ANNA UNIVERSITY, CHENNAI
NON - AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. MEDICAL ELECTRONICS

REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To enable the graduates to pursue Clinical Research or lead a successful career in the academic field of medical electronics.

II. To enable the graduates to acquire all the required Medical Electronics Manufacturing skills for Industrial Application or for Hospital Requirement

III. To enable the graduates to critically analyse, acquire essential skills ,innovate medical products and to become successful Entrepreneurs in the field of medical electronics.

IV. To facilitate the graduates to exhibit leadership skills, make decisions with societal and ethical responsibilities, function and communicate effectively in multidisciplinary settings.

V To enable the graduates to identify, analyze sustainable solutions and to develop ethical practicing ability to collaborate with team members for building medical electronics systems with cutting-edge technology.

2. PROGRAM OUTCOMES (POs)

1. An ability to independently carry out research/investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4. Ability to acquire and understand, synthesize and generate hypotheses using knowledge of mathematics and electronics
5. Model, design and realize devices and systems using the techniques and tools of Medical Electronics Engineering in healthcare domain
6. Optimize, maintain and Provide sustainable solutions for health care devices / systems and its allied fields by imbibing managerial and techno-social values

PEO/PO Mapping:

PEO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
I.	√	√	√	√	-	-
II.	√	-	√	√	-	√
III.	√	-	-	√	√	√
IV.	-	-	√	-	-	√
V.	√	-	√	√	√	-

(3-High, 2- Medium, 1- Low)

MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Advanced Applied Mathematics						
		Research Methodology and IPR						
		Biomedical Instrumentation and Equipment	2.2	1.8	1.6	1.8	2	1.6
		Embedded Systems and Internet of Things for	2.8	1.6	2.6	2.6	1.6	2.75
		Bio Signal Processing	2.6	1	2	2.6	2.6	2
		Human Anatomy and Physiology	2.2	1.8	1.8	1.5	1.4	1.6
		Biomedical Instrumentation Laboratory	1.8	1.8	1.6	1.6	1.6	1.6
		Bio Signal Processing Laboratory	3	2	3	3	2.2	2
	SEMESTER II	Medical Image Processing	2	0.6	1.8	2.4	1.8	1.4
		Medical Electronics Device Design	2	2	1.6	1.4	1.8	1.4
		Medical Imaging Systems and Radio Therapy	1.8	2	1.4	2	1.6	1.4
		AI and Machine Learning	1.4		2.5	2.6	2.4	1.6
		Medical Electronics Device Design Laboratory	2	2	1.6	1.4	1.8	1.4
		Term Paper Writing and Seminar						
YEAR II	SEMESTER III							
	SEMESTER IV							

PROFESSIONAL ELECTIVE COURSES [PEC]

S. NO.	COURSE TITLE	PO1	PO2	PO3	PO4	PO5	PO6
1.	Nanotechnology and Its applications	2.2	1.5	1.75	1	1	1
2.	Biomechanics	2.2	2	2	1.6	1	1
3.	Biometrics	2	2	1.6	1.8	1.8	1.8
4.	Biomaterials	2.2	1.8	1.8	1.5	1.7	1
5.	Medical Optics	1.6	1	1.8	1	-	1.75
6.	Human Assist Devices	1		1.4	1.2	2.4	2
7.	Wearable Technologies	2.5	1.4	2	1.6	1	2.25
8.	Brain Computer Interface	1.95	-	3	2	1	1.95
9	Genetic Algorithms and Fuzzy Logics	2.3		2.5	2	2.4	1
10.	Medical Robotics	2		2	1.8	2.6	2.3
11.	Big Data Mining and Analytics						
12.	Rehabilitation Engineering	1.6	2.4	1.4	2.5	2	1.8
13.	Tele Health Technology	1.6	1.4	1.6	2	2.5	3
14.	Health Care, Hospital and Equipment Management	1	1	1.4	0	1.66	1.4
15.	Ultra Sound in Medicines	2.2	2.4	1.6	2.2	2	1.8
16.	Bio Ethics and Standards	1	1	1.4	0	1.66	1.4
17.	Medical Device Standards and Regulation	1	2	1		1	
18.	Tissue Engineering and Immuno Engineering	2	2.2	1.6	1.6	1.6	1.6
19.	Medical Equipment	1.5		2.2	1.75	1.6	2
20.	Biomems and Artificial Organs	2	2.2	1.4	1.8	1.6	1.6
21	Physiological Modeling	2	2.2	1.8	1.8	1.8	1.8
22	Pattern Recognition Techniques and Applications	1.6		2	2.6	2	2
23	Mixed Reality						
24	3D Printing in Medicines	2.6	1.6	2	2	3	2

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M.E. MEDICAL ELECTRONICS
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CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABI
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4152	Advanced Applied Mathematics	FC	3	1	0	4	4
2.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
3.	MX4101	Biomedical Instrumentation and Equipment	PCC	3	0	0	3	3
4.	MX4102	Embedded Systems and Internet of Things for Medical Application	PCC	3	0	2	5	4
5.	BM4151	Bio Signal Processing	PCC	3	0	0	3	3
6.	BM4152	Human Anatomy and Physiology	PCC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	MX4111	Biomedical Instrumentation Laboratory	PCC	0	0	3	3	1.5
9.	BM4161	Bio Signal Processing Laboratory	PCC	0	0	3	3	1.5
			TOTAL	**19**	**1**	**8**	**28**	**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.	MX4291	Medical Image Processing	PCC	3	0	2	5	4
2.	MX4201	Medical Electronics Device Design	PCC	3	0	0	3	3
3.	MX4202	Medical Imaging Systems and Radio Therapy	PCC	3	0	0	3	3
4.	BM4251	AI and Machine Learning	PCC	3	0	2	5	4
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
8.	MX4211	Medical Electronics Device Design Laboratory	PCC	0	0	4	4	2
9.	MX4212	Term Paper Writing and Seminar	EEC	0	0	2	2	1
			TOTAL	**20**	**0**	**10**	**30**	**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		
THEORY								
1.		Professional Elective III	PEC	3	0	0	3	3
2.		Professional Elective IV	PEC	3	0	2	5	4
3.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
4.	MX4311	Project Work I	EEC	0	0	12	12	6
5.	MX4312	Hospital / Biomedical Industry Training	EEC	0	0	4	4	2
			TOTAL	**9**	**0**	**18**	**27**	**18**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	MX4411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 75

PROFESSIONAL ELECTIVES
SEMESTER II, PROFESSIONAL ELECTIVES – I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX4001	Nanotechnology and Its applications	PEC	3	0	0	3	3
2.	MX4002	Biomechanics	PEC	3	0	0	3	3
3.	MX4003	Biometrics	PEC	3	0	0	3	3
4.	MX4004	Biomaterials	PEC	3	0	0	3	3
5.	MX4072	Medical Optics	PEC	3	0	0	3	3
6.	MX4071	Human Assist Devices	PEC	3	0	0	3	3

SEMESTER II, PROFESSIONAL ELECTIVES – II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BM4074	Wearable Technologies	PEC	3	0	0	3	3
2.	BM4071	Brain Computer Interface	PEC	3	0	0	3	3
3.	BM4091	Genetic Algorithms and Fuzzy Logics	PEC	3	0	0	3	3
4.	MX4073	Medical Robotics	PEC	3	0	0	3	3
5.	BD4251	Big Data Mining and Analytics	PEC	3	0	0	3	3
6.	BM4072	Rehabilitation Engineering	PEC	3	0	0	3	3
7.	BM4073	Tele Health Technology	PEC	3	0	0	3	3

SEMESTER III, PROFESSIONAL ELECTIVES – III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX4005	Health Care, Hospital and Equipment Management	PEC	3	0	0	3	3
2.	MX4006	Ultra Sound in Medicines	PEC	3	0	0	3	3
3.	MX4007	Bio Ethics and Standards	PEC	3	0	0	3	3
4.	BM4092	Medical Device Standards and Regulation	PEC	3	0	0	3	3
5.	MX4008	Tissue Engineering and Immuno Engineering	PEC	3	0	0	3	3
6.	MX4009	Medical Equipment	PEC	3	0	0	3	3

SEMESTER III, PROFESSIONAL ELECTIVES - IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX4010	Biomems and Artificial Organs	PEC	3	0	2	5	4
2.	MX4011	Physiological Modeling	PEC	3	0	2	5	4
3.	MX4074	Pattern Recognition Techniques and Applications	PEC	3	0	2	5	4
4.	MU4291	Mixed Reality	PEC	3	0	2	5	4
5.	MX4012	3D Printing in Medicines	PEC	3	0	2	5	4

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.	CX4016	Environmental Sustainability	3	0	0	3

25.	TX4092	Textile Reinforced Composites	3	0	0	3
26.	NT4002	Nanocomposite Materials	3	0	0	3
27.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4152	Advanced Applied Mathematics	3	1	0	4	I

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MX4101	Biomedical Instrumentation and Equipment	3	0	0	3	I
2.	MX4102	Embedded Systems and Internet of Things for Medical	3	0	2	4	I
3.	BM4151	Bio Signal Processing	3	0	0	3	I
4.	BM4152	Human Anatomy and Physiology	3	0	0	3	I
5.	MX4111	Biomedical Instrumentation Laboratory	0	0	3	1.5	I
6.	BM4161	Bio Signal Processing Laboratory	0	0	3	1.5	I
7.	MX4291	Medical Image Processing	3	0	2	4	II
8.	MX4201	Medical Electronics Device Design	3	0	0	3	II
9.	MX4202	Medical Imaging Systems and Radio Therapy	3	0	0	3	II
10.	BM4251	AI and Machine Learning	3	0	2	4	II
11.	MX4211	Medical Electronics Device Design Laboratory	0	0	4	2	II

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MX4212	Term Paper Writing and Seminar	0	0	2	1	II
2.	MX4311	Hospital / Biomedical	0	0	4	2	III
3.	MX4311	Project Work I	0	0	12	6	III
4.	MX4411	Project Work II	0	0	24	12	IV

SUMMARY

Sl. No.	NAME OF THE PROGRAMME: M.E. MEDICAL ELECTRONICS						
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	16	16	00	00	32
3.	PEC	00	06	07	00	13
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	01	08	12	21
7.	Non Credit/Audit Course	✓	✓	00	00	
8.	**TOTAL CREDIT**	**22**	**23**	**18**	**12**	**75**

MA4152 ADVANCED APPLIED MATHEMATICS L T P C
3 1 0 4

COURSE OBJECTIVES:

- To encourage students to develop a working knowledge of the central ideas of Linear Algebra.
- To enable students to understand the concepts of Probability and Random Variables.
- To make students understand the notion of a Markov chain, and how simple ideas of conditional probability and matrices can be used to give a thorough and effective account of discrete-time Markov chains.
- To familiarize the students with the formulation and construction of a mathematical model for a linear programming problem in real life situation.
- To introduce the Fourier Transform as an extension of Fourier techniques on parodic functions and to solve partial differential equations.

UNIT – I LINEAR ALGEBRA 12

Vector spaces – Norms – Inner products – Eigenvalues using QR transformations – QR factorization – Generalized eigenvectors – Canonical forms – Singular value decomposition and applications – Pseudo inverse – Least square approximations – Toeplitz matrices and some applications.

UNIT – II ONE DIMENSIONAL RANDOM VARIABLES 12

Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

UNIT – III RANDOM PROCESSES 12

Classification – Auto correlation – Cross correlation - Stationary random process – Markov process – Markov chain – Poisson process – Gaussian process.

UNIT – IV LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Two phase method – Transportation and Assignment models.

UNIT – V FOURIER TRANSFORM FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Fourier transforms: Definitions, properties – Transform of elementary functions, Dirac Delta functions – Convolution theorem, Parseval's identity – Solutions to partial differential equation: Heat equations, Wave equations, Laplace and Poisson's equations.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

- apply the concepts of linear algebra to solve practical problems.
- use the ideas of probability and random variables in solving engineering problems.
- classify various random processes and solve problems involving stochastic processes.
- formulate and construct mathematical models for linear programming problems and solve the transportation and assignment problems.

- apply the Fourier transform methods of solving standard partial differential equations.

REFERENCES:

1. Andrews, L. C. and Philips. R.L., "Mathematical Techniques for engineering and scientists", Prentice Hall of India, New Delhi,2006.
2. Bronson, R.," Matrix Operation", Schaum's outline series, Tata McGrawHill, New York,2011.
3. O'Neil P.V.,, "Advanced Engineering Mathematics", Cengage Learning", 8th Edition, India, 2017.
4. Oliver C. Ibe, "Fundamentals of Applied Probability and Random Processes", Academic Press, Boston, 2014.
5. Sankara Rao,K., " Introduction to partial differential equations" Prentice Hall of India Pvt. Ltd., 3rd Edition, New Delhi,2010.
6. Taha H.A., "Operations Research: An Introduction", Ninth Edition, Pearson Education, Asia, 10th Edition, New Delhi, 2017.

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

UNIT I RESEARCH DESIGN 6

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

UNIT II DATA COLLECTION AND SOURCES 6

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

Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association.

Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

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

UNIT V PATENTS 6

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

TOTAL: 30 PERIODS

REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).

2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

MX4101 BIOMEDICAL INSTRUMENTATION AND EQUIPMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

- Study about the different bio potential and electrodes for its measurement.
- Understand the biosignal characteristics and the electrode placement for recording.
- Familiarize the different signal conditioning circuits.
- Learn the different measurement techniques for non-electrical parameters.
- Familiarize the different biochemical measurements.

UNIT I BIO POTENTIAL ELECTRODES 9

Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell potential, impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Biochemical-and Transcutaneous- electrodes: pH, pO2, pCO2.

UNIT II ELECTRODE CONFIGURATIONS 9

Biosignals characteristics – frequency and amplitude ranges. ECG – Einthoven’s triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. Recording of ERG, EOG and EGG.

UNIT III BIOAMPLIFIERS 9

Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering

UNIT IV MEASUREMENT OF NON-ELECTRICAL PARAMETERS 9

Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers, Systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement

UNIT V BIO-CHEMICAL MEASUREMENT 9

Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors, Blood gas analyzers - colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description) – Bio Sensors – Principles – Amperometric and Voltometric techniques.

TOTAL:45 PERIODS

SUGGESTED ACTIVITIES:

1: Demonstration on various electrodes and study of its characteristics
2: Demonstration about ECG, EEG, ERG, EOG & EGG
3: Design of amplifiers for ECG, EMG, EEG, EGG & EOG
4: Conduct experiments to measure BP, SpO2, Heart Rate, Body temperature
5: Conduct experiments to measure Blood Glucose, Blood cell counts,

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1: Understand the origin of bio potentials and electrodes for its measurement.
CO2: Describe the biosignal characteristics and the electrode placement for various physiological recording
CO3: Design bio amplifier for various physiological recording.
CO4: Perform various techniques for measuring non-electrical parameters.
CO5: Apply different techniques for biochemical measurements.

REFERENCES:

1. John G. Webster, Amit J. Nimunkar, Medical Instrumentation application and design – 5th Edition, (An Indian Adaptation), Wiley India, 2021.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", edition, 2015. Pearson education, 2012
3. Leslie Cromwell, —Biomedical Instrumentation and measurement, Prentice hall of India, New Delhi, 2nd edition, 2015.
4. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw Hill, 2003.
5. KhandpurR.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd edition, 2014.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	1	1	1	1
2	2	2	2	2	2	1
3	2	2	2	2	2	2
4	3	2	2	2	2	2
5	3	2	1	2	3	2
Avg	2.2	1.8	1.6	1.8	2	1.6

MX4102 EMBEDDED SYSTEMS AND INTERNET OF THINGS FOR MEDICAL APPLICATION **L T P C 3 0 2 4**

COURSE OBJECTIVES:

- To understand hardware and software for ARM processor.
- To understand ARM processor and Building Blocks of Embedded Systems
- To provide information about sensor interfacing with microcontroller boards
- To provide information about various protocols for IoT

- To familiarize the student with the various applications in healthcare using IOT

UNIT I HARDWARE AND SOFTWARE OF ARM PROCESSOR 9

ARM processor fundamentals, architecture, Instruction set, Memory system, Exception/ Interrupt handling. Cortex-M Processors, Embedded Software Development- Introduction to C language and C preprocessor.

