometer
Cell counter
Metabolic analyser
PCR

COURSE OUTCOMES

At the end of the course, learners will be able to

CO 1	Demonstrate the immunization methods and handling of animals
CO 2	Carry out the experiment on immunological assays for identifying drugs and vaccines.
CO 3	Describe the principles of PCR and their uses in genetic engineering.
CO 4	Illustrate the principle, detection and quantification of protein by bioanalytical techniques
CO 5	Learn about the gene amplification and methods for analysis of DNA
CO 6	Apply methods adapted in gene synthesis

CO-PO Mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3		3		2
CO 2		3	2	3	3	
CO 3		3		3	3	
CO 4	2	3	2	3	3	
CO 5		3	2	3	3	2
CO 6	2		2			2
Average	2	3	2	3	3	2

REFERENCES:

1. "Antibodies", Cold Spring Harbour Laboratory, 1988.
2. Goldsby, R.A. et al."Kuby Immunology". 6th Edition, W.H. Freeman, 2002.
3. Turgeon, Mary Louise. "Immunology and Serology in Laboratory Medicine", 2nd Edition, Elsevier, 2007.
4. Brostoff J et al., "Clinical Immunology", 6th Edition, Gower Medical Publishing, 2002.
5. Coligan, J. E. et al, "Current Protocols in Immunology", 4th Edition John Wiley & Sons, 1994.
6. Paul, "Fundamental of Immunology", 4th Edition, Lippincott Raven, 1999.

PB4212 DRUG DISCOVERY LABORATORY L T P C
0 0 6 3

COURSE OBJECTIVES:

- This course will explore the process of drug discovery from Synthetic and natural products .

SYNTHETIC METHODS FOR DRUG DISCOVERY

1. Synthesis of selected drugs involving two or more steps of synthesis and study of spectral analysis
   of drug synthesized (Paracetamol, Aspirin, Fluorscein, acetanilide, etc.).
2. Determination of pharmacopoeia standards for the synthesized drugs.

DISCOVERY OF DRUGS FROM NATURAL PRODUCTS

1. Extraction Techniques: Cold maceration, Hot Percolation and Soxhalation.
2. Evaluation of extraction Efficiency by yield calculation and TLC.
3. Isolation and purification of some of the following natural products
   a. Piperine from black pepper
   b. Strychnine and Brucine from *Strychnos nuxvomica* seeds
   c. Caffeine from Tea Powder
   d. Curcumin from Turmeric
   e. Diosgenin from Diascoria tubers
   f. Sennosides from Senna leaves
   g. Embelin from *Emblica ribes* fruits
4. Identification of alkaloids in mixture by TLC.
5. Identification of phytoconstituents like alkaloids, steroids, flavanoids etc in plant extracts by TLC.
6. Separation (of sugars/amino acids) by paper chromatography.
7. Separation of compounds by HPLC
8. Analysis of recorded spectra of some simple organic compounds.
9. Tests to detect alkaloids, steroids, flavanoids and their glycosides.
10. Evaluation of antioxidant potential of herbal extracts using DPPH freeRadicalscavenging
    assay.

TOTAL: 90 PERIODS

Required Equipments:

Soxhlet apparatus, rotary flash evaporator, Hot air oven, sonicator, mortar and pestle, TLC chamber, Fume hood, purification columns, micro-plate reader, UV spectrometer, centrifuge, required strains & consumables.

COURSE OUTCOMES:

On completion of this course students should be able to

1. describe the process of drug discovery and development.
2. discuss the challenges faced in each step of the drug discovery process .
3. have gained a basic knowledge of synthetic and extraction methods used in drug discovery.
4. organise information into a clear report.
5. demonstrate their ability to work in teams and communicate scientific information effectively.
6. perform common extraction techniques including maceration, percolation, soxalation etc.

CO-PO Mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2		2		
CO 2	3	1	2	2	2	
CO 3	3	1		2	2	
CO 4	3	3	2	2	2	
CO 5		3	2	2	2	
CO 6	2		2			
Average	3	2	2	2	2	

REFERENCES

1. Foye's Principles of Medicinal Chemistry. By David A. Williams, Thomas L.Lemke, Thomas L.
   Lernke, William O. Foye. Lippincott Williams& Wilkins Publishers; 7th Edition,2012.
2. Modern Methods of Plant Analysis – Peech and M. V. Tracey, 1955.
3. Natural Product Chemistry “A laboratory guide” by Raphealikan,2nd edition, 1991.
4. Phytochemistryvol I & II by Miller, Jan, Nostrant, Rein Hid, 2003.
5. Recent advances in Phytochemistry Vol. I & IV – Scilicet, Runeckles.
6. Remington: The Science and Practice of Pharmacy, 21st Edition, 2011.
7. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry. ByJaime N. Delgado (Editor), Ole Gisvold (Editor), William A. Remers (Editor). Lippincott Williams& Wilkins Publishers; 10thEdition (August 1998) ISBN: 0397515839.1998

SEMESTER III

PB4311 PROTEIN AND PROTEIN FORMULATIONS LABORATORY L T P C
0 0 6 3

COURSE OBJECTIVES

The course aims to

- Impart the knowledge of the formulation concepts on proteins.
- Evaluate the various protein and protein formulations through various characterization techniques.
- Expertise in various formulation approaches of proteins.

LIST OF EXPERIMENTS

- Preformulation study with suitable proteins and peptides
- Study on factors influencing solubility profile and partition coefficient of proteins.
- Compatibility and interactions studies of peptides and proteins with pharmaceutical excipients
- Stability study of protein and protein formulations
- Protein estimation using various methods.
- Isolation and estimation of DNA
- Isolation and estimation of RNA
- Estimation of Enzymatic activity.
- Prepare and characterize protein immobilized alginate beads.
- Quality control experiments with marketed protein and protein formulations
- Formulation and characterisation of vesicle based protein and peptide.
- Computational approaches in study of aggregation

LIST OF EQUIPMENTS REQUIRED

- UV Spectrophotometer
- pH Meter
- Analytical Weighing Balance
- Microscopes
- Stability Chamber
- Software for computational works to characterize the protein and protein formulations

TOTAL: 90 PERIODS

COURSE OUTCOMES:

On completion of the course, the student will be able to

1. Execute preformulation study on protein formulations.
2. Carryout the stability protocol on proteins.
3. Isolate and estimate DNA and RNA.
4. Formulate the various protein formulations.
5. Analyse the various quality control test on marketed formulations.
6. Become Expertise in the field of protein formulation discipline

CO – PO mapping

Course Outcome	ProgrammeOutcomes(PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	2	1		1	2
CO2	2	2	1		1	2
CO3	2	2	1			
CO4	2	2	1	2	1	
CO5	2	2	1	2		2
CO6	2	2		2		2
Average	2	2	1	2	1	2

REFERENCES

- Awesh Kumar Yadav, Rajeev Sharma, Atul Jain. "Practical Manual for M.Pharm. Students", Nirali Prakashan, 2019.
- R. S. Sengar. Laboratory Manual of Biochemistry: Methods and Techniques. New India Publishing Agency, 2014.
- Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA, Struhl K (eds.) Current Protocols in Molecular Biology. John Wiley & Sons, Inc. New York. 2003.
- Morriss-Andrews A, Shea J-E. Computational studies of protein aggregation:

methods and applications. Annual Review of Physical Chemistry 2015(66):643–666
- Jeffrey L. Cleland, Robert Langer. "Formulation and Delivery of Proteins and Peptides", Wiley VCH, 1994.
- Rakesh K. Tekade. "Dosage Form Design Parameters, Volume I", Elsevier, Academic Press, 2018.

PB4312 BIOINFORMATICS AND COMPUTATIONAL BIOLOGY LABORATORY **L T P C**
0 0 6 3

COURSE OBJECTIVES:

The course aims to,

- introduce biopharma related databases, 3D structures of drugs, small molecules and targets
- get familiarized with Next Generation Sequencing Data analysis in a disease context
- perform Quantitative Structure Activity Relationship, Molecular Docking and simulations

LIST OF EXPERIMENTS

1. Introduction to Multiuser Operating System Linux.
2. Databases : Biological and Pharma related.
3. Computing molecular properties of drugs / compounds.
4. Molecular modeling of small molecules : obtaining 3D structures, understanding data formats.
5. Drug targets, Data resources and PDB structures.
6. Homology modeling of Protein Targets and Model evaluation.
7. Next Generation Sequencing Data Analysis Bioconductor Package for Differential gene expression analysis using a disease related dataset.
8. Quantitative Structure Activity relationship (QSAR) Model (partition co-efficient, dissociation constant, molar refractivity, etc.)
9. Pharmacophore identification.
10. Drug like property evaluation of compounds and ADME (Lipinski's rule of five).
11. Methodology of building and refining protein drug targets structure models from X-ray crystallographic data using CCP4i.
12. Molecular docking : Protein – Protein, Protein-Small Molecule.
13. Molecular Dynamics Simulation using GROMACS.
14. Pharmacogenomics : Effect of SNPs / mutations on drug binding using docking approaches.

