ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M.TECH BIOPHARMACEUTICAL TECHNOLOGY
REGULATIONS - 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SEMESTER SYLLABUS

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

I.	To provide students with adequate scientific information regarding basic principles of Pharmaceutics with good scientific and technical knowledge so as to comprehend, analyze, design, and create novel products and solutions for developing novel therapeutics, drugs and enzymes.
II.	To prepare students to excel and succeed in biopharmaceutical research or industry through the latest state-of-art post graduate education and to demonstrate an adaptable, flexible and effective approach towards organizational development
III.	To sensitize students about scientific temper and the necessity of bioethics, social responsibility and awareness of the environment and to demonstrate knowledge of professional and ethical responsibilities as per pharmaceutical jurisprudence. They will be able to demonstrate knowledge and skills in all disciplines of pharmaceutical sciences and develop a sound pharmaceutical care plan to manage medication-related problems
IV.	To enable the student to develop good communication and leadership skills, respect for authority, loyalty and the life-long learning needed for a successful scientific and professional career and to develop an ability to communicate scientific knowledge in non-expert/lay term by adopting various modes of scientific communications

PROGRAM OUTCOMES (POs)

PO	PROGRAMME OUTCOMES
1.	Theprogramme enablesacquiring in-depth knowledge in the field of pharmaceutical sciences, biological sciences, applied mathematics to correlate the insights in the research field to develop innovative solutions for complex pharmaceutical problems.
2.	To gain the practical knowledge of using various modern techniques and methodologiesin the pharmaceutical field which enhance the learner's skills to design and develop potential solutions for existing and upcoming needs
3.	Engaging inbasic research and conducting investigations in contemporary issues in an efficient way with intellectual integrity for thebenefit of the society.
4.	Possessing scientific, technical and ethical knowledge will allow the students to engineer application based industrial products with environmental consciousness and sustainable development.
5.	Cultivating the interest in creating a positive impact by one's own ideology and skills helps them in constant personal growth and life long learning
6.	Enabling students to take part in team work, research projects, social interactions aid them to exhibit scientific communications effectively

PEO / PO Mapping:

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

MAPPING OF M.TECH. BIOPHARMACEUTICAL TECHNOLOGY

YEAR	SEMESTER	COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Drug Regulatory, Quality and Safety Management	3	2	1	2	1	2
		Formulation of Pharmaceuticals	3	2	1	2	3	2
		Molecular Pharmacology	3	3	1	3	2	2
		Research Methodology and IPR	3	1	1	1	1	2
		Professional Elective I						
		Professional Elective II						
		Professional Elective III						
		Audit Course I*						
	SEMESTER II	Pharmacokinetics and Pharmacodynamics	3	3	1	2	1	2
		Immunopharmacology	3	1	2	3	2	3
		Conventional and Rational Drug Discovery Strategies	3	2	1	2	1	2
		Professional Elective IV						
		Professional Elective V						
		Audit course II*						
		Open Elective						
YEAR II	SEMESTER III	Modern Methods of Pharmaceutical Analysis Laboratory	1	2	2	3	2	3
		Computational methods in Pharmaceuticals Laboratory	1	2	3	2	3	2
		Drug Discovery Laboratory	1	2	3	3	3	2
		Project Work I	2	2	3	3	3	3
	SEMESTER IV	Project Work II	2	2	3	3	3	3

YEAR	SEMESTER	COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
PROFESSIONAL ELECTIVE	PROFESSIONAL ELECTIVE I	Clinical Trials and Bioethics	3	2	3	2	3	2
		Bioconjugate Technology and Applications	3	1	3	2	3	2
		Biogenerics and Biopharmaceuticals	3	1	3	2	2	3
		Techniques in Molecular Biology and Genetic Engineering	3	1	3	2	3	2
	PROFESSIONAL ELECTIVE II	Advances in Omics Sciences and Technology	3	1	2	2	3	2
		Metabolic Process and Engineering	3	3	1	2	1	2
		Chemistry of Natural Products	3	1	3	2	3	2
		Modern Methods of Pharmaceutical Analysis	2	3	2	3	2	3
		Protein Engineering and Industrial Applications	3	3	1	2	1	2
	OPEN ELECTIVES	Business Data Analytics	3	2	-	-	-	-
		Industrial safety	1	2	3	2	-	1
		Operations Research	1	2	-	3	2	3
		Cost Management of Engineering Projects	-	-	3	2	3	2
		Composite Materials	2	3	-	2	3	2
		Waste to Energy	3	3	-	2	2	2
	PROFESSIONAL ELECTIVE III	Biomaterials and Tissue Engineering	3	1	3	2	3	2
		Computational Systems Biology	3	1	2	3	2	3
		Novel Drug Delivery Systems	3	1	2	3	2	3
		Nanobiotechnology	3	1	3	2	3	2
	PROFESSIONAL ELECTIVE IV	Advances in Pharmacogenomics	3	1	2	3	2	3
		Gene Manipulation Technology	3	2	3	2	3	2
		Human physiology and Drug Metabolism	3	2	1	1	1	1
		Fermentation Technology	3	2	3	2	3	2
		Advances in Pharmacogenomics	3	1	1	3	3	2

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SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	BO4101	Drug Regulatory, Quality and Safety Management	PCC	3	0	0	3	3
2.	BO4102	Formulation of Pharmaceuticals	PCC	3	0	0	3	3
3.	BO4103	Molecular Pharmacology	PCC	3	0	0	3	3
4.	RM4151	Research Methodology and IPR	RMS	2	0	0	2	2
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Professional Elective III	PEC	3	0	0	3	3
8.		Audit Course I*	AC	2	0	0	2	0
PRACTICALS								
9.	BO4111	Formulation and Quality Control Methods for Pharmaceuticals Laboratory	PCC	0	0	4	4	2
			TOTAL	**22**	**0**	**4**	**26**	**22**

***Audit Course is Optional**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	BO4201	Pharmacokinetics and Pharmacodynamics	PCC	3	0	0	3	3
2.	BO4202	Immunopharmacology	PCC	3	0	0	3	3
3.	BO4203	Conventional and Rational Drug Discovery Strategies	PCC	3	0	0	3	3
4.		Professional Elective IV	PEC	3	0	0	3	3
5.		Professional Elective V	PEC	3	0	0	3	3
6.		Audit course II*	AC	2	0	0	2	0
7.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
8.	BO4211	Immunopharmacology Laboratory	PCC	0	0	6	6	3
9.	BO4212	Mini project with seminar	EEC	0	1	2	3	2
			TOTAL	**20**	**1**	**8**	**29**	**23**

***Audit Course is Optional**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	BO4311	Modern Methods of Pharmaceutical Analysis Laboratory	PCC	0	0	6	6	3
2.	BO4312	Computational methods in Pharmaceuticals Laboratory	PCC	0	0	6	6	3
3.	BO4313	Drug Discovery Laboratory	PCC	1	0	4	5	3
4.	BO4314	Project Work I	EEC	0	0	12	12	6
		TOTAL		**1**	**0**	**28**	**29**	**15**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BO4411	Project Work II	EEC	0	0	24	24	12
		TOTAL		**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 72

SEMESTER I, ELECTIVES I

S. NO	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BO4001	Clinical Trials and Bioethics	PEC	3	0	0	3	3
2.	BO4002	Bioconjugate Technology and Applications	PEC	3	0	0	3	3
3.	BO4003	Biogenerics and Biopharmaceuticals	PEC	3	0	0	3	3
4.	BO4004	Techniques in Molecular Biology and Genetic Engineering	PEC	3	0	0	3	3

SEMESTER I, ELECTIVES II

S. NO	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BO4005	Advances in Omics Sciences and Technology	PEC	3	0	0	3	3
2.	BY4251	Metabolic Process and Engineering	PEC	3	0	0	3	3
3.	BO4006	Chemistry of Natural Products	PEC	3	0	0	3	3
4.	BO4007	Modern Methods of Pharmaceutical Analysis	PEC	3	0	0	3	3

SEMESTER I, ELECTIVES III

S. NO	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	BO4008	Protein Engineering and Industrial Applications	PEC	3	0	0	3	3
2	BO4009	Microbial Technology	PEC	3	0	0	3	3
3	BO4010	Molecular Medicine and Mechanism	PEC	3	0	0	3	3
4	BO4011	Applied Statistics for Biologists	PEC	2	1	0	3	3

SEMESTER II, ELECTIVES IV

S. NO	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BY4071	Biomaterials and Tissue Engineering	PEC	3	0	0	3	3
2.	BO4012	Computational Systems Biology	PEC	3	0	0	3	3
3.	BO4013	Novel Drug Delivery Systems	PEC	3	0	0	3	3
4.	BO4014	Nanobiotechnology	PEC	2	1	0	3	3

SEMESTER II, ELECTIVES V

S. NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BO4015	Advances in Pharmacogenomics	PEC	3	0	0	3	3
2.	BO4016	Gene Manipulation Technology	PEC	3	0	0	3	3
3.	BO4017	Human physiology and Drug Metabolism	PEC	3	0	0	3	3
4.	BO4018	Fermentation Technology	PEC	3	0	0	3	3

PROGRAM CORE COURSES (PCC)

S. NO.	CODE NO.	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			LECTURE	TUTORIAL	PRACTICAL		
1.	BO4101	Drug Regulatory, Quality and Safety Management	3	0	0	3	1
2.	BO4102	Formulation of Pharmaceuticals	3	0	0	3	1
3.	BO4103	Molecular Pharmacology	3	0	0	3	1
4.	BO4111	Formulation and Quality Control Methods for Pharmaceuticals Laboratory	0	0	4	2	1
5.	BO4201	Pharmacokinetics and Pharmacodynamics	3	0	0	3	2
6.	BO4202	Immunopharmacology	3	0	0	3	2
7.	BO4203	Conventional and Rational Drug Discovery Strategies	3	0	0	3	2
8.	BO4211	Immunopharmacology Laboratory	0	0	6	3	2
9.	BO4311	Modern Methods of Pharmaceutical Analysis Laboratory	0	0	6	3	3
10.	BO4312	Computational Methods in Pharmaceuticals Laboratory	0	0	6	3	3
11.	BO4313	Drug Discovery Laboratory	1	0	4	3	3
					TOTAL CREDITS	**32**	

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. No.	Code No.	Course Title	Periods per week			Credits	Semester
			Lecture	Tutorial	Practical		
1	RM4151	Research Methodology and IPR	2	0	0	2	1
					Total Credits:	**2**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO.	CODE NO.	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1	BO4212	Mini project with seminar	0	1	2	2	2
2	BO4314	Project Work I	0	0	12	6	3
3	BO4411	Project Work II	0	0	24	12	4
					Total Credits:	**20**	

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

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

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

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

SUMMARY

S.NO.	Subject Area	Credits per Semester				Credits Total
		I	II	III	IV	
1	PCC	11	12	9	-	32
2	PEC	9	6	-	-	15
3	OEC	-	3	-	-	3
4	EEC	-	2	6	12	20
5	RMC	2	-	-	-	2
	Total	**22**	**23**	**15**	**12**	**72**
	Audit courses (Non Credit)	*	*			

BO4101 DRUG REGULATORY, QUALITY AND SAFETY MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

The course aims to,

- Enable the students to learn about the various agencies in drug regulatory affairs in India and at International level.
- Acquire knowledge about intellectual property rights, drug development approval processes and safety management.

UNIT I INTRODUCTION TO DRUG REGULATORY LAWS 9

Drugs and Cosmetics Act 1940 with its amendments, The Drugs (Price Control) Order 2013 with its amendments, The Environmental Protection Act-1986 with its amendments, Consumer Protection Act-2019, The Factories (amendment) Act-1987 and Pollution control Act-1989, The Indian Patents and Designs, Act 1911, The Grugs and Magic Remedies (Objectionable advertisements) Act 1954, Prevention of Food Adulteration Act 1954, Guidelines for evaluation of nanopharmaceuticals in India

UNIT II PHARMACOPOEIA 8

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

UNIT III cGMPs& REGULATORY RECORDS 10

cGMP concepts – Development, Manufacturing Record, Analytical &process Validation, Equipment & utility Qualification and Calibration, Personnel procedures; Regulatory bodies &requirements - Indian FDA, WHO GMP ; U.S. FDA, U.K. MCA, Australian TGA, Japanese PMDA.Drug dossier contents - CTD (CMC section) & data.

UNIT IV DRUG DEVELOPMENT APPROVAL PROCESS/CLINICAL TRIALS 8

Drug development stages, FDA guidelines on IND, NDA, ANDA approvals. European regulatory agency: types of filing process (Centralized, decentralized, RMS countries), Regulation of preclinical studies, Schedule-Y, pre-clinical study; Introduction to animal ethics; Animal rights and use of animals in the advancement of medical technology; Introduction to laws and regulations regarding the use of animals in research.

UNIT V PRODUCT MANAGEMENT AND QUALITY ASSURANCE 10

GLP, ISO 9000, TQM, Quality Review and Quality Documentation, Regulatory control, regulatory drug analysis, interpretation of analytical data, Basic requirements - design of product, facility,equipment selection and personnel. Industrial hazards due to fire, accident, mechanical, electricalequipment, monitoring and preventive system (Safety measures including insurance).Effluent testing, treatment and waste management. Safety and Environmental Control; ISO 14000.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1 Enable the students to learn the principles of drug regulation.

CO2 Insight about current regulatory process in the pharmaceutical industry.

CO3 Assure the learning of quality standards in pharmaceutical industry.

REFERENCES:

1. N Udupa and Krishnamurthy Bhat. A Concise Textbook of Drug Regulatory Affairs , Manipal University Press, Edition: 1, 2015.