UNIT II DATA ACQUISITION SYSTEMS 10

Analog signals: amplitude, bandwidth; Analog multiplexing, Anti-aliasing filters, Analog to Digital converter, Sensor interfacing, sampling theorem, Digital filters, UART to USB converters, Bluetooth, Zigbee and Wi-fi Communication protocols.

UNIT III SENSOR INTERFACING WITH MICROCONTROLLER BOARDS 8

Basics of hardware design, functions of passive components-sensors and actuators, Introduction to Arduino Due; Arduino integrated development environment and programming.

UNIT IV IOT: AN INTRODUCTION 9

Networked Embedded System types and overview, Introduction to IOT , Application of IOT in health-care - Patient Monitoring & diagnostics, Home healthcare & Personal care & Fitness.

UNIT V EMBEDDED WEB-SERVER & IOT CLOUD SERVICES APPLICATION & CASE STUDY 9

Embedded web server: Basic introduction and its application in IOT.

Case Study1: Wireless Patient Monitor system

Case Study2: Wearable Fitness & Activity Monitor

Application Design: Design of IOT based pulse oximeter, block diagram, concepts of analog front end, signal process and Wi-Fi integration, Design of single channel and multi-channel ECG and EMG amplifier systems incorporating analog, digital communication.

45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

LIST OF EXPERIMENTS

1. Interfacing with Pressure sensor, Light sensor, IR sensor.
2. Temperature sensor Interfacing using ARM processor
3. Experiments with Atmega -Digital: - Button, Digital Input Pullup, Blink Without Delay
4. Introduction to ARM7- Cortex processor Instruction set
5. EPROM Interfacing using ARM processor.
6. Study of basic image processing algorithm using Single board computers such as Raspberry Pi, Beagle Bone black etc

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1: Develop hardware and software for ARM processor, Understand ARM processor and Building Blocks of Embedded Systems

CO2: Understand the data acquisition system.

CO3: Acquire Knowledge on sensor interfacing with Arduino

CO4: Analyze various protocols for IoT,

CO5: Build various applications in healthcare using IOT based approach and substantiate the

same with appropriate

TOTAL:75 PERIODS

REFERENCES:

1. Andrew Sloss, Dominic Symes, Chris Wright, ARM system developer's guide: designing and optimizing system software, Morgan Kaufmann, 2004.
2. Getting Started with Internet of Things- CunoPfister, 2011
3. S. Salivahanan, S. Arivazhagam, "Digital circuits and Design", 4th Edition, Vikas Publishing House, 2012.
4. Interconnecting Smart Objects with IP- J. P Vasseur, Adam Dunkels, 2010 24 Course
5. R. S. Khandpur, "Printed Circuit Boards Design - Fabrication, Assembly and Testing", 1st Edition, McGraw Hill Education, 2017.
6. Brian W. Kernighan, Dennis M. Ritchie, "The C programming language", 2nd Edition, Prentice Hall, Englewood Cliffs, New Jersey, 1988

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	3	3	1	3
2	2	1	1	2	-	-
3	3	1	3	2	-	2
4	3	2	3	3	2	3
5	3	2	3	3	2	3
Avg	2.8	1.6	2.6	2.6	1.6	2.75

BM4151 BIO SIGNAL PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the characteristics of different biosignals
- To discuss linear and non-linear filtering techniques to extract desired information
- To demonstrate the significance of wavelet detection applied in biosignal processing.
- To extract the features from the biosignal
- To introduce techniques for automated classification and decision making to aid diagnosis

UNIT I SIGNAL, SYSTEM AND SPECTRUM 9

Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum – power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

UNIT II TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION 9

Time series analysis – linear prediction models, process order estimation, non-stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG and HRV signals, model based ECG simulator. Spectral estimation – Blackman Tukey method, periodogram and

model based estimation. Application in Heart rate variability, PCG signals.

UNIT III ADAPTIVE FILTERING AND WAVELET DETECTION 9

Filtering – LMS adaptive filter, adaptive noise cancelling in ECG, improved adaptive filtering in FECG, EEG and other applications in Bio signals, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

UNIT IV ANALYSIS OF BIOSIGNAL 9

Removal of artifact – ECG, Event detection –ECG, P Wave, QRS complex, T wave, Correlation analysis of ECG signals, Average of Signals-PCG, ECG and EMG.

UNIT V BIOSIGNAL CLASSIFICATION AND RECOGNITION 9

Statistical signal classification, linear discriminate function, direct feature selection and ordering, Back propagation neural network based classification.

Case study: 1. Various methods used to extract features from EEG signal

Case Study 2: Diagnosis and monitoring of sleep apnea

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1: Analyse the different types of signals & systems

CO2: Analyse signals in time series domain & estimate the spectrum

CO3: Understand the significance of wavelet detection applied in biosignal processing

CO4: Extract the features from biosignal

CO5: Describe the performance of the classification of biosignals

TOTAL:45 PERIODS

REFERENCES:

1. P.Ramesh Babu, —Digital Signal Processing, Sixth Edition, Scitech publications, Chennai, 2014.
2. Raghuveer M. Rao and AjithS.Bopardikar, Wavelets transform – Introduction to theory and its applications, Pearson Education, India 2000
3. Rangaraj M. Rangayyan, 2nd edition “Biomedical Signal Analysis-A case study approach”, Wiley- Interscience /IEEE Press, 2015
4. Emmanuel C. Ifeachor, Barrie W.Jervis, second edition, “Digital Signal processing- A Practical Approach” Pearson education Ltd., 2002
5. Willis J.Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2006

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	2	3	3	2
2	2	1	1	3	2	2
3	2	1	2	3	3	2
4	2	1	2	2	2	2
5	3	1	3	3	3	2
Avg	**2.6**	**1**	**2**	**2.6**	**2.6**	**2**

BM4152 **HUMAN ANATOMY AND PHYSIOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To identify all the organelles of an animal cell and their function.
- To understand the structure and functions of the different types of systems of the human body.
- To understand about sensory organs and accessory organs of human being
- To demonstrate their knowledge of importance of anatomical features and physiology of human systems
- Gain knowledge in regulatory mechanism of human body

UNIT I **ORGANIZATION OF THE HUMAN BODY** **8**

Organization of the human body: from atoms to the entire organism. Anatomical directions and planes. Cell structures and functions – Plasma membrane and sub-organelles. Cell membrane transport. Cell to cell signaling, Cell cycle and regulations. Action potential, Homeostasis, Types of specialized tissues

UNIT II **INTEGUMENTARY, SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS** **9**

Skin: Structure of skin and their parts, Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton – Types of joints and function – Types of cartilage and function. Muscular: Parts of Muscle – Movements. Respiratory: Parts of Respiratory Systems – Types of respiration - Mechanisms of Breathing – Regulation of Respiration

UNIT III **CARDIOVASCULAR, LYMPHATIC AND ENDOCRINE SYSTEMS** **10**

Cardiovascular: Structure of Heart, Conducting System of Heart – Properties of Cardiac Muscle - Cardiac Cycle – Heart Beat – Types of Blood vessel – Regulation of Heart rate and Blood pressure. Blood: Components of Blood and functions.- Blood Groups and importance Lymphatic: Types of Lymphatic organs and vessels – Functions. Endocrine: Pituitary and Thyroid glands

UNIT IV **NERVOUS, SENSE ORGANS AND REPRODUCTIVE SYSTEMS** **10**

Nervous: Structure, types and properties of Neuron, Mechanism of Nerve impulse. Brain: Structure and parts of brain – central and peripheral nervous system – Reflex mechanism. Sense: Structure and functions of eye and ear. Reproductive: Anatomy of testis and ovary

UNIT V **DIGESTIVE AND URINARY SYSTEMS** **8**

Digestive: Organs of Digestive system – Digestion and Absorption. **Urinary:** Structure of Kidney and Nephron – Mechanisms of Urine formation – Regulation of Blood pressure by Urinary System – Urinary reflex

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1: Explain the general terminology, cell structure and function, histology, gross anatomy, and physiology related to the various human systems

CO2: Acquire knowledge various anatomical parts of the human systems

CO3: Understand about interconnectedness of anatomy and physiology of various systems

CO4: Acquire knowledge in human organ systems interrelation and apply a holistic approach to human health.

CO5: Apply concept and knowledge of human systems to novel technical and/or clinical scenarios

REFERENCES:

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy and Physiology. 11th Edition, Pearson Publishers, 2014 -
2. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Fifth Edition , Oxford University Press, USA, 2017.
3. William F.Ganong, “Review of Medical Physiology”, 22nd Edition, Mc Graw Hill, New Delhi, 2010.
4. Eldra Pearl Solomon, “Introduction to Human Anatomy and Physiology”, - 4th Edition , W.B. Saunders Company, 2015.
5. Guyton & Hall, “Medical Physiology”, 13th Edition - Elsevier Saunders, 2015.
6. Elaine.N.Marieb, "Essential of Human Anatomy and Physiology", Eleventh Edition, Pearson Education, New Delhi, 2015.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	2	2	2	2
2	2	2	2	2	2	2
3	2	2	2	1	1	2
4	2	2	2	-	1	1
5	2	1	1	1	1	1
Avg	**2.2**	**1.8**	**1.8**	**1.5**	**1.4**	**1.6**

MX4111 BIOMEDICAL INSTRUMENTATION LABORATORY L T P C
0 0 3 1.5

COURSE OBJECTIVES:

- Familiarize the preamplifiers and signal conditioning circuits for ECG acquisition.
- Understand the designing of amplifiers for acquiring bio signals like EEG, EOG, and EMG.
- Study the concept of designing an isolation amplifier.
- Learn the different measurement techniques for non-electrical parameters.
- Design the PCB layout for any bio amplifier.

LIST OF EXPERIMENTS:

1. Design of pre amplifiers to acquire bio signals along with impedance matching circuit using suitable IC‘s.
2. Design of ECG Amplifiers with appropriate filter to remove power line and other artefacts.
3. Design of EMG amplifier.
4. Design a suitable circuit to detect QRS complex and measure heart rate.
5. Design of frontal EEG amplifier.
6. Design of EOG amplifier to detect eye blink.

7. Design a right leg driven ECG amplifier.
8. Design a Pulse Oximeter and Measure O2 Saturation and HR
9. Design and study the characteristics of optical Isolation amplifier.
10. Measurement of pulse-rate using Photo transducer.
11. Measurement of pH and conductivity.
12. Measurement of blood pressure using sphygmomanometer.
13. Measurement and recording of peripheral blood flow.
14. Design a PCB layout for any bio amplifier using suitable software tool.

COURSE OUTCOMES:

Upon completion of this course the students will be able to

CO1: Design and implement preamplifiers and signal conditioning circuits for ECG signal acquisition.

CO2: Design and implement amplifiers for different bio signals like EEG, EOG, EMG.

CO3: Design an optical isolation amplifier

CO4: Acquire various non-electrical parameters using suitable sensors/transducers.

CO5: Implement PCB layout for any bio amplifier.

TOTAL:45 PERIODS

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	2	2	2	2
2	2	2	2	2	2	2
3	2	2	1	2	1	2
4	2	2	2	1	2	1
5	1	1	1	1	1	1
Avg	1.8	1.8	1.6	1.6	1.6	1.6

BM4161 BIO SIGNAL PROCESSING LABORATORY L T P C

0 0 3 1.5

COURSE OBJECTIVES:

- To understand the analysis of biosignals
- To know the various methods for denoising of biosignals.
- To understand the extraction of features in biosignals
- To gain knowledge about biosignal compression.
- To detect and classify the abnormalities in biosignals

LIST OF EXPERIMENTS: MATLAB / EQUIVALENT SOFTWARE PACKAGE

1. Removal of noise and artifact using filtering
2. Denoising of biosignals using wavelets
3. Noise cancellation using Adaptive filters
4. QRS detection using Pan-Tompkins algorithm
5. Heart rate variability analysis in ECG signals
6. Event detection in EEG signals

7. Cepstral analysis of speech signals
8. Multiresolution analysis of EEG signal using wavelet transform
9. Feature extraction in EMG signals
10. Adaptive segmentation of EEG signals
11. Feature reduction using PCA
12. Disease classification of biosignals
13. Autoregressive modelling of biosignals
14. Biosignal compression
15. Biosignal analysis in virtual instrumentation platform

COURSE OUTCOMES:

On completion of the laboratory course, the students will be able to:

CO1: Develop an algorithm for preprocessing of biosignals.

CO2: Perform denoising and analyze the spectral characteristics of biosignals.

CO3: Perform biosignal compression.

CO4: Analyze the biosignals in virtual instrumentation platform

TOTAL:45 PERIODS

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	3	3	2	2
2	3	2	3	3	2	2
3	3	2	3	3	2	2
4	3	2	3	3	2	2
5	3	2	3	3	3	2
Avg	**3**	**2**	**3**	**3**	**2.2**	**2**

MX4291 MEDICAL IMAGE PROCESSING L T P C
3 0 2 4

COURSE OBJECTIVES:

- To understand the fundamentals of medical image processing techniques.
- To understand the basic concepts of image enhancement, image restoration, morphological image processing, image segmentation, feature recognition in medical images
- To provide information about various medical imaging modalities
- To provide information about classification and image visualization in medical image processing projects.
- To familiarize the student with the image processing facilities in Matlab, Python and openCV

UNIT I FUNDAMENTALS OF IMAGE PROCESSING 9

Image perception, MTF of the visual system, Image fidelity criteria, Image model, Image sampling and quantization – two dimensional sampling theory, Image quantization, Optimum mean square quantizer, Image transforms – 2D-DFT and other transforms. DFT, DCT, KLT, SVD

UNIT II MEDICAL IMAGE ENHANCEMENT AND RESTORATION 9

Image Enhancement operation, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contra harmonic mean filters, Homomorphic filtering, Color image enhancement. Image Restoration - degradation model, Unconstrained and constrained restoration, Inverse filtering- Wiener filtering

UNIT III MEDICAL IMAGE REPRESENTATION 9

Pixels and voxels – algebraic image operations - gray scale and color representation- depth-color and look up tables - image file formats- DICOM- other formats- Analyze 7.5, NifTI and Interfile, Image quality and the signal to noise ratio

UNIT IV MEDICAL IMAGE ANALYSIS AND CLASSIFICATION 9

Image segmentation- pixel based, edge based, region based segmentation. Image representation and analysis, Feature extraction and representation, Statistical, Shape, Texture, feature and image classification – Statistical, Rule based, Neural Network approaches

UNIT V IMAGE REGISTRATIONS AND VISUALIZATION 9

Image Registration: Rigid body transformation – Affine transformation, Principal axes registration, Iterative principal axes registration, Feature based registration, Elastic deformation based registration, Registration of Images from Different modalities, Evaluation of Registration Methods. **Image visualization**: 2-D display methods, 3-D display methods, surface and volume based 3-D display methods – Surface Visualization and Volume visualization, 3-D Echocardiography, 3D+time Echocardiography, virtual reality based interactive visualization.

45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

The following experiments should be performed in OpenCV / Python / Scilab / Matlab Octave / other Open source software.

LIST OF EXPERIMENTS

1. Preprocessing of medical images
2. Filtering of medical images.
3. Edge detection using Python
4. Segmentation of ROI in medical images.
5. Feature extraction in medical images
6. Steganography using OpenCV.
7. Medical image fusion.
8. Statistical analysis of features
9. Neural network based classification.