TOTAL : 90 PERIODS

COURSE OUTCOMES:

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

1. Classify different types of Biological Databases.
2. retrieve data related to small molecules, drugs and their targets, use computational tools for their analysis.
3. explain about biological macromolecular structures and structure prediction methods
4. perform basic next generation sequencing data analysis.
5. perform computational structural studies like QSAR, Molecular docking, Molecular Dynamics simulations and interpret the results.
6. Present and discuss experimental results

CO – PO mapping

Course Outcome	ProgrammeOutcomes(PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	2	1		2	2
CO2	2	2	1		2	2
CO3	2	2	1			
CO4	2	2	1	2	2	
CO5	2	2	1	2		2
CO6	2	2		2		2
Average	2	2	1	2	2	2

REFERENCES:

1. Introduction to Bioinformatics by Arthur K. Lesk, Oxford University Press.2014
2. Algorithms on Strings, Trees and Sequences by Dan Gusfield, Cambridge University Press.2004
3. Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by R.Durbin, S.Eddy, A.Krogh, G.Mitchison, Cambridge University Press,1998
4. Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor
   Laboratory Press. 2004
5. Bioinformatics The Machine Learning Approach by Pierre Baldi and SorenBrunak, Cambridge University Press,2001
6. RNA-seq Data Analysis: A Practical Approach, by Eija Korpelainen, Jarno Tuimala, Panu Somervuo, Mikael Huss and GarryWong. CRC Press 2014
7. Next Generation Sequencing Data Analysis, by XinkunWang CRC Press.2016

PB4313 **PROJECT WORK I** **L T P C**
0 0 12 6

COURSE OBJECTIVES:

The course aims to enable the students to

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

TOTAL : 180 PERIODS

COURSE OUTCOMES:

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

1. Identify the research/industrial problems
2. Collect the relevant literature
3. Analyze the relevant literature
4. Design the experiment
5. Conduct experiment and analyse the data
6. Prepare project report

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	2	1
CO2	2	1	2	1		1
CO3	2	1	2	1		
CO4	2	1	2	1		1
CO5	2	1	2	1	2	1
CO6		1	2			1
Average	2	1	2	1	2	1

PB4314 **SUMMER INTERNSHIP** **L T P C**
0 0 0 2

COURSE OBJECTIVES:

1. To strengthen the association of students with Pharma/Biotech Industry.
2. To create awareness amongst the students the recent trends in Pharma/Biotech industries.
3. To percept the role and responsibility of pharmaceutical biotechnologists in Pharma/Biotech industries.

COURSE OUTCOMES:

After completion of the internship students will be able to:

1. learn the application of knowledge in real world problems.
2. expose to team-work and leadership quality.
3. deal with industry-professionals
4. familiarize with ethical issues in the work environment.
5. get self-motivation in learning the courses
6. identify the gap between the professional world and the academic institutions.

CO Vs PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2		
CO2					3	
CO3				3		
CO4						2
CO5				1	3	2
CO6			1			2
Average	1	1	1	2	3	2

SEMESTER IV

PB4411 PROJECT WORK II L T P C
0 0 24 12

COURSE OBJECTIVES:

The course aims to

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

TOTAL : 360 PERIODS

.**COURSE OUTCOMES:**

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

1. Formulate and analyze problems for developing new methods/solutions/processes.
2. Plan experiments to find solutions in a logical manner
3. Conduct experiments to find solutions in a logical manner
4. Analyze and interpret the results
5. Prepare project report
6. Know the strategies for Commercialization

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	3	2
CO2	3	2	3			2
CO3	3	2	3	2	3	2
CO4	3	2	3	2		
CO5				2		2
CO6						2
Average	3	2	3	2	3	2

SEMESTER I

ELECTIVE I

PB4001 NANOBIOTECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

The course aims to

- provide fundamental concepts in nanomaterials and their use with biocomponents to synthesize and address larger systems.
- provides perspective for students who are interested in nanoscale physical and biological systems and their applications in medicine.

UNIT I INTRODUCTION TO NANOSTRUCTURES 9

Carbon Nanotubes (CNT), Fullerenes (C60, C300) Nano Peapods Quantum Dots and Semiconductor Nanoparticles, Metal-based Nanostructures (Iron Oxide Nanoparticles),

Nanowires, Polymer-based Nanostructures (Dendrimers), Gold Nanostructures:(Nanorods, Nanocages, Nano shells)

UNIT II PROTEIN-BASED NANOSTRUCTURES 9

Nanomotors: Bacterial (E. coli) and Mammalian (Myosin family), Nano biosensors: Science of Self-assembly - from Natural to Artificial Structures (Biological Nanomotors - Biologically Inspired Hybrid Nanodevices) .Engineered Nanopores.

UNIT III NANOSTRUCTURES FOR ANALYTICS 9

Nanoparticles for Electrochemical Bioassays - Luminescent Semiconductor Quantum Dots in Biology - Nanoscale Localized Surface Plasmon Resonance Biosensors - Cantilever Array Sensors for Bioanalysis and Diagnostics - Bio nanoarrays

UNIT IV 3-D BIO -PRINTING (THREE-DIMENSIONAL BIO-PRINTING) 9

Introduction - History, principle and its components, Classification of 3D bio-printing techniques - Extrusion-based bio-printing, Droplet-based bio-printing, Laser-based bio-printing, Design Requirements for 3D Bio-printing- Magnetic Resonance Imaging, Computed Tomography, Computer-Aided Design Based Systems, 3D modelling software, Bio inks for 3D bio-printing - Applications of 3D Bio-printing and future trends.

UNIT V NANOMEDICINE AND NANOSENSING 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. understand varied nanostructures
2. understand protein-based nanostructures
3. explore the nanotechnology for bioanalysis and diagnostics
4. understanding of most recent advances in Nanobiotechnology with novel Techniques.
5. know nano-based drug delivery and nanomedicine
6. explain the interaction between biomolecules and nanoparticle surface and its applications

CO-PO Mapping

Course outcome		Programme Outcomes (PO)					
		1	2	3	4	5	6
CO 1	understand varied nanostructures	2				1	
CO 2	Understand protein-based nanostructures	2	2			1	
CO 3	Explore the nanotechnology for bioanalysis and diagnostics	2		1	1		1
CO 4	Understanding of most recent advances in Nanobiotechnology with novel Techniques.	2	2	3	1	1	2
CO 5	know nano-based drug delivery and nanomedicine	2	2	3	1	1	3
CO6	explain the interaction between biomolecules and nanoparticle surface and its applications	2	2	1	1		
Average		2	2	2	1	1	2

REFERENCES:

1. Nanobiotechnology: Concepts, Applications and Perspectives, Christ of M. Niemeyer (Editor), Chad A. Mirkin (Editor) , Wiley-VCH; 1 edition, 2004.

2. Nanobiotechnology II More Concepts and Applications Edited by Chad A. Mirkin and Christof M. Niemeyer. Wiley-VCH; 1 edition, 2007.
3. Nano Biotechnology: BioInspired Devices and Materials of the Future by Oded Shoseyovand Ilan Levy, Humana Press; 1 edition 2007.
4. 3D Bio-printing -Fundamentals, Principles and Applications, Ibrahim T. Ozbolat, Academic Press, (2016).
5. 3D Bio-printing in Regenerative Engineering, Principles and Applications, Ali Khademhosseini, Gulden Camci-Unal, 1st edition, CRC press, (2018).
6. Bio-Nanotechnology Concepts and applications. Madhuri Sharon, Maheshwar Sharon, Sunil Pandey and Goldie Oza, Ane Books Pvt Ltd, 1 edition 2012

BY4008 THERMODYNAMICSFORBIOLOGICALSYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

- Students will learn about the behavior of fluids, laws of thermodynamics, thermodynamic property relations and their application in different chemical processes

UNITI THERMODYNAMICLAWS 9

Basic thermodynamic concepts, Energy and first Law; Reversibility and second Law; Review of BasicPostulates, equation of state and its applications, corresponding states, equilibrium criteria, LegendreTransformationand Maxwell'srelations

UNITII GIBBSPHASERULE 9

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

UNITIII SOLUTIONTHERMODYNAMICS 9

Partialmolarproperties,Gibbs-Duhemequation,fugacitiesingasandliquidmixtures,activity coefficients, Ideal and Non-idealsolutions, azeotropes, Wilson, NRTL, and UNIQUAC equations ,UNIFAC method.

UNITIV PHASEEQUILIBRIA 9

VapourLiquidEquilibriuminvolvinglowpressure,highpressuresandmulticomponentsystems,VLEin idealand non-idealsolutions,Henry'sLaw,Otherphaseequilibriums- SLE/LLE/VLLE.

UNITV CHEMICALEQUILIBRIA 9

Criteria of chemical reaction equilibrium in thermodynamic systems, Homogeneous gas and liquidphasereactions,heterogeneousreactions–phaseandchemicalequilibrium

TOTAL:45PERIODS

COURSE OUTCOMES:

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

1. Understand the basic concepts, laws and different process related to chemical engineering thermodynamics.
2. characterize the chemical state of a system, and predict the equilibrium relations of the phases present as a function of physical conditions such as pressure and temperature
3. Understand the thermodynamic potential, its correlation and analyze and distinguish between ideal and non-ideal solution.
4. Understand and demonstrate the activity coefficient and activity property of solution.
5. Demonstrate the Chemical and phase equilibria equations
6. Understand the interrelationships between different thermodynamic properties and become familiar with the graphs to develop an intuition for the variation of these

properties during various processes.

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2			
CO2	2	2	2	2		
CO3	2	2	2			
CO4		2	2	2		
CO5	2	2				
CO6	2	2	2	2		
Average	2	2	2	2		

REFERENCES:

1. M. Smith, H. C. Van Ness and M. M. Abbott; Introduction to Chemical Engineering Thermodynamics, Tata-McGraw Hill (2003).
2. Sandler; Chemical, Biochemical, and Engineering Thermodynamics, John Wiley &Sons,New Delhi (2007).
3. Koretsky, M. D.; Engineering and Chemical Thermodynamics, John Wiley and Sons, NewDelhi (2004).
4. Callen, H. B. Thermodynamics and an Introduction to Thermostatistics; John iley and Sons: New York (1985).
5. Tester, J. W., Modell, M., Thermodynamics and its Applications, Prentice-Hall, New Jersey(1996).
6. Rao., Y.V.C., Chemical Engineering Thermodynamics, University Press, Hyderabad,2005
7. Narayanan K.V"A Text Book of Chemical Engineering Thermodynamics "Prentice Hall ofIndia Pvt.Ltd.2001..