2. Manohar A. Potdar and Ramkumar Dubey. cGMP Current Good Manufacturing Practices for Pharmaceuticals, Pharmamed Press / Bsp Books, Second Edition, 2018.
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. “Drug Safety Evaluation”, Wiley-Interscience, 3rd Edition, 2016.
6. Malik, Vijay “Laws Relating to Drugs and Cosmetics Act & Rules”. EBC Publishing Co, 2018.
7. “Quality Assurance of Pharmaceuticals: A Compendium of Guidelines and Related Materials”, Vol. I & II, World Health Organization and Pharma Syndicate, 2002.
8. Berry, Ira R. and Harpaz, Daniel “Validation of Active Pharmaceutical Ingredients”, 2ndEdition, CRC Press, 2001
9. British Pharmacopoeia, Andesite Press, 2021.
10. United States Pharmacopoeia, 2020
11. https://cdsco.gov.in/opencms/opencms/en/Home/
12. https://pharmaceuticals.gov.in/

CO – PO MAPPING

Course outcome	PO					
	1	2	3	4	5	6
CO1	3	3	1	2	2	-
CO2	2	3	-	-	1	3
CO3	3	-	2	3	-	-
Average	**2.6**	**3**	**1.5**	**2.5**	**1.5**	**3**

BO4102 FORMULATION OF PHARMACEUTICALS L T P C
3 0 0 3

COURSE OBJECTIVES:

The course aims to,

- Enable the students to acquire theoretical knowledge in pharmaceutical dosage forms
- Understand the theoretical principles with application oriented problems.

UNIT I INTRODUCTION TO DOSAGE FORMS 5

History & Evolution; Definitions and Classification of Dosage forms and routes of administration (Oral, Parenteral, Topical, Rectal and Nasal), Pharmacokinetics/Pharmacodynamics parameters for Dosage form development

UNIT II PREFORMULATION AND STABILITY STUDIES 9

Physical properties of drugs - physical form, polymorphism, particle size, shape, density, wetting, dielectric constant, solubility, dissolution, organoleptic property and their effect on formulation, stability and bioavailability. Study of chemical properties of drugs – hydrolysis, oxidation, reduction,

polymorphisms racemization, polymerization and their influence on formulation and stability of products. Stabilization and stability testing protocol for various pharmaceutical products.

UNIT III SOLID DOSAGE FORMS 9

Capsules: Materials for production of hard/Soft gelatin capsules, size of capsules and method of capsule filling. Soft gelatin Capsule Manufacturing and evaluation - Micro-encapsulation-Classification, Methods of preparation and Evaluation of microcapsules. Tablets: Classification, tablet formulation excipients, Tablet Manufacturing methods: Wet granulation, dry granulation, direct compression methods. Tabletting machinery, processing problems and evaluation. Coating- Types, materials for coating, formulation, equipment, film defects and evaluation of coated tablets.

UNIT IV LIQUID, SEMI-SOLID AND AEROSOL DOSAGE FORMS 12

Liquid Dosage forms: Additives in formulations, vehicles, stabilizers, preservatives, suspending agents, emulsifying agents, solubilizer, colors, flavors, manufacturing, packaging and evaluation of clear liquids, suspensions and emulsions official in pharmacopoeia. Semisolid Dosage Forms: Mechanisms of drug penetration, factors influencing penetration, semisolid bases and their selection. General formulation of semisolids, clear gels, formulations of semisolids Cream, Gel, Paste; Suppositories, manufacturing procedure, evaluation and packaging. Aerosols: Types of propellants, general formulation, manufacturing, packaging methods, pharmaceutical applications and evaluation.

UNIT V PARENTERALS AND DRUG DELIVERY OF LARGE MOLECULES 10

Parenteral; Liquids, (Solutions, Suspensions and Emulsions); Nasal; Ophthalmic and Optic Preparations; Packaging dosage design & delivery. Delivery systems for Peptides and Proteins – Delivery of Nucleic acids, Antibodies and siRNA.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Have learnt Pharmacokinetics/Pharmacodynamics parameters for dosage form development.
CO2 Learn formulation of various dosage forms of drugs.
CO3 Learn evaluation of various dosage forms of drugs.
CO4 Have knowledge of technological advancements to improve formulations at the completion course.

REFERENCES:

1. Ansel, H.C. “Pharmaceutical Dosage Forms and Drug Delivery Systems”, 11th Edition, LippincottWilliams &Wilkins, 2018.
2. Misra, Ambikanandan, Shahiwala, Aliasgar “Novel Drug Delivery Technologies”, 1st Edition, Springer, 2019
3. Lieberman, H.A. “Pharmaceutical Dosage Forms: Tablets”. Vol.1-3, 2nd Edition, Marcel Dekker, 2005.
4. Lieberman, H.A. “Pharmaceutical Dosage Forms: Parenteral Medications”, Vol.1-3, 2nd Edition, Marcel Dekker, 2005.
5. Lieberman, H.A. “Pharmaceutical Dosage Forms: Disperse Systems”, Vol.1-3, 2nd Edition,Marcel Dekker, 2005.
6. Vyas S.P, Khar K.R. “ Targeted & Controlled Drug Delivery -Novel Carrier Systems”, 1st Edition, CBS Publishers, 2012.
7. Surendra Nimesh, Ramesh Chandra, Nidhi Gupta.”Nanotechnology for the Delivery of Therapeutic Nucleic Acids”. 1ST Edition, Woodhead Publishing, 2017.
8. Manfred Ogris, David Oupicky. “Nanotechnology for Nucleic Acid Delivery”.1st Edition Humana Press, 2013.

CO – PO MAPPING

	FORMULATION OF PHARMACEUTICALS					
Course outcome	PO					
	1	2	3	4	5	6
CO1	3	3	-	1	3	-
CO2	3	3	3	3	3	-
CO3	2	3	3	-	-	-
CO4	2	3	3	3	1	-
Average	**2.5**	**3**	**3**	**2.3**	**2.3**	

BO4103 MOLECULAR PHARMACOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

The course aims to,

- Study the mechanism of action of drugs at molecular level and different molecular targets.
- Provide advanced knowledge about pharmacology of drugs and toxicology.

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:

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

CO1 Developresearch skills based on the knowledge gained about molecular basis of drug action.

CO2 Providean insight about bioactive molecules, receptors and different classes of drugs in pharmacology.

CO3 Acquire knowledge on performing toxicity studies with appropriate guidelines.

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.

CO – PO MAPPING

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

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, PCT, 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. Intellectual property: patents, trademarks, copyrights, trade secrets. By Catherine J. Holland. Entrepreneur Press, 2007
3. Patent searching: tools & techniques. By David Hunt, et al. Wiley, 2007.
4. Professional Programme Intellectual Property Rights, Law and practice, The Institute of Company Secretaries of India, Statutory body under an Act of parliament, September 2013

BO4111 FORMULATION AND QUALITY CONTROL METHODS FOR PHARMACEUTICALS LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

The course aims to

- Provide hands on experience on different forms of drug formulation
- Learn the quality control methods available for evaluation of pharmaceuticals.

PART I: FORMULATION EXPERIMENTS

1. Preparation of Nano Emulsions.
2. Preparation of Lyophilised powder
3. Preparation of solid dosage forms (Eg. Granules, Tablets, Capsules)
4. Preparation of liquid dosage forms (Eg. True Solutions, mixtures, Elixirs)
5. Preparation of biphasic dosage forms (Eg. Emulsion, Suspension)
6. Preparation of semisolid dosage forms (Eg. Ointments, Creams, Gels, lotions
7. Preparation of Parenteral and ophthalmic formulations
8. Preparation of specialized dosage forms (Eg. Suppositories, Patches)

PART II: QUALITY CONTROL METHODS FOR PHARMACEUTICALS

1. Disintegration test, weight variation.
2. Particulate matter, Transmittance of light, Viscosity, Extractables and leachable, Freeze-Thaw test.
3. pH, Dissolution, Sedimentation volume, Rheological method, Zeta potential measurement,
4. Particle size distribution, In-vitro release testing,
5. Leakage test, Pyrogen test, Sterility, Particulate matter, Preservative efficacy test.
6. Sprays & Inhalations – Valve discharge rate, Spray pattern & Plume geometry, Dosage with metered valves, Foam stability.
7. Net content and Weight loss, pH, Osmolality.
8. Stability testing for all dosage forms.

EQUIPMENTS REQUIRED

1. Mortar and Pestle
2. Sieves of all sizes
3. Granulator
4. Punching machine
5. Capsule filler
6. Disintegration, dissolution and friability testing apparatus
7. Formulation reagents (surface acting agents, glidants, diluents etc,)
8. pH meter, physical balances

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 Develop of different dosage forms of drugs.

CO2 Learn the evaluation of various dosage forms of drugs.

CO3 Get knowledge of developing new formulation.

CO4 Find out the stability of the dosage forms

CO5 Have hands on experience in dosage form formulation and pursue a career in industry.

REFERENCES:

1. Ansel, H.C. “Pharmaceutical Dosage Forms and Drug Delivery Systems”, 11th Edition, Lippincott Williams & Wilkins, 2018.
2. Lieberman, H.A. “Pharmaceutical Dosage Forms: Tablets”. Vol.1-3, 2nd Edition, Marcel Dekker, 2005.

3. Lieberman, H.A. “Pharmaceutical Dosage Forms: Parenteral Medications”, Vol.1-3, 2nd Edition, Marcel Dekker, 2005.
4. Lieberman, H.A. “Pharmaceutical Dosage Forms: Disperse Systems”, Vol.1-3, 2nd Edition,Marcel Dekker, 2005.
5. Lachman, Leon “The Theory And Practice of Industrial Pharmacy”, 4th Edition, Varghese Publishing House, 2013.
6. USP NF, guidelines: http://www.usp.org, https://www.uspnf.com, & http://www.fda.gov.

CO – PO MAPPING

Course outcome	FORMULATION AND QUALITY CONTROL METHODS FOR PHARMACEUTICALS LABORATORY					
	PO					
	1	2	3	4	5	6
CO1	3	3	3	3	2	-
CO2	3	3	2	-	-	-
CO3	3	3	3	3	3	-
CO4	3	3	-	2	-	-
CO5	3	3	3	3	3	3
Average	**3**	**3**	**2.7**	**2.7**	**2.6**	**3**

BO4201 PHARMACOKINETICS AND PHARMACODYNAMICS L T P C
3 0 0 3

OBJECTIVES

This subject will enable the students

- to understand the essential principles of pharmacokinetics and pharmacodynamics required for the development of formulations.
- To understand the basic concepts in biopharmaceutics andpharmacokinetics.
- To derive the pharmacokinetic models and parameters to describe the process of drug absorption, distribution, metabolism andelimination.
- To critically evaluate biopharmaceutic studies involving drug productequivalency.
- To understand the factors affecting bioavailability of drugs.

UNIT I FUNDAMENTALS ON DRUG ABSORPTION AND DISTRIBUTION 9

Definitions, various routes of administration with advantages/disadvantages, bioavailability concepts in drug absorption and distribution, theories of drug dissolution, drug partition hypothesis,permeability and distribution of drugs, perfusion rate and volume of distribution, protein binding of drugs, kinetics of drug binding, various factors that affect drug absorption and distribution, drug interactions in the level of drug absorption and distribution.

UNIT II FUNDAMENTALS ON DRUG METABOLISM AND EXCRETION 9

Biotransformation of drugs, pathways and enzymes of drug metabolism, Phase I and Phase II, drugs excretion –renal and non-renal routes, various factors that affect drug metabolism and excretion, prodrugs, drug interactions in the level of drug metabolism and excretion, bioavailability concepts in drug metabolism and excretion.

UNIT III PHARMACOKINETIC INVESTIGATION AND EVALUATION 9

Concept of therapeutic concentration, time-profile, rates and various order of reactions (first, zero, mixed), Michaelis-Menton kinetics, differential equations for a simple pharmacokinetic models, compartment models (one, two, multi, open models), definition and calculation of parameters such as drug half-life, of Drugs, Volume of Distribution, and bioavailability(AUC) and their application to compartment models and kinetics of IV Bolus administration, comparison between bioavailability and bioequivalence.

UNIT IV PHARMACODYNAMIC FUNDAMENTALS 10

Definitions – agonist/antagonist, antagonism as a mechanism of drug action, classification of antagonists, drug-receptor interactions, factors affecting drug-target interactions, law of mass action applied to drugs, quantifying drug-target interactions: dose-response relationships - graded dose and quantal dose-responses; molecular mechanisms mediating drug action, receptor coupling and transduction mechanisms, intracellular transduction mechanisms, second messenger systems, amplification of drug responses, factors modifying drug responses.

UNIT V APPLICATION OF PK/PD PRINCIPLES IN DOSAGE FORM DEVELOPMENT 8

Regimens for dosage form design, concentration response relationships, individualization therapeutics, controlled release formulations and novel drug delivery (oral, parenteral, transdermal, ophthalmic and intrauterine) systems, bioavailability testing of novel release formulations.

TOTAL : 45 PERIODS

COURSE OUTCOME

CO1. Explain the various factors influencing the drug disposition, various pharmacokinetic parameters
CO2. Design and interpret the bioavailability and bioequivalence of dosage forms.
CO3. Identify the factors affecting the rate of drug absorption.
CO4. Know about clinical pharmacokinetics
CO5. Recognize the application of pharmacokinetics
CO6. Be familiar with applications of Biopharmaceutics.

REFERENCES

1. Brahmankar, D.M., “Biopharmaceutical and Pharmacokinetics: A Treatise”, VallabhPrakashan, 1995.
2. Notari, R.E., “Biopharmaceutics and Clinical Pharmacokinetics: An Introduction”, 4thedition, MarcellDeckker, 2005
3. Oliver Kayser, Rainer H. Müller, “Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications”, Wiley-VCH Publication,Jan 2004
4. Schoenwald, R.D., “Pharmacokinetics In Drug Discovery And Development”, CRC Press, 2002.