COURSE OUTCOMES:

Upon Completion of the course, the students should be able to:

CO1: Apply basic medical image processing algorithms

CO2: Image pre-processing applications that incorporates different concepts of filters for medical Image Processing and reconstruction of an image

CO3: Describe the image representation model

CO4: Analysis of image segmentation, feature extraction and image classification

CO5: Explore the knowledge in image registration and visualization and possibility of applying Image processing concepts in modern hospitals

TOTAL:75 PERIODS

REFERENCES

1. Atam P.Dhawan, Medical Image Analysis, 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2011.
2. Anil K Jain, Fundamentals of Digital Image Processing, 1st Edition, Pearson Education India, 2015.
3. Rafael C.Gonzalez and Richard E.Woods, Digital Image Processing, 4th Edition, Pearson Education, 2018.
4. Wolfgang Birkfellner, ―Applied Medical Image Processing – A Basic course‖, CRC Press, 2011
5. Geoff Dougherty, Digital Image Processing for Medical Applications, 1st Edition, Cambridge University Press, 2010.
6. John L.Semmlow, ―Biosignal and Biomedical Image Processing Matlab Based applications‖ Marcel Dekker Inc.,New York,2004
7. Kavyan Najarian and Robert Splerstor, ―Biomedical signals and Image processing‖,CRC – Taylor and Francis,New York,2006
8. Milan Sonka et al, ―Image Processing, Analysis and Machine Vision‖, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.
9. Ravikanth Malladi, Geometric Methods in Biomedical Image Processing (Mathematics and Visualization), 1st Edition, Springer-Verlag Berlin Heidelberg 2002.
10. Joseph V. Hajnal, Derek L.G. Hill and David J. Hawkes, Medical Image Registration, CRC Press, 2001.

CO-PO Mapping

CO	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	2	-	2	2	2	1
2	2	1	2	3	2	1
3	1	1	2	2	1	1
4	3	-	2	3	3	2
5	2	1	1	2	1	2
Avg	**2**	**0.6**	**1.8**	**2.4**	**1.8**	**1.4**

MX4201 MEDICAL ELECTRONICS DEVICE DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

- To explore the concepts in designing power systems for medical electronics.
- To understand the essential circuitry needed for sensor design.
- To develop an understanding of data acquisition system design.
- To provide knowledge about noise cancellation system
- To gain necessary knowledge about the hardware implementation of DSP.

UNIT I DESIGN OF POWER SUBSYSTEMS IN MEDICAL ELECTRONICS **9**

Transient voltage protections- Electromagnetic interference- Inrush current control-

Overvoltage protection- Under voltage protection- Overload protection- Output filtering- Power failure warning- Flightback switch back power supplies- Half-bridge Flyback converters

UNIT II SENSOR DESIGN FUNDAMENTALS 9

Sensor parameters- Sensor Interfacing- Signal conditioning amplifiers- Instrumentation amplifiers- Isolation amplifiers- Charge-coupled device sensors- Position and motion sensors- Accelerometers- Temperature sensors- Fiber optics based medical sensors

UNIT III DATA ACQUISITION SYSTEMS 9

Sample and hold conversion- Multichannel acquisition- High speed sampling in ADC- Selection of drive amplifier for ADC performance- Driving ADCs with switched capacitor inputs- ADC input protection- External protection of amplifiers- High speed ADC architectures

UNIT IV NOISE AND INTERFERENCE ISSUES IN ANALOG CIRCUITS 9

Noise calculations in Op-Amp- Internal noise in Op-Amps- Proper power supply decoupling- Bypass capacitors and resonances- Designing power bus rails in power-ground planes for noise control- ASIC

UNIT V HARDWARE APPROACH TO DIGITAL SIGNAL PROCESSING 9

DSP hardware- Arithmetic logic unit- Multiplier-accumulator- Shifter- Data address generators- Program sequencer- Serial ports- Interfacing ADCs and DACs to digital signal processors- Parallel ADCs o DSP interface- Parallel DAC to DSP interface- Serial interfacing to DSP processors

COURSE OUTCOMES:

CO1: Understand the power systems used in the design of medical electronics devices
CO2: Classify the biosensors design according the type of device
CO3: Interpret the data acquired from the sensors.
CO4: Enumerate the noise and interference issues in the devices
CO5: Understand the signal processing of the medical electronic device

TOTAL:45 PERIODS

REFERENCES

1. Kunal Pal, Heinz-Bernhard Kraatz, Anwesha Khasnobish, Bioelectronic and medical devices, Elsevier, 2019.
2. Rüdiger Kramme, Klaus-Peter Hoffmann, Robert Steven Pozos, Springer handbook of medical technology, Springer, 2011
3. Reinaldo Perez, Design of medical electronic devices, Academic press, 2002.
4. David prutchi, Michael Norris, Design and Development of Medical electronic instrumentation, Wiley interscience, 2005.
5. Dennis Fitzpatrick, Implantable electronic medical devices, Elsevier, 2015.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	1	2	2	1

2	2	2	2	1	2	1
3	2	2	2	1	1	1
4	2	2	1	1	2	2
5	2	2	2	2	2	2
Avg	**2**	**2**	**1.6**	**1.4**	**1.8**	**1.4**

MX4202 MEDICAL IMAGING SYSTEMS AND RADIO THERAPY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the production of x-rays and its application to different medical Imaging
- To explore the different types of Radio diagnostic techniques.
- To understand the special imaging techniques for visualizing the cross sections of the body.
- To understand the production of Magnetic resonance images for various pulse sequences.
- To realize the importance of image quality assessments for medical imaging systems.

UNIT I X – RAYS 9

Principle and production of soft X – Rays, X- ray machine and digital radiography, principles of Angiography and Fluoroscopic Techniques, digital subtraction angiography, mammography.

UNIT II CT AND ULTRASOUND IMAGING 9

CT principle- Multi section Radiography, Computerized Axial Tomography, Type of Detection, image reconstruction, Spiral CT, Transverse Tomography,3D Imaging. Ultrasonic frequency for medical application, different modes of Display A, B and M, ultrasonic probes, Real time echo and 2D scanner.

UNIT III COMPUTER AIDED TOMOGRAPHY 9

Need for sectional images, Principles of sectional scanning, Method of convolution and Back Propagation, Methods of reconstruction, Multislice CT, artifacts.

UNIT IV MAGNETIC RESONANCE IMAGING AND EMISSION COMPUTED TOMOGRAPHY IMAGING 9

Principle of MRI, MRI instrumentation, Imaging Different Sections of the Body, Tissue Characterization, MR Spectroscopy, Functional MRI. Alpha, Beta, Gamma Emission, different types of Radiation Detectors, Functions of Gamma Camera, PET, SPECT, PET/CT, PET/MRI.

UNIT V QUALITY METRICS FOR IMAGING SYSTEMS 9

Global parameter assessment, spatial – frequency assessment, Image – processing assessment, Observer assessment, Image discrimination models, figure of merit, Comparing model to human performance.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1: Explain the functionalities and applications of X ray in medicine.
CO2: Demonstrate the images acquisition procedures using CT.
CO3: Explain the suitable projection methods for anatomy and biology specific.
CO4: Demonstrate the applications of magnetic fields in the field of medicine.
CO5: Explain the assessment method to quantify the presence of noise in the image.

REFERENCES

1. Richard L. Van Metter, Jacob Beutel, Harold L. Kundel, Handbook of Medical Imaging, Volume 1. Physics and Psychophysics, SPIE, 2000
2. Chesney D. N., Chesney M. O. Radio graphic imaging, CBS Publications, New Delhi, 1987.
3. Donald W. McRobbice, Elizabeth A. Moore, Martin J. Grave and Martin R. Prince MRI from Picture to proton, Cambridge University press, second edition, New York 2007.
4. Frederick W Kremkau, Diagnostic Ultrasound Principles & Instruments, Saunders Elsevier, 2005.
5. Jerry L. Prince, Jonathan M. Links, Medical Imaging Signals and Systems- Pearson Education Inc. 2014.
6. Peggy, W., Roger D. Ferimarch, MRI for Technologists, McGraw Hill, New York, second edition, 2000.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	1	2	1	2
2	2	2	1	2	2	1
3	2	2	2	2	1	1
4	2	2	1	2	2	1
5	2	2	2	2	2	2
Avg	1.8	2	1.4	2	1.6	1.4

BM4251 AI AND MACHINE LEARNING L T P C
3 0 2 4

COURSE OBJECTIVES:

- To introduce the concept of machine learning
- To learn and apply neural networks for pattern classification and regression problems
- To introduce the ideas of fuzzy sets, fuzzy logic
- To familiarize with genetic algorithms for seeking global optimum in self-learning situations
- To introduce the Deep learning concept for medical image analysis

UNIT I INTRODUCTION TO MACHINE LEARNING 9

Machine Learning – Basic Concepts in Machine Learning – Types of Machine Learning – Examples of Machine Learning – Applications – Linear Models for Regression – Linear Basis Function Models – The Bias-Variance Decomposition – Bayesian Linear Regression – Dimensionality Reduction.

UNIT II NEURAL NETWORKS 9

Biological Neurons and their Artificial models, Learning Rules, Single Layer Perceptron Classifiers., Back Propagation Network, generalized delta rule, Associative Memory, Adaptive Resonance Theory (ART) Network Descriptions

UNIT III FUZZY LOGIC SYSTEMS 9

Fuzzy Logic System: Basic of fuzzy logic theory , crisp and fuzzy sets, Basic set operation like

union , interaction , complement , T-norm , T-conorm , fuzzy relations, fuzzy if-then rules , fuzzy reasoning, Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference System (ANFIS) , ANFIS architecture , Hybrid Learning Algorithm

UNIT IV EVOLUTIONARY COMPUTATION & GENETIC ALGORITHMS **9**

Evolutionary Computation (EC) – Features of EC – Classification of EC – Advantages – Applications. Genetic Algorithms: Introduction – Biological Background – Operators in GA-GA Algorithm – Classification of GA – Applications

UNIT V ADVANCES AND APPLICATIONS **9**

Support Vector Machines, RBF Network. Introduction to Deep Learning – Convolutional Neural Network. Case Study – Neural Network based Classification of Biosignal and Medical Images.

45 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

1. Implement Simple Programs like vector addition in TensorFlow.
2. Implement a simple problem like regression model in Keras.
3. Implement a perceptron in TensorFlow/Keras Environment.
4. Implement a Feed-Forward Network in TensorFlow/Keras.
5. Implement an Image Classifier using CNN in TensorFlow/Keras.
6. Develop an abnormal detection system for bio signal data using fuzzy logic.
7. Develop a system to implement Neural Networks techniques to define predictive models for Abnormal detection.
8. Develop a system that can optimize the solution of the abnormal detection system developed by fuzzy logic
9. Implement a biosignal/medical image Classifier using CNN.

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1: Identify and describe machine learning techniques and their roles in building intelligent system

CO2: Design neural networks for pattern classification and regression problems

CO3: Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems**.**

CO4: Apply genetic algorithms to optimization problems**.**

CO5: Apply Deep learning concept for biomedical signal analysis and Medical image analysis

TOTAL:75 PERIODS

REFERENCES

1. Tom M. Mitchell, “Machine Learning”, McGraw-Hill Education (INDIAN EDITION), 2013
2. Ethem Alpaydin, “Introduction to Machine Learning”, 2nd Ed., PHI Learning Pvt. Ltd., 2013.
3. T. Hastie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning, Springer; 1st edition, 2001.
4. Wolfgang Ertel, “Introduction to Artificial Intelligence”, Springer, 2nd Edition, 2017
5. Nello Cristianini, John Shawe-Taylor, "An Introduction to Support Vector Machines and Other Kernel-based Learning Methods”,Cambridge University Press. 2013
6. Timothy Ross, “Fuzzy Logic with Engineering Applications”, Wiley, 2016

7. David E. Goldberg, “Genetic Algorithms in search, Optimization & Machine Learning”, Pearson Education, 2006
8. Neural Networks and Deep Learning by Michael Nielsen., March 2017.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1			2	2	
2	1			2	2	
3	1			3	2	1
4	1		2	3	3	1
5	3		3	3	3	3
Avg	1.4		2.5	2.6	2.4	1.6

MX4211 MEDICAL ELECTRONICS DEVICE DESIGN LABORATORY **L T P C 0 0 4 2**

COURSE OBJECTIVES

- To understand the production of x-rays and its application to different medical Imaging
- To explore the different types of Radio diagnostic techniques.
- To understand the special imaging techniques for visualizing the cross sections of the body.
- To understand the production of Magnetic resonance images for various pulse sequences.
- To realize the importance of image quality assessments for medical imaging systems.

LIST OF EXPERIMENTS:

1. Simulation of over voltage protection circuit
2. Simulation of under voltage protection circuit
3. Simulation of instrumentation amplifier
4. Accelerometer data acquisition and displaying system
5. Multichannel data acquisition for EEG recording
6. Simulation of switched capacitor system
7. Modeling and simulation of internal noise cancellation circuit.
8. Cross talk cancellation system
9. Serial Interfacing to DSP
10. Parallel interfacing to DSP

TOTAL:60 PERIODS

COURSE OUTCOMES:

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

CO1: Explain the functionalities and applications of X ray in medicine.

CO2: Demonstrate the images acquisition procedures using CT.

CO3: Explain the suitable projection methods for anatomy and biology specific.

CO4: Demonstrate the applications of magnetic fields in the field of medicine.

CO5: Explain the assessment method to quantify the presence of noise in the image.

CO-PO Mapping

CO	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	2	2	1	2	2	1
2	2	2	2	1	2	1
3	2	2	2	1	1	1
4	2	2	1	1	2	2
5	2	2	2	2	2	2
Avg	**2**	**2**	**1.6**	**1.4**	**1.8**	**1.4**

MX4212 TERM PAPER WRITING AND SEMINAR L T P C
0 0 2 1

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.
Activities to be carried out

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic	You are requested to select an area of interest, topic and state an objective	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Stating an Objective			

Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area.	3rd week	**3%** (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered	4th week	**6%** (the list of standard papers and reason for selection)
Reading and notes for first 5 papers	Reading Paper Process • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion?	5th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)

	• What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)		
Reading and notes for next5 papers	Repeat Reading Paper Process	6th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	**8%** (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	**6%** (Clarity, purpose and conclusion) **6%** Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	**5%** (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11thweek	**10%** (this component will be evaluated based on the linking and classification among the papers)

Your conclusions	Write your conclusions and future work	12th week	**5%** (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13th week	**10%** (formatting, English, Clarity and linking) **4%** Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th & 15th week	**10%** (based on presentation and Viva-voce)

TOTAL: 30 PERIODS

MX4001 NANOTECHNOLOGY AND ITS APPLICATIONS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the essential features of biology and nanotechnology that are converging to create the new areas of bio nanotechnology and nanomedicine.
- To understand the principles behind nanomedicine and the applications of nanomaterials in medicine.
- To understand the need, problem and solutions for polymeric, lipidous and solid nanosized drug delivery systems.
- To impart the knowledge to apply the nanomaterials in different medical applications.
- To know the underlying concept in engineering and implement in nano centric applications

UNIT I INTRODUCTION OF NANOPARTICLES 9

Overview of nanotechnology from a medical perspective, different types of nanobiomaterials and nanostructure interactions. Synthesis and characterization of smart nanomaterials, surface modification, biofunctionalization of nanomaterials.

UNIT II NANOMATERIALS AND NANOENGINEERING 9

Lipid- based (liposomes, micelles, solid lipid nanoparticles) and magnetic based particles and their delivery for biomedical applications. Inorganic nanoparticles, carbon- based (fullerenes, buckyballs and carbon nanotubes), biodistribution and its fate.

UNIT III NANOTECHNOLOGY IN DRUG DELIVERY 9

Nanoshells, nanopores, Tectodendrimers, active and passive cell targeting, viral based drug delivery system-nanoparticle drug system for oral administration, drug system for nasal administration, drug system for ocular administration, nanotechnology in diagnostic application. Preformulation studies: on various dosage forms such as tablets, capsule, suspension, creams, emulsion, injectables ophthalmic and aerosols etc.

UNIT IV NANOTECHNOLOGY IN IMAGING, DIAGNOSTIC AND DETECTION 9

Nuclear imaging systems –SPECT and PET, advanced MR imaging, optical imaging and CT. Ultrasound imaging and therapy, nanoimaging systems, micro/nano fluidics, diagnostics, and

biosensors.