BY4006 ENZYMEENGINEERING ANDTECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the IUBMB system of enzyme classification
- To know the catalytic activity of enzyme and its regulation
- To learn the enzyme immobilization; methods of immobilizing the enzymes and their kinetics
- To learn the significant features of the biochemical catalyst

UNIT I INTRODUCTION 9

Introductiontoenzymes,Classification,Sources,Mechanismofenzymeaction.Strategiesofpurification ofenzymes,criteria ofpurity, molecularweightdetermination and characterization ofenzymes, Enzymes of biological importance - Acetyl cholinesterase, angiotensin converting enzyme(ACE), ACE Inhibitors, HMG Co A reductase inhibitors, pseudo cholinesterase, 5'-nucleotidase (5NT),glucose-6-phosphatedehydrogenase (GPD) ,Isoforms,immunoreactivetrypsinogen(IRT)andchymotrypsin;amylaseisoenzymes

UNIT II KINETICSOFENZYMEACTION 9

Methods for investigating the kinetics of enzyme catalyze dreactions— Initialvelocity Studies, Estimation of Michaelis Menten parameters, Effect of pH andtemperatureonenzymeactivity, kineticsofinhibition.Modelingofrateequationsforsingleandmultiple substratereactions

UNITIII IMMOBILIZEDENZYMES 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; applicationsof immobilized enzyme technology,Economicargumentforimmobilization

UNIT IV ENZYMESINFUNCTIONALGROUPTRANSFORMATION 9

Functionalgroupinterconversionusingenzymes(hydrolysisreaction,oxidation/reductionreactions,C-Cbond formations), Retrosynthetic biocatalysis, Chemoenzymatic synthesis of naturalproducts.Industrialprocessusingenzymesforproductionofdrugs,finechemicalsandchiralintermediates, Catalytic antibodies, The design and construction of novel enzymes, artificial enzymes, Biotransformationofdrugs(hydroxylationof Steroids).

UNIT V APPLICATIONSOFENZYMES 9

Enzymes inorganic synthesis, Enzymesasbiosensors ,Enzyme for environmental application, Enzymes formolecular biology research, Enzymes for analytical and diagnosticapplications.

TOTAL:45PERIODS

COURSE OUTCOMES:

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

1. Describe about the enzyme and its classification, reaction in order to proceed towards various concepts in biotechnology.
2. Illustrate the enzyme kinetics which will provide the importance and utility of enzyme towards research.
3. Discuss about the enzyme immobilization techniques and its application in food, pharmaceutical and chemical industries.
4. Elaborate and explain how enzymes are used in a broad spectrum of industrial processes and describe how different enzymes can be modified for optimal performance in these processes.
5. Defend the enzyme applications in the field of organic synthesis, electronics, environment, research and diagnostics.
6. Acquire knowledge on biological, chemical, physical and mathematical principles which constitute the basis of bioengineering applications.

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2		
CO2	2		2	2	1	
CO3	2	2	2	2		
CO4	2		2			
CO5	2	2		2		
CO6	2		2	2		
Average	**2**	**2**	**2**	**2**	**1**	

REFERENCES:

1. Bailey J.E., Ollis D.F. “Biochemical Engineering Fundamentals.”. McGraw Hill, 2nd Edition1986.
2. Faber, Kurt “Biotransformations in Organic Chemistry: A Textbook.”, 5th Edition. Springer,2008.
3. Palmer, Trevor. “Enzymes: Biochemistry, Biotechnology, Clinical

Chemistry." 2nd Edition,East West Press, 2008.
4. Blanch H.W., Clark D. S., "Biochemical Engineering", Marcel Dekker, Inc. 2nd Edition, 1997.
5. Lee, James M., "Biochemical Engineering." PHI, 1st Edition, 1992.
   Yeh W.K., Yang H.C., James R.M., "Enzyme Technologies: Metagenomics, Biocatalysis andBiosynsthesis", Wiley- Blackwell, 1st Edition, 2010.

BY4251 METABOLICPROCESSANDENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

- This course aims to provide fundamental and advanced knowledge in the development of microbial strain for bio production through metabolic engineering.

UNIT I CELLULAR METABOLISM 9

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

UNIT II REGULATION, MANIPULATION AND SYNTHESIS OF METABOLIC PATHWAY 9

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

UNIT III ANALYSIS AND METHODS FOR THE METABOLIC FLUX 9

Metabolic flux map – Fluxes through the catabolic pathways in microbes– Metabolic flux analysis for determined, over-determined and under-determined systems –Sensitivity analysis – Direct flux determination from fractional label enrichment – Applications involving complete enumeration of metabolite isotopomers – Carbon metabolite balances-GC-MS for metabolic flux analysis – genome wide technologies

UNIT IV GENOME BASED METABOLIC MODEL DEVELOPMENT 9

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

UNIT V ANALYSIS OF METABOLIC CONTROL AND INDUSTRIAL CASE STUDIES 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. highlights the engineering of the biology of microbes for maximal metabolite production.
2. summarize the cellular transport process, Regulation of enzyme activity and metabolic pathway synthesis algorithm.
3. acquire foundational technical knowledge of the production of biosynthetic products through recombinant DNA technology.
4. implement genome-scale metabolic modelling for design and evaluation of metabolic engineering strategies
5. Characterize metabolic flux map through the catabolic pathways in microbes and propose relevant metabolic engineering strategies
6. detail cellular modifications of metabolic, gene regulatory, and signalling processes/networks to achieve enhanced production of metabolites including pharmaceuticals, biochemicals and other biotechnology products.

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2		
CO2	3		2	2		
CO3	2	1	2	2	2	
CO4	2		2			
CO5	2	1		2		
CO6	2	1	2	2		
Average	2	1	2	2	2	

REFERENCES

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

SEMESTER I
ELECTIVE II

PB400 APPLIED BIOPHARMACEUTICS AND PHARMACOKINETICS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To learn the principle parameters involved in drug absorption and disposition
- To understand the concepts of bioavailability and bioequivalence of drug products and their significance
- To understand the pharmacokinetic parameters and its application as clinical pharmacokinetics

UNIT I BIOPHARMACEUTICS IN DRUG ABSORPTION AND DISTRIBUTION 9

Mechanisms of drug absorption through GIT, factors influencing drug absorption though GIT, absorption of drug from Non-per oral extra-vascular routes, Distribution of drugs, Tissue permeability of drugs, binding of drugs, apparent volume of drug distribution, plasma and tissue protein binding of drugs, factors affecting protein-drug binding. Kinetics of protein binding, Clinical significance of protein binding of drugs.

UNIT II BIOPHARMACEUTICS IN ELIMINATION 9

Drug metabolism, metabolic pathways, factors affecting metabolism, renal excretion of drugs, factors affecting renal excretion of drugs, renal clearance, Non- renal routes of drug excretion of drugs

UNIT III BIOAVAILABILITY AND BIOEQUIVALENCE 9

Definition and Objectives of bioavailability, absolute and relative bioavailability, measurement of bioavailability, in-vitro drug dissolution models, in-vitro-in-vivo correlations, bioequivalence studies, methods to enhance the dissolution rates and bioavailability of poorly soluble drugs.

UNIT IV PHARMACOKINETICS 9

Introduction to Pharmacokinetics, Pharmacokinetic models, One compartment open model Intravenous Bolus Injection – Intravenous infusion - Extra vascular administrations. Determination of pharmacokinetics parameters and their significance - Absorption Rate Constant (ka), Elimination Rate Constant (K) & Elimination Hal- life (t½), AUC, Cmax, and tmax. Apparent Volume of Distribution (Vd) & Renal Clearance (Q).

UNIT V CLINICAL PHARMACOKINETICS AND NONLINEAR PHARMACOKINETICS 9

Altered kinetics in pregnancy, child birth, infants and geriatrics.kinetics in GI disease, malabsorption syndrome, liver, cardiac, renal and pulmonary disease states.Concept, Accumulation, Persistent and elimination factors.Calculation of dosage regimen following repetitive IV and oral administration. Nonlinear Pharmacokinetics - Introduction, factors causing Non-linearity, Michaelis-menton method of estimating pharmacokinetic parameters.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The student will be able to

- Explain the various factors influencing the drug disposition, various pharmacokinetic parameters
- Design and interpret the bioavailability and bioequivalence of dosage forms.
- Identify the factors affecting the rate of drug absorption.
- Know about clinical pharmacokinetics
- Recognize the application of pharmacokinetics
- Be familiar with applications of Biopharmaceutics.

CO – PO MAPPING						
APPLIED BIOPHARMACEUTICS AND PHARMACOKINETICS						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	3	**3**	**2**	**1**	**1**	**-**
CO 2	3	**3**	**2**	**1**	**1**	-
CO 3	3	**3**	**2**	**1**	**1**	-
CO 4	3	**3**	**2**	**1**	**1**	-
CO 5	3	**3**	**2**	**1**	**1**	-
CO 6	3	**3**	**2**	**1**	**1**	-
Average	3	3	2	1	1	

REFERENCES:

1. Shargel,L and Andrew, B.C. Yu. “Applied Biopharmaceutics & Pharmacokinetics”,7th Edition, The McGraw-Hill Companies, Inc, 2016.
2. Brahmankar, D.M. and Jaiswal, S.B. “Biopharmaceutics and Pharmacokinetics: a Treatise” ,3rd Edition, Vallabh Prakashan, 2015.
3. Chatwal, G.R. “Biopharmaceutics and Pharmacokinetics”, 2nd Edition, Himalaya Publishing House, 2014.
4. Rosenbaum, S. E. “Basic Pharmacokinetics and Pharmacodynamics: An Integrated Textbook and Computer Simulations”, 2 nd Edition, John Wiley & Sons, 2016.
5. Gibaldi, M. “Biopharmaceutics & Clinical Pharmacokinetics”, 4th Edition, Pharma Book Syndicate, 2016.
6. Jambhekar, S.S. and Philip, J. B. “Basic Pharmacokinetics” 2nd Edition, Pharmaceutical Press,2012

PB4003 MOLECULARMEDICINE L T P C
3 0 0 3

COURSE OBJECTIVES:

- Toprovide an in-depth analysis of molecular medicine and mechanisms of diseases associated with Cardiac, renal endocrine and Nephrons.

UNITI MOLECULAR BASIS OF DISEASES 9

Concepts pertaining to the Molecular basis of Infectious disease and metabolic disorders.Human genetics relevant to molecular medicine, single nucleotide polymorphisms, multiple gene polymorphisms, single and multi-gene diseases, gene-environment interactions in disease manifestation, genetic and physical mapping of human genome and identification of diseases gene.