CO – PO MAPPING

Course Outcome	APPLIED BIOPHARMACEUTICS AND PHARMACOKINETICS					
	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	2	-	-
CO 2	3	3	3	2	1	-
CO 3	3	3	3	2	-	-
CO 4	3	-	-	3	-	3
CO 5	3	2	-	2	2	-
CO 6	3	2	-	2	2	-
Average	**3**	**2.5**	**3**	**2.2**	**1.6**	**3**

BO4202 IMMUNOPHARMACOLOGY L T P C
3 0 0 3

OBJECTIVES

The course aims to,

- Enhance the knowledge pertaining to the function and diseases of the human immune system.
- Learn the strategies of development, classification and application of immunotherapeutic drugs, vaccines and biologicals.
- Explain the mechanism of drug actions at cellular and molecularlevel
- Discuss the Pathophysiology and pharmacotherapy of certaindiseases
- Understand the adverse effects, contraindications and clinical uses of drugs used in treatment ofdiseases

UNIT I BASICS OF PHARMACOLOGY AND IMMUNOLOGY 10

Principles of basic and clinical pharmacokinetics and pharmacodynamics of immune drugs; Overview of discovery and development of immuno-drugsand various therapeutic pathways and targets of immune system, immune cell and organ classification, Innate and adaptive immunity, Immunity to virus, bacteria and fungi; neuro humoral regulation of immune responses, complement pathways, cytokine classification and activation, T-cell and B-cell development, bioassay and animal models for immune drug validation.

UNIT II VACCINOLOGY AND IMMUNODIAGNOSTICS 10

T and B epitopes classification, adjuvant and hapten classification, immuno-screening of antigens, vaccine formulation technology, vaccine production and validation, recombinant vaccines, peptide vaccines, therapeutic vaccines. Concept of reverse vaccinology, Monoclonal antibody production and applications, antibody engineering, scFv Antibodies, immunoconjugates, immunotoxins. Immunodiagnostics– ELISA types, Flow cytometry principle, instrumentation and diagnostic applications, principle/development of Rapid immuno diagnostic tests.

UNIT III IMMUNOTHERAPEUTICS AND CANCER IMMUNOTHERAPY 8

(WHO) Anatomical Therapeutic Chemical (ATC) Classification and pharmacology of drugs affecting the immune system (L, L01, L02, L03, L04), therapeutic use of cytokines, therapeutic Mabs classification and formulation. Cancer vaccines, CAR T-cell therapy, immune check-point inhibitors.

UNIT IV TRANSPLANTATION 8

Laws of transplantation, host vs graft and graft versus host reactions; Role of T cell in allograft rejection, HLA Classification, HLA typing and transplantation, general immunosuppressive therapy – Corticosteroids, mitotic inhibitors, fungal metabolites, lymphoid irradiation; Specific immunosuppressive therapy– Mabs, Co stimulatory signal blockers and adjuvant therapies.

UNIT V IMMUNOLOGY OF ALLERGY 9

Classification of hypersensitivity reactions, Classification of allergens, Drug Hypersensitivity – pharmacologic perspective, immunologic perspective, Off-target toxicity, Cellular Basis, Chemical Basis – The Hapten/pro hapten hypothesis, The Danger theory, The pi concept, therapy and prevention of allergies;. Pharmacology of antihistamines, mast cell stabilizers, anti-inflammatory agents and anti-rheumatoid drugs

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 gain knowledge on the diseases impacted in the domain of humoral/cellular immune responses.

CO2 apply their knowledge on the pharmacology of drugs affecting the immune system

CO3 develop research skills related to developing and evaluating immunotherapeutics for emerging diseases.

REFERENCES

1. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby. “Kuby Immunology”. 6th Edition, W.H. Freeman, 2007.
2. Kenneth Murphy, Casey weaver. “Janeway’s Immunobiology”, 9th Edition, Garland Science, Taylor & Francis Group, 2017.
3. David Male Jonathan Brostoff David Roth Ivan Roitt “Immunology”, 8th Edition, Elsevier, 2012.
4. Laurence Brunton, Bjorn Knollmann, RandaHilal-Dandan, “Goodman and Gilman’s: The Pharmacological basis of therapeutics”, McGraw-Hill Education / Medical, 13th edition, 2017.
5. Karen Whalen, “Lippincott Illustrated Reviews: Pharmacology”, Lippincott Williams and Wilkins, 7th Edition, 2019 Katzung, B.G., “Basic and Clinical Pharmacology”, 14th Edition, McGraw Hill 2017.

CO – PO MAPPING

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

BO4203 CONVENTIONAL AND RATIONAL DRUG DISCOVERY STRATEGIES L T P C
3 0 0 3

OBJECTIVES

The course aims to,

- Expose the students to various principles and methodologies involved in the drug discovery and validation process.
- Provide an insight about in-silico based drug discovery techniques.
- Explain the various stages of drugdiscovery.
- Appreciate the importance of the role of genomics, proteomics and bioinformatics in drugdiscovery
- Explain various targets for drugdiscovery.
- Explain various lead seeking method and leadoptimization
- Appreciate the importance of the role ofcomputeraided drug design in drugdiscovery

UNIT I DRUG DESIGN STRATEGIES 9

Various approaches in drug discovery process– conventional versus rational, drug targets, lead identification; Principles of ligand chemistry– lead optimization, pharmacophores, bioisosteres, principles of ligand chemistry such as configuration, conformation, chirality, isosteric replacement; Parameters of ligand design such as–Phytochemical, geometric, conformational, topological, partitional, steric, stereochemical and electronic properties of drug molecules; Pharmacokinetic parameters of ligand design such as- Lipinski "rule of 5", partition coefficient, Hammet constant, Hansch analysis. Biological, chemical and physical descriptors used in QSAR and QSPR. Statistical methods used for analysing QSAR/ QSPR data

UNIT II IN-SILICO METHODS FOR DRUG DISCOVERY 9

Introduction to molecular docking, Principles of macromolecule-ligand docking, docking algorithms, AUTODOCK; de novopharmacophore elucidation/ drug design for structurally well-defined receptor targets from casestudies (Eg. HIV protease inhibition, ACE inhibition); Molecular dynamic simulations, relative energy, energy minimization methods, ligand binding free energy calculations (both simulation and empirical methods), intermolecular interactions, forces related to drug binding, force-field calculations including solution, role of solubility in drug binding and pKa, PoissonBoltzmann Surface Area (PBSA), AMBER,GROMOS and GROMACS.

UNIT III COMBINATORIAL CHEMISTRY FOR DRUG DISCOVERY 9

Combinatorial Chemistry in drug development, Biopolymers as natural libraries, Selection and evolution of expression genetic libraries, Combinatorial assembly of antibody genes, Molecular solutions to Combinatorial problems, Solid-Phase peptide synthesis, Peptide on pins, Other iterative deconvolution strategies, Examples of Split/Couple/Mix Peptide Libraries, Positional Scanning., Polystyrenes, Grafted supports, Coupling strategies, linkers, Supported Solution and Phase Synthesis, analytical methods for solid-phase.

UNIT IV HIGH THROUGHPUT SCREENING IN DRUG DISCOVERY 9

Classification of HTS: Protein based biochemical screens, methods of analytical biochemistry used in HTS (photometry, purification, electrophoresis, kinetic assay, radioisotopes, immunoassay, HTS FACS based assays). Assay design for HTS and statistical treatment of the results for decision. Introduction to state of the art technologies used in HTS (including automated liquid handling machines (robots), Microfluidic Tools for HTS, Miniaturization); preclinical toxicological studies, Correlation between in-vitro and in-vivo screens.

UNIT V GENETIC BASED TOOLS IN DRUG DISCOVERY PROCESS 9

Basics of gene silencing, transgenic worms in drug screening; designing SiRNAs, Types ofRNAi Screens– Loss of Function screens (LOF), Synthetic Lethal screen, Mini-clonogenic RNAi screen;

optimizing, and implementing high-throughput siRNA genomic screening for the discovery of survival genes and novel drug targets, siRNA HTS Screening for identification of targeted pathways in biological systems. Microarray technologies- Classification with microarrays and class prediction, Visualization and functional analysis. Bio molecular pathways, gene ontology, genome browsing, Gene expression biology, microarray platforms (Eg.Affymetrix); Preprocessing of microarray data for Image analysis, quality control and array normalization.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 learn about different conventional and rational drug discovery strategies.

CO2 know about molecular modelling in drug development.

CO3 understand the Gene based tools and high throughput screening methods.

REFERENCES

1. Williams, D.A. and Lemke, T.L., "Foye's Principles for Medicinal Chemistry" 5th Edition, Lippincott, Williams & Wilkins, 2002.
2. Leach, AR, "Molecular Modeling& Drug Design", 2nd Edition, John Willy, 2000.
3. GROMOS and GROMACS Manuals.
4. Murray, K.J. "Principles and Practice of High Throughput Screening". Blackwell Scientific Publishers, 2004.
5. Ye, S., and Day, I.N.M. "Microarrays and Microplates: Applications in Biomedical Sciences". BIOS 2003.
6. "Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry".12th Edition, Lippincott-Raven Publisher, 2010.
7. Fassina, G. "Combinatorial Chemistry and Technologies: Methods and Applications", 2nd Edition, CRC Press, 2005
8. Janzen W. P. "High Throughput Screening: Methods and protocols". Humana Press. 2002

CO – PO MAPPING

Course outcome	CONVENTIONAL AND RATIONAL DRUG DISCOVERY STRATEGIES					
	PO					
	1	2	3	4	5	6
CO1	3	2	1	2	2	-
CO2	3	2	2	-	-	-
CO3	3	3	2	2	2	-
Average	**3**	**2.3**	**1.6**	**2**	**2**	

BO4211 IMMUNOPHARMACOLOGY LABORATORY **L T P C**
0 0 6 3

OBJECTIVES

The course aims to,

- provide hands-on-experience on handling animal for research and various relevantimmunological techniques like ELISA, Flow cytometry etc.

- provide practical experience on performing and understanding immunoassays forevaluating drugs and vaccines.
- To provide practical exposure in the clinical diagnosis.
- To provide laboratory training for different immunotechnological techniques.
- To give hands on training in cell staining, separation and identification.

LIST OF EXPERIMENTS

1. Selection and Handling of animals used in immunopharmacological assays (Eg. Mice, Rat, Rabbit, Zebra fish, Caenorhabditis elegans etc.,).
2. Preparation of antigens and immunization procedures for raising anti-sera.
3. Demonstration of various methods of bleeding, serum separation and storage. 4. Antibody titre by ELISA method (Indirect ELISA).
5. Sandwich ELISA – Quantification of antigens.
6. Immunoprecipitation/Immunoelectrophoresis. 7. Isolation and purification of IgG from serum (Ammonium sulphate method/Protein A).
8. Studies for characterisation of antigens - SDS -PAGE, Immunoblotting, Dot blot assays.
9. Assay for immunostimulants (Erythropoietin assay etc.,).
10. Direct Agglutination-Widal test, Salmonella detection.
11. Separation of mononuclear cells by Ficoll-Hypaque.
12. Separation and culturing of splenocytes and demonstration of T cell proliferation.
13. PBMC proliferation/cell viability by mitogen/antigen byMTT or Thymidine uptake assay. 14. Flow Cytometry- Identification of lymphocytes and their subsets.
15. Evaluation of monoclonal antibodies for diagnostic and therapeutic applications.
16. Demonstration of Immunodiagnostics using commercial kits (Rapid Flow through and Lateral flow devices– Dot Blot and StripTest).

TOTAL : 90 PERIODS

COURSE OUTCOMES

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

CO1 learn the principles of immunoassays employed in academic research.

CO2 learn how to perform the immunopharmacological assays used in the evaluation of vaccines and immunotherapeutics.

CO3 learn how to handle methods of planning and performing immunological techniques required in industries.

REFERENCES

1. “Antibodies”, Cold Spring Harbour Laboratory, 1988.
2. Goldsby, R.A. et al.“Kuby Immunology”. 6 thEdition, W.H. Freeman, 2002.
3. Turgeon, Mary Louise. “Immunology and Serology in Laboratory Medicine”, 2ndEdition, 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”, 4thEdition John Wiley & Sons, 1994.
6. Paul, “Fundamental of Immunology”, 4thEdition, Lippincott Raven, 1999.

CO – PO MAPPING

Course outcome	IMMUNOPHARMACOLOGYLABORATORY					
	PO					
	1	2	3	4	5	6
CO1	3	3	3	2	2	-
CO2	3	3	3	2	2	-
CO3	3	3	3	3	3	1
Average	**2.5**	**2.7**	**3**	**2.7**	**3**	**3.5**

BO4212 **MINI PROJECT WITH SEMINAR** **L T P C**
0 1 2 2

OBJECTIVES

The course aims to

- encourage the students to get connected with relevant industries/laboratory/research institutes.
- acquire knowledge on solving practical problems, gaining work experience and skills.
- learn the basics of research methodologies in academic/industrial/research environment.
- To train students in reputed companies/research institutes/ organizationsfor the specified duration.

TOTAL : 45 PERIODS

COURSE OUTCOMES

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

CO1 learn methods and procedures from industrial/academic/research institute

CO2 gain experience to work as an member in industrial or research team for

CO3 acquire practical knowledge and enhance skills

CO – PO MAPPING

Course outcome	MINI PROJECT WITH SEMINAR					
	PO					
	1	2	3	4	5	6
CO1	3	3	3	3	-	3
CO2	3	3	3	3	3	3
CO3	3	3	3	2	2	-
Average	**3**	**3**	**3**	**2.6**	**2.5**	**3**

BO4311 MODERN METHODS OF PHARMACEUTICAL ANALYSIS LABORATORY L T P C
0 0 6 3

OBJECTIVE:

- To carry out analytical experiments related to spectroscopic and chromatographic techniques.
- The analysis of various drugs in single and combination dosageforms.
- Theoretical and practical skills of theinstruments.
- Method development and validation for the analysis of drugs in pharmaceutical formulations.

LIST OF EXPERIMENTS

1. Calibration of volumetric glasswares.
2. Establishing standard operating procedure (SOP) and Calibration records for analytical balance, pH meter and UV/Vis spectroscopy.
3. Determination of λmax.
4. Effect of change in physio-chemical parameters on absorbance spectrum of a drug molecule.

5. Quantitative and qualitative analysis of drug molecule using standard comparison method by UV/Vis spectroscopy and HPLC.
6. Quantitative analysis of drug molecule using E1%1cm method by UV/Vis spectroscopy.
7. Quantitative analysis of drug molecule using calibration graph method by UV/Vis spectroscopy and HPLC.
8. Separation and identification of mixtures of drugs by TLC.
9. Separation and identification of amino acids by paper chromatography.
10. Identification of functional group of a drug molecule by IR spectroscopy.
11. Determination of impurities by limit test.
12. Quantitative analysis by titrimetric methods.