UNIT V APPLICATION IN CANCER THERAPY 9

Introduction and rationale for nanotechnology in cancer therapy - passive targeting of solid tumors and active targeting strategies in cancer, Pharmacokinetics of nanocarrier-mediated drug and gene delivery - multifunctional nanoparticles for cancer therapy- neutron capture therapy of cancer: Nanoparticles and high molecular weight boron delivery agents. Nanooncology, nano neurology, nanocardiology, nano-orthopedics and nano-Ophthalmology.

COURSE OUTCOMES: On completion of this course the student will be able to:

CO1: Understand latest scientific developments and discoveries in the field of Nanomedicine.

CO2: Understand the toxicological aspects of Nano sized particles.

CO3: Understand basic stem cell biology and corresponding requirement for tissue engineering.

CO4: Follow the new findings in the area of Nanomedicine and implement the perspectives in own research.

CO5: Understand new approaches in nanotechnology that can be used in biomedical therapies.

TOTAL:45 PERIODS

REFERENCES

1. CM, Niemeyer C.A. Mirkin., Nanobiotechnology – Concepts, Applications and Perspectives – 2004, Wiley – VCH.
2. Nicholas A. Kotov, Nanoparticle Assemblies and Superstructures. 2006 -CRC.
3. Nano: The Essentials: T. Pradeep. McGraw – Hill education – 2007.
4. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschner, Nanofabrication towards Biomedical Applications, Techniques, Tools, Applications and Impact.2005, Wiley – VCH.
5. Kewal K. Jain, The Handbook of Nanomedicine. Humana Press, (2008).
6. Zhang, Nanomedicine, A Systems Engineering Approach 1st Ed., Pan Stanford Publishing, (2005).
7. Robert A. Freitas Jr., Nanomedicine Volume IIA: Biocompatibility, Landes Bioscience Publishers, (2003).

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	2		1	1
2	1	1			1	1
3	2	2	2			1
4	3	2	2	1		1
5	2	1	1	1		1
Avg	2.2	1.5	1.75	1	1	1

MX4002 BIOMECHANICS L T P C

3 0 0 3

COURSE OBJECTIVES:

- To get a clear understanding of the application of mechanics in medicine.
- To study the properties of blood, bone and soft tissues like articular cartilage tendons

and ligaments

- To gain necessary knowledge about accidents and injuries.

UNIT I INTRODUCTION 9

Introduction to biomechanics, relation between mechanics and Medicine, Newton's laws, stress, strain, shear rate, viscosity, viscoelasticity, non-Newtonian viscosity, soft tissue mechanics, mechanical properties of soft biological tissues. Anthropometry.

UNIT II MECHANICS OF CIRCULATION 9

Flow properties of blood, effect of shear rate, hematocrit, temperature and protein Content of blood, rheology of blood and microvessels, dynamics of circulatory system, turbulence flow around prosthetic heart valves.

UNIT III MECHANICS APPLIED TO ORTHOPEDICS 9

Orthopedic biomechanics, mechanical properties of bones, stress-induced bone growth, kinematics and kinetics of joints, lubrication of joints, gait analysis, spatio-temporal parameters of gait. Analysis of force in orthopedic implants.

UNIT IV MECHANISM OF BIOLOGICAL SYSTEMS 9

Skeletal muscles servo mechanism, Cardiovascular control mechanism, respiratory control mechanism, Finite element analysis in Biomechanics - case study.

UNIT V BIOMECHANICAL ASPECT OF ACCIDENT INVESTIGATION 9

Experimental and Analytical method of analysis, Clinical evaluation, Head Injury tolerance, rotational injury, spine injury – Accident reconstruction, Analysis of impact, skid analysis – Damage analysis.

COURSE OUTCOMES: On completion of this course the student will be able to:

CO1: To get a clear understanding of application of mechanics in medicine

CO2: To study the properties of blood, bone and soft tissues like articular cartilage tendons and ligaments

CO3: Acquire knowledge of evaluating the force in implants

CO4: Analysis on different injuries from accident investigation

CO5: Acquired a conceptual and theoretical framework of the design, development, and implementation of orthopedic implants

TOTAL:45 PERIODS

REFERENCES

1. Y.C.Fung, Biomechanics: Mechanical properties in living tissues, Springer Verlag, New York 1981.
2. Susan J.Hall, Basics BioMechanics 4th Edition, McGraw-Hill Publishing Co, 2002.
3. Subrata pal, Text book of Biomechanics, Viva education private limited, 2009.
4. C.R Ethier and C.A.Simmons , Biomechanics from cells to organisms,
5. D.Dawson and Right, Introduction to Biomechanics of joints and joint replacement, Mechanical Engineering, publications Ltd. 1989
6. Jacob Kline, Head book of BioMedical Engineering, Academic Press

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	3	1	1	1
2	1	2	2	1		1
3	2	2	1	2		
4	3	3	2	2		1
5	2	2	2	2	2	
Avg	2.2	2	2	1.6	1	1

MX4003 **BIOMETRICS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of Biometrics and its functionalities
- To learn the role of physiological traits in biometrics
- To identify the concept of behavioral traits
- To expose the user interface in context of Biometric Applications
- To learn to develop applications with biometric security

UNIT I INTRODUCTION **9**

Biometrics versus traditional techniques, Characteristics, Processes, Performance measures, Assessing the privacy risks of biometrics - Designing privacy sympathetic biometric systems, Biometric standards, Applications and properties, Biometrics in medicine.

UNIT II PHYSIOLOGICAL TRAITS **9**

Face, Ear, Retina, Iris, Finger, Automated fingerprint identification system, Palm print, Hand vascular geometry analysis, , Dental, Cognitive Biometrics: ECG, EEG

UNIT III BEHAVIORAL TRAITS **9**

Signature, Keystroke, Voice, Gait, Gesture recognition, Video face, Mapping the body technology, Case Study.

UNIT IV USER INTERFACE **9**

Biometric interfaces: Human machine interface - Iris image interface - Hand geometry and fingerprint sensor, - Securing Biometric templates - Cancellable biometrics

UNIT V APPLICATION AREAS **9**

Surveillance applications- personal applications –design and deployment -user system interaction-operational processes – architecture –application development –design validation disaster recovery plan-maintenance-privacy concerns

COURSE OUTCOMES:

CO1: Knowledge on the general principles of design of biometric systems and the underlying trade-offs

CO2: Identify the technologies of fingerprint, iris, face and speech recognition
CO3: Understand the various Behavioral Biometrics.
CO4: Enumerate the user interfaces
CO5: Inculcate knowledge on personal privacy and security implications of biometrics based identification technology and the issues involved.

TOTAL:45 PERIODS

REFERENCES

1. Paul Reid, "Biometrics for Network Security", Pearson Education, New Delhi, 2013.
2. Samir Nanavati, Michael Thieme and Raj Nanavati, "Biometrics – Identity Verification in a Networked World", John Wiley and Sons, New Delhi, 2012.
3. Anil K Jain, Patrick Flynn and Arun A Ross, "Handbook of Biometrics", Springer, USA,2010.
4. John D Woodward, Nicholas M Orlans and Peter T Higgins, "Biometrics: The Ultimate Reference", Dream Tech, New Delhi,2009.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	2	1	1	1
2	2	2	2	2	2	2
3	2	2	1	2	1	1
4	2	2	2	2	3	3
Avg	**2**	**2**	**1.6**	**1.8**	**1.8**	**1.8**

MX4004 BIOMATERIALS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce concepts of materials and interaction of surfaces towards biomaterials.
- To learn about the polymeric materials and composites in tissue replacements.
- To study the various techniques involved in controlling the microbial growth on the surfaces.
- To understand diverse elements controlling biological responses to materials.
- To know the compatibility and functioning of artificial organs inside the living system.

UNIT I INTRODUCTION 10

Definition of biomaterials, mechanical properties, surface chemistry of materials, surface modification, Tissue Reaction, Wound Kinetics, Bio Compatibility.

UNIT II MATERIALS IN MEDICAL DEVICES 10

Metals, Ceramics, Polymers and Biomimetic Materials, Composites. Material preparation, chemical composition, properties, uses in medicine and biosciences and failure mechanisms.

UNIT III STERILIZATION OF BIOMATERIALS 7

Sterilization techniques: Process and mechanism of action of steam sterilization, radiation

sterilization, electron beam sterilization, ethylene oxide, chlorine dioxide and plasma gas sterilization

UNIT IV TESTING OF MATERIALS 8

Testing with Tissue Culture – in vitro and in vivo assessment of biocompatibility, Testing with Soft Tissues and testing at non Thrombogenic surface – blood compatibility and thrombogenicity, ISO 10993- standard for assessment of biocompatibility.

UNIT V HARD AND SOFT REPLACEMENT 10

Cardiac Implants, Orthopedic Implants, Neuro Muscular Implants, Transcutaneous Implants, Intraocular lenses.

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1: Understand the basic principles in material science and their contribution towards Biomedical engineering

CO2: Analyze different types of materials and apply them in designing a device

CO3: Select the materials for designing an implant in tissue replacement

CO4: Identify significant gaps required to overcome challenges and further developments

CO5: Critically review papers from the scientific journals and identify areas of research opportunities

TOTAL:45 PERIODS

REFERENCES

1. J.H.U.Brown (Ed), Advances in BioMedical Engineering, Academic Press 1975.
2. Andrew F.Von Racum, HandBook of Bio Medical Evaluation, Mc-Millan Publishers, 1980.
3. Jacob Cline, HandBook of BioMedical Engineering, Academic Press in Sandiego, 1988.
4. Jonathan Black, Biological Performance of Materials- Fundamentals of biocompatibility, 4th Edition, CRC Press 2005.
5. Larry L. Hench and Julian R.Jones, Biomaterials, Artificial organs and Tissue Engineering, 2005.
6. Buddy D.Ratner, Allan S .Hoffman, Frederick J. Schoen, Jack E. Lemons, Biomaterial Science; An Introduction to Materials in Medicine,2nd Edition, Elsevier Academic Press, San Diego, 2004.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	3	2	2	1
2	2	2	2	1	2	1
3	2	1	1		1	1
4	2	2	2			1
5	2	2	1		2	1

Avg	**2.2**	**1.8**	**1.8**	**1.5**	**1.7**	**1**

MX4072 **MEDICAL OPTICS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand various optical properties of tissue
- To gain the knowledge of photonics instruments
- To know the engineering and practical applications of optics related to diagnostics applications
- To acquire knowledge about therapeutic and surgical applications of lasers in medical fields
- To gain the knowledge of fiber optic sensors used In medical application

UNIT I OPTICAL PROPERTIES OF THE TISSUES 9

Optical properties of tissue- melanin, bilirubin, tissue and their spectrum, optical characteristics of constituents of blood – RBC, hemoglobin properties, plasma, oxygenated and deoxygenated hemoglobin, Laser tissue Interaction-Chemical, Thermal, Electromechanical. Photo ablative processes. Laser safety procedures

UNIT II INSTRUMENTATION IN PHOTONICS 9

Review of basic properties of light – Reflection, Refraction, Scattering, fluorescence and phosphorescence. Instrumentation for absorption, scattering and emission measurements. Optical sources – high pressure arc lamps, LEDs, Medical Lasers. Optical filters. Optical detectors - Time resolved and phase resolved detectors, optical tweezers

UNIT III DIAGNOSTIC APPLICATIONS 9

Wood's lamp, Imaging techniques - Optical coherence tomography, Elastography, Fluorescence Imaging, Raman Imaging, FLIM, FRAP, NIRS-Application, X-Ray Diagnostic Techniques, Speckle Correlometry, Near-Field Imaging in Biological and Biomedical Applications

UNIT IV THERAPEUTIC AND SURGICAL APPLICATIONS OF LIGHT 9

Phototherapy, Photodynamic therapy (PDT) - Principle and mechanism - Oncological and non-oncological applications of PDT - Biostimulation effect – applications. Laser in tissue welding, lasers in dermatology, lasers in ophthalmology, otolaryngology, urology, neurology, orthopedics, gastroenterology.

UNIT V FIBER OPTIC SENSORS AND APPLICATIONS 9

Light transport in the optical fiber - Total internal reflection, Numerical aperture, Angle of acceptance. losses in fiber, Optical sensors based on polarization, magnetic sensors, Medical applications of fiber optic sensors in measuring temperature, pressure, flow and chemical activities

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1: Understand various optical properties of tissue

CO2: Describe the photonics instruments

CO3: Know the diagnostic applications of lasers in medical fields
CO4: Explain the therapeutic and surgical applications of lasers in medical fields
CO5: Describe the types of fiber optic sensors used in medical application

TOTAL:45 PERIODS

REFERENCES

1. Mark E. Brezinski, "Optical Coherence Tomography: Principles and Applications",Academic Press, 2006.
2. Markolf H.Niemz, "Laser-Tissue Interaction Fundamentals and Applications", Springer, 2007.
3. Paras N. Prasad, "Introduction to Biophotonics, A. John Wiley and sons", Inc. Publications,2003.
4. R. Splinter and B.A. Hooper, "An Introduction to BioMedical Optics", Taylor and Francis,2007.
5. Tuan Vo Dinh, "Biomedical photonics – Handbook", CRC Press LLC, 2003. .

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	2	1	-	-
2	1	1	1	-	-	1
3	2	1	2	-	-	2
4	2	1	2	1	-	2
5	2	1	2	1	-	2
Avg	1.6	1	1.8	1	-	1.75

MX4071 HUMAN ASSIST DEVICES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To know the principle and design of Heart lung machine and artificial heart
- To acquire knowledge of various cardiac assist devices,
- To study implantation of artificial kidney
- To understand the principle of prosthetic and orthotic devices for the disability
- To Gain knowledge in respiratory devices and hearing aids

UNIT I HEART LUNG MACHINE AND ARTIFICIAL HEART 9

Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Mock test setup for assessing its Functions

UNIT II CARDIAC ASSIST DEVICES 9

Synchronous Counter pulsation, Assisted through Respiration Right Ventricular Bypass Pump, Left Ventricular Bypass Pump, Open Chest and closed Chest type, Intra Aortic

Balloon Pumping Veno Arterial Pumping, Prosthetic Cardiac Valves, Principle and problem, Biomaterials for implantable purposes, its characteristics and testing.

UNIT III ARTIFICIAL KIDNEY 9

Indication and Principle of Haemodialysis, Membrane, Dialysate, Different types of hemodialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type

UNIT IV PROSTHETIC AND ORTHOTIC DEVICES 9

Spinal orthotics and Prosthesis, Splint – Static and Dynamic. Hand and Arm Replacement - Different Types of Models Externally Powered Limb Prosthesis, Intelligent prosthesis, Lower Limb and Upper limb orthotic devices, Functional Electrical Stimulation, Sensory Assist Devices, Materials for Prosthetic and orthotic devices, Haptic Devices, Transcutaneous electrical nerve stimulator.