UNITII MOLECULAR BASIS OF GENETIC DISORDERS 9

Single-Gene Disorders,Autosomal Dominant Disorders -Polycystic Kidney Disease, Marfan’s Syndrome, Huntington’s Disease .Autosomal Recessive Disorders-Cystic Fibrosis, Phenylketonuria, Gaucher Disease, Ichthyosis, Tay–Sachs Disease.

UNITIII BACTERIAL INFECTIONS, ANTIBIOTIC ACTION AND DRUG RESISTANCE 9

Principles of Microbial Pathogenesis, Molecular basis of infection and pathogenesis of *Bacillus anthracis,* Mycobacterium spp., Mechanism of bacterial persistence and survival, Immunological response of Mycobacterial infection, Antibiotic action and resistance mechanisms, Drug resistance - origin (genetic and non-genetic), mechanisms**.**

UNITIV MOLECULAR VIROLOGY 9

Molecular basis of Dengue infection and pathogenesis, molecular biology of Hepatitis A, B, C, D & E, and virulence, molecular Biology of HIV Infection, Influenza Virus, Measles, Mumps, Chicken Pox, Poliomyelitis, Human Papilloma virus (HPV), Rabies, Yellow fever and and Japanese Encephalitis. Anti-viral chemotherapy and viral vaccines.

UNITV MOLECULAR DIAGNOSTICS 9

PCR-Based Methods for Mutation Detection, Alternative Methods for Mutation Detection and DNA Sequencingfor Disease Association, Microarray Approaches to Gene Expression Analysis, Methods for Analysis of DNA Methylation, Other Clinical Diagnostic Technologies:Flow Cytometry, Medical Cytogenetics, Fluorescence In Situ Hybridization, Immunohistochemistry, Laser Capture Microdissection (FFPE).

TOTAL:45PERIODS

COURSE OUTCOMES:

Upon successful completion of this course a students will be able to:

1. explain the organizational requirements for the translation of biomedical therapeutics from bench to bedside.
2. debate the impact translational research has had on human health and disease.
3. explain why pharmaceutical companies select particular drug or therapeutic targets for further study.
4. articulate the significance and potential of molecular medical advances in biomedical research.
5. apply the knowledge to decipher the mechanisms of molecular and cell biology.
6. synthesize the ideas for the improvement in the current technology.

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2		
CO2	3		2	2		
CO3	3	1	2	2		
CO4	3		2			
CO5	3	1		2		
CO6	3	1	2	2		
Average	3	1	2	2		

REFERENCES:

1. Jameson,J.L.,Francis,S.C.,“PrinciplesofMolecularMedicine”,HumanPress,1998.
2. Ross,D.W.“IntroductiontoMolecularMedicine”,3rdEdition,Springer,2002.
3. Elles, R., Mountfield, R. (2011). Molecular Diagnosis of Genetic Diseases. Springer Publication..
4. Pasternak,J.J.“AnIntroductiontoHumanMolecularGenetics”,2ndEdition,WileyLiss, 2005.
5. Strachan,Tom andAndrewP.Read.“HumanMolecular Genetics,Bios, 1996.

BO4003 BIOGENERICSANDBIOPHARMACEUTICALS L T P C
3 0 0 3

COURSE OBJECTIVES:

- Introduce the students about biogenerics and biosimilars and their characterization using analytical methods.
- Correlate the conceptual learning of biopharmaceuticals with their therapeutic equivalence using case studies..

UNIT I BIOGENERICS INTRODUCTION 9

Definition: Generics and its advantages; Biogenerics and Biosimilars; why biosimilars are not (bio) generics; The advent of Biosimilars; The role of patents in the drug industry; Protein-based biopharmaceuticals; Manufacturing processes; Global market; International Non-proprietary Names (INN) nomenclature system biosimilars regulation (EU position, US pathways, Government initiatives)

UNIT II BIOSIMILARS AND ITS SCENARIO 9

Approved follow-on proteins/Biosimilars; Characteristics of high selling peptides and proteins,; Products with expired patents; Challenging originator's patents; Target products for FOB (follow-on biologics) /Biosimilars development peptides; Recombinant Non Glycosylated proteins; Recombinant glycosylated proteins; Industries dealing with biogenerics and its market value; World scenario; Indian scenario.

UNIT III CHARACTERIZATION OF BIOSIMILARS 9

Approaches to the characterization of biosimilars; Problems in characterizing biologics(Types of biologic, Peptides, Non-glycosylated proteins, Glycosylated proteins, Monoclonal antibodies); Equivalence issues; Post-translational modifications; Effect of microheterogeneity; Pharmacokinetics; Pharmacodynamics; and Clinical efficacy; Analytical Methods for the characterization of biosimilars (Chromatography, Protein sequencing, Mass Spectrometry, UV absorption, Circular dichroism, X-ray techniques, Nuclear magnetic resonance, Electrophoresis, Western blotting, Bioassays, ELISA, Immunoprecipitation and other procedures)

UNIT IV IMMUNOGENICITY OF BIOPHARMACEUTICALS 9

Immunogenicity of biopharmaceuticals: Immunogenicity; Factors contributing to immunogenicity, (product-related factors and host-related factors), consequence of immunogenicity to biopharmaceuticals; Measurement of immunogenicity.

UNIT V CASE STUDIES 9

Case Studies: Erythropoietin, Insulin, Somatotropin, Interleukin-2, Interferon, Granulocyte-macrophage-CSF, DNase, Factor VIIa, Factor IX, Factor VIII, Activated protein C, Tissue plasminogen activator, Monoclonal antibodies etc., Immunogenicity of biopharmaceuticals: Immunogenicity; Factors contributing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Acquire knowledge about biogenerics, biosimilars, their nomenclature and regulations.
2. Update the patent and market scenario of follow on proteins.
3. learn about the characterization of biosimilars.
4. Attain the knowledge of immunogenicity of biopharmaceuticals
5. Have exposure on case studies dealing with immunogenicity of biopharmaceuticals
6. Apply the knowledge of biopharmaceuticals regulations, characterization and it Immunogenicity properties

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3			
CO2						
CO3	3	2	3	1		
CO4	3	2				
CO5	3	2	1			
CO6	3	2	3	1		
Average	3	2	2	1		

REFERENCES:

1. Niazi, Sarfaraz K. “Handbook of Biogeneric Therapeutic Proteins: Regulatory, Manufacturing, Testing, and Patent Issues”. CRC Press, 2006.
2. Ho, Reedney J. Y., MiloGibaldi. “Biotechnology & Biopharmaceuticals ransforming Proteins andGenes into Drugs”, 2nd edition, 2013.
3. S. Lakshmana Prabu, TNK. Suriyaprakash, “Intellectual Property Rights”, InTech, Croatia, 2017.
4. Sarfaraz K. Niazi, Handbook of Biogeneric Therapeutic Proteins: Regulatory, Manufacturing, Testing, andPatent Issues, CRC Press, 2006.
5. Rodney J Y Ho, MILO Gibaldi, Biotechnology & Biopharmaceuticals Transforming proteins and genes intodrugs, 1stEdition, Wiley Liss, 2003.
6. Prugnaud, Jean-Louis, Trouvin, Jean Hugues. “Biosimilars” Springer, 2012
7. Shein-Chung Chow. “Biosimilars: Design and Analysis of Follow-on Biologics” CRC Press, 2013.

PB4004 ENVIRONMENTAL BIOTECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES

- To study the environmental biotechnology is to understand the current applications of biotechnology to environmental quality evaluation, monitoring and remediation, of contaminated environments.

UNIT I CONCEPTS OF ENVIRONMENTAL BIOTECHNOLOGY 9

Definition, Historical background, scope applications of biotechnology. Biosorption - use of bacteria, fungi and algae in biosorption.Biodegradation of polychlorinated hydrocarbons.Biodegradation of Pesticides.Microbial treatment of oil pollution.Genetically engineered organisms – Merits and demerits – Bio tools for environmental monitoring.

UNIT II BIOTECHNOLOGY AND VALUE ADDITION 9

Bio processes in waste treatment - Production of value added products from waste – single Cell Protein (SCP), ethanol, methane and hydrogen, amino acids, vitamins -Enzyme production from wastes – Biodegradable plastics - Environmental implications - .Biotechnology of Microbial composting - Biofertilizers- Biopesticides.

UNIT III BIOMEDICAL WASTE AND ITS MANAGEMENT 9

Biomedical waste: Introduction: definition, Classification, types and composition, Types of solids, liquids, sharps, blood and blood tissue, radioactive material, biological and chemical material. Documentation of Biomedical waste types and guidelines. Storage of hospital

waste; Types of bags and containers used for storage; Segregation of biomedical waste into different type; Handling and transport of hospital waste. Transport of medical waste: Authorization and accidental spilling reporting.

UNIT IV ENVIRONMENT AND HEALTH 9

Concept, indicators and determinants of health- Bioindicators –Biomarkers –Biosensors – Biomonitoring.Environmental hazards-physical, chemical, biological, sociological & psychological.Concept, causation and natural history of disease.Principles of environmental control. National health policy and health situation in India

UNIT V ENVIRONMENTAL IMACT ASSEMENT 9

Environmental Impact Assessment (EIA): Concepts, objectives, origin & generalised approach to EIA. Methodologies of EIA and EIA guidelines (GOI Notification of 1994, 2006). Environmental Impacts, their types & important impacts to be considered in EIA .Environmental Impact Statement & Environmental Management Plan. Environmental Auditing: Concept & guidelines.

TOTAL: 45PERIODS

COURSE OUTCOMES:

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

1. summarise biodegradation of polychlorinated hydrocarbons,pesticides through genetically engineered organisms.
2. illustrate bio processes in waste treatment and its end products
3. segregate biomedical waste into different type.
4. detail biomonitoring system in securing human health.
5. learn environmental impact assessment techniques.
6. recognise the environment and different processes that take place on Earth.

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3		3	
CO2		3				
CO3			3			
CO4	3					
CO5						
CO6				3	3	3
Average	3	3	3	3	3	3

REFERENCES:

1. Alcamo, I.E.(1994). Fundamentals of Microbiology. The Benjamin/Cummings Pub. Co., USA.
2. Kumar, R. (1987). Environmental Pollution & Health Hazards in India. Ashish Pub. House, New Delhi.
3. Abbasi, S.A. & Ramasami, E. (1999). Biotechnological Methods of Pollution Control. Unviersities Press (India) Ltd., Hyderabad.
4. Baldwin, J.H. 1985. Environmental Planning & Management. International Book Distributors. Dehradun, India.
5. Chatterji. A.K., 2003. Introduction to Environmental Biotechnology. Prentice Hall of India Pvt. Ltd., New Delhi.