TOTAL: 90 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Digital weighing balance
2. Digital pH meter
3. UV chamber
4. TLC chamber
5. UV/Vis spectroscopy
6. HPLC
7. IR spectroscopy

OUTCOMES:

Student will be able to perform,

1. * Preparation and standardization of various assay reagents with respect to chemical and drug analysis.
2. * Separation and quantification of drugs molecules by chromatographic and spectral techniques.

REFERENCES:

1. Atherden L.M, “Bentley and Driver’s Textbook of Pharmaceutical Chemistry”, 8th Edition, Oxford University Press, 2004.
2. Siddiqui, Anees A, “Pharmaceutical Analysis”. Vol.I& II, 3rd edition, CBS Publishers, 2014.
3. Takeru Higuchi, Einar Brochmann, Hanffen Hanssen, Hamffen Hanssen, “Pharmaceutical Analysis” 1st Edition, CBS Publishers, 2005.
4. Loyd V. Allen Jr, “Remington: The Science and Practice of Pharmacy”. Vol. I & II, 22nd Edition, Pharmaceutical Press;, 2012.
5. Kenneth A. Connors, “Text book of Pharmaceutical Analysis”, 3rd Edition, John wiley and sons, New York,2007

CO – PO MAPPING

Course outcome	MODERN METHODS OF PHARMACEUTICALANALYSIS LABORATORY					
	PO					
	1	2	3	4	5	6
CO1	3	3	2	2	-	-
CO2	3	3	2	2	-	-
Average	**3**	**3**	**2**	**2**		

BO4312 COMPUTATIONAL METHODS IN PHARMACEUTICS LABORATORY LT P C
0 0 6 3

OBJECTIVES

The course aims to,

- introduce pharma 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
- understand Computational Modelling of DrugDisposition
- acquire knowledge on Computers in PreclinicalDevelopment

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 Pharmacophore identification.
9. Drug like property evaluation of compounds and ADME (Lipinski's rule of five).
10. Methodology of building and refining protein drug targets structure models from X-ray crystallographic data using CCP4i.
11. Molecular docking : Protein – Protein, Protein-Small Molecule.
12. Molecular Dynamics Simulation using GROMACS. 13. 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,

CO1 retrieve data related to small molecules, drugs and their targets, use computational tools for their analysis.

CO2 perform basic next generation sequencing data analysis.

CO3 perform computational structural studies like QSAR, Molecular docking, Molecular Dynamics simulations and interpret the results.

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 EijaKorpelainen, JarnoTuimala, PanuSomervuo, Mikael Huss and Garry Wong. CRC Press 2014
7. Next Generation Sequencing Data Analysis, by Xinkun Wang CRC Press.2016.

CO – PO MAPPING

Course outcome	COMPUTATIONAL METHODS IN PHARMACEUTICS LABORATORY					
	PO					
	1	2	3	4	5	6
CO1	3	3	3	1	-	-
CO2	3	3	3	2	3	-
CO3	3	3	3	3	1	-
Average	**3**	**3**	**3**	**2**	**2**	

BO4313 **DRUG DISCOVERY LABORATORY** **L T P C**
1 0 4 3

OBJECTIVES

To enable the students to enhance their hands-on experience in learning techniques towards discovery of new drugs and utilize this knowledge for industrial needs on.

- Different stages of drug discovery.
- Role of medicinal chemistry in drug research.
- Different techniques for drug discovery.
- Various strategies to design and develop new drug like molecules for biological targets.

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.
3. Determination of QSAR parameters for drugs (partition co-efficient, dissociation constant, molar refractivity, etc.)

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. Fractionation : Solvent-solvent
4. Evaluation of fractionation efficiency by TLC fingerprinting.
5. Column chromatography and flash column chromatography.
6. Extraction and determination of alkaloids (caffeine acid from tea leaves).
7. To evaluate the antioxidant potential of herbal extracts using DPPH freeRadicalscavenging assay.
8. To evaluate the cytotoxic effect of herbal extracts using MTT assay.
9. To evaluate the nitric oxide (NO) modulatory effect of herbal extracts usingGriessmethod.
10. Biotransformation study

TOTAL : 75 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.

OUTCOME

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 drugdiscovery.
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.

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; 10th Edition (August 1998) ISBN: 0397515839.1998

CO – PO MAPPING

Course outcomes	DRUG DISCOVERY LABORATORY					
	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	3	3	2	3
CO 2	3	3	3	2	2	3
CO 3	3	3	3	2	2	-
CO 4	3	3	3	3	2	3
CO 5	3	3	3	3	2	3
CO 6	3	3	3	3	2	-
Average	**3**	**3**	**3**	**2.6**	**2**	**3**

B04314 **PROJECT WORK I** **L T P C**
0 0 12 6

OBJECTIVES

The course aims to enable the students to

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

TOTAL : 180 PERIODS

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

OUTCOMES:

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

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

CO – PO MAPPING

Course outcome	PROJECT WORK I					
	PO					
	1	2	3	4	5	6
CO1	2	-	3	3	3	3
CO2	3	-	3	2	3	1
CO3	3	3	3	3	3	-
CO4	-	-	-	-	-	3
Average	2.6	3	3	2.6	3	2.3

BO4411 PROJECT WORK II L T P C
0 0 24 12

OBJECTIVES

The course aims to

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

TOTAL :360 PERIODS

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

COURSE OUTCOMES

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

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

CO - PO MAPPING

Course outcomes	PROJECT WORK II					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	-
CO2	3	3	3	3	-	2
CO3	3	3	3	3	-	3
AVERAGE	3	3	3	3	3	2.5

BO4001 CLINICAL TRIALS AND BIOETHICS L T P C
3 0 0 3

OBJECTIVES

- To introduce the fundamentals of clinical trial design and conduction
- Provide the learning of regulations and ethical practice in clinical research.

UNIT I INTRODUCTION TO CLINICAL TRIALS 8

Fundamentals of Clinical Trials – Introduction to terminology – Clinical Trial Phases – Need of trials – Problems in the Timing of a Trial – Study Protocol – Basic statistics for clinical trials – Clinical trials in practice – Reporting and reviewing clinical trials.

UNIT II REGULATIONS OF CLINICAL TRIALS 9

Good clinical practice – Principles of ICH-GCP – Responsibilities – Functions – Operations of IRB/IEC – Investigator – Sponsor – Trial protocol and amendment(s) – Investigator Brochure; Legislation and good clinical practice – Overview of the European directives and legislation governing clinical trials in the 21st century – International perspectives of clinical trials.

UNIT III STUDY DESIGN AND POPULATION 12

Design - Randomized Control Trials – Nonrandomized Concurrent Control Studies – Historical Controls and Databases –Cross-Over Designs – Withdrawal Studies – Factorial Design – Group Allocation Designs – Hybrid Designs – Large, Simple and Pragmatic Clinical Trials - Studies of Equivalency and Noninferiority – Adaptive Designs; **Randomization –** Fixed Allocation Randomization – Adaptive Randomization Procedures – Mechanics of Randomization; **Blinding –** Types of Blinding – Protecting the Double-Blind Design – Debriefing of Participants; **Recruitment –** Considerations Before Participant Enrollment – Conduct – Monitoring; **Population** – Potential for Benefit – Likelihood of Benefit – Avoiding Adverse Effects – Competing Risk – Avoiding Poor Adherers – Pharmacogenetics – Recruitment of Study Participants.

UNIT IV ETHICAL ISSUES 8

Planning and Design – Ethics Training – Randomization Control Group – Protection from Conflicts of Interest – Informed Consent – Conduct – Trials in Low and Middle Income Countries – Recruitment – Safety and Efficacy Monitoring – Early Termination for other than Scientific and Safety Reasons – Privacy and Confidentiality – Data Falsification.

UNIT V QUALITY CONTROL AND ASSURANCE & DATA ANALYSIS 8

Quality control and assurance procedures – Performance monitoring – Training procedures – Assurances and certifications – Site visiting procedures – Audit procedures; Analysis datasets – Frequentist vs Bayesian analysis – Final analysis – Subgroup analysis; Pharma covigilance;

Research governance; Trial closure and pitfalls-trial closure; Reporting and legal requirements; Common pitfalls in clinical trial management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Acquire the fundamentals of clinical trials and the way of preparation of study protocol.
- Know the implementation of guidelines and responsibilities of various stakeholders of clinical trials.
- Learn the way of design of study and recruitment procedures of study participants.
- Know the ethical practices of acquirement of informed consent and trial conduction.
- Learn to assess the quality of clinical trials through monitoring and auditing procedure.

REFERENCES:

1. Lawrence M.Friedman et. al, “Fundamentals of Clinical Trials”, Mosby,1996
2. Curtis L Meinert et. al, “Clinical Trials - Design Conduct and Analysis”, Oxford University, 2012.
3. ICH - Harmonised Tripartite Guideline – Guideline for Good Clinical Practice E6 (R1) - Current Step 4 version - dated 10 June 1996.
4. Lee, Chi-Jen et. al, “Clinical Trials or Drugs and Biopharmaceuticals.” CRC/Taylor & Francis, 2011.
5. Matoren, Gary M. “The Clinical Research Process In The Pharmaceutical Industry. “Marcel Dekker, 1984.

CO – PO MAPPING

Course outcome	CLINICAL TRIALS AND BIOETHICS					
	PO					
	1	2	3	4	5	6
CO1	3	3	3	3	-	-
CO2	3	3	3	3	2	3
CO3	3	3	3	3	3	3
CO4	3	-	3	3	-	3
CO5	3	3	3	3	-	3
Average	**3**	**3**	**3**	**3**	**2.5**	**3**

BO4002 BIOCONJUGATE TECHNOLOGY AND APPLICATIONS L T P C
3 0 0 3

COURSE OBJECTIVES:

The course aims to,

- Provide advanced theoretical knowledge on Bioconjugate technologies.
- Learn about the biological and clinical applications of bioconjugate technology

UNIT I MODIFICATION OF 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 ACTIVE GROUPS 9

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

UNIT III BIOCONJUGATE REAGENTS 9

Zero length cross linkers – Homo bifunctional crosslinkers – Hetero bifunctional cross linkers – 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 – biotinylated enzymes– chemical modification of nucleic acids – biotin labeling of DNA- enzyme conjugation toDNA – Fluorescent of DNA.

UNIT V BIOCONJUGATE APPLICATIONS 9

Preparation of Hapten-carrier Immunogen conjugates - antibody modification and conjugation – 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,

CO1 Understand target bio-molecules target and their active groups for conjugation.

CO2Get knowledge about different types of bio-conjugate reagents.

CO3 Have exposured to conjugation of enzymes, antibody and nucleic acid and the application of the conjugated products.

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.

CO – PO MAPPING

Course outcome	BIOCONJUGATE TECHNOLOGY AND APPLICATIONS					
	PO					
	1	2	3	4	5	6
CO1	3	-	3	-	-	-
CO2	3	-	3	-	-	-
CO3	3	-	3	-	-	-
Average	3	-	3	-	-	-

BO4003 BIOGENERICS AND BIOPHARMACEUTICALS L T P C
3 0 0 3

COURSE OBJECTIVES:

The course aims to,

- 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

CO1. Acquire knowledge about biogenerics, biosimilars, their nomenclature and regulations.
CO2. Update the patent and market scenario of follow-on proteins.
CO3. learn about the characterization of biosimilars.
CO4. Attain the knowledge of immunogenicity of biopharmaceuticals
CO5. Have exposure on case studies dealing with immunogenicity of biopharmaceuticals
CO6. Apply the knowledge of biopharmaceuticals regulations, characterization and it Immunogenicity properties

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 TransformingProteins and Genes into Drugs”, 2nd edition, 2013

CO - PO mapping

Course outcomes	BIOGENERICS AND BIOPHARMACEUTICALS					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	-
CO2	-	-	-	2	3	3
CO3	3	3	2	-	-	-
CO4	3	3	2	3	3	-
CO5	3	3	3	3	3	3
CO6	3	3	3	3	3	-
Average	**3**	**3**	**2.6**	**2.8**	**2.8**	**3**

BO4004 TECHNIQUES IN MOLECULAR BIOLOGY AND GENETIC ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

The course aims to

- Enlightenkey molecular biology and genetic engineering techniques
- Applythe latest techniques in current biological research as well as in biotechnology 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 8

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 10

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:

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

CO1. detail the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.

CO2. apply concept of genetic engineering techniques in basic and applied experimental biology.

CO3. possess proficiency in designing and conducting experiments involving genetic manipulation.

CO4. demonstrate the skills on gene manipulation, gene expression, etc which prepares them for further studies in the area of genetic engineering.

CO5. *Illustrate* technical know-how on versatile techniques in recombinant DNA technology.

CO6. describe the genome editing and sequencing and methods for gene therapy.

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-Reyero Natàlia. “Gene expression analysis: Methods and protocols” 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, CSHL press, 2012.

CO – PO MAPPING

Course Outcome	TECHNIQUES IN MOLECULAR BIOLOGY AND GENETIC ENGINEERING					
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	3	-	-	-	-	-
CO2	3	3	3	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	-	-	3
CO5	3	3	3	-	-	3
CO6	3	3	3	-	-	3
Average	**3**	**3**	**3**			**3**

BO4005 ADVANCES IN OMICS SCIENCES AND TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

Thecourse aims to,

- Provideadvancedtheoreticalknowledgeontheorganizationandfunctionof genome
- Understandtheprinciplesoffunctionalgenomicanalyses
- Haveknowledge onthe advancedmethodsand approachesinproteomics.

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,

CO1. Understand the designing and application of microarrays in genomics.

CO2. Have knowledge in next generation sequencing technologies and their use in diagnosis and personalized therapy.

CO3. Have exposure to protein analysis using high end technology

CO4. Acquire the knowledge of 2D gel Electrophoresis of proteins

CO5. Understand the concepts of mass spectrometry in protein analysis

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, John Wiley & Sons Ltd.