UNIT V RESPIRATORY AND HEARING AIDS 9

Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, Construction and Functional Characteristics

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Knowledge about the importance of Heart lung machine and artificial Heart
CO2: Knowledge about the importance of different types of assist devices and related issues
CO3: Understand about the implantation of artificial kidney
CO4: Explore the different types of models for Prosthetic and orthotic purpose
CO5: Perceive the knowledge in different types of respiratory and hearing aids

REFERENCES

1. Andreas.F.Von racum, Handbook of biomaterial evaluation, Mc-Millan publishers, 1980
2. Albert M.Cook and Webster J.G., Therapeutic Medical Devices, Prentice Hall Inc.,New Jersey,1982
3. Gray E Wnek, Gray L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering –Marcel Dekker Inc New York 2004
4. John. G . Webster – Bioinstrumentation - John Wiley & Sons (Asia) Pvt Ltd - 2008
5. Kolff W.J., Artificial Organs, John Wiley and Sons, New York, 1979.
6. Gerr . M. Craddock “Assistive Technology-Shaping the future”, IOS Press, 1st edition, 2003.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1		1	1	3	2
2	1		1	1	3	1
3	1		1	1	3	1
4	1		2	1	2	3

5	1		2	2	1	3
Avg	**1**		**1.4**	**1.2**	**2.4**	**2**

BM4074 WEARABLE TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- Identify the motivation, guiding principles, and challenges of Wearable Computing.
- Develop skills pertaining to the design of a holistic interactive wearable system comprising of the physical, digital, and the human aspects.
- To provide the basic understanding of measurement and instrumentation systems and the insight of the resistive sensors and its applications in real life..
- To introduce the concept of the reactive sensors and self-generating sensors and its applications in real life
- To impart the importance of smart sensors, sensor interface standards for wearable device applications and to provide a brief overview of the wearable technology and its impact on social life

UNIT I INTRODUCTION 9

Attributes of wearables, Meta-wearable, Challenges and opportunities, Future of wearables - Social aspects of wearability and interaction: Social interpretation of Aesthetics - Case study: Google glass - Wearable haptics: Need for wearable haptic devices - Categories of wearable haptic and tactile display – Wearable sensorimotor enhancer.

UNIT II WEARABLE SENSORS 9

Chemical and Biochemical sensors, System design, Challenges in chemical
Bio-chemical sensing, Application areas - Inertia sensors, Parameters from inertia sensors - Applications for wearable motion sensors - Measurement of energy expenditure by body worn heat flow sensors.

UNIT III FLEXIBLE ELECTRONICS 9

Introduction, Thin-film transistors: Materials and Technologies, Review of
Semi-conductors in flexible electronics - Low-power Integrated Circuit Design for Bio-potential sensing: Analog circuit design techniques - Low- power design for ADCs - Digital circuit design techniques - Architectural design for low-power bio-potential acquisition, Practical considerations.

UNIT IV ENERGY HARVESTING SYSTEMS 9

Energy harvesting from human body: Temperature gradient, Foot motion - Wireless energy transmission - Energy harvesting from light and RF energy - Energy and power consumption issues, Future considerations.

UNIT V MONITORING PHYSICAL AND PHYSIOLOGICAL PARAMETERS 9

Wearable sensors for physiological signal measurement - Physical measurement: Cardiovascular diseases, Neurological diseases, Gastrointestinal diseases - Wearable and non-invasive assistive technologies: Assistive devices for individuals with severe paralysis, Wearable tongue drive system, Sensor signal-processing algorithm, Dual-mode tongue drive system.

COURSE OUTCOMES:

CO1: Understand the fundamentals of wearables, wearable design issues and user interfaces

CO2: Identify the different types of sensors used in wearable devices

CO3 : Recognize the materials used in the field of flexible electronics technology and its power constraints

CO4: Summarize the techniques and issues associated with energy harvesting from human body

CO5: Elucidate the applications of wearable technology in health care

TOTAL: 45 PERIODS

REFERENCES

1. Edward Sazonov, Michael R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications", Academic Press, USA, 2014.
2. Tom Bruno , "Wearable Technology: Smart Watches to Google Glass for Libraries", Rowman & Littlefield Publishers, Lanham, Maryland, 2015.
3. Raymond Tong , "Wearable Technology in Medicine and Health Care", Academic Press, USA, 2018.
4. Haider Raad , "The Wearable Technology Handbook", United Scholars Publication, USA, 2017.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	-	1	2	2	-	2
2	3	2	2	2	-	1
3	3	2	2	1	-	2
4	1	1	2	1	1	2
5	3	1	2	2	-	2
Avg	2.5	1.4	2	1.6	1	2.25

BM4071 BRAIN COMPUTER INTERFACE L T P C
3 0 0 3

COURSE OBJECTIVES:

The objective of this course is to enable the student to

- Understand the basic concepts of brain computer interface.
- Explore the various signal acquisition methods.
- Understand the signal processing methods used in BCI.
- Understand the various machine learning methods of BCI.
- Learn the various applications of BCI.

UNIT I INTRODUCTION TO BCI 9

Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, MEG, fMRI.

UNIT II BRAIN ACTIVATION 9

Brain activation patterns - Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials – Visual Evoked Potentials – P300 and Auditory Evoked Potentials.

UNIT III FEATURE EXTRACTION METHODS 9

Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction - Phase synchronization.

UNIT IV MACHINE LEARNING METHODS FOR BCI 9

Classification techniques –Binary classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Support vector machine, Graph theoretical functional connectivity analysis.

UNIT V APPLICATIONS OF BCI 9

Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Ethics of Brain Computer Interfacing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- Evaluate concept of BCI.
- Describe the different brain activation signals.
- Select appropriate feature extraction methods.
- Use machine learning algorithms for translation.
- Develop high-fidelity BCI prototypes.

REFERENCE BOOKS:

1. Rajesh P.N. Rao, Brain-Computer Interfacing: An Introduction, Cambridge University Press, 1st Edition, 2013.
2. Ella Hassianien A and Azar A.T Ed, Brain-Computer Interfaces Current Trends an Applications, Springer, 2015.
3. Jonathan Wolpaw and Elizabeth Winter Wolpaw, Brain Computer Interfaces: Principles and practice, Oxford University Press, USA, 1stEdition, 2012.
4. Bernhard Graimann, Brendan Allison and Gert Pfurtscheller, Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction, Springer, 2010
5. Ali Bashashati, Mehrdad Fatourechi, Rabab K Ward and Gary E Birch, A survey of signal Processing algorithms in brain–computer interfaces based on electrical brain signals, Journal of Neural Engineering, Vol.4, 2007, pp.32-57.
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8. Bishop C.M., Neural networks for Pattern Recognition, Oxford, Clarendon Press, 1995.
9. Andrew Webb, Statistical Pattern Recognition, Wiley International, 2nd Edition, 2002.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6

1	1	-	3	2	1	1
2	1	-	3	2	1	1
3	2	-	3	2	1	2
4	2	-	3	2		2
5	2	-	3	2		2
Avg	**1.95**	**-**	**3**	**2**	**1**	**1.95**

BM4091 GENETIC ALGORITHMS AND FUZZY LOGICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide basic knowledge about the fundamentals of genetic algorithm
- To familiarize with the ant colony and particle swam optimization techniques
- To learn the basics of fuzzy logic
- To enrich the students knowledge with fuzzy systems and its applications
- To lean the neuro fuzzy system and fuzzy logic controller

UNIT I GENETIC ALGORITHMS 9

Introduction, Building block hypothesis, working principle, Basic operators and Terminologies like individual, gene, encoding, fitness function and reproduction, Genetic modeling:,Significance of Genetic operators, Inheritance operator, cross over, inversion & deletion,mutation operator, Bitwise operator, GA optimization problems, Applications of GA.

UNIT II OTHER OPTIMIZATION TECHNIQUES 9

Ant Colony Optimization: Introduction – From real to artificial ants- Theoretical considerations – Particle Swarm Optimization-:Introduction – Principles of bird flocking and fish schooling – Evolution of PSO – Operating principles – PSO Algorithm

UNIT III FUZZY LOGIC 9

Introduction to Fuzzy Logic, Classical and Fuzzy Sets, Membership Function, Operations on Fuzzy Sets, Fuzzy Arithmetic, Compliment, Intersections, Unions, Fuzzy Relation

UNIT IV FUZZY RULE BASED SYSTEM 9

Linguistic Hedges. Rule based system, Fuzzification and Defuzzification, Fuzzy inference systems - Mamdani and Sugeno model, Fuzzy clustering- fuzzy c- means algorithm- fuzzy control method- fuzzy decision making.

UNIT V ADVANCES AND APPLICATIONS 9

Case studies: Fuzzy logic control of Blood pressure during Anaesthesia, Fuzzy logic application to Biosignals and medical Image processing **,** Adaptive fuzzy system. Introduction to Neuro-fuzzy logic

COURSE OUTCOMES:

CO1: Apprehend the principles of genetic algorithms as well as techniques used in its implementation.

CO2: Apply the optimization algorithms for real time applications

CO3: Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems**.**

CO4: Design a fuzzy rule based system for biomedical application
CO5: Apply the fuzzy controller for resulting the blood pressure

TOTAL:45 PERIODS

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1. Marco Dorigo and Thomas Stutzle, “Ant Colony optimization”, Prentice Hall of India, New Delhi, 2004**.**
2. David E. Goldberg, “Genetic Algorithms in search, Optimization & Machine Learning”, Pearson Education, 2006
3. Kenneth A DeJong,“Evolutionary Computation A Unified Approach”, Prentice Hall of India, New Delhi, 2006
4. H.-J. Zimmermann, “Fuzzy Set Theory and its Applications”, Springer Science+Business Media New York, 4th edition, 2001
5. Timothy Ross, “Fuzzy Logic with Engineering Applications”, Wiley, 2016

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1				2	2	
2				2	2	
3	2			3	2	1
4	2		2	3	3	1
5	3		3	3	3	3
Avg	2.3		2.5	2	2.4	1

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
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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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1				1		
2				2		
3	2		2	2	2	2
4	2		2	2	3	2
5	2		2	2	3	3
Avg	2		2	1.8	2.6	2.3

BD4251 BIG DATA MINING AND ANALYTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the computational approaches to Modeling, Feature Extraction
- To understand the need and application of Map Reduce
- To understand the various search algorithms applicable to Big Data
- To analyse and interpret streaming data
- To learn how to handle large data sets in main memory and learn the various clustering techniques applicable to Big Data

UNIT I DATA MINING AND LARGE SCALE FILES 9

Introduction to Statistical modeling – Machine Learning – Computational approaches to modeling – Summarization – Feature Extraction – Statistical Limits on Data Mining - Distributed File Systems – Map-reduce – Algorithms using Map Reduce – Efficiency of Cluster Computing Techniques.

UNIT II SIMILAR ITEMS 9

Nearest Neighbor Search – Shingling of Documents – Similarity preserving summaries – Locality sensitive hashing for documents – Distance Measures – Theory of Locality Sensitive Functions – LSH Families – Methods for High Degree of Similarities.

UNIT III MINING DATA STREAMS 9

Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows.

UNIT IV LINK ANALYSIS AND FREQUENT ITEMSETS 9

Page Rank –Efficient Computation - Topic Sensitive Page Rank – Link Spam – Market Basket Model – A-priori algorithm – Handling Larger Datasets in Main Memory – Limited Pass Algorithm – Counting Frequent Item sets.

UNIT V CLUSTERING 9

Introduction to Clustering Techniques – Hierarchical Clustering –Algorithms – K-Means – CURE – Clustering in Non -– Euclidean Spaces – Streams and Parallelism – Case Study: Advertising on the Web – Recommendation Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Design algorithms by employing Map Reduce technique for solving Big Data problems.

CO2: Design algorithms for Big Data by deciding on the apt Features set .

CO3:Design algorithms for handling petabytes of datasets

CO4: Design algorithms and propose solutions for Big Data by optimizing main memory consumption

CO5: Design solutions for problems in Big Data by suggesting appropriate clustering techniques.

REFERENCES:

1. Jure Leskovec, AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 3rd Edition, 2020.
2. Jiawei Han, MichelineKamber, Jian Pei, “Data Mining Concepts and Techniques”, Morgan Kaufman Publications, Third Edition, 2012.
3. Ian H.Witten, Eibe Frank “Data Mining – Practical Machine Learning Tools and Techniques”, Morgan Kaufman Publications, Third Edition, 2011.
4. David Hand, HeikkiMannila and Padhraic Smyth, “Principles of Data Mining”, MIT PRESS, 2001

WEB REFERENCES:

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2. *https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106104189/lec1.pdf*

ONLINE RESOURCES:

1. *https://examupdates.in/big-data-analytics/*
2. *https://www.tutorialspoint.com/big_data_analytics/index.htm*
3. *https://www.tutorialspoint.com/data_mining/index.htm*

BM4072 REHABILITATION ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVES:

- To learn the basics of rehabilitation engineering
- To study about principle of rehabilitation engineering
- To understand different types of Therapeutic Exercise Technique.
- To understand the tests to assess the hearing loss and development techniques of electronic devices for visually and auditory impaired
- To study about various orthopaedic devices and prosthetic devices

UNIT I INTRODUCTION TO REHABILITATION 9

Rehabilitation: Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Rehabilitation team Classification of members, The Role of Psychiatrist, Occupational therapist, Physical therapist, Recreation therapist, Prosthetist - Orthotist, Speech pathologist, Rehabilitation nurse, Social worker, Corrective therapist, Psychologist, Music therapist, Dance therapist & Biomedical engineer

UNIT II PRINCIPLE OF REHABILITATION 9

Introduction, The Human Component, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering- Key Engineering Principles, Key Ergonomic Principles - Practice of Rehabilitation and Assistive Technology.

UNIT III THERAPEUTIC EXERCISE TECHNIQUE 9

Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilisation exercises, Endurance exercises.

UNIT IV MANAGEMENT OF COMMUNICATION & VIRTUAL REALITY 9

Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids. Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.

UNIT V ORTHOTIC, PROSTHETIC DEVICES & RESTORATION TECHNIQUES 9

General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Calipers- FO, AFO, KAFO, HKAFO. Prosthetic devices: Hand and arm replacement, Body powered prosthetics, Myoelectric controlled prosthetics and Externally powered limb prosthetics.Functional Electrical Stimulation systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).

COURSE OUTCOMES:

CO1: Explain the fundamentals of rehabilitation and rehabilitation team members.

CO2: Descirbe the key engineering principles of rehabilitation and assitive technology.

CO3: Apply the types of therapeutic exercises to benefit the society

CO4: Design and apply different types Hearing aids, visual aids and their application in biomedical field and hence the benefit of the society.

CO5: Explain engineering concepts in Virtual reality based rehabilitation devices

CO6: Identify prosthetic and orthotic devices for restoration of limb function

TOTAL:45 PERIODS

REFERENCES

1. Rory A Cooper, An Introduction to Rehabilitation Engineering, Taylor & Francis, CRC press, 2006.
2. Susan B O'Sullivan, Thomas J Schmitz, Physical Rehabilitation. 5th Edition, Davis publications, 2007.
3. Joseph D.Bronzino,The Biomedical Engineering Handbook,Third Edition: Three Volume Set,CRC Press,2006
4. MacLachlan M. and Gallagher P. Enabling Technologies – Body Image and Body Function, Churchill Livingstone, 2004.
5. Mann W.C. (ed). Smart Technology for Aging, Disability, and Independence – The State of The Science, Wiley, New Jersey, 2005.
6. Muzumdar A. Powered Upper Limb Prostheses – Control, Implementation and Clinical Application. Springer, 2004.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	1		1	1
2	2	2	1			2
3	1	2	1			2
4	2	3	2	3	3	2
5	1	3	2	2	2	2
Avg	**1.6**	**2.4**	**1.4**	**2.5**	**2**	**1.8**

BM4073 TELE HEALTH TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To teach the key principles for telemedicine and health.
- To make student understand telemedical technology.
- To introduce the students with the knowledge of telemedical standards
- To design and develop m-Health platforms for telemedical applications. diagnosis
- To make student understand the applications of health care sectors

UNIT I TELEMEDICINE AND HEALTH 9

History and Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Tele health, Tele care, Organs of telemedicine, Global and Indian scenario, International regulations in e-health and telemedicine, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

UNIT II TELEMEDICAL TECHNOLOGY 9

Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Modulation techniques, Types of Antenna, Integration and operational issues, Communication infrastructure for telemedicine – LAN and WAN technology. Satellite communication. Mobile hand held devices and mobile communication. Internet technology and telemedicine using world wide web (www). Video and audio conferencing. Clinical data –local and centralized

UNIT III TELEMEDICAL STANDARDS SECURITY AND LEGAL ISSUES 9

Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Realtime Telemedicine integrating doctors / Hospitals, Clinical laboratory data, Radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentially of medical records and access control, Cyber laws related to telemedicine.