SEMESTER II

ELECTIVE III

PB4005 BIOINFORMATICS AND COMPUTATIONAL BIOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To get familiarized with protein three dimensional structure, modeling, docking and molecular dynamics simulations
- Understand basics concepts in Machine learning, Systems Biology approaches and informatics techniques for protein identification

UNIT I GENOME BIOINFORMATICS 9

Automatic analysis, alignment, comparison and annotation of biological sequences; analysis of genome evolution and variation; molecular biology databases.

UNIT II PROTEIN STRUCTURE, MODELLING AND SIMULATIONS 9

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Protein Protein Interactions, Molecular Docking principles and applications, Molecular dynamics simulations.

UNIT III PHARMACOINFORMATICS 9

Molecular library management and virtual screening, computer assisted drug design and quantitative modelling of structure-activity relationships (QSAR and 3D-QSAR)

UNIT IV BIOMEDICAL COMPUTING 9

Clinical and healthcare information systems, biomedical imaging analysis, studying genotype-phenotype relationships and IT support systems for healthcare decision making.

UNIT V MACHINE LEARNING, SYSTEMS BIOLOGY AND OTHER ADVANCED TOPICS 9

Machine learning techniques: Artificial Neural Networks Applications in Protein secondary structure prediction, Hidden Markov Models for protein and gene families, Introduction to Systems Biology, Biological networks : Protein interaction and Gene regulatory networks and network motifs Single Input Module, Dense Overlapping Regulon and Feed Forward Loops, Microarrays and Clustering techniques for microarray data analysis, Informatics techniques for analysis of Mass spectrometry data : protein identification.

TOTAL:45PERIODS

COURSE OUTCOMES:

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

1. summarise the basic procedures involved in genome assembly and annotation.
2. understand concepts in biological sequence analysis, next generation sequencing data analysis.
3. domonstrate the utility of molecular docking and simulations and analyze the results.
4. Illustrate machine learning techniques, networks in Systems biology, microarray data analysis and interpretation of results.
5. possess competence to unveil the relationship between the three-dimensional structure of bio-molecules and their biological activity.
6. have proficiency to handle macromolecular data of sequence and three-dimensional coordinates

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2		
CO2	2		2	2	1	
CO3	2	2	2	2		
CO4	2	3	2		1	
CO5	2	3		2		
CO6	2	2	2	2		
Average	2	2	2	2	1	

REFERENCES:

1. David W. Mount. Bioinformatics - Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York
2. Finkelstein A, Ptitsyn O. Protein physics: a course of lectures. 2nd ed Academic Press. 2016.
3. PHILIP E. BOURNE Structural Bioinformatics / edited by Philip E. Bourne, Helge Weissig Hoboken, N.J. : Wiley-Liss, C 2003
4. TAYLOR, W. R. (Willie R.). Protein Geometry, Classification, symmetry and topology: a computational analysis of structure / William R. Taylor and András Aszódi Bristol: Institute of Physics Pub., Once. 2005.
5. Leach, A. Molecular Modelling: Principles and Applications. 2a. ed. Harlow: Pearson Education, 2001.

PB4006 BIOPROCESS ENGINEERING AND TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- Gain knowledge about the design of production of bioproducts under aerobic and anaerobic states, process economic and preparation of flow sheet of production process.
- State the enzyme kinetics, various factors regulating catalysis, different models for analyzing the enzyme kinetics, Immobilization and large-scale production of enzyme;

UNIT I BLACK BOX MODEL 9

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

UNIT II DESIGN OF FERMENTATION PROCESSES 9

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

UNIT III MODELING OF VARIOUS FERMENTATION PROCESSES 9

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

UNIT IV BIOREACTOR DESIGN & CONSTRUCTION 9

Basic design and construction of CSTR, bioreactor design of agitator / agitator motor, power consumption in aerated bioreactor, design of sparger, mixing time estimation, oxygen

mass transfer capability in bioreactor, Removal of Heat in bioreactor, Main parameters to be monitored and controlled in fermentation processes.

UNIT V CASE STUDIES IN FERMENTATION DERIVED PRODUCTS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Develop the capacity of production processes and control of aerobic and anaerobic systems, solve calculation based on process economy as well as to recognize the importance of flow sheet of the production system
2. Explain the kinetics of enzyme catalysed reaction in free and immobilized states.
3. organise the production of microbial enzymes and operate variables affecting the production process.
4. demonstrate about concept and criteria of scale up of laboratory process, Instrumentation and process control- offline and online.
5. Collect the proficient knowledge of translation of lab data to pilot level, they will be able to solve features involved in the scale up process, process monitoring and control.
6. plan a research career or to work in the biotechnology industry with strong foundation about bioreactor design and scale-up.

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3		3		
CO2		3	2	3		
CO3		3		3		
CO4	2	3	2	3		
CO5		3	2	3		
CO6	2		2			
Average	2	3	2	3		

REFERENCES:

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

BO4103 MOLECULAR PHARMACOLOGY L T P C

3 0 0 3

COURSE OBJECTIVES:

- know the basic molecular mechanism of drug action, receptors and their mode of

action, endogenous bioactive molecules, drugs acting on various systems, toxicology applicable in drug discovery.

UNIT I MOLECULAR MECHANISM OF DRUG ACTION 10

Basic concepts in molecular pharmacology: agonists, antagonists and inverse agonists; potency, intrinsic activity and efficacy; Transducer mechanisms of receptors; Receptor occupancy theory and cellular signalling systems such as G-proteins, cyclic nucleotides, calcium and calcium binding proteins, phosphatidylinositol. Ion channels and their modulators: measurement of binding and response, Voltage-gated ion channels. G protein-coupled receptors, G proteins and effectors, Mechanism of G protein-mediated signalling: - Wnt, hedgehog and notch; Signal transduction through tyrosine kinases; Receptors regulating gene expression.

UNIT II RECEPTORS AND THEIR MODE OF ACTION 8

Angiotensin receptors Excitatory amino acid receptors Kinin receptor, Adrenoceptors, Low molecular weight heparins, hirudins and GP IIB/IIIa receptor antagonists, Cholinergic receptors, Dopamine receptors, Serotonin receptors, Hormone receptors, GABA and Benzodiazepine receptors, Opioid receptors, Purinergic receptors, Glutamate receptors.

UNIT III BIOACTIVE MOLECULES 8

Endogenous bioactive molecules: Cytokines, neuropeptides and their modulators, neurosteroids, nitric oxide, phosphodiesterase enzyme and protein kinase C, arachidonic acid metabolites, COX- 2 regulators and their role in inflammation, endothelium derived vascular substances (NO, endothelins) and their modulators.

UNIT IV OVERVIEW OF DRUGS ACTING ON VARIOUS SYSTEMS 10

Central nervous system, Autonomic nervous system, Autacoids, Analgesic, Antipyretic, and Anti-inflammatory Agents, Renal and cardiovascular system, Anti Infective agents, Hormones, Hematopoietic agents.

UNIT V TOXICOLOGY 9

Principles of toxicology, Physicochemical, Biochemical and genetic basis of toxicity, principles of toxicokinetics, mutagenesis and carcinogenesis, Acute, sub-acute and chronic toxicity studies according to guidelines. Guidelines and regulatory agencies – CPCSEA, OECD, FDA, ICH, FHSA, EPA, EEC, WHO.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. To describe basic concepts in molecular pharmacology of several agonists: antagonists transducer mechanisms of receptors and receptors regulating gene expression.
2. To illustrate various receptor mechanism required for drug discovery Process.
3. To detail endogenous bioactive molecules and neuro transmitters essential for drug development procedure.
4. To highlight drugs acting on Central nervous system, Autonomic nervous system to understand the mechanism of drug action.
5. To explain the principles of toxicology, guidelines and regulatory agencies – CPCSEA, OECD, FDA, ICH, FHSA, EPA, EEC, WHO.
6. To summarize various applications of drugs in human health care and safety regulations

CO Vs PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	2		
CO2		3	2	2		
CO3	2	2	2	2	2	
CO4		2	2			
CO5	2	3		2		
CO6	2	2	2	2		
Average	2	2.5	2	2	2	

REFERENCES:

1. Laurence Brunton, Bjorn Knollmann, RandaHilal-Dandan, "Goodman and Gilman's: The Pharmacological basis of therapeutics", McGraw-Hill Education / Medical, 13th edition, 2017.
2. Tripathi, K.D. "Essentials of Medical Pharmacology", Jaypee Brothers Medical Publishers, 8 th edition, 2018.
3. RS Satoskar Nirmala Rege SD Bhandarkar, "Pharmacology and PharmacoTherapeutics", Elsevier India, 26 th edition, 2020.
4. Francesco Clementi (Editor), Guido Fumagalli (Editor), "General and Molecular Pharmacology: Principles of Drug Action", Wiley, 1st edition, 2015.
5. Karen Whalen, "Lippincott Illustrated Reviews: Pharmacology", Lippincott Williams and Wilkins, 7th Edition, 2019.
6. James Ritter, Rod Flower, Graeme Henderson, Yoon Kong, Loke David, Mac Ewan Humphrey Rang "Rang and Dales Pharmacology", Elsevier, 9 th edition, 2018.
7. Katzung, B.G., "Basic and Clinical Pharmacology", 14th Edition, McGraw Hill 2017.

PB4007 BIOCONJUGATE TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- At the end of the course, the student would have learnt about enzymes, nucleic acidsand how to modify them for target specificity. Student also gets familiarized with the industrial applications of this technology.

UNIT I FUNCTIONAL TARGETS 9

Modification of Amino Acids, Peptides and Proteins – Modification of sugars, polysaccharides and glycoconjugates – modification of nucleic acids and oligonucleotides.