CO - PO mapping

Course outcomes	ADVANCES IN OMICS SCIENCES AND TECHNOLOGY					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	1	-
CO2	3	3	3	3	1	-
CO3	3	3	3	3	1	-
CO4	3	3	3	-	1	-
CO5	3	3	3	-	1	-
Average	**3**	**3**	**3**	**3**	**1**	

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

OBJECTIVES:

- To familiarize the students with aquantitativebasis, for the analysis of cellular metabolism
- To understand the metabolic networks insinglecellsandattheorganlevel
- Toenablethestudentstouseorganismstoproducevaluablesubstancesonanindustrialscaleincosteffectivemanner
- To know how to optimize strategy for directed genetic changes in microbes for better strain production

UNIT I CELLULAR METABOLISM 9

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

UNIT II REGULATION, MANIPULATION AND SYNTHESIS OF METABOLIC PATHWAY 9

Regulation of enzyme activity – Regulation of enzyme concentration – Regulation of metabolic networks – Regulation at the whole cell level – Metabolic pathway manipulations – Enhancementof 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:

Aftercompletionofmetabolicengineering,studentswillbeable

CO1. Tolearnstoichiometryandenergeticsofmetabolism.

CO2. Toapply practical applications ofmetabolic engineeringin chemical, energy, medical andenvironmentalfields.

CO3. have a clear understanding on metabolic controlanalysis

CO4. gain experience in the development of genome scale metabolicmodelling

CO5. To integratemodernbiologywithengineeringprocesstomeetdesiredneeds

REFERENCES

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

CO – PO MAPPING

Course outcome	METABOLIC PROCESS AND ENGINEERING					
	PO					
	1	2	3	4	5	6
CO1	3	-	-	-	-	-
CO2	3	3	3	3	-	-
CO3	3	-	-	-	-	-
CO4	3	3	3	-	-	-
CO 5	3	3	3	3	3	-
Average	3	3	3	3	3	

BO4006 CHEMISTRY OF NATURAL PRODUCTS L T P C
3 0 0 3

COURSE OBJECTIVES:

The course aims to,

- Enhancetheoreticalknowledgeofstudentsinthechemistryofnaturalproducts
- Explorethisknowledgeforpracticalapplications.

UNIT I CARBOHYDRATES AND RELATED COMPOUNDS 7

Sugars and sugar containing drugs, polysaccharides and polysaccharide containing drugs, cellulose gums and mucilages, pectin.

UNIT II GLYCOSIDES AND TANNINS 9

Biosynthesis of glycosides, Phenol and alcohol glycosides, anthraquinone glycosides, cyanophore glycosides, saponin glycosides, cardiac glycosides, isothiocyanate flavonol lactone glycosides, tannins, volatile oils, resins and resin combinations.

UNIT III ALKALOIDS AND PURINES 10

Pyridine and piperidine alkaloids, Tropane alkaloids, Quinoline Alkaloids, isoquinoline alkaloids, Indole alkaloids, Imidazole alkaloids, Steroidal alkaloids, Alkaloidal amines and purine bases. Chemistry and structural elucidation of uric acid, interrelation between caffeine, theophylline and theobromine.

UNIT IV VITAMINS, TERPENOIDS AND FLAVONOIDS 10

Chemistry, medicinal and pharmaceutical uses of vitamin A, D, E, K, B_1, B_2, B_6, B_{12} and Folic Acid. Chemistry and structural elucidation of Terpenes, camphor, menthol, carotenes. Classification and application of flavonoids (hespiridine, rutin, quercetin).

UNIT V MOLECULES FROM NATURAL SOURCES 9

Classification of Drug molecules of Plant/marine/microbial and animal sources - cytotoxic / antineoplastic agents, cardiovascular drugs - antimicrobial substances – anti-inflammatory and anti-spasmodic agents.

TOTAL :45 PERIODS

COURSEOUTCOMES:

Attheendofthecoursethestudentwill beable to,

CO1: Comprehend the medicinally important carbohydrates and related compounds from natural origin

CO2: Explain the biosynthetic pathways and chemistry of important secondary metabolites including glycosides and alkaloids.

CO3: Obtain knowledge on vitamins, terpenoids and flavonoids and some harmaceutically important molecules from natural sources.

REFERENCES:

1. Evans, W.C., 'Trease and Evans Pharmacognosy', 16th Edition, Saunders, 2009.
2. Wallis, T.E. "Textbook of Pharmacognosy", 5th Edition, CBS Publishers, 2005.
3. Kokate, C.K. "Pharmacognosy", 29th Edition, Nirali Prakashan, 2004.
4. O.P. Agarwal, Chemistry of Natural Products (Vol.-1 & 2), 41st edition, Goel publishing House, 2014.
5. Varro E. Tyler, Lynn R. Brady, James E. Robbers, Pharmacognosy, 9th edition, Published by Lea & Febiger, 2011.
6. Gurdeep Chatwal, Organic Chemistry of Natural Products (Vol. 1 & 2), Himalaya Publishing House, 2015.

7. I.L.Finar, “Organic chemistry” Volume 2, 5th edition, Published by Pearson India, 2012.

CO – PO MAPPING

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

BO4007 MODERN METHODS OF PHARMACEUTICAL ANALYSIS L T P C
3 0 0 3

COURSE OBJECTIVE:

- Toenablestudentstoacquireknowledgeinvariousadvancedanalyticaltechniquesusedinthescreening ofpharmaceuticalagents.

UNIT I UV-VISIBLE SPECTROSCOPY 9

Brief introduction of spectroscopy, EMR and principle of absorptions by molecule. The absorption law – Beer’s and Lambert’s law, limitations and Chromophores and their interaction with EMR, Theory of electronic transition theory, choice of solvent and solvent effects, modern instrumentation – design and working principle. Applications of UV-Visible spectroscopy (various qualitative and quantitative methods), Woodward – Fischer rules for calculating absorption maximum.

UNIT II IR SPECTROSCOPY AND THERMAL METHODS OF ANALYSIS 9

Infrared radiation, theory of IR absorption by a molecule, vibrational frequency and factors influencing vibrational frequency, rotational degrees of freedoms, transmission/absorption modes, types of bands, instrumentation and sampling techniques, interpretation of spectra, applications in pharmaceuticals. FT-IR-theory and applications, Attenuated Total Reflectance (ATR).Instrumentation and applications of thermal methods - Thermo Gravimetric Analysis (TGA),Differential Scanning Calorimetry (DSC), Differential Thermal Analysis (DTA) and Thermo Mechanical Analysis (TMA).

UNIT III NUCLEAR MAGNETIC RESONANCE PECTROSCOPY 9

Basic theory of NMR/PMR, excitation/emission process and instrumentation. solvents, reference compound, scale of measurement, shielding/deshielding; chemical shift, and factors affecting chemical shift, spin-spin coupling, coupling constant, and factors influencing the value of coupling constant, spin-spin decoupling and shift reagents, proton exchange reactions, FT- NMR, 2D -NMR, NMDR, NOE, NOESY, COSY and applications in pharmaceuticals, spectral interpretations, ^{13}C NMR, Natural abundance and applications.

UNIT IV MASS SPECTROMETRY 9

Basic principles, instrumentation and ionization methods; precursor ion/product ion production and

fragmentation pattern; atmospheric pressure ionization (API), Chemical ionization (CI), Field Ionization (FI), Fast Atom Bombardment (FAB), Matrix assisted laser desorption ionization(MALDI), Time of Flight (TOF), hybridization with other techniques, and interpretation of mass spectrum and applications in pharmaceuticals.

UNIT IV CHROMATOGRAPHIC METHODS 9

Classification of chromatographic methods on mechanism of separation: High Performance Liquid Chromatography : Principle, instrumentation, solvents, packing materials and applications in pharmaceuticals; Gas Chromatography: principle, theory, column operations, instrumentation, derivatisation methods and applications in pharmaceuticals; HPTLC and Super Critical Fluid Chromatography (SFC): Theory, instrumentation, elution techniques and pharmaceutical applications; Principles, classifications, instrumentation, moving boundary electrophoresis, Zone Electrophoresis (ZE), Iso-electric focusing (IEF) and applications.

TOTAL: 45 PERIODS

COURSE OUTCOME:

CO1. Understand the fundamental principles and applications of UV-visible, IR, flame emission, atomic absorption, NMR and Mass spectroscopy

CO2. Demonstrate the principles and applications of chromatographic and electrophoretic separation techniques

CO3. Recognize the importance of modern instruments in the pharmaceutical analysis

CO4. Apply the theoretical knowledge of instruments for new analytical method development in screening of various pharmaceutical agents.

CO5. Develop ability to involve in chemical and biological standardization of pharmaceutical products.

CO6. Assess appropriate techniques for the analysis of various pharmaceuticals and biotechnological products

REFERENCES

1. "Chromatographic Analysis of Pharmaceuticals", John A. damovics,2nd edition, 1996.
2. "HPTLC – Quantitative Analysis of Pharmaceutical Formulations"– P. D. Sethi,1990.
3. "Identification of Drugs and Pharmaceutical Formulations by Thin LayerChromatography"– P. D. Sethi, Dilip Charegaonkar, 2nd Edition, 2014.
4. "Instrumental Methods of Analysis"– Hobert H. Willard, 7th Edition, 1992.
5. "Instrumental Methods of Chemical Analysis"– B. K. Sharma - 9th Edition,2000.
6. "Liquid Chromatography – Mass Spectrometry", W.M.A.Niessen, J. Van Der Greef, Vol.58,2006.
7. "Organic Chemistry" by I.L.Finar Vol. II – 5thedition, 1956
8. "Organic Spectroscopy"– William Kemp, 3rd Edition, 1991.
9. "Pharmaceutical Analysis – Modern Methods"– Part A, Part B, James W.Munson–2001.
10. "Practical Pharmaceutical Chemistry", Part II, A. H. Beckett &J. B. Stenlake, 4th Edition,2015.
11. "Principles of Instrumental Analysis" by Donglas A. Skoog, James, J. Leary, 4th Edition,1992.
12. "Spectrometric Identification of Organic Compounds", Robert. M. Silverstein Et Al, 8th edition, 2014.
13. "Spectroscopy of Organic Compounds" by P. S. Kalsi, 2007.
14. "Techniques and Practice of Chromatography"– Raymond P. W. Scott, Vol. 70,2003.
15. "Vogel's Text Book of Quantitative Chemical Analysis", 6th Edition, 2004.

CO – PO MAPPING

Course outcomes	MODERN METHODS OF PHARMACEUTICAL ANALYSIS					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	-	-	-
CO2	3	3	-	-	-	3
CO3	3	3	-	-	-	-
CO4	3	2	3	3	-	-
CO5	3	3	3	3	-	-
CO6	3	3	3	3	-	-
Average	**3**	**2.8**	**3**	**3**		**3**

BO4008 PROTEIN ENGINEERING AND INDUSTRIAL APPLICATIONS LT P C
3 0 0 3

COURSE OBJECTIVE:

- 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
- To provide advanced knowledge of proteins and their structure function relationship, essential for future pharmaceutical technology.

UNIT I INTRODUCTION 6

Amino acids, primary structure of proteins, amino acid composition, industrial significance, primary structure determination by chemical methods including automated sequencing and by gene sequencing, significance of primary structure determination, peptide synthesis, secondary structure and super secondary structures

UNIT II PROTEIN ARCHITECTURE 6

Tertiary structure of proteins, types of proteins, domains, quaternary structure, protein complexes, protein-protein interactions

UNIT III STRUCTURE-FUNCTION RELATIONSHIP 15

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eucaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers Membrane proteins: General characteristics, Transmembrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center Immunoglobulins: IgG Light chain and heavy chain architecture, Abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate assisted catalysis other commercial applications.

UNIT IV PROTEIN ENGINEERING METHODS 9

Protein engineering methods, amino acid side chain reactions, chemical modification of proteins, site-directed mutagenesis, posttranslational modifications and engineering.

UNIT V INDUSTRIAL APPLICATIONS OF PROTEIN ENGINEERING 9

Examples of industrial protein engineering applications Engineering of serine proteases, engineering of antibodies, engineering of proteins for thermal stability, engineering of proteins for preventing aggregation, His-tagged proteins in purification, engineering proteins for secretion, de novo protein synthesis.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, students will learn to:

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

REFERENCES:

1. Alberghina, L. “Protein Engineering in Industrial Biotechnology”. Harwood Academic Publications, 2000.
2. Branden C. and Tooze J., “Introduction to Protein Structure”, 2nd Edition, Garland Publishing,1999.
3. Creighton, T.E. “Proteins: Structure and Molecular Properties”, 2nd Edition, W.H.Freeman, 1993
4. Holland, I Barry et al., “ABC Proteins: From Bacteria to Man”. Academic Press Elsevier, 2003.
5. Moody P.C.E. and Wilkinson A.J. “Protein Engineering”. IRL Press, Oxford, 1990.
6. Rees, A.R., Sternberg, M.J.E. and Wetzel, R. “Protein Engineering: A Practical Approach”. IRL Press, 1992
7. Voet, D. and Voet, G., “Biochemistry”. 4th Edition, John Wiley and Sons, 2001.
8. Whitford, David “Proteins: Structure and Function”. John Wiley & Sons, 2005.

CO – PO MAPPING

Course outcomes	PROTEIN ENGINEERING AND INDUSTRIAL APPLICATIONS					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	-	-	-
CO2	3	3	-	-	-	3
CO3	3	3	-	-	-	3
CO4	3	3	3	3	-	-
CO5	3	-	-	-	-	-
CO6	3	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**

BO4009 MICROBIAL TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVE:

- To provide fundamental knowledge of pharmaceutical microbiology and microorganisms associated with the manufacture of pharmaceuticals
- To study the importance of Microorganisms in Industry
- To study the Structure and function of cell and cell communication

- To gain knowledge on Cell culture technology and its applications in pharmaceutical industries.
- To gain knowledge on Microbial pathogenesis and correlating it to rational use of antimicrobial agents.