UNIT IV m-HEALTH AND TELEMEDICINE 9

Mobile Devices : Smart phones, Tablet PCs, iPads, PDAs, Wearable computers – m-Health technology and communication infrastructure - Healthcare Apps – m-Health applications: Education and awareness, Remote data collection, Remote monitoring, Communication and training for healthcare workers, Disease and epidemic outbreak tracking, Diagnostic and treatment support – m-Health and the Transformation of Clinical Trials - Harnessing data, advanced analytics, and the Internet of Things to optimize digitized clinical trials

UNIT V TELEMEDICAL APPLICATIONS 9

Telemedicine access to health care services – health education and self-care. · Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability., Telemedicine access to health care services– health education and self-care, Business aspects - Project planning and costing, Usage of telemedicine. Telemedicine and in loco assistance of patients, Interactive videoconferencing consults, Store and forward consults, Remote monitoring and home care.

TOTAL:45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1: Describe the key principles for telemedicine and health
CO2: Understand telemedical technology
CO3: Introduce the students with the knowledge of telemedical standards
CO4: Design and develop m-Health platforms for telemedical applications
CO5: Acquire knowledge of evaluating the force in implants.

REFERENCES

1. Wootton, R., Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006.
2. Teresa L. Thompson, Roxanne Parrott, Jon F. Nussbaum, TheRoutledge Handbook of Health Communication, Routledge, 2011.
3. David Dagan Feng, Biomedical Information Technology, Academic Press Series in Biomedical Engineering, Elsevier Inc, USA, 2008
4. Ilias G. Maglogiannis, Kostas Karpouzis and Manolis Wallace, Image and Signal Processing for Networked E-Health Applications, Morgan & Claypool Publishers' series, USA, 2006
5. Bernard Fong, A.C.M. Fong, C.K. Li, Telemedicine Technologies: Information Technologies in Medicine and Telehealth, Wiley, 2011.
6. Bemmel, J.H. van, Musen, M.A. (Eds.) (1997). Handbook of Medical Informatics. Heidelberg, Germany: Springer. (ISBN 3-540-63351-0).
7. Ferrer-Roca, O., Sosa-Iudicissa, M. (editors), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54). (ISBN 90-5199-413-3), 2002.
8. Magnuson, J.A., Fu, Jr., Paul C. (Eds.), Public Health Informatics and Information systems, ISBN 978-1-4471-4237-9, Springer, 2014
9. Simpson, W. 2006. Video over IP. A practical guide to technology and applications. Focal Press (Elsevier). ISBN-10: 0-240-80557-7.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	-	-	-	-
2	1	1	1	-	-	-
3	1	1	-	-	-	-
4	2	2	2	3	3	3
5	2	2	2	1	2	3
Avg	1.6	1.4	1.6	2	2.5	3

MX4005 HEALTH CARE, HOSPITAL AND EQUIPMENT MANAGEMENT **L T P C 3 0 0 3**

COURSE OBJECTIVES:

- To develop an understanding of the various setups of hospital, health care codes and equipment management,
- To enable the student to work in the hospital environment.

UNIT I HEALTH SYSTEM **9**

Health organization of the country, the State, the Cities and the Region, Health Financing System, Health services, Functions of Hospitals, Types of Hospitals, Primary Health Care –An Introduction, Ambulatory care.

UNIT II HOSPITAL ORGANIZATION AND MANAGEMENT **9**

Management of Hospital Organisation, Nursing Sector, Medical Sector, Central Services, Technical Department, Definition and Practice of Management by Objective, Transactional Analysis, Human Relation in Hospital, Importance of Team Work, Legal aspect in Hospital Management.

UNIT III REGULATORY REQUIREMENT AND HEALTH CARE CODES **9**

FDA Regulation, Joint Commission of Accreditation for Hospitals, National Fire Protection Association Standard, IRPQ.

UNIT IV TRAINED TECHNICAL PERSONNEL **9**

Function of Clinical Engineer, Role to be performed in Hospital, Manpower requirement for different types of hospitals, Professional Registration, Structure in Hospital.

UNIT V EQUIPMENT MAINTENANCE MANAGEMENT **9**

Organising Maintenance Operations, Paper Work Control, Maintenance Job Planning, Maintenance Work Measurement and Standards, Preventive Maintenance, Maintenance Budgeting and Forecasting, Maintenance Training, Contract Maintenance.

COURSE OUTCOMES: On completion of this course the student will be able to:

CO1: Basics about Health system and their services

CO2: Apprehend the organisation structure in hospitals

CO3: Knowledge about the regulation of health care codes
CO4: Understand the duties of technical personnel
CO5: Analyse the standards and the training required for technical work for equipment management

TOTAL:45 PERIODS

REFERENCES

1. Cesar A. Caceres and Albert Zara, The Practice of Clinical Engineering, Academic Press, New York, 1977.
2. Webster. J. G. and Albert M. Cook, Clinical Engineering Principles and Practices Prentice Hall Inc., Englewood Cliffs, New Jersey, 1979.
3. Hans Pfeiff, Vera Dammann (Ed.), Hospital Engineering in Developing Countries, Z Report, Eschbom, 1986
4. Jacob Kline, Handbook of Bio Medical Engineering, Academic Press Inc. San Deigo 1988
5. R.C. Goyal, Human Resource Management in Hospital, Prentice Hall of India, 3rd Edition, 2000.
6. Syed Amin Tabish, Hospital and Health Services Administration Principles and Practices Oxford Press New Delhi 2001.
7. G D Kunders, Hospitals, Facilities planning and Management, Tata McGraw Hill Education Private Ltd, New Delhi 2004.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	2		2	2
2	1	1	2		1	1
3		1	1			1
4		1	1			1
5		1	1		2	2
Avg	1	1	1.4	0	1.66	1.4

MX4006 ULTRA SOUND IN MEDICINES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand ultrasound principles and explain the basic physical properties of ultrasound
- To describe the indications of ultrasound, particularly in the evaluation of disease
- To describe the advantages and limitations of Ultrasound compared to other imaging modalities.
- To describe various types of ultrasound-guided diagnostic and therapeutic procedures
- To Describe the normal ultrasound anatomy of various organs and recognize the ultrasound characteristics of various pathologic conditions

UNIT I INTRODUCTION 9

History - Role of Ultrasound in Medical Imaging - Stress And Strain Relationships – Acoustic Wave Equation - Acoustic Properties of Biological Tissues - Doppler Effect.
- Continuous mode and pulsed mode. Measurement of ultrasonic energy, Manipulation of ultrasonic beam – Beam profile and intensity distribution in different axes.

UNIT II ULTRASOUND TRANSDUCERS 9

Piezoelectric Effect - Properties of Important Piezoelectric Materials - Ultrasonic Transducers - Acoustic Properties of Transducer Materials - Transducer Beam Characteristics.

UNIT III GRAY-SCALE ULTRASONIC IMAGING 9

A (Amplitude)-Mode - B (Brightness)-Mode Imaging - Beam Forming -
Speckle - Image Quality - M-Mode - C-Mode - Ultrasound Computed Tomography.
Scan converters, Signal processing, signal controls- TGC, Flares and acoustic shadows, artefact

UNIT IV DOPPLER FLOW MEASUREMENTS 9

Non-directional CW Flow Meters - Directional Doppler Flow Meters - Pulsed
Doppler Flow Meters - Techniques for direction detection – Envelope Fluctuation Methods, Phase Tracking Methods -Clinical Applications And Doppler Indices - fetal heart rate detection, blood flow detection using Doppler signal and imaging technique. Color Doppler Flow Imaging - Elasticity Imaging - Intravascular imaging

UNIT V BIOLOGICAL EFFECTS AND APPLICATIONS 9

Acoustic Phenomena at High-Intensity Levels – Ultrasound Bioeffects: Mechanical Effects and Index - Ultrasound Therapy - Hyperthermia - High-Intensity Focused Ultrasound - - Lithotripsy - Diagnostic Ultrasound Imaging. Ultrasonic diagnosis in Abdomen, Breast, Thyroid, Heart, Chest, Eye, Kidney, Skull, Pregnant and Non Pregnant uterus, 3-Dimensional Ultrasonic Imaging of the Fetus, Advantages and Limitations of 3-Dimensional Ultrasound,

COURSE OUTCOMES:

CO1: Understand the basic principle of Ultrasound in biomedical engineering
CO2: Identify and use appropriate transducers based on their characteristics
CO3: Understand the principles of gray scale imaging
CO4: Identify various Doppler flow measurements
CO5: Understand the different applications of ultrasound in biomedical field

TOTAL: 45 PERIODS

REFERENCES

1. Brain M Dale, Mark A. Brown, Richard C. Semelka , "MRI Basic Principles and Applications", John Wiley & Sons, Oxford, 2015
2. Vincent Perrin, "MRI Techniques", John Wiley & Sons, USA, 2013.
3. Catherine Westbrook , "Handbook of MRI Technique", John Wiley & Sons, Oxford, 2013
4. Govind B Chavhan , "MRI made easy (for Beginners)", Jaypee, New Delhi, 2013

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	1	2	1	1

2	2	2	2	2	2	2
3	2	2	1	2	2	2
4	2	3	2	3	3	2
5	3	3	2	2	2	2
Avg	**2.2**	**2.4**	**1.6**	**2.2**	**2**	**1.8**

MX4007 BIO ETHICS AND STANDARDS L T P C
3 0 0 3

COURSE OBJECTIVES:

- Achieve familiarity with some basic ethical frameworks & understand how these ethical frameworks can help us to think through contemporary questions in medical ethics.
- Students will be able to know about the legal and ethical principles
- To apply these principles in health care settings & gain knowledge about the medical standards that are to be followed in hospitals.

UNIT I INTRODUCTION TO MEDICAL ETHICS 8

Definition of Medical ethics, Scope of ethics in medicine, American Medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and The Profession, Professional Independence, The Doctor and Society.

UNIT II ETHICAL THEORIES & MORAL PRINCIPLES 9

Theories-Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Principles- Non- Maleficence, Beneficence, Autonomy, Veracity, Justice. Autonomy & Confidentiality issues in medical practice, Ethical Issues in biomedical research, Bioethical issues in Human Genetics & Reproductive Medicine

UNIT III HOSPITAL ACCREDITATION STANDARDS 9

Accreditation- JCI Accreditation & its Policies. Patient Organization management standards.

UNIT IV HOSPITAL SAFETY STANDARDS 10

Life Safety Standards- Protecting Occupants, Protecting the Hospital from Fire, Smoke, and Heat, Protecting Individuals from Fire and Smoke, Providing and Maintaining Fire Alarm Systems, Systems for Extinguishing Fires Environment of Care Standards-Minimizing EC Risks, Smoking Prohibitions, Managing Hazardous Material and Waste, Maintaining Fire Safety Equipment, Features, Testing, Maintaining, and Inspecting Medical Equipment.

UNIT V MEDICAL EQUIPMENT SAFETY STANDARDS 9

General requirements for basic safety & essential performance of medical equipment. IEC 60601 standards, Indian and International standards, ISO standards - Base Standard-general requirement of electrical medical devices, Collateral Standards- EMC radiation protection & programmable medical device system, Particular Standards-type of medical device

COURSE OUTCOMES: On completion of this course the student will be able to:

CO1: Describe the Social responsibility in healthcare systems

CO2: Discuss the Bioethics and engineers role

CO3: Apply Legal and professional guidelines for the hospital accreditation
CO4: Understand hospital safety aspects
CO5: Comprehend the medical equipment safety standards and medical device maintenance**.**

TOTAL:45 PERIODS

REFERENCES

1. Domiel A Vallero, Biomedical Ethics for Engineers, Elsevier Pub.1st edition, 2007
2. Johnna Fisher, Biomedical Ethics: A Canadian Focus., Oxford University Press Canada, 2009.
3. Robert M Veatch, The Basics of Bio Ethics, 3rd Edition. Routledge, 2011.
4. Physical Environment Online: A Guide to The Joint Commission's Safety Standards is published by HCPro, Inc. 2010
5. Joint Commission Accreditation Standards for Hospitals, 6th Edition 2018.
6. Ben Mepham, Bioethics-An Introduction for the biosciences, 2nd Edition, Oxford University Press, 2008.
7. Nils Hoppe and Jose Miola - Medical law and Medical Ethics - Cambridge University Press-2014

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	2		2	2
2	1	1	2		1	1
3		1	1			1
4		1	1			1
5			1		2	2
Avg	1	1	1.4	0	1.66	1.4

BM4092 MEDICAL DEVICE STANDARDS AND REGULATION L T P C
3 0 0 3

COURSE OBJECTIVES:

- Understand standards and safety aspects of medical devices.
- Understand the hospital safety standards and maintenance.
- Describe the medical equipment safety standards.
- Describe medical device regulations
- Describe medical device risk assessment and regulatory requirements.

UNIT I STANDRADS AND SAFETY 9

Quality management system for medical devices (ISO 9001 and ISO13485), safety and standardization for risk management (ISO 14971), European standard conformity (CE marking), FDA guidelines for medical devices approval and classification based on risk assessment

UNIT II HOSPITAL SAFETY STANDARDS 9

Life Safety Standards- Protecting Occupants, Protecting the Hospital From Fire, Smoke, and

Heat, Protecting Individuals From Fire and Smoke, Providing and Maintaining Fire Alarm Systems, Systems for Extinguishing Fires Environment of Care Standards-Minimizing EC Risks, Smoking Prohibitions, Managing Hazardous Material and Waste, Maintaining Fire Safety Equipment, Features, Testing, Maintaining, and Inspecting Medical Equipment.

UNIT III MEDICAL EQUIPMENT ESSENTIAL REQUIREMENTS 9

General requirements for basic safety & essential performance of medical equipment, IEC 60601 standards- Base Standard-general requirement of electrical medical devices, Collateral Standards- EMC radiation protection &programmable medical device system, Particular Standards-type of medical device.

UNIT IV MEDICAL DEVICE REGULATION 9

Medical device and in vitro diagnostics: Introduction & types of devices including combination devices. Medical Device Rules, 2017: Implications on medical devices. Classification of medical devices. Labelling of medical devices and in vitro diagnostics

UNIT V MEDICAL DEVICE RISK ASSESSMENT 9

Inspection of medical device and IVD establishments. ISO 14971 (Medical devices: Application of risk management to medical devices). Regulatory requirements of biocompatibility of medical devices and ISO 10993. Clinical investigation of medical devices, regulation of investigational medical devices. Medical device regulation: International practices.

TOTAL:45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1: Describe the key point in standard and safety of medical devices

CO2: Introduce the students with the knowledge of hospital safety and standards.

CO3: Introduce the students with the knowledge of essential requirements in medical equipments

CO4: Introduce device regulation and its types.

CO5: Acquire knowledge medical device risk assessment.

REFERENCES

1. Seeram Ramakrishna, Lingling Tian, Charlene Wang, Susan Liao, Wee Eong Teo, Medical Devices Regulations, Standards and Practice, Wood head Publishing, 1st Edition, 2015.
2. Joint Commission International Accreditation Standards for Hospitals, Joint Commission International, 6th Edition, 2017.
3. Joseph D. Nally (ed.), Good Manufacturing Practices for Pharmaceuticals ,CRC Press sixth edition, 2007
4. https://nptel.ac.in/courses/127106136
5. MDR17, Regulation of Medical Devices,

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	1		1	

2	1	2	1		1	
3	1	2	1		1	
4	1	2	1		1	
5	1	2	1		1	
Avg	**1**	**2**	**1**		**1**	

MX4008 TISSUE ENGINEERING AND IMMUNO ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand basics of tissue engineering
- To learn basics of cell mechanics in tissue engineering
- To know the importance of biomaterials in tissue engineering
- To understand basics of Immunology
- To understand the importance of applied immunology for therapy

UNIT I INTRODUCTION TO TISSUE ENGINEERING 9

History and scope of tissue engineering – Scientific and Social Challenges - Structure and organization of Tissues – Development of Tissue – Cell and Extracellular matrix interaction – Morphogenesis and Tissue Engineering – Cell Determination and Differentiation

UNIT II FUNDAMENTALS OF CELL MECHANISMS 9

Cell adhesion, Cell migration and Cell aggregation – Cell growth and Cell cycle. Cellular Interactions: Cell – Cell and Cell – Matrix. Control of Cell migration in Tissue Engineering –Cell delivery and Recirculation – Cell Culture in vitro – 3D culture in Tissue Engineering - In vitro Organogenesis - Cell transplantation.