UNIT II CHEMISTRY OF ACIVE GROUPS 9

Amine reactive chemical reactions – Thiol reactive chemical reactions – carboxylatereactive chemical reactions – hydroxyl reactive chemical reactions – aldehyde and ketone reactive chemical reactions – Photoreactive chemical reactions.

UNIT III BIOCONJUGATE REAGENTS 9

Zero length cross linkers – Homobifunctional cross linkers – Heterobifunctional crosslinkers – Trifunctional cross linkers – Cleavable reagent systems – tags and probes.

UNIT IV ENZYME AND NUCLEIC ACID MODIFICATION AND CONJUGATION 9

Properties of common enzymes – Activated enzymes for conjugation – biotinylatedenzymes – chemical modification of nucleic acids – biotin labeling of DNA- enzymeconjugation to DNA – Fluorescent of DNA.

UNIT V BIOCONJUGATE APLICATIONS 9

Preparation of Hapten-carrier Immunogen conjugates - antibody modification andconjugation – immunotoxin conjugation techniques – liposome conjugated and derivatives- Colloidal – gold-labeled proteins – modification with synthetic polymers.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

1. Acquire the knowledge of modifying functional agents such as proteins, sugars, etc.,
2. Apply the knowledge of chemical reactivity of active groups
3. Know about the conjugate reagents
4. Attain the knowledge of enzyme and nucleic acids modification and conjugation
5. Have the knowledge of bioconjugate applications
6. Apply the knowledge of bioconjugate and its applications

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	1		
CO2	3					
CO3	3			1		
CO4	3		1	1		
CO5	3	1	2	1		
CO6	3	1	2	1		
Average	3	1	2	1		

REFERENCES:

1. Chemistry of bioconjugates : synthesis, characterization, and biomedical applications / edited by Dr. Ravin Narain, Department of Chemical and Materials Engineering, University of Alberta, Edmonton, Alberta, Canada.
2. Hermanson, G.T. “Bioconjugate Techniques”. Academic Press 3rd edition, 2013.
3. Sam Massa and Nick Devoogdt (eds.), Bioconjugation: Methods and Protocols, Methods in Molecular Biology, vol. 2033, Springer Science Business Media, LLC, part of Springer Nature 2019.
4. Sonny S. Mark (ed.), Bioconjugation Protocols: Strategies and Methods, Methods in Molecular Biology vol. 751, DOI 10.1007/978-1-61779-151-2_1, Springer Science+Business Media, LLC 2011.
5. Chrostof M.Niemeyer (Eds) Methods in Molecular Biology. 283. Bioconjugation Protocols Strategies and Methods. Humana Press.

SEMESTER II, ELECTIVES IV

PB4008 PHARMACOGENOMICS L T P C

3 0 0 3

COURSE OBJECTIVES:

Upon successfully completing this course, students will:

- Describe the fundamental concepts of pharmacogenomics.

- Recognize how new technologies, such next-generation sequencing, are affecting the development and use of pharmacogenomics.
- Aware of the significance of pharmacogenomics and its use in clinical practise.

UNIT I PHARMACOGENOMICS AND PERSONALIZED MEDICINE 9

Historical aspects of Pharmacogenetics, Pharmacogenetics and Populations, Monogenic and Multigenic Variations of Drug Responses, personalized medicine, strategies for application of pharmacogenomics to customize therapy, Barriers, Future Perspectives.

UNIT II PHARMACOGENETICS OF ENZYMES AND RECEPTORS 9

Pharmacogenetics of two clinically important polymorphic enzymes, CYP2D6 and TPMT, nuclear receptors, cell surface receptors, Future Perspectives on the Pharmacogenetics of Drug Metabolism, Nuclear Receptors, Cell Surface Receptors.

UNIT III PHARMACOGENETICS OF DRUG TRANSPORTERS 9

Organic anion and cation transporter polypeptide family – OATP-B, OATP-C, OATP-8, OATP-D, OATP-E, OATP-F, OATP-H, OATP-I, OATP-J, and PGT OAT1, OAT2, OAT3; OCT1, OCT2, OCT3, PepT and MRP families- MDR1, MDR3, BSEP, MRP1, MRP3, MRP4, MRP5, MRP6, MRP8 BCRP protein.

UNIT IV TECHNOLOGIES IN PHARMACOGENOMICS 9

Single Nucleotide Polymorphism, SNP Analysis Technologies, Biochemistries, Hybridization-Based Approaches - Enzyme-Based Approaches, Combined Hybridization/Enzymatic Approaches, Detection Methods, Platforms

UNIT V PHARMACOEPIGENETICS 9

General principles of epigenetic regulation – epigenetic mechanisms, DNA methylation, methylated cytosine binding proteins, histone modifications, coordination of epigenetic machinery, epigenetic functions, genetic imprinting, x inactivation, geneome defence, epigenetics and human disease - therapeutic applications – HDAC inhibitors, DNMT inhibitors, CpG Oligonucleotides and Immune Response, Designer Transcription Factors

TOTAL: 45PERIODS

COURSE OUTCOMES

The students will be able to

- Differentiate how individual genetic variations affect drug therapy outcomes, as well as therapeutic efficacy and toxicity.
- Describe how single nucleotide polymorphism functions as a biomarker for the assessment of disease, therapeutic response, and prognosis.
- As new tools based on genetics become available, use them, manage them, and decide on the best course of action.
- Use pharmacogenomics approaches to address issues in pharmaceutical care by using a specific pharmacological therapy.
- Be aware of the ethical and societal ramifications of genetic testing and the individualised pharmacological therapy that results from it.
- Recognize the effectiveness of different medications based on genetics and apply it to clinical research.

TEXTBOOKS

1. Pharmacogenetics: An Introduction and Clinical Perspective" edited by Joseph S. Bertino, et al. 2013.
2. Concepts in pharmacogenomics. Martin M. Zdanowicz. Bethesda, Md. American Society of Health-System Pharmacists, 2010.
3. Genomics and Pharmacogenomics in Anticancer Drug Development and Clinical Response Beverly A. Teicher, Federico Innocenti, Springer, USA, 2008.

4. Gene-Environment Interactions: Fundamentals of Ecogenetics Costa, LG and Eaton DL., Wiley Press, 2006.

REFERENCES

1. Pharmacogenomics Werner Kalow, Rachel F Tyndale, Urs A Meyer, Marcel Dekker Inc., USA, 2001.
2. Pharmacogenomics in Drug Discovery and Development Second Edition Edited by Qing Yan PharmTao, Santa Clara, Springer New York, 2014.
3. Pharmacogenomics Challenges and Opportunities in Therapeutic Implementation second edition Edited by Y. W. Francis Lam Stuart A. Scott. Academic Press, 2019.
4. Pharmacogenomics in clinical therapeutics edited by Loralie J. Langman and Amitava Dasgupta, John Wiley & Sons, Ltd, 2012.

CO – PO MAPPING						
PHARMACOGENOMICS						
Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3				3	
CO2			3			3
CO3	3	3				
CO4				2	3	
CO5	3					3
CO6		3				
Average	3	3	3	2	3	3

PB4009 BIO-ENTREPRENEURSHIP L T P C
3 0 0 3

COURSE OBJECTIVES:

The main objectives of this course are to:

- Enable the students to understand the sources of innovation opportunities and development of the skills to identify and analyze these opportunities for bioentrepreneurship and innovation.
- Develop personal skills set for creativity, innovation and entrepreneurship and specific
- Concepts and tools for combining and managing creativity in organization

UNIT I BASICS OF BIOENTREPRENEURSHIP 9

Introduction to bioentrepreneurship – Biotechnology in a global scale, Scope in Bioentrepreneurship, Importance of entrepreneurship.Meaning of entrepreneur, function of an entrepreneur, types of entrepreneur, and advantages of being entrepreneur. Innovation – types, out of box thinking, opportunities for Bioentrepreneurship. Entreprenuership development programs of public and private agencies (MSME, DBT, BIRAC, Startup and Make in India).

UNIT II MANAGEMENT, ACCOUNTING AND FINANCE 9

Management principles of Henry Fayol. Business plan preparation: business feasibility analysis by SWOT, socio-economic costs benefit analysis, Sources of financial assistance – making a business proposal, approaching loan from bank and other financial institutions, budget planning and cash flow management, basics in accounting practices - balance sheet, P&L account, double entry book keeping, and estimation of income, expenditure and Income tax.

UNIT III KNOWLEDGE CENTRE AND R & D 9

Knowledge centers - Universities, innovation centre, research institutions and business incubators. R&D - technology development and upgradation, assessment of technology development, managing technology transfer, industry visits to successful bio-enterprises, regulations for transfer of foreign technologies, quality control, technology transfer agencies,

UNIT IV MEDIUM & SMALL SCALE INDUSTRY 9

Definition, characteristics, need and rationale, objectives, scope and advantages of small scale industries.Types of bioindustries – Pharma, Agri and Industry.Biofertilizers production - Azospirillium, Azolla, Cyanobacteria and its applications.Biopecticides production - Bacterial, fungal, viral and plant insecticides.Sericulture.Apiculture.Dairy farming.Single Cell Protein Production and applications.

UNIT V MARKETING AND HUMAN RESOURCE DEVELOPMENT 9

Assessment of market demand for potential product(s) of interest, Market conditions, segments, prediction of market changes, identifying needs of customers including gaps in the market. Branding issues, developing distribution channels – franchising policies, promotion, advertising, branding and market linkages. Marketing of agro products. Recruitment and selection process, leadership skills, managerial skills, organization structure, training, team building and teamwork.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. know the legal and financial conditions for starting a business venture
2. explain the importance of marketing and management in small businesses venture and can interpret their own business plan
3. identify the elements of success of bioentrepreneurial scheme and projects
4. Can able to specify the basic performance indicators of various entrepreneurial activities.
5. Summarise the regulations for transfer of foreign technologies
6. Student will be able to analyse the business environment in order to identify business opportunities.