UNIT I BIOLOGY OF MICROORGANISMS 9

Introduction – Microscopy - Structure and form of the bacterial cell – size, shape and structure of the cell wall and cytoplasmic membrane - Appendages to the bacterial cell - Capsules and slime - Bacterial spore - process of spore formation – Germination of spores – Toxins produced by bacteria – Yeasts and moulds - Introduction – Structure- Cell wall - Properties of selected fungi - Saccharomyces cerevisiae, Neurospora crassa, Penicillium, Aspergillus, Epidermophyton, Microsporum and Trichophyton

UNIT II INFECTIOUS DISEASES 9

Introduction - Spread of infection - Common source infections – Principles of microbial pathogenicity and epidemiology - Properties of selected pathogens – Staphylococcus, Streptococcus, Neisseria, Clostridium, Listeria, Pseudomonas, Vibrio, Yersinia, Haemophilus, Escherichia, Salmonella, Shigella, Proteus, Helicobacter- Chlamydia, Rickettsia, Mycobacterium – Spirochetes – Borrelia, Treponema and Leptospira, Candida and Cryptococcus

UNIT III ANTIBIOTICS AND OTHER ANTIMICROBIAL AGENTS 9

Antibiotics – definition, sources and types of antibiotics – penicillins, cephalosporins – Lincomycins, Tetracyclines, Rifamycins and Macrolides – Structure- activity relationships – Pharmacokinetic properties – Antifungals - synthetic antimicrobial agents – Mechanism of action – Bacterial resistance to antibiotics – Antivirals – Methisazone, nucleoside analogues – interferons – Clinical uses of antimicrobial agents

UNIT IV MICROBIAL ASPECTS OF PHARMACEUTICAL PROCESSING 9

Ecology of microorganisms as it affects the pharmaceutical industry - Microbial spoilage and preservation of pharmaceutical products - Contamination of non-sterile pharmaceuticals in hospitals and community Environments - Principles and practice of sterilization - Sterilization control and sterility assurance - Sterile pharmaceutical products - Factory and hospital hygiene and good manufacturing practice.

UNIT V BIOCATALYST TECHNOLOGY 9

Advantages and disadvantages of biocatalysis over chemical catalysis; Different types of biocatalysis: Microbial, enzymatic and immobilized system of biocatalysis; Current industrial biocatalysis; Biocatalysis with different enzymes: Lipase, amidase/ aminopeptidase, Acylase, Hydantoinase, lyases, Oxidoreductase, Nitrilase, Epoxide hydrolase, Hydroxylase, Aldolases, Decarboxylase;

TOTAL : 45 PERIODS

COURSE OUTCOME:

The students would have learnt various aspects of pharmaceutical microbiology include:

CO1. the research and development of anti-infective agents

CO2. the use of microorganisms to detect mutagenic and carcinogenic activity in prospective drugs,

CO3. the use of microorganisms in the manufacture of pharmaceutical products.

REFERENCES:

1. Ching T. Hou. Handbook of Industrial Biocatalysis. CRC Press, 2019.
2. Frank Austen, K., Burakoff, S.J., Fred Rosen, Terry B. Strom, Therapeutic Immunology, Blackwell Science, Boston, 3rd Edition, 2006.
3. Hugo, W.B. and Russell, A.D. Pharmaceutical Microbiology – 8th Edition – Wiley-Blackwell, 2011

4. Mims C.A. The Pathogenesis of Infectious Disease, 6th Edition - London: Academic Press, 2015.
5. Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, Kuby Immunology, W.H., Freeman & Co, San Francisco, 6th Rev. Edition, 2006.

CO-PO MAPPING

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

BO4010 MOLECULAR MEDICINE AND MECHANISM L T P C
3 0 0 3

COURSE OBJECTIVES:

The course aims to,

- Understand the molecular mechanism of the disease and advanced understanding of drug interactions.
- Learn the molecular organisation of different organ systems and its functions.
- Discuss the pathophysiology and pharmacotherapy of certain diseases
- Explain the mechanism of drug actions at cellular and molecular level
- Understand the adverse effects, contraindications and clinical uses of drugs used in treatment of diseases
- Explain the mechanism of drug actions at cellular and molecular level

UNIT I INTRODUCTION TO MOLECULAR MEDICINE 9

Organization of the Human Genome, Chromosomes and Genes – Recombinant DNA and Genetic Techniques – Transcriptional Control of Gene Expression – transmission of Human Genetic Disease –Human Genome Project – Cell Cycle Oncogenes and Tumor suppressor Genes – Molecular Diagnostic Testing – Genetic Counseling – Transgenic Mice as Models of Disease, Introduction to gene therapy.

UNIT II CARDIOLOGY 9

Molecular Cardiology Congenital Heart Disease – Inherited Cardiomyopathies – Coronary Atherosclerosis – Endothelium – Derived Nitric Oxide and Control of Vascular Tone – Hypertension – Cardiac Arrhythmias – Cardiovascular Gene Therapy.

UNIT III PULMONOLOGY 9

Asthma – Cystic Fibrosis – Pulmonary Emphysema – Surfactant Deficiency – Lung Cancer: The Role of Tumor Suppressor Genes – Strategies for controlling the diseases.

UNIT IV ENDOCRINOLOGY 9

Mechanisms of Hormone Action – Diabetes Mellitus – Pituitary Function and Neoplasia Hormone Deficiency- Disorders –Thyroid Disorders – Disorders of the parathyroid Gland – Congenital Adrenal

Hyperplasia– Adrenal Disease – Multiple Endocrine Neoplasia Type, Mechanisms of Hypoglycemia Associated with increased Insulin Production.

UNIT V NEPHROLOGY 9

Renal Development – Mechanisms of Leukocyte Extravasation – Ischemic Acute Renal Failure – Potassium Secretory Channels in the Kidney – Alport Syndrome – Nephrogenic Diabetes Insipidus – Polycystic Kidney Disease – Renal Neoplasms: Wilms' Tumor and Renal-Cell Carcinoma.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1. explain the organizational requirements for the translation of biomedical therapeutics from bench to bedside.

CO2. debate the impact translational research has had on human health and disease.

CO3. explain why pharmaceutical companies select particular drug or therapeutic targets for further study.

CO4. articulate the significance and potential of molecular medical advances in biomedical research.

CO5. apply the knowledge to decipher the mechanisms of molecular and cell biology.

CO6. synthesize the ideas for the improvement in the current technology.

REFERENCES:

1. Jameson, J. L., Francis, S.C., "Principles of Molecular Medicine", Human Press, 1998.
2. Ross, D.W. "Introduction to Molecular Medicine", 3 rd Edition, Springer, 2002.
3. Ross, D.W. "Introduction to Oncogenes and Molecular Medicine", Springer, 1998.
4. Pasternak, J.J. "An Introduction to Human Molecular Genetics", 2 ndEdition, Wiley Liss, 2005.
5. Strachan, Tom and Andrew P. Read. "Human Molecular Genetics, Bios, 1996.

CO-PO MAPPING

Course outcomes	MOLECULAR MEDICINE AND MECHANISM					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	**3**	**3**
CO2	3	3	3	-	**-**	**3**
CO3	3	-	3	2	**2**	**2**
CO4	3	3	3	3	**3**	**-**
CO5	3	3	3	3	**3**	**3**
CO6	3	3	3	3	**3**	**3**
Average	3	3	3	2.8	**2.8**	**2.8**

BO4011 APPLIED STATISTICS FOR BIOLOGISTS L T P C
2 1 0 3

COURSE OBJECTIVES:

This course will help the students to

- Study the mathematical aspects of probability, determination of probability and moments.
- Study the distributions of discrete and continuous random variables and their properties.
- Obtain the covariance and correlation between jointly distributed random variables, interpretsimple linear regression and fitting of curves by least square method.
- Study concepts and methods of sampling and various statistical tests in testing hypothesis on data.

- Analyze one-way, two-way and three-way classifications of analysis of variance and problems using them.

UNIT I PROBABILITY 9

Random variable-sample spaces-Events-Axiomatic approach to probability-conditional probability-additional theorem, Multiplication theorem -Bayes theorem problems-continuous and discrete random variables, Distribution function-Expectation with properties-Moments, mean, Variance problems-for continuous and discrete distributions.

UNIT II DISTRIBUTION 9

Bivariate distribution-conditional and marginal distribution-Discrete distribution-Binomial, Poisson, geometric distribution-Continuous distribution, Normal, exponential and negative exponential, gamma distributions-simple problems-properties.

UNIT III METHODS OF CORRELATION 9

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

UNIT IV SAMPLING 9

Concept of sampling-Methods of sampling-sampling distributions and Standard Error-Small samples and large samples-Test of hypothesis-Type I, Type II Errors-Critical region-Large sample tests for proportion, mean-Exact test based on normal, t, f and chi-square distribution-problems- Test of goodness of fit.

UNIT V DESIGN OF EXPERIMENT 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand basic probability and distribution in statistics.
CO2 Learn correlation and regression with sampling in biological experiments.
CO3 Design experiments and justify the statistical significance of the results of the experiment in testing hypothesis.
CO4 Understand and apply statistical methods of analysis in biological research.

REFERENCES:

1. Kapoor, V. K. “Elements of Mathematical statistics”3rd edition,2002. .
2. Vittal, P.R. and V.Malini.”Statistical and Numerical Methods”. Margham Publications. 2012.
3. Veerarajan,T. “Probability, Statistics and Random Processes”.3rd Edition., Tata McGraw- Hill, 2008.
4. Johnson, R. A.”Miller& Freund’s Probability and Statistics for Engineers”. 6 ed. PHI, 2003.
5. Arora, P. N. SmeetArora, and Arora, S. “Comprehensive Statistical Methods”. S. Chand & Co,1997.
6. Spiegel, Murray R., J.Schiller and R. AluSrinivasan. ”Schaum’sOutlines Probability and Statistics”, 2nd Edition. Tata McGraw-Hill 2000.
7. Kandasamy, P. K. Thilagavathi& K. Gunavathi.”Probability Statistics and Queuing Theory”. S. Chand & Co., 2004. 61 61 Course Articulation Matrix Course Outcome Statements rogramme Outcome (PO) 1 2 3 4 5

Course outcomes	APPLIED STATISTICS FOR BIOLOGISTS					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	-	-	-
CO2	3	3	3	-	-	3
CO3	3	3	3			
CO4	3	3	3	-	-	-
Average	3	3	3			3

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

COURSE OBJECTIVES:

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

UNIT I FUNDAMENTAL OF TISSUE ENGINEERING 9

Cell cycle – Stem cells – Types, factors influencing stem cells – Mechanical properties of cells and tissues, cell adhesion – Extracellular matrix – Glycans, laminin, fibronectin, collagen, elastin, extracellular matrix functions – Signalling – Mechanics and receptors – Ligand diffusion and binding, trafficking and signal transduction – *In vitro* cell proliferation.

UNIT II BIOMATERIALS FOR TISSUE ENGINEERING 9

Introduction to Biomaterials - classification- significance.in tissue engineering based therapies, Modifications of Biomaterials, Measurement of protein adsorption – Direct and indirect methods, fibrinogen adsorption – Displaceable and non-displaceable – Changes in protein conformation upon adsorption – Vroman effect principle to maximize the amount of fibrinogen adsorption – Devices for tissue engineering transplant cells.

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

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

UNIT IV BIOMATERIALS AND CONTROLLED DRUG DELIVERY 9

Biomaterials: Properties of biomaterials ,Surface, bulk, mechanical and biological properties .Natural and synthetic biodegradable Polymers – Engineered tissues – Skin regeneration – Nerve regeneration – Liver, cartilage, bone – Biodegradable polymers in drug delivery –Polymeric drug delivery systems – Applications of biodegradable polymers, Recent advancements of Nanotechnology based biomaterials in targeted and controlled drug delivery .

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

Natural polymers – Structural and chemical properties, scaffold processing, mechanical properties and biodegradability – Biocompatibility and host response – Application of scaffolds in tissue engineering. Use of stem cells in tissue engineering – Embryonic stem cells, mesenchymal stem cells (MSC), adult stem cells, markers for detection of stem cells – Risks with the use of stem cells. Applications of macro, micro and nano sized commercially available biomaterials for stem cell therapy.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course the students will be able to

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

REFERENCES

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

CO – PO MAPPING

Course outcome	BIOMATERIALS AND TISSUE ENGINEERING					
	PO					
	1	2	3	4	5	6
CO1	3	-	-	-	-	-
CO2	3	-	-	-	-	-
CO3	3	-	-	-	-	3
CO4	3	-	-	1	-	-
CO5	3	-	-	-	-	-
Average	3			1		3

BO4012 COMPUTATIONAL SYSTEMS BIOLOGY LT P C

3 0 0 3

OBJECTIVES

The course aims to,

•Introduce Systems Biology concepts, Graph theory, network models and properties.
•Familiarize with data resources and tools, kinetic modelling and flux balance analysis.
•Understand network motifs, SBML and genome scale modelling.

UNIT I INTRODUCTION TO NETWORKS 9

Introduction to Systems Biology, Systems level understanding of biological systems. Basic concepts in Systems modeling, Networks and graph theory: Basic properties of Network: Degree, average degree and degree distribution. Adjacency matrix, weighted and unweighted networks, Bipartite network, Paths and distances, Random Networks: Erdos-Renyi model, Small-world effect, clustering coefficient, Scale-free networks: Power laws, Hubs, ultra-small property, degree exponent, The Barabasi-Albert Model. Degree correlations: assortativity and disassortativity.

UNIT II KINETIC MODELING 9

Kinetic modelling of biochemical reactions, describing dynamics with ODEs, rate equations, deriving a rate equation, incorporating regulation of enzyme activity by effectors, E-cell platform and erythrocyte modeling

UNIT III FLUX BALANCE ANALYSIS 9

Introduction to Flux balance analysis, Construction of stoichiometric matrices, Constraint based models. Network basics, examples of mathematical reconstruction of transcriptional networks and signal transduction networks.

UNIT IV NETWORK MOTIFS AND MODELS 9

Network motifs, Feed forward loop network motif. Gene circuits, robustness of models, Chemotaxis model, Integration of data from multiple sources: Building genome scale models.