UNIT III BIOMATERIALS IN TISSUE ENGINEERING 9

Biological vs Nonbiological materials – Extra Cellular Matrix – Collagen, Chitin & Degradable and Nondegradable materials – Polymer, Ceramics and Metals – Cell interaction with different materials –- Scaffolds - Control releaser agents in Tissue Engineering – Cell interaction with suspension and gels – Tissue response to implants

UNIT IV INTRODUCTION TO IMMUNOLOGY 9

Introduction of Immunology – Antigen; Antibody; Cytokine; Heparin; Histamine; Innate and Adaptive Immunity. Immune Recognition – Immune Effectors function – Immune Regulation – Immune memory. Introduction of Stem cells - Induced Pluripotent Stem cells - Stem cell identification - Surface markers & FACS analysis

UNIT V APPLIED IMMUNOLOGY 9

Introduction – Inflammation – microorganisms survival strategies – Vaccines – Newer approaches to vaccine development – Immunization against cancer – Immune Responses – Pathogens, Cancer and Biomaterials. Immunotherapy

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Define the statement of tissue engineering in healthcare

CO2: Explain the *invitro* organization of tissue culture

CO3: Explain different methods involved in characterization and preparation of biomaterials in tissue engineering

CO4: Explain different types of stem cells and its application in tissue engineering

CO5: Explain the basics of immunology in human being

CO6: Explain the applications of immunoengineering to healthcare sector

REFERENCES

1. R.Lanza, J.Gearhart et.al,(Eds), Essential of Stem cell Biology, Elsevier Academic Press, 2nd edition 2009.
2. Robert P. Lanza, Robert Langer and Joseph Vacanti., Principles of Tissue Engineering, 2nd Edition, Academic press, Elsevier 2013.
3. Gary E Wnek, Gary L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering – Marcel Dekker Inc New York, 2nd edition, 2008.
4. SujataV.Bhatt, Biomaterials (2nd Edition), Narosa Publishing House, 2005.
5. W. Mark Saltzman Tissue Engineering – Engineering Principles for Design of Replacement Organs and Tissue, Oxford University Press Inc. New York, 2004
6. Peter J Delves, Seamus J Martin, Dennis R Burtn and Ivan M Roitt., Roitts Essential Immunology, 13th Edition, Wiley –Blackwell, 2016
7. Judith a Owen, Jenni Punt and Sharon A Stranford, Kuby Immunology, Macmillan Internation, 7th Edition, 2012
8. Ananthanarayan and Paniker. Textbook of Microbiology, Eleventh Edition. Himayatnagar, Hyderabad : Orient Longman

CO-PO Mapping

CO	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	2	3	1	2	1	2
2	2	2	1	1	1	2
3	2	2	2	1	2	1
4	2	2	2	1	2	1
5	2	2	2	3	2	2
Avg	**2**	**2.2**	**1.6**	**1.6**	**1.6**	**1.6**

MX4009 **MEDICAL EQUIPMENT** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To learn about cardiac care unit , pulmonary analyzers and aid equipments and their functions
- To understand the principle involved in physiotherapy and electrotherapy equipments
- To gain knowledge about instruments used to kidney and bones measurements
- To study about the instruments used for sensory measurements and be able to design

sensors

- To provide latest knowledge of special medical assistive and therapeutic equipments

UNIT I CARDIAC CARE UNIT AND PULMONARY ANALYSERS 9

Pacemakers – Need different types, electrode types and placement, batteries for pacemakers. Defibrillators AC and DC defibrillators. Regulation of Breathing - Pulmonary gas flow measurements - Pulmonary volume measurements - Respiratory gas analyzers – Nitrogen Gas Analyzer, Oxygen Analyzer - Humidifier, Nebulizer – Ventilators - Anesthesia machine.

UNIT II PHYSIOTHERAPY AND ELECTROTHERAPY EQUIPMENTS 9

Tissue response -Short wave diathermy - Microwave diathermy - Ultrasonic therapy Unit - Electrotherapy - FES, TENS - Bladder stimulator - Lithotripter system - Extra corporeal Shock wave therapy- Electrical safety-IEC-60601 standard, Physiological effects of current, Leakage current, Micro and macro electric shock, GFI units, Earthing Scheme, Electrical safety Analyzer.

UNIT III INSTRUMENTS DEALING WITH KIDNEY AND BONES 9

Regulation of Water and Electrolyte Balance – Artificial Kidney – Hemodialysis - Grafts for dialysis - Peritoneal dialysis - Dialyzers – different types, Thermograph BMD Measurements – SXA – DXA - Quantitative ultrasound bone densitometer.

UNIT IV SENSORY INSTRUMENTATION 9

Basic Audiometer, Pure tone audiometer, Audiometer system Bekesy – Hearing Aids - Ophthalmoscope – Tonometer - Measurement of Basal Skin response and Galvanic skin response - Instruments for testing Motor responses - Biofeedback Instrumentation.

UNIT V SPECIAL EQUIPMENTS AND RECENT TRENDS 9

Endoscopy – Laparoscopy - Cryogenic Equipment - Automated drug delivery system – Components of drug infusion system – Implantable infusion systems. Biotelemetry and Multipatient telemetry **,** Applications of IoT in Healthcare.

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon completion of this course the student will be able to

CO1: Describe the working of the pacemaker, pulmonary analyzers and aid equipments and their functions

CO2: Obtain knowledge on different physiotherapy equipments and

CO3: Obtain the domain knowledge of instruments dealing with kidney and bones

CO4: Develop measurement systems for sensory parameter measurements

CO5: Familiar with the special therapeutic equipments available

REFERENCES

1. Geddes LA and Baker L.E Principles of Applied Biomedical Instrumentation, 3rd Edition, John Wiley and sons, New york 1989
2. Joseph J Carr and John Brown – Introduction to Biomedical equipment Technology- Pearson Education 4th edition New Delhi 2001
3. Khandpur R.S HandBook of Biomedical Instrumentation – Tata Mc Graw Hill

publication , New Delhi 3rd edition 2014
4. Khandpur R.S HandBook of Biomedical Instrumentation – Tata Mc Graw Hill publication , New Delhi 2nd edition 2003
5. R. Anand Natarajan - Biomedical Instrumentation and Measurements- PHI Learning, New Delhi, 2nd edition, 2015
6. Webster J.G Medical Instrumentation application and design – John Wiley and sons New York 3rd edition 1999

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1			2	2	2	
2			3	1	2	
3			2	2	2	
4	1		2		1	2
5	2		2	2	1	2
Avg	1.5		2.2	1.75	1.6	2

MX4010 BIOMEMS AND ARTIFICIAL ORGANS L T P C
3 0 2 4

COURSE OBJECTIVES:

- To understanding of the basics with current advancement and challenges associated with operations
- To understand the uses of bioinstrumentation, processes for microelectromechanical systems and their applications in the biomedical areas
- To give a basic idea of the artificial organs that can aid a human to live a normal life.
- To comprehend the processes and challenges involved in implants and prosthesis using alloys.
- To determine and selection of right materials for its bio applications

UNIT I INTRODUCTION 9

Historical perspective, Development of MEMS Technology, MEMS Technology: Present, Future and Challenges, MEMS Applications, Comparison of MEMS and Microelectronics.

UNIT II SENSORS AND ACTUATORS 9

MEMS Actuators, MEMS Sensing, Electron Tunneling, Sensor Noise, MEMS Physical Sensors, MEMS Chemical Sensors, Classification of Physical Sensors, Integrated, Intelligent or Smart sensors, Bio Sensing Principles and Sensing Methods, Biosensors Arrays and Implantable devices.

UNIT III ARTIFICIAL ORGANS / IMPLANTS 9

Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyser membrane) – Wearable artificial kidney, Dental Implants. Artificial Organs design and simulation – Case study – Design of artificial pancreas.

UNIT IV REPLACEMENT DEVICES FOR RESPIRATORY AND DIGESTIVE SYSTEM **9**

Artificial lung versus natural lung – Lung replacement devices - Tracheal replacement devices - Laryngeal replacement devices - Artificial esophagus - Liver functions: Hepatic failure, Liver support systems, General replacement of liver functions – Endocrine pancreas and insulin secretion - Diabetes - Insulin therapy - Insulin administration systems

UNIT V TISSUE REPLACEMENT IMPLANTS **9**

Soft-tissue replacements, sutures, surgical tapes, adhesive, and Dental implants - Fracture plates - Joint and Spinal replacement - Artificial skin: Current treatment for skin loss, Design principles for skin replacement - Ear and Eye implants.

45 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

1. Simulation of structures for MEMS sensors
2. Designing of MEMS based accelerometer
3. Modeling and simulation of MEMS biosensor
4. Designing of micro cantilever for medical application
5. Modeling and simulation of chemical sensor
6. Modeling and simulation of prosthetic heart valves
7. Modeling and simulation of dialyzer membrane for hemodialysis
8. Modeling and stress analysis of dental implants.
9. Modeling and simulation of artificial joints.
10. Designing of bone plates and comparison of its mechanical properties with selected biocompatible materials

COURSE OUTCOMES:

CO1: Compare and explain about the characteristics of MEMs Physical and chemical sensor

CO2: Classify the biosensors according to its working principle and discuss its application as an implantable device

CO3: Design various grafts for tissue repair and artificial organs.

CO4: Enumerate biomaterials for implants, soft and hard tissue 5 replacements

CO5: Recall the cell-biomaterial interactions for constructing artificial organs

TOTAL:75 PERIODS

REFERENCES

1. BioMEMS and Biomedical Nanotechnology, volume III Tejaldesai, sangetha Bhatia
2. Gerald Miller , "Artificial Organs", Morgan and Claypool Publisher, Narosa Publishing HouseWilliston, 2006.
3. Wanjun Wang, Stephen A.Soper, BioMEMS: Technologies and Applications, CRC Press, New York, 2007..
4. Joseph D, Bronzino, Donald R. Peterson , "The biomedical engineering handbook", CRC Press Taylor and Francis,, 2015.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	1	2	1	2

2	2	2	1	2	2	1
3	2	2	2	2	2	2
4	2	2	2	1	1	2
5	**2**	**3**	**1**	**2**	**2**	**1**
Avg	**2**	**2.2**	**1.4**	**1.8**	**1.6**	**1.6**

MX4011 PHYSIOLOGICAL MODELING L T P C
3 0 2 4

COURSE OBJECTIVES:

- To identify and describe general principles for modeling and simulating a system.
- To apply these principles when designing mathematical models for a number of realistic systems.
- To model the dynamic systems.
- To analyze models for cardio, pulmonary and respiration activities.
- To implement and use computer based modeling and simulation for studying physiological systems

UNIT I INTRODUCTION 9

Introduction to physiological system and mathematical modeling of physiological system, classification of model – gray box & black box, parametric & non parametric, lumped & distributed models, linear & non-linear, characteristics of models. Purpose of physiological modelling and signal analysis, linearization of nonlinear models. Engineering system and physiological system, System variables & properties- Resistance, Compliance & their analogy.

UNIT II DYNAMIC PHYSIOLOGICAL SYSTEM 9

Dynamic systems and their control, modeling and block diagrams, Types of Eye movement, Eye movement system and Wetheimer's saccadic eye model. Robinson's Model, Oculomotor muscle model, Linear Reciprocal Innervations Oculomotor Model. Open &close loop systems instability, automatic aperture control.

UNIT III NON LINEAR MODELS 9

Nonparametric Modeling-Volterra Models. Wiener Models. Efficient Volterra Kernel Estimation. Parametric Modeling- Basic Parametric Model Forms and Estimation Procedures- Volterra Kernels of Nonlinear Differential Equations. Discrete-Time Volterra Kernels of NARMAX Model

UNIT IV CARDIO, PULMONARY AND RESPIRATORY MODELING 9

Cardiovascular system and pulmonary mechanics modeling and simulation, Model of Cardiovascular Variability, Model of Circadian Rhythms. Respiratory mechanics & muscle mechanics. Voltage clamp experiment - Hodgkin and Huxley's model of action potential, model for strength-duration curve, model of the whole neuron

UNIT V SIMULATION OF PHYSIOLOGICAL SYSTEMS 9

Simulation of physiological systems using OpenCV / MATLAB software. Biological receptors: - Introduction, receptor characteristics, transfer function models of receptors, receptor

45 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

1. Design Lumped and Distributed SIMULINK model for simple lung mechanism.
2. Design a SIMULINK model for steady-state analysis of muscle stretch reflex.
3. Design a SIMULINK model for steady-state respiratory control.
4. Design a SIMULINK model of neuromuscular reflex models.
5. Design a SIMULINK model to compute frequency response of linearized lung mechanics model.
6. Design a SIMULINK model to compute frequency response of glucose-insulin regulation (Stolwijk and Hardy model).
7. Design a SIMULINK model for respiratory sinus arrhythmia (Saul model).
8. Design a SIMULINK model of simplified and linearized version of Hodgkin-Huxley model.
9. Design a SIMULINK model for cardiovascular variability. (stroke volume constant)
10. Design a SIMULINK model for cardiovascular variability. (stroke volume variable)

COURSE OUTCOMES:

CO1: Build on a basic understanding of physiology to develop a more in-depth level of understanding that will enable engineering analysis of selected physiological systems

CO2: Describe the dynamic models, simulate and visualize, dynamic responses of physiological models using software

CO3: Describe nonlinear models of physiological systems.

CO4: Be able to translate the understanding of physiological function into an engineering model for cardio, and respiratory systems

CO5: Compute the Simulation of physiological systems

TOTAL:75 PERIODS

REFERENCES

1. Michel C Khoo, Physiological Control Systems -Analysis, simulation and estimation, Prentice Hall of India, 2010.
2. Marmarelis, “Nonlinear Dynamic Modeling of Physiological Systems”, Wiley-IEEE Press, 2004
3. Joseph D. Bronzino, The Biomedical Engineering Hand Book, 3rd Edition, CRC Press, 2006
4. John D. Enderle, “Model of Horizontal eye movements: Early models of saccades and smooth pursuit”, Morgan & Claypool Publishers, 2010.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	1	2	2	1
2	2	2	2	2	1	2
3	2	2	2	2	2	2
4	2	2	2	2	2	2
5	2	3	2	1	2	2
Avg	2	2.2	1.8	1.8	1.8	1.8

MX4074 PATTERN RECOGNITION TECHNIQUES AND APPLICATIONS **L T P C 3 0 2 4**

COURSE OBJECTIVES:

- To understand the fundamentals of Pattern recognition
- To impart knowledge on various clustering techniques
- To study about feature extraction and selection
- To explore different classification models
- To understand Fuzzy Pattern Classifiers and applications

UNIT I PATTERN CLASSIFIER **9**

Overview of Pattern recognition – Discriminant functions – Supervised learning – Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach– Non Parametric techniques, Perceptron Algorithm-LMSE Algorithm-Pattern classification by distance functions – Minimum distance pattern classifier.

UNIT II CLUSTERING **9**

Clustering Concept – Hierarchical Clustering Procedures – Partitional Clustering, k- means algorithm – Clustering of Large Data Sets – EM Algorithm – Grid Based Clustering– Density Based Clustering.