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	2	2	3
CO2	1			2	2	3
CO3		1		2	2	3
CO4	1				2	3
CO5	1			2	2	3
CO6	1	1	2	2		
Average	1	1	2	2	2	3

REFERENCES

1. Principles of Management", PC Tripati, PN Reddy,–Tata Mc Graw Hill

2. Management Fundamentals", Robert Lusier – Concepts, Application, Skill Development" Thomson
3. Entrepreneurship Development" S S Khanka , S Chand & Co
4. Dynamics of Entrepreneurial Development & Management" Vasant Desai Himalaya Publishing House

PB4010 BIOMATERIALS AND TISSUE ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

The objective of this course is to

- Acquire knowledge on biomaterials and its applications
- Enable the students to learn the aspects of tissue engineering
- Get information about the applications of tissue engineering

UNIT I BIOMATERIALS 9

Biomaterials: Properties of biomaterials-Surface, bulk, mechanical and biological- Scaffolds & tissue engineering - Types of biomaterials-biological and synthetic materials- Biopolymers-Applications – Modifications – Nanotechnology in biomaterials.

UNIT II BASIC BIOLOGY OF STEM CELLS 9

Stem Cells: Introduction- hematopoietic differentiation pathway -Potency and plasticity of stem cells- Stem Cell markers- Types and sources of stem cell with characteristics: embryonic- adult- haematopoietic- fetal- cord blood-placenta- bone marrow-primordial germ cells- cancer stem cells.

UNIT III TISSUE ENGINEERING 10

Introduction to tissue engineering: Basic definition-current scope - cell numbers and growth rates- measurement of cell characteristics –morphology- number viability- motility and functions. Measurement of tissue characteristics - appearance- cellular component-ECM component- physical properties.

UNIT IV TISSUE REPAIR 8

Tissue types and Tissue components, Tissue repair and Engineering -wound healing and sequence of events - Cell-Matrix- Cell-Cell Interactions - telomeres and Self renewal-Control of cell migration in tissue engineering.

UNIT V CLINICAL APPLICATIONS AND ETHICAL ISSUES 9

Stem cell therapy-Molecular therapy - In vitro Organogenesis-Neuro degenerative diseases-spinal cord injury- heart disease- diabetes- burns and skin ulcers- muscular dystrophy-orthopaedic applications - Patent protection and regulation of tissue engineered products-ethical issues.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students would get

1. Awareness about the properties and broad applications of biomaterials
2. Overall exposure to the role of tissue engineering and stem cell therapy in organogenesis
3. Knowledge of tissue engineering principles
4. Ability to understand the tissue components and tissue repair
5. Opportunity to get familiarized with the stem cell characteristics and their relevance in medicine
6. to know the applications of Biomaterials and Tissue Engineering

CO – PO MAPPING						
BIOMATERIALS AND TISSUE ENGINEERING						
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	3	3	2	-	1	**-**
CO 2	3	3	2	-	1	-
CO 3	3	3	2	-	1	-
CO 4	3	3	2	-	1	-
CO 5	3	3	2	-	1	-
CO 6	3	3	2	-	1	-
Average	3	3	2		1	

REFERENCES:

1. Bernhard O.Palsson, Sangeeta N.Bhatia, "Tissue Engineering" Pearson Publishers 2009.
2. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. Fundamentals of Tissue Engineering and Regenerative Medicine. 2009.
3. R. Lanza, J. Gearhart et al (Eds), Essential of Stem Cell Biology, Elsevier Academic press, 2006.
4. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches in Tissue Engineering & Regenerative Medicine" Artech House, INC Publications, 2008
5. Bernard N. Kennedy (editor), Stem cell transplantation, tissue engineering, and cancer applications, New York: Nova Science Publishers, 2008.
6. Raphael Gorodetsky, Richard Schäfer Stem cell- based tissue repair, Cambridge: RSC publishing, 2011.

BO4005 ADVANCESINOMICSSCIENCESANDTECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES

The course aims to,

- Provide advanced theoretical knowledge on the organization and function of genome
- Understand the principles of functional genomic analyses
- Have knowledge on the advanced methods and approaches in proteomics.

UNIT I MICROARRAYS IN GENOMICS 9

Microarrays, types, Designing and production of microarrays; cDNA microarray technology; Oligonucleotide arrays; Sample preparation, labeling, hybridization, generation of microarray data. Transcriptomics using cDNA and oligonucleotide arrays.

UNIT II NEXT GENERATION SEQUENCING TECHNOLOGIES 9

Overview of Next Generation Sequencing (NGS) technologies; Principles of NGS by Roche/454, Illumina, Life Technologies, Pacific Biosciences, Ion Torrent technologies; Applications of NGS to disease diagnosis and personalized medicine.

UNIT III PROTEIN MICROARRAYS AND YEAST TWO-HYBRID SYSTEM 9

Types of protein arrays; Protein microarray fabrication; Experimental analysis of proteins

arrays. Data acquisition and processing; Applications of protein microarray types. Principles and methods in yeast two-hybrid system, Advances in yeast two hybrid system and its applications.

UNIT IV TWO-DIMENSIONAL GEL ELECTROPHORESIS OF PROTEINS 9

Sample preparation, First-dimension IEF with IPG; Second dimensional separation of proteins; Image analysis of 2-DE gels; DIGE, Protein expression profiling and comparative proteomics of complex proteomes using 2-DE.

UNIT V MASS-SPECTROMETRY 9

Basics of Mass-spectrometry (MS) and bimolecular analysis; Common ionization methods for peptide/protein analysis; Principles of Time of Flight (TOF), Ion Trap (IT), and Orbitrap mass analyzers; Mass spectrometry based proteomics: MALDI-TOF, Nano-LC-MS; Gas-chromatography coupled to Mass spectrometry; Mass-spectrometry analysis of Post-Translational Modifications of proteins.

TOTAL: 45 PERIODS

COURSEOUTCOMES:

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

- Understand the designing and application of microarrays in genomics.
- Have knowledge in next generation sequencing technologies and their use in diagnosis and personalized therapy.
- Have exposure to protein analysis using high end technology
- Acquire the knowledge of 2D gel Electrophoresis of proteins
- Understand the concepts of mass spectrometry in protein analysis
- Attain the knowledge of micro array , sequencing, 2D gel electrophoreses and mass spectrometry techniques in proteins and genomics

CO - PO mapping

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2		
CO2	3		2	2		
CO3	3	1	2	2		
CO4	3		2			
CO5	3	1		2		
CO6	3	1	2	2		
Average	3	1	2	2		

REFERENCES:

1. Schena M. (2000) DNA Microarrays - A Practical Approach. Oxford University Press.
2. Rinaldis E. D. and Lahm A (2007) DNA Microarrays. Horizon bioscience. Causton,H.C.
3. Muller H. J. and Roder T. (2006) Microarrays. Elsevier Academic Press.
4. Causton H. C., Quackenbush J., and Brazma A. (2004) A Beginner's Guide.
5. Schena M. (2005) Protein Microarrays. Jones and Bartlett Publishers.
6. O'Connor C. D. and Hames B. D. (2008) Proteomics. Scion Publishing Ltd.
7. Hoffman E. D. and Stroobant V. (2007) Mass Spectrometry – Principles and Applications, JohnWiley & Sons Ltd.

AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
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: 30 PERIODS

COURSE OUTCOMES:

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES:

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX4092 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

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 : 30 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:

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

AX4093 **CONSTITUTION OF INDIA** **L T P C**
2 0 0 0

COURSE OBJECTIVES:

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

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

UNIT VI ELECTION COMMISSION

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to:

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

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition,

2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094 **நற்றமிழ்இலக்கியம்** **L T P C**
2 0 0 0

UNIT I **சங்கஇலக்கியம்** **6**

1. தமிழின்துவக்கநூல்தொல்காப்பியம் – எழுத்து, சொல், பொருள்
2. அகநானூறு (82) - இயற்கைஇன்னிசைஅரங்கம்
3. குறிஞ்சிப்பாட்டின்மலர்க்காட்சி
4. புறநானூறு (95,195) - போரைநிறுத்தியஔவையார்

UNIT II **அறநெறித்தமிழ்** **6**

1. அறநெறிவகுத்ததிருவள்ளுவர் - அறம்வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்
2. பிறஅறநூல்கள்- இலக்கியமருந்து – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையைவலியுறுத்தும்நூல்)

UNIT III **இரட்டைக்காப்பியங்கள்** **6**

1. கண்ணகியின்புரட்சி - சிலப்பதிகாரவழக்குரைகாதை
2. சமூகசேவைஇலக்கியம்மணிமேகலை - சிறைக்கோட்டம்அறக்கோட்டமாகியகாதை

UNIT IV **அருள்நெறித்தமிழ்** **6**

1. சிறுபாணாற்றுப்படை - பாரிமுல்லைக்குத்தேர்கொடுத்தது, பேகன்மயிலுக்குப்போர்வைகொடுத்தது, அதியமான்ஔவைக்குநெல்லிக்கனிகொடுத்தது, அரசர்பண்புகள்
2. நற்றிணை - அன்னைக்குரியபுன்னைசிறப்பு
3. திருமந்திரம் (617, 618) - இயமம்நியமம்விதிகள்
4. தர்மச்சாலையைநிறுவிய வள்ளலார்
5. புறநானூறு - சிறுவனேவள்ளலானான்
6. அகநானூறு (4) - வண்டு நற்றிணை (11) - நண்டு கலித்தொகை (11) - யானை, புறா ஐந்திணை 50 (27) - மான் ஆகியவைபற்றியசெய்திகள்

UNIT V நவீனதமிழ்இலக்கியம் 6

1. உரைநடைத்தமிழ்,
   - தமிழின்முதல்புதினம்,
   - தமிழின்முதல்சிறுகதை,
   - கட்டுரைஇலக்கியம்,
   - பயணஇலக்கியம்,
   - நாடகம்,
2. நாட்டுவிடுதலைபோராட்டமும்தமிழ்இலக்கியமும்,
3. சமுதாயவிடுதலையும்தமிழ்இலக்கியமும்,
4. பெண்விடுதலையும்விளிம்புநிலையினரின்மேம்பாட்டில்தமிழ்இலக்கியமும்,
5. அறிவியல்தமிழ்,
6. இணையத்தில்தமிழ்,
7. சுற்றுச்சூழல்மேம்பாட்டில்தமிழ்இலக்கியம்.