UNIT V RESOURCES AND SBML 9

Tools and databases for modeling: Pathway databases KEGG, EMP, Metacyc, Enzyme kinetics database BRENDA, Gene expression databases, Biomodels database, Basics of Systems Biology Markup Language (SBML), SBML editors.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Understand Systems Biology concepts, network models and properties from biological networks' perspective

CO2 Understand the design of kinetic models, flux balance analysis and interpret results

CO3 Get acquainted with the steps involved in genome scale modeling

REFERENCES

1. Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald,"Systems Biology a Textbook", Wiley-CH, 2nd Edition,2016
2. Uri Alon, "An introduction to Systems Biology: Design Principles of Biological Circuits", Chapman and Hall /CRC,2006
3. EddaKlipp, Ralf Herwig, Axelkowald, Christoph Wierling, Hans Lehrach,"Systems Biology in Practice: concepts, implementation and application",Wiley-VCH,2005
4. Hiroaki Kitano, "Foundations of Systems Biology", MIT Press,2001
5. Lilia Albhergina, Hans V Westerhoff "Systems Biology: Definitions and perspectives", Springer Publications, 2008

CO – PO MAPPING

Course outcome	COMPUTATIONAL SYSTEMS BIOLOGY					
	PO					
	1	2	3	4	5	6
CO1	3	-	-	-	-	-
CO2	3	-	-	-	-	-
CO3	3	3	-	-	-	-
Average	3	3				

BO4013 NOVEL DRUG DELIVERY SYSTEMS LT P C
3 0 0 3

OBJECTIVES:

To enable the students to

- Understand the properties of polymer and its significance in drug delivery systems.
- Interpret physicochemical properties of the drug with the drug delivery system
- modules.
- Apply the concepts of newer method of drug delivery systems involved in the pharmaceutical sciences and relevance of their drug delivery strategies.
- To gain knowledge on targeted drug delivery systems

UNIT I POLYMERS 9

Polymers used in controlled drug delivery modules – Classification – Advantages and disadvantages of polymers – Polymer Characterisation - Various classes of controlled release systems.

UNIT II SUSTAINED RELEASE FORMULATIONS 9

Introduction, concept, advantages and disadvantages. Physicochemical and biological properties of drugs relevant to sustained release formulations.

UNIT III TRANSDERMAL DRUG DELIVERY SYSTEMS 9

Permeation through skin – factors affecting permeation – basic components of TDDS – permeation enhancers – formulation approaches used in development of TDDS and their evaluation.

UNIT IV TARGETED DRUG DELIVERY SYSTEMS 9

Concepts – Advantages and disadvantages – Nanoparticles – Liposomes – Microspheres – Magnetic microspheres.

UNIT V DRUG DELIVERY LARGE MOLECULES 9

Delivery system for Peptides and Proteins – Delivery of nucleic acids – Antibodies and siRNA.

TOTAL : 45 PERIODS

OUTCOMES:

The student will be able to

CO1. Understands the properties, importance and influence of polymers in novel drug delivery systems.

CO2. Gains the importance of various physicochemical and biological properties of the drug with the drug delivery systems.

CO3. Discuss the concepts of transdermal drug delivery systems.

CO4. Relate the importance of various targeted drug delivery systems.

CO5. Illustrate the concepts of large molecules based delivery systems.

CO6. Apply the knowledge in developing various drug delivery modules

REFERENCES:

1. Vyas S.P., Khar R.K, “Targeted & Controlled Drug Delivery: Novel Carrier Systems”, CBSPD, 2006.
2. Junginger H.E “Drug Targeting and Delivery- concepts in dosage form design” EllisHarwood series in Pharmaceutical Technology
3. Vasant Ranade , mannfred A Hollinger “Drug delivery systems” II ed , CRC Press.
4. Grietje Molema and Dirk K F Meijer “Drug Targetting organ-specific strategies” WILEYVCH , 2001
5. Anya M Hillery et al “ Drug Delivery and Targeting”, CRC Press, 2010.

CO – PO MAPPING

Course outcome	NOVEL DRUG DELIVERY SYSTEMS					
	PO					
	1	2	3	4	5	6
CO1	3	-	-	-	-	-
CO2	3	-	-	-	-	-
CO3	3	-	-	-	-	3
CO4	3	3	3	3	-	3
CO5	3	3	3	3	-	3
CO6	3	3	3	3	3	-
Average	**3**	**3**	**3**	**3**	**3**	**3**

BO4014 NANOBIOTECHNOLOGY L T P C
2 1 0 3

OBJECTIVES

The course aims to,

- provide fundamental concepts of nanotechnology.
- use the fundamental knowledge for the application of nanotechnology to biologicalsciences including nanomedicine.
- To gain knowledge on the characterization of nanomaterials.
- To understand the principle and protocol for nano characterization equipments.

UNIT I NANOSCALE AND NANOBIOTECHNOLOGY 9

Introduction to Nanoscience and Nanotechnology; Milestones in Nanotechnology; Overview of Nanobiotechnology and Nanoscale processes; Physicochemical properties of materials in Nanoscales.

UNIT II FABRICATION AND CHARACTERIZATION OF NANOMATERIALS 9

Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Buckyballs, Nanotubes); Gas, liquid, and solid –phase synthesis of nanomaterials ;Lithography techniques (Photolithography, Dip-pen and Electron beam lithography); Thin film deposition; Electrospinning. Bio-synthesis of nanomaterials.

UNIT III PROPERTIES AND MEASUREMENT OF NANOMATERIALS 9

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

UNIT III PROPERTIES AND MEASUREMENT OF NANOMATERIALS 9

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

UNIT V NANO DRUG DELIVERY AND NANOMEDICINE 9

Properties of nano carriers; drug delivery systems used in nanomedicine; Enhanced Permeability and Retention effect; Blood-brain barrier; Active and passive targeting of diseased cells; Health and environmental impacts of nanotechnology. COURSE OUTCOMES:

TOTAL: 45 PERIODS

COURSE OUTCOME

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

CO1 Understand fundamental concepts of nanotechnology and nanomaterials
CO2 Have knowledge on the fabrication and characterization of nanomaterials
CO3 Understand nanobiology and modification of nanomaterials
CO4 Know nano-based drug delivery and nanomedicine

REFERENCES

1. Nanobiotechnology: Concepts, Applications and Perspectives, Christ of M. Niemeyer(Editor), Chad A.Mirkin (Editor) , Wiley-VCH; 1 edition, 2004.
2. Nano Biotechnology: BioInspired Devices and Materials of the Future by OdedShoseyovandIlan Levy, Humana Press; 1 edition 2007.
3. Nano Biotechnology Protocols (Methods in Molecular Biology) by Sandra J Rosenthal And David W.W right , Humana Press; 1 edition, 2005.
4. Bio-Nanotechnology Concepts and applications. Madhuri Sharon, Maheshwar Sharon,SunilPandey and Goldie Oza, Ane Books Pvt Ltd, 1 edition 2012.
5. Microscopy Techniques for Material Science. A. R. Clarke and C. N. Eberhardt (Editors) CRC Press. 1stEdition, 2002.

CO – PO MAPPING

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

BO4015 ADVANCES IN PHARMACOGENOMICS L T P C

3 0 0 3

OBJECTIVES

The course aims to,

- Provide knowledge about Pharmacogenomics and drug design using genomic applications.
- Study the genome applications on drug action and toxicity.
- To understand the human genome.
- To understand the correlation between pharmacogenomics and drug design.

UNIT I INTRODUCTION TO PHARMACOGENOMICS 9

Pharmacogenetics-The roots of pharmacogenomics, Genetic drug response profiles, the effect of drugs on Gene expression, pharmacogenomics in drug discovery and drug development.

UNIT II THE HUMAN GENOME 9

Expressed sequence Tags (EST) and computational biology, Microbial genomics,computational analysis of whole genomes, computational genome analysis, Genomic Differences that affect the outcome of host pathogen interactions: A template for the future of whole genome-based pharmacological science.

UNIT III ASSOCIATION STUDIES IN PHARMACOGENOMICS 9

Viability and ADR in drug response: contribution of genetic factor, Multiple inherited genetic factors influence the outcome of drug treatments, Plasma binding proteins, Drug targets.

UNIT IV GENOMICS APPLICATIONS FOR DRUG ACTION AND TOXICITY 9

Genomics, Proteomics, Bioinformatics, The pharmaceutical process, applications of pharmaceutical industry, Understanding biology and diseases, Target identification and validation, Drug candidate identification and optimization.

UNIT V PHARMACOGENOMICS AND DRUG DESIGN 9

The need of protein structure information, protein structure and variation in drug targets-the scale of problem, Mutation of drug target s leading to change in the ligand binding pocket.

TOTAL : 45 PERIODS

COURSE OUTCOMES

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

CO1 learn about the human genome, gene expression and their effect on drug therapy and toxicity.

CO2 know about the influence of epigenetic on therapeutic outcome.

CO3 have a complete understanding about the fundamentals of pharmacogenomics and personalized medicine.

REFERENCES

1. Licinio, Julio and Ma-Li Wong, “Pharmacogenomics: The Search for the Individualized Therapies”, Wiley-VCH, 2002.
2. Chiranjib Chakraborty and Atana Bhattacharyya, “Pharmacogenomics: An Approachto New Drugs Development”, 2004.
3. Rothstein, Mark, A. “Pharmacogenomics: Social, Ethical and Clinical Dimensions”, Wiley- Liss, 2003.

CO – PO MAPPING

Course outcome	ADVANCES IN PHARMACOGENOMICS					
	PO					
	1	2	3	4	5	6
CO1	3	-	-	-	-	-
CO2	3	-	-	-	-	-
CO3	3	3	3	3	-	-
Average	**3**	**3**	**3**	**3**		

BO4016 GENE MANIPULATION TECHNOLOGY LT P C
3 0 0 3

OBJECTIVE

- This subject will give conceptual knowledge in the Cloning & Expression of genes,Construction of DNA libraries & Sequencing; PCR & mutagenesis; Gene transfer & Gene therapy to students.
- To gain knowledge on Gene targeting and silencing.
- To understanding the practical techniques and challenges of gene cloning.
- To understand the principles of gene transfer.
- To acquire knowledge on construction of DNA libraries.

UNITI CLONING AND EXPRESSIONOFGENES 10

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

UNITII CONSTRUCTION OF DNALIBRARIES 10

DNA library – Types and importance. cDNA library: Conventional cloning strategies – OligodT priming, self-priming and its limitations. Full length cDNA cloning – Capture method andOligo capping. Strategies for gDNA library construction – Chromosome walking. Differences between gDNA and cDNA library. Screening strategies – Hybridization, PCR, Immunoscreening,South-western and North-Western. Functional cloning – Functional complementation and gain of function. Difference cloning: Differential screening, Subtracted DNA library, differential display by PCR.Overview on microarray and itsapplications, Microarrays – Principles ofDNA microarray technology, steps and techniques involved, types of DNA arrays, applications, advantages and disadvantages.

UNITIII DNASEQUENCING 8

DNA sequencing – Importance, methodology, Chemical & Enzymatic methods, Pyrosequencing, How to sequence a genome? , Short gun sequencing and clone contig approach, Automated sequence, Genome sequencing methods – top down approach, bottom up approach.

UNITIV PCRANDMUTAGENESIS 9

PCR – Principle and applications. Different types of PCR – Hot start PCR, Touchdown PCR, Multiplex PCR, Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, LATE-PCR, Colony PCR, *in-situ* PCR, Long P CR. Real-time PCR SYBRGreen assay, Taqman Probes, Molecular beacons. Mutagenesis and chimeric protein engineering by PCR, RACE, Kuntel's method of mutagenesis. Overview of types of PCR and its importance, PCR - Designing the oligonucleotide primers, studying of PCR products – Gel electrophoresis. Issues concerned with error rate of Taq polymerase. Real time PCR – Outline and concepts involved.

UNIT V GENE TRANSFER AND GENE THERAPY 8

Introduction to foreigngenes into animal cells – Importance of DNA, Micro

njection,Retroviralvectors, Trasnsfection of Embryonic stem cells, recombination. Transgenic plants – ImportanceTi Plasmid, Cointegrate and Binary vectors. Overview of Gene therapy. Gene therapy – Introduction and types. Methods of Gene therapy, target sites, Gene targeting and silencing, Transgenic plants and its applications.

TOTAL : 45 PERIODS

OUTCOME

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, sequencing, and methods for gene therapy.

REFERENCES

1. Desmond Nicholl, “An Introduction to Genetic Engineering”, Cambridge University Press2002.
2. Lemonie, N. R. and Cooper, D.N. Gene Therapy, BIOS,1996.
3. Primrose S.B., Twyman R.H., and Old R.W. “Principles of Gene Manipulation”. 6th Edition., Blackwell Science,2001
4. Winnacker E.L. “From Genes to Clones: Introduction to Gene Technology”. Panima,2003
5. Brown, T. A. (2010). Gene cloning and DNA analysis (6th ed.). Wiley Blackwell.

CO – PO MAPPING

Course Outcome	GENE MANIPULATION TECHNOLOGY					
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	-	-	-	-	-
CO2	3	3	3	3	-	-
CO3	3	3	3	3	2	-
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
CO6	3	-	-	-	-	3
Average	**3**	**3**	**3**	**3**	**2.666667**	**3**

BO4017 HUMAN PHYSIOLOGY AND DRUG METABOLISM L T P C
3 0 0 3

OBJECTIVES

- To provide fundamental knowledge on human physiology, drug metabolism and biotransformation of drug in human body.
- To understand the principles of biotransformation of drugs.
- To study the drug metabolism in correlation with the physiology of the body.

UNIT I FOUNDATIONS OF PHYSIOLOGY 12

Introduction to physiology. Chemical & Physical Foundations. Basic cell physiology-Cell-Introduction, Cell Organelles, Cell membrane, Movement of the substances and water through the cell membrane, Bioelectric potentials. Homeostasis – Definition, negative and positive feedback mechanisms – neural & endocrine mechanisms. Endocrine control of organic metabolism, growth and reproduction.

UNIT II PHYIOLOGICAL CONCEPTS 9

Nervous system-Sensory nervous system, Motor nervous system, Higher functions of the nervous system, Synapse, Reflexes, Cerebrospinal fluid, Blood brain and blood CSF barrier. Properties of cardiac muscles, Conducting system of the heart, Pressure changes during cardiac cycles, Capillary circulation, Arterial and venous blood pressure. Gastro intestinal system - General structure of alimentary canal, Gastric secretion, Pancreatic secretion, Gastric motility-digestive peristalsis Gastrointestinal hormones

UNIT III PHYSIOLOGICAL CONCEPTS 9

Neuro muscular system - Muscles - Skeletal muscles - Properties of skeletal muscles, Muscular contraction and relaxation, Neuromuscular junction, Sarcotubular system, Smooth muscle - mechanism of contraction. Renal physiology - Nephrones, Juxtra glomerular filtrate, Reabsorption, Secretion-mechanism of secretion, Concentrating and diluting mechanism of urine, Dialysis.

UNIT IV DRUG ABSORPTION AND BIOTRANSFORMATION CONCEPTS 8

Factors influencing enzyme induction and inhibition; Extraction of drugs; Biliary and fecal excretion; Factors effecting drug metabolism; Drug metabolism in fetus and new born. Biotransformation of drugs; Enzymes responsible for bio-transformations; Microsomal and non-microsomal, mechanisms.

UNIT V DRUG METABOLISM - STUDY MODELS 7

Models to study drug metabolism; Dose effect relationships; Adverse drug reactions and drug interactions; Toxic reactions; Allergic reactions; Idiosyncrasy; Acute poisoning and its treatment.

TOTAL: 45 PERIODS

OUTCOMES

CO1. Understand the basic principles of cells and endrocrine systems.
CO2. Demonstrate the working principles of Nervous, Cardio vascular and Gastro intestinal systems
CO3. Demonstrate the concepts on Neuro muscular, Renal Physiology systems.
CO4. Explain the drug absorption and biotransformation of drugs in the human physiological systems.
CO5. Acquire the knowledge on drug metabolism in various models.
CO6. Expertise in the course of Human Physiology and Drug Metabolism

REFERENCES

1. Ganong W.F., "Review of Medical Physiology", 16th Edition, Prentice Hall, 1993.
2. Vander A.J., Sherman, J.H. and Luciano, D.S. "Human Physiology", McGraw-Hill, 1990.
3. Carola, R., Harley, J.P. and Noback, C.R., 'Human Anatomy and Physiology', 2nd Edition, McGraw Hill, 1992
4. Guyton, A.C., "Text book of Medical Physiology", 9th Edition, Harcourt Brace & Co., 1996.
5. Ross and Wilson, "Human Anatomy and Physiology", ELBS Edition.? 2007
6. Goodman & Gilman, Laurence L Brunton, The Pharmacological Basis of Therapeutics, 11th Edition, McGraw Hill, 2005.
7. Woolf, Thomas F. "Handbook of Drug Metabolism". Marcel Dekker, 1999.
8. Human Physiology 15th Edition. Stuart Fox and Krista Rompolski, 2019.
9. C C Chatterjee's Human Physiology 13ed Vol 1 & 2. Pb 2020.

CO – PO MAPPING

Course outcome	HUMAN PHYSIOLOGY AND DRUG METABOLISM					
	ProgrammeOutcome					
	1	2	3	4	5	6
CO1	3	-	-	-	-	-
CO2	3	3	3	3	-	3
CO3	3	3	3	3	-	3
CO4	3	-	-	-	-	3
CO5	3	-	-	-	-	-
CO6	3	3	3	3	3	3
Average	3	3	3	3	3	3

BO4018 FERMENTATION TECHNOLOGY LT P C
3 0 0 3

OBJECTIVE

- The subject provides knowledge involving basic principle of fermentation process, microbial kinetics and recombinant protein production along with case studies, to help the students understand fermentation processes involved in Pharmaceutical Industries.
- To acquire knowledge on down streaming process.
- To design and construct bioreactor for various applications.
- To acquire knowledge on different separation techniques.
- To acquire knowledge on microbial kinetics.

UNIT I INTRODUCTION TO BIOREACTOR DESIGN AND CONSTRUCTION 9

General requirements Basics of fermentation processes- range and component parts, functions of a fermenter. 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, achievement of aseptic conditions, Removal of Heat in bioreactor, Main parameters to be monitored and controlled in fermentation processes.

UNIT II MICROBIAL KINETICS AND DESIGN OF VARIOUS CULTIVATION PROCESSES 9

Overview of batch, continuous and fed batch cultures and comparison between the underlying concepts. Simple unstructured kinetic models for microbial growth of bacterial, fungal, animal and plant systems, kinetics of substrate utilization, biomass growth and product formation in continuous

cultures, batch and fed batch cultures, total cell retention cultivation, inhibition on cell growth and product formation.

UNIT III MODELING OF RECOMBINANT CULTIVATIONANIMAL AND PLANT CELL CULTIVATION SYSTEMS FORTHERAPEUTIC PROTEINS 9

Structured models of metabolism and growth, models of gene expression and regulation, a generalized model of plasmid replication, Genetic instability, predicting host-vector interactions and genetically instability. Process considerations for utilizing genetically engineered strains. Media, aeration in cell culture systems, Bioreactors for plant/animal suspension culture, cell immobilization and organized tissue, bioreactor considerations for animal /plant cell culture for production of pharmaceuticals, Therapeutic proteins and Monoclonal antibodies. Industrial applications of the bioreactors as cell cultivation systems.

UNIT IV DOWNSTREAM PROCESSING AND SEPARATION TECHNIQUES 9

Characteristics of biological materials: Recovery and purification of fermentation products; pretreatment methods; Separation of cell mass: centrifugation, clarification and filtration; Different methods of cell disruption; Solid shear method and liquid shear method; Different concentration methods: evaporation, distillation, crystallization, evaporation, SCFE, solvent extraction, phase separation, drying etc., whole broth extraction, protein precipitation; extraction; adsorption; Modern techniques: Electrophoresis; Chromatographic methods; Membrane processes- Ultrafiltration; Reverse osmosis; Cross flow filtration; Microfiltration; Isoelectric focusing; Affinity based separations. Advantages and disadvantages of the above methods.

UNIT V CASE STUDIES IN FERMENTATION DERIVED PRODUCTS 9

Case studies on Production of penicillin, recombinant Insulin. Case studies should deal with strain improvement, medium design, reactor design and process optimization etc.

TOTAL: 45 PERIODS

OUTCOME

This course work will made the students to:

CO1 apply the knowledge of design and construction of bioreactor in fermentation technology

CO2 Acquire the knowledge on microbial kinetics and biomass growth

CO3 design and use the reactor systems for bioprocesses

CO4 Analyse the various separationtechniques and its application principles in the downstream processing

CO5 Expand and update the current fermentation technology information by using recent case studies

CO6 Acquire the knowledge and become expert in the field of field of fermentation technology

REFERENCES

1. Stanbury, Stephen. P. F., Hall, J. and Whitaker, A. “Principles of fermentation technology” Elsevier 3rd edition.
2. Bailey, J.E. and Ollis, D.F. “Biochemical Engineering Fundamentals” 2nd Edition., McGrawHill,1986.
3. B.Sivashankar, “Bioseparation principles and techniques”. Prentice Hall of India Pvt Ltd 2007
4 Blanch, H.W and Clark D.S., “Biochemical Engineering”, Marcel Dekker,1997
5. Doran, Pauline M, “Bioprocess Engineering Principles”. Academic Press, 1995
6. Nielsen, J. and Villadsen, J. “Bioreaction Engineering Principles”. Springer, 2007.
7. Shuler, M.L. and Kargi, F. “Bioprocess Engineering: Basic Concepts”. 2nd Edition, Prentice-Hall, 2002.

CO – PO MAPPING

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

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:

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

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

CO2 – Learn about what to write in each section

CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

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:

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

CO1 Ability to summarize basics of disaster

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

CO3 Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

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

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

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: Zila Pachayat.

Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

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

TOTAL: 30 PERIODS

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 சங்க இலக்கியம் 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, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான்ஔவைக்குநெல்லிக்கனிகொடுத்தது, அரசர் பண்புகள்

2. நற்றிணை
- அன்னைக்குரியபுன்னைசிறப்பு

3. திருமந்திரம் (617, 618)
- இயமம்நியமம்விதிகள்

4. தர்மச்சாலையை நிறுவிய 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. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல்தமிழ்,
6. இணையத்தில்தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

<u>தமிழ்இலக்கியவெளியீடுகள் / புத்தகங்கள்</u>

1. தமிழ்இணையகல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org

2. தமிழ்விக்கிப்பீடியா (Tamil Wikipedia) -https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல்களஞ்சியம் - தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக்களஞ்சியம் - தமிழ்வளர்ச்சித்துறை (thamilvalarchithurai.com)
6. அறிவியல்களஞ்சியம் - தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர்

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

OBJECTIVE

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

UNIT I CONTEXT FOR IWRM 9

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

UNIT II WATER ECONOMICS 9

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

UNIT III LEGAL AND REGULATORY SETTINGS 9

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

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9

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

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9

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

TOTAL: 45 PERIODS

OUTCOMES

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

CO1 Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.

CO2 Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.

CO3 Apply law and governance in the context of IWRM.

CO4 Discuss the linkages between water-health; develop a HIA framework.

CO5 Analyse how the virtual water concept pave way to alternate policy options.

REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
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 the course, the student is expected to be able to

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

REFERENCES:

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla, IIED and UNFPA, Earthscan, UK, 2008

5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
6. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.

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

OBJECTIVES:

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

UNIT I INTRODUCTION 9

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

UNIT II IMPACT INDENTIFICATION AND PREDICTION 10

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

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8

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

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

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

UNIT V CASE STUDIES 9

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

TOTAL: 45 PERIODS

OUTCOMES:

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

REFERENCES:

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

OIC431 BLOCKCHAIN TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

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

UNIT II BITCOIN AND CRYPTOCURRENCY 9

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

UNIT III INTRODUCTION TO ETHEREUM 9

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

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

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

UNIT V BLOCKCHAIN APPLICATIONS 8

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES:

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

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

COURSE OBJECTIVES:

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

UNIT I DEEP LEARNING CONCEPTS **6**

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

UNIT II NEURAL NETWORKS **9**

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

UNIT III CONVOLUTIONAL NEURAL NETWORK **10**

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

UNIT 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.

OME432ENERGY 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:

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

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment
3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001
4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors
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
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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:

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

TEXT BOOK:

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

OBA434 ETHICAL MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVE

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

UNIT I ETHICS AND SOCIETY 9

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

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS 9

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

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9

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

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9

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

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

REFERENCES

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

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

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

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

UNIT II IOT ARCHITECTURE 9

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

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9

PROTOCOLS:

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

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

UNIT IV IOT PROCESSORS 9

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

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

UNIT V CASE STUDIES **9**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES:

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

ET4072 MACHINE LEARNING AND DEEP LEARNING **L T P C**

3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

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

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

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

UNIT II NEURAL NETWORKS 9

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

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

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

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

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

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

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

CO1 : Illustrate the categorization of machine learning algorithms.

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

CO3: Acquaint with the pattern association using neural networks

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

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

REFERENCES:

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

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

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

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

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

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

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

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

TOTAL : 45 PERIODS

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

REFERENCES:
1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford UniversityPress,

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

PS4093 **SMART GRID** **L T P C**
3 0 0 3

COURSE OBJECTIVES

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

UNIT I INTRODUCTION TO SMART GRID 9

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

UNIT II SMART GRID TECHNOLOGIES 9

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

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

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

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

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

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

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

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to

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

REFERENCES

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

CP4391 SECURITY PRACTICES L T P C

3 0 0 3

COURSE OBJECTIVES:

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

UNIT I SYSTEM SECURITY 9

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

UNIT II NETWORK SECURITY 9

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

UNIT III SECURITY MANAGEMENT 9

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

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud

infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012
6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

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

COURSE OBJECTIVES:

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

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

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

Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

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

UNIT III AWS CLOUD PLATFORM - IAAS 9

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

UNIT IV PAAS CLOUD PLATFORM 9

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

UNIT V PROGRAMMING MODEL 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES

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

IF4072 **DESIGN THINKING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I UX LIFECYCLE TEMPLATE 8

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

UNIT II CONTEXTUAL INQUIRY 10

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

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9

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

UNIT IV UX GOALS, METRICS, AND TARGETS 8

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

UNIT V ANALYSING USER EXPERIENCE 10

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

SUGGESTED ACTIVITIES:

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

stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES

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

MU4153 PRINCIPLES OF MULTIMEDIA L T P C

3 0 0 3

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

UNIT II ELEMENTS OF MULTIMEDIA 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

UNIT III MULTIMEDIA TOOLS 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

UNIT IV MULTIMEDIA SYSTEMS 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

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

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

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO BIG DATA 9

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

UNIT II SEARCH METHODS AND VISUALIZATION 9

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

UNIT III MINING DATA STREAMS 9

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

UNIT IV FRAMEWORKS 9

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

UNIT V R LANGUAGE 9

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

COURSE OUTCOMES:

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

TOTAL:45 PERIODS

REFERENCE:

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

NC4201 INTERNET OF THINGS AND CLOUD L T P C

3 0 0 3

COURSE OBJECTIVES:

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

UNIT I FUNDAMENTALS OF IoT 9

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

UNIT II PROTOCOLS FOR IoT 9

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

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS 9

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

UNIT IV CLOUD COMPUTING INTRODUCTION 9

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

UNIT V IoT AND CLOUD 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES

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

MX4073 MEDICAL ROBOTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO ROBOTICS 9

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

Sensors and Actuators

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

UNIT II MANIPULATORS & BASIC KINEMATICS 9

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

Navigation and Treatment Planning

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

UNIT III SURGICAL ROBOTS 9

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

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

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

UNIT V WEARABLE ROBOTS 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

REFERENCES

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

11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

VE4202 EMBEDDED AUTOMATION L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING 9

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

UNIT - II AVR MICROCONTROLLER 9

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

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

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

UNIT – IV VISION SYSTEM 9

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

UNIT – V HOME AUTOMATION 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, students will be able to
CO1: analyze the 8-bit series microcontroller architecture, features and pin details
CO2: write embedded C programs for embedded system application
CO3: design and develop real time systems using AVR microcontrollers
CO4: design and develop the systems based on vision mechanism
CO5: design and develop a real time home automation system

REFERENCES:

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