TOTAL : 30 PERIODS

தமிழ்இலக்கியவெளியீடுகள் / புத்தகங்கள்

1. தமிழ்இணையகல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ்விக்கிப்பீடியா (Tamil Wikipedia)
   -https://ta.wikipedia.org
3. தர்மபுரஆதீனவெளியீடு
4. வாழ்வியல்களஞ்சியம்
   - தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக்களஞ்சியம்
   - தமிழ்வளர்ச்சித்துறை (thamilvalarchithurai.com)
6. அறிவியல்களஞ்சியம்
   - தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர்

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

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

OBJECTIVE

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

UNIT I CONTEXT FOR IWRM 9

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

UNIT II WATER ECONOMICS 9

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

UNIT III LEGAL AND REGULATORY SETTINGS 9

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

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9

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

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9

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

TOTAL: 45 PERIODS

OUTCOMES

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

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

REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
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.

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

OBJECTIVES:

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

UNIT I FUNDAMENTALS WASH **9**

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

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT **9**

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

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT **9**

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

UNIT IV GOVERNANCE **9**

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

UNIT V INITIATIVES **9**

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

TOTAL: 45 PERIODS

OUTCOMES:

CO1	Capture to fundamental concepts and terms which are to be applied and understood all through the study.
CO2	Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
CO3	Critically analyse and articulate the underlying common challenges in water, sanitation and health.
CO4	Acquire knowledge on the attributes of governance and its say on water sanitation and health.
CO5	Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R.,Kjellstorm, 2006, "Basic Epidemiology", 2nd Edition, World Health Organization.
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. New Directions for Teaching and Learning, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda
3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary***.** Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. On Economic Inequality.Enlarged edition, with annex by JamesFoster and Amartya Sen, Oxford: Claredon Press, 1997.
5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

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

OBJECTIVES:

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

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLEGES 9

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

UNIT II PRINCIPLES AND FRAME WORK 9

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

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

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

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

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

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8

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

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of thecourse, thestudent isexpected tobeableto

CO1	Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
CO2	Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
CO3	Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
CO4	Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
CO5	Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

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

OCE434 ENVIRONMENTAL IMPACT ASSESSMENT L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I INTRODUCTION 9

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

UNIT II IMPACT INDENTIFICATION AND PREDICTION 10

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

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8

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

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

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

UNIT V CASE STUDIES 9

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

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of thecourse, thestudent isexpected tobeableto

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

REFERENCES:

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent

problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

OIC431 BLOCKCHAIN TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

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

UNIT II BITCOIN AND CRYPTOCURRENCY 9

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

UNIT III INTRODUCTION TO ETHEREUM 9

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

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

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

UNIT V BLOCKCHAIN APPLICATIONS 8

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to
CO1: Understand and explore the working of Blockchain technology
CO2: Analyze the working of Smart Contracts
CO3: Understand and analyze the working of Hyperledger
CO4: Apply the learning of solidity to build de-centralized apps on Ethereum
CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology,

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

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

COURSE OBJECTIVES:

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

UNIT I DEEP LEARNING CONCEPTS **6**

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

UNIT II NEURAL NETWORKS **9**

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

UNIT III CONVOLUTIONAL NEURAL NETWORK **10**

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

UNIT 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

COURSE OUTCOMES:

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

TOTAL : 45 PERIODS

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

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

OBJECTIVES

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

UNIT- I BASICS OF VIBRATION 9

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

UNIT- II BASICS OF NOISE 9

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

UNIT- III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9

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

UNIT- IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9

Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters -

Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

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

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

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

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

REFERENCES:

1. Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.
2. Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw – Hill Publishing Com. Ltd., 2007.
3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000.
4. William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.
5. G.K. Grover, “Mechanical Vibrations”, Nem Chand and Bros.,Roorkee, 2014.
6. A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.
7. David A. Bies and Colin H. Hansen, “Engineering Noise Control – Theory and Practice”, Spon Press, London and New York, 2009.

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

COURSE OBJECTIVES:

- 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: 45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment
3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001
4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors
6. (Could be downloaded from www.energymanagertraining.com)
7. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
8. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
9. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

OME433 ADDITIVE MANUFACTURING L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.

UNIT III VAT POLYMERIZATION 9

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

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION 9

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

POWDER BASED PROCESS

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

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES 9

Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics.Business Opportunities and Future Directions - Intellectual Property.

TOTAL: 45 PERIODS

REFERENCES:

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

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

UNIT I NEED FOR ELECTRIC VEHICLES 9

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

UNIT II ELECTRIC VEHICLE ARCHITECHTURE 9

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

UNIT III ENERGY STORAGE 9

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

UNIT IV ELECTRIC DRIVES AND CONTROL 9

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

UNIT V DESIGN OF ELECTRIC VEHICLES 9

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

TOTAL: 45 PERIODS

REFERENCES:

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

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

COURSE OBJECTIVES:

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

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identfying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product

design and development.

4. Generating, selecting, and testing the concepts for new product design and development.
5. Appling the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCTDESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of Product Development – The Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations.

UNIT II OPPORTUNITY DENTIFICATION & PRODUCT PLANNING 9

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

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

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

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

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

UNITV INDUSTRIAL DESIGN & PROTOTYPING 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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

TEXT BOOK:

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

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.
2. Rosenthal S.,“Effective Product Design and Development”, Business One Orwin,Homewood, 1992,ISBN1-55623-603-4.

OBA431 SUSTAINABLE MANAGEMENT LT P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I MANAGEMENT OF SUSTAINABILITY 9

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

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

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

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

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

UNIT IV SUSTAINABILITY AND INNOVATION 9

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

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

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

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

COURSE OBJECTIVES

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

UNIT I INTRODUCTION TO SMALL BUSINESS 9

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

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

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

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

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

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

UNIT IV FINANCING SMALL BUSINESS 9

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

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

REFERENCES

1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.

2. Parker,R.(2000). “Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia.” Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME’s.

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

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

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

UNIT II PROCESS 9

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

UNIT III STATUTES 9

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

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9

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

UNIT V MODELS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

REFERENCES

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

OBA434 ETHICAL MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVE

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

UNIT I ETHICS AND SOCIETY 9

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

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS 9

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

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9

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

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9

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

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

REFERENCES

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

ET4251 **IoT FOR SMART SYSTEMS** **LT P C**
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

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

UNIT II IOT ARCHITECTURE 9

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

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9

PROTOCOLS:

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

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

UNIT IV IOT PROCESSORS 9

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

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

UNIT V CASE STUDIES 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Analyze the concepts of IoT and its present developments.
CO2: Compare and contrast different platforms and infrastructures available for IoT
CO3: Explain different protocols and communication technologies used in IoT
CO4: Analyze the big data analytic and programming of IoT
CO5: Implement IoT solutions for smart applications

REFERENCES:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John

Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain," Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series in Communication, 2013.
9. Vijay Madisetti , ArshdeepBahga, "Internet of Things (A Hands on-Approach)", 2014.
10. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, "Smart Grid applications, communications and security", Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, " Smart Grid Technology and Applications", Wiley, 2015.
13. UpenaDalal,"Wireless Communications & Networks,Oxford,2015.

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

COURSE OBJECTIVES:

The course is aimed at

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

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

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

UNIT II NEURAL NETWORKS 9

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

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

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

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

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

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

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

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

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

PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9

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

UNIT II SOLAR PHOTOVOLTAICS 9

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

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9

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

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9

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

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

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

TOTAL : 45 PERIODS

OUTCOMES:

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

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

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford UniversityPress, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

PS4093 SMART GRID L T P C

3 0 0 3

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.

- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

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

UNIT II SMART GRID TECHNOLOGIES 9

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

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

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

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

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

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS9

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

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to

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

REFERENCES

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

CP4391 **SECURITY PRACTICES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I SYSTEM SECURITY 9

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

UNIT II NETWORK SECURITY 9

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

UNIT III SECURITY MANAGEMENT 9

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

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

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

UNIT V PRIVACY AND STORAGE SECURITY 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0

5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012
6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

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

COURSE OBJECTIVES:

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

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

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

UNIT II CLOUD PLATFORM ARCHITECTURE 12

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

UNIT III AWS CLOUD PLATFORM - IAAS 9

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

UNIT IV PAAS CLOUD PLATFORM 9

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

UNIT V PROGRAMMING MODEL 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES

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

IF4072 DESIGN THINKING L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I UX LIFECYCLE TEMPLATE 8

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

UNIT II CONTEXTUAL INQUIRY 10

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

analysis process. History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9

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

UNIT IV UX GOALS, METRICS, AND TARGETS 8

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

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

SUGGESTED ACTIVITIES:

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES

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

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

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

UNIT II ELEMENTS OF MULTIMEDIA 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

UNIT III MULTIMEDIA TOOLS 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

UNIT IV MULTIMEDIA SYSTEMS 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

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

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

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO BIG DATA 9

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

UNIT II SEARCH METHODS AND VISUALIZATION 9

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

UNIT III MINING DATA STREAMS 9

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

UNIT IV FRAMEWORKS 9

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

UNIT V R LANGUAGE 9

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

COURSE OUTCOMES:

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

TOTAL:45 PERIODS

REFERENCE:

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

NC4201 INTERNET OF THINGS AND CLOUD L T P C

3 0 0 3

COURSE OBJECTIVES:

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

UNIT I FUNDAMENTALS OF IoT 9

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

UNIT II PROTOCOLS FOR IoT 9

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

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS 9

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

UNIT IV CLOUD COMPUTING INTRODUCTION 9

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

UNIT V IoT AND CLOUD 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES

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

MX4073 MEDICAL ROBOTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO ROBOTICS 9

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

Sensors and Actuators

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

UNIT II MANIPULATORS & BASIC KINEMATICS 9

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

Navigation and Treatment Planning

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

UNIT III SURGICAL ROBOTS 9

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

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

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

UNIT V WEARABLE ROBOTS 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

REFERENCES

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

VE4202 EMBEDDED AUTOMATION L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING 9

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

UNIT - II AVR MICROCONTROLLER 9

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

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

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

UNIT – IV VISION SYSTEM 9

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

UNIT – V HOME AUTOMATION 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES:

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