UNIT III FEATURE EXTRACTION AND SELECTION **9**

Entropy Minimization – KL Transforms – Regression-Linear, Non-linear and Logistic, Prediction, Feature Selection through Functions Approximation – Binary Feature Selection

UNIT IV HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE **9**

State Machines – Hidden Markov Models: Maximum Likelihood for the HMM, Forward-Backward Algorithm, Sum and Product Algorithm for the HMM, Extensions of the Hidden Markov Model – Support Vector Machines: Maximum Margin Classifiers, Relevance Vector Machines

UNIT V RECENT ADVANCES AND APPLICATIONS **9**

Elementary Neural Network for Pattern Recognition, Fuzzy pattern classifier, Application of PR in image segmentation, CAD system in breast cancer detection, ECG signal classification, Fingerprint recognition, cell cytology classification

45 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

1. Implementation of Image classification using Perceptron model in Matlab / python.
2. Implementation of Fuzzy pattern classifier in Matlab/OpenCV/python.
3. Implementation of Feature extraction using KL transform in Matlab / Open CV / python.
4. Implementation of partitional clustering in Matlab/OpenCV/python.
5. Implementation of density based clustering in Matlab/OpenCV/ python
6. Implementation of Classification using SVM in Matlab/OpenCV/python.
7. Implementation of Classification using HMM in Matlab/OpenCV/python.
8. Implementation of Bayes classifier in Matlab/OpenCV/python.
9. Implementation of Classification using Neural Networks in Matlab / OpenCV / python.
10. Implementation of image segmentation in Matlab/OpenCV/python

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1: Perform classification using Bayes approach
CO2: Implement clustering algorithms for classification

CO3: Perform Feature extraction, feature reduction
CO4: Apply HMM and SVM for real time applications
CO5: Apply pattern recognition techniques for biosignal and medical image applications

TOTAL:75 PERIODS

REFERENCES

1. Andrew Webb, "Statistical Pattern Recognition", Arnold publishers, London,2002
2. C.M.Bishop, "Pattern Recognition and Machine Learning", Springer, 2006
3. Earl Gose, Richard Johnsonbaugh Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall of India Pvt Ltd., New Delhi, 1996
4. M. Narasimha Murthy and V. Susheela Devi, "Pattern Recognition", Springer 2011
5. R.O.Duda, P.E.Hart and D.G.Stork, "Pattern Classification", John Wiley, 2001
6. Robert J.Schalkoff, "Pattern Recognition Statistical, Structural and Neural Approaches", John Wiley & Sons Inc., New York, 1992
7. S.Theodoridis and K.Koutroumbas, "Pattern Recognition", 4th Edition, Academic Press, 2008

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1			2	2	
2	1			2	2	
3	2			3	2	
4	2			3	1	2
5	2		2	3	3	2
Avg	1.6		2	2.6	2	2

MU4291 MIXED REALITY L T P C
3 0 2 4

OBJECTIVES:

- To study about Fundamental Concept and Components of Virtual Reality
- To study about Interactive Techniques in Virtual Reality
- To study about Visual Computation in Virtual Reality
- To study about Augmented and Mixed Reality and Its Applications
- To know about I/O Interfaces and its functions.

UNIT I INTRODUCTION TO VIRTUAL REALITY 9

Introduction, Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality. Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism Stereographic image.

Suggested Activities:

- Flipped classroom on uses of MR applications.
- Videos – Experience the virtual reality effect.
- Assignment on comparison of VR with traditional multimedia applications.

Suggested Evaluation Methods:

- Tutorial – Applications of MR.
- Quizzes on the displayed video and the special effects

UNIT II INTERACTIVE TECHNIQUES IN VIRTUAL REALITY 9

Introduction, from 2D to 3D, 3D spaces curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modeling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

Suggested Activities:

- Flipped classroom on modeling three dimensional objects.
- External learning – Collision detection algorithms.
- Practical – Creating three dimensional models.

Suggested Evaluation Methods:

- Tutorial – Three dimensional modeling techniques.
- Brainstorming session on collision detection algorithms.
- Demonstration of three dimensional scene creation.

UNIT III VISUAL COMPUTATION IN VIRTUAL REALITY 9

Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

Suggested Activities:

- External learning – Different types of programming toolkits and Learn different types of available VR applications.
- Practical – Create VR scenes using any toolkit and develop applications.

Suggested Evaluation Methods:

- Tutorial – VR tool comparison.
- Brainstorming session on tools and technologies used in VR.
- Demonstration of the created VR applications.

UNIT IV AUGMENTED AND MIXED REALITY 9

Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems

Suggested Activities:

- External learning - AR Systems

Suggested Evaluation Methods:

- Brainstorming session different AR systems and environments.

UNIT V I/O INTERFACE IN VR & APPLICATION OF VR 9

Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modeling virtual world, Physical simulation, VR toolkits, Introduction to VRML, Input -- Tracker, Sensor, Digitalglobe, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual /Auditory / Haptic Devices. VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR.

Suggested Activities:

- External learning – Different types of sensing and tracking devices for creating mixed reality environments.
- Practical – Create MR scenes using any toolkit and develop applications.

Suggested Evaluation Methods:

- Tutorial – Mobile Interface Design.
- Brainstorming session on wearable computing devices and games design.
- Demonstration and evaluation of the developed MR application.

OUTCOMES:

CO1: Understand the Fundamental Concept and Components of Virtual Reality
CO2: Able to know the Interactive Techniques in Virtual Reality
CO3: Can know about Visual Computation in Virtual Reality
CO4: Able to know the concepts of Augmented and Mixed Reality and Its Applications
CO5: Know about I/O Interfaces and its functions.

PERIODS: 45

PRACTICALS: PERIODS: 30

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection methods by handling the camera.
3. Download objects from asset stores and apply various lighting and shading effects.
4. Model three dimensional objects using various modeling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop MR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

TOTAL :75 PERIODS

REFERENCES

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, First Edition 2013.

3. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
4. John Vince, “Virtual Reality Systems “, Pearson Education Asia, 2007.
5. Adams, “Visualizations of Virtual Reality”, Tata McGraw Hill, 2000.
6. Grigore C. Burdea, Philippe Coiffet , “Virtual Reality Technology”, Wiley Inter Science, 2nd Edition, 2006.
7. William R. Sherman, Alan B. Craig, “Understanding Virtual Reality: Interface, Application and Design”, Morgan Kaufmann, 2008

MX4012 3D PRINTING IN MEDICINES L T P C
3 0 2 4

COURSE OBJECTIVES:

- To apply the concepts of medical imaging, 3D scanning and digitizing for accurate 3D model construction.
- To identify the errors during processing of medical image data and minimize them.
- To select the suitable material for the given medical application.
- To analyze and select an additive manufacturing technology for a given medical application.
- To analyze and design the virtual models of the patient for planning the surgery

UNIT I DESIGN OF POWER SUBSYSTEMS IN MEDICAL ELECTRONICS 9

Overview, Workshop on Medical Applications for Reverse Engineering and Rapid Prototyping, Background on Rapid Prototyping, Stereolithography and Other Resin-type Systems, Fused Deposition Modelling and Selective Laser Sintering, Droplet/Binder Systems, Related Technology: Microsystems and Direct Metal Systems, File Preparation, Relationship with Other Technologies, Disadvantages with RP for Medical Applications

UNIT II BIOMODELLING 9

Introduction, Surgical Applications of Real Virtuality - Cranio-maxillofacial bio modeling, Use of real virtuality in customized cranio-maxillofacial prosthetics, Bio-model-guided stereotaxy, Vascular bio-modelling, Skull-base tumors surgery, Spinal surgery, Orthopedic bio modeling.

UNIT III MEDICAL DATA TRANSFER 9

Introduction, Medical Imaging: from Medical Scanner to 3D Model, Computer Approach in Dental Implantology. Bio Build Paradigm - Importing a dataset, Volume reduction, Anatomical orientation confirmation, Volume editing, Image processing, Build orientation optimization, 3D visualization, RP file generation, Future Enhancements

UNIT IV ORTHOPEDIC IMPLANTS 9

Introduction to orthopedic implants, Electron Beam Melting Technology, Direct Fabrication of Titanium Orthopedic Implants - EBM fabrication of custom knee implants, EBM fabrication of custom bone implants, Direct fabrication of bone ingrowth surfaces.

UNIT V SCAFFOLD BASED TISSUE ENGINEERING 9

Introduction, Medical Imaging: from Medical Scanner to 3D Model, Computer Approach in Dental Implantology. Bio Build Paradigm - Importing a dataset, Volume reduction, Anatomical

orientation confirmation, Volume editing, Image processing, Build orientation optimization, 3D visualization, RP file generation, Future Enhancements.

45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1) Review of CAD Modeling Techniques and Introduction to Rapid Prototyping
2) Forming Groups & Assigning Creative Idea
3) Generating STL files from the CAD Models & Working on STL files
4) Modeling Creative Designs in CAD Software
5) Assembling Creative Designs in CAD Software
6) Processing the CAD data in Catalyst software (Selection of Orientation, Supports generation, Slicing, Tool path generation)
7) Simulation in Catalyst Software
8) Fabricating the physical part on FDM RP machine
9) Removing the supports & post processing (cleaning the surfaces)
10) Demonstrating Creative Working Models

COURSE OUTCOMES:

CO1: Apply the concepts of medical imaging, 3D scanning and digitizing for accurate 3D model construction

CO2: Identify the errors during processing of medical image data and minimize them

CO3: Interpret the data acquisition and data transfer mechanisms.

CO4: Analyze and select an additive manufacturing technology for orthopedic implants

CO5: Analyze and select models suitable for scaffold based tissue engineering

TOTAL:75 PERIODS

REFERENCES

1. Ian Gibson, Advanced Manufacturing Technology for Medical Applications, John Wiley, 2005.
2. Paulo Bartolo and Bopaya Bidanda, Bio-materials and Prototyping Applications in Medicine, Springer, 2008.
3. Joseph D. Bronzino, The Biomedical Engineering Hand Book, 3rd Edition, CRC Press, 2006
4. Dennis Fitzpatrick, Implantable electronic medical devices, Elsevier, 2015.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1		2	1	
2	2	1		2	1	
3	3	2		2	2	
4	3	2		1	2	2
5	3	2	2	3		2
Avg	**2.6**	**1.6**	**2**	**2**	**3**	**2**

AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

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

UNIT II PRESENTATION SKILLS 6

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

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

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

UNIT V VERIFICATION SKILLS 6

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

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

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

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION 6

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

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

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

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of disaster

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

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

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

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

REFERENCES:

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

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

COURSE OBJECTIVES:

Students will be able to:

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

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

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

UNIT IV ORGANS OF GOVERNANCE

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

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: 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 **நற்றமிழ் இலக்கியம்** **L T P C**
2 0 0 0

UNIT I **சங்க இலக்கியம்** **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரை நிறுத்திய ஔவையார்

UNIT II **அறநெறித் தமிழ்** **6**

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

(தூய்மையை வலியுறுத்தும் நூல்)

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

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

UNIT IV **அருள்நெறித் தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப்

போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்

2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்

ஆகியவை பற்றிய செய்திகள்

UNIT V **நவீன தமிழ் இலக்கியம்** **6**

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

TOTAL : 30 PERIODS

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

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

OPEN ELECTIVES

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 VI NATURAL LANGUAGE PROCESSING USING RNN 10

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

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING 10

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

COURSE OUTCOMES:

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

TOTAL : 45 PERIODS

REFERENCES

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

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

OBJECTIVES

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

UNIT- I BASICS OF VIBRATION 9

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

UNIT- II BASICS OF NOISE 9

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

UNIT- III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9

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

UNIT- IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9

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

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

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

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

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

REFERENCES:

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

OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To learn the present energy scenario and the need for energy conservation.
2. To understand the different measures for energy conservation in utilities.
3. Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.

4. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
5. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I ENERGY SCENARIO 9

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

UNIT II HEATING, VENTILLATION & AIR CONDITIONING 9

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

UNIT III LIGHTING, COMPUTER, TV 9

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

UNIT IV ENERGY EFFICIENT BUILDINGS 9

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

UNIT V ENERGY STORAGE TECHNOLOGIES 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES:

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

OME433 ADDITIVE MANUFACTURING L T P C
3 0 0 3

UNIT I INTRODUCTION 9

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

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

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

UNIT III VAT POLYMERIZATION 9

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

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION 9

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

POWDER BASED PROCESS

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

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES 9

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

TOTAL: 45 PERIODS

REFERENCES:

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

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

UNIT I NEED FOR ELECTRIC VEHICLES 9

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

UNIT II ELECTRIC VEHICLE ARCHITECHTURE 9

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

UNIT III ENERGY STORAGE 9

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

UNIT IV ELECTRIC DRIVES AND CONTROL 9

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

UNIT V DESIGN OF ELECTRIC VEHICLES 9

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

TOTAL: 45 PERIODS

REFERENCES:

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

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

COURSE OBJECTIVES:

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

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.

2. Identfying opportunity and planning for new product design and development.

3. Conducting customer need analysis; and setting product specification for new product design and development.

4. Generating, selecting, and testing the concepts for new product design and development.

5. Appling the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCTDESIGN & DEVELOPMENT 9

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

UNIT II OPPORTUNITY DENTIFICATION & PRODUCT PLANNING 9

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

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

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

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

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

UNITV INDUSTRIAL DESIGN & PROTOTYPING 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Apply the principles of generic development process; and understand the organization structure for new product design and development.

2. Identify opportunity and plan for new product design and development.

3. Conduct customer need analysis; and set product specification for new product design and development.

4. Generate, select, and test the concepts for new product design and development.

5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

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

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.

2. Rosenthal S.,“Effective Product Design and Development”, Business One

Orwin,Homewood, 1992,ISBN1-55623-603-4.

3. Pugh.S,"Total Design Integrated Methods for Successful Product Engineering", Addison Wesley Publishing,1991,ISBN0-202-41639-5.

4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.

5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

OBA431 SUSTAINABLE MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I MANAGEMENT OF SUSTAINABILITY 9

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

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

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

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

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

UNIT IV SUSTAINABILITY AND INNOVATION 9

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

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

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

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

COURSE OBJECTIVES

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

UNIT I INTRODUCTION TO SMALL BUSINESS 9

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

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

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

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

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

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

UNIT IV FINANCING SMALL BUSINESS 9

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

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

REFERENCES

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

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

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

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

UNIT II PROCESS 9

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

UNIT III STATUTES 9

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

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9

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

UNIT V MODELS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.

2. Intellectual Property rights and copyrights, EssEss Publications.

3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.

4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.

5. WIPO Intellectual Property Hand book.

OBA434 ETHICAL MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVE

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

UNIT I ETHICS AND SOCIETY 9

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

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS 9

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

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9

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

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9

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

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.

2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.

3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

ET4251 IoT FOR SMART SYSTEMS L T 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

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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

CX4016	ENVIRONMENTAL SUSTAINABILITY	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION **9**

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

UNIT II CONCEPT OF SUSTAINABILITY **9**

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

UNIT III SIGNIFICANCE OF BIODIVERSITY **9**

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

UNIT IV POLLUTION IMPACTS **9**

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT V ENVIRONMENTAL ECONOMICS **9**

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

TOTAL : 45 PERIODS

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

TX4092 TEXTILE REINFORCED COMPOSITES L T P C
3 0 0 3

UNIT I REINFORCEMENTS 9
Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

UNIT II MATRICES 9
Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

UNIT III COMPOSITE MANUFACTURING 9
Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

UNIT IV TESTING 9
Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS 9
Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

TOTAL: 45 PERIODS

REFERENCES

1. BorZ.Jang,“Advanced Polymer composites”,ASM International,USA,1994.

2. Carlsson L.A. and Pipes R.B., “Experimental Characterization of advanced composite Materials”,SecondEdition,CRCPress,NewJersey,1996.

3. George LubinandStanley T.Peters, “Handbook of Composites”, Springer Publications,1998.

4. Mel. M. Schwartz, “Composite Materials”, Vol. 1 &2, Prentice Hall PTR, New Jersey,1997.

5. RichardM.Christensen,“Mechanics of compositematerials”,DoverPublications,2005.

6. Sanjay K. Mazumdar, “Composites Manufacturing: Materials, Product, and Process Engineering”,CRCPress,2001

NT4002 NANOCOMPOSITE MATERIALS L T P C
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UNIT I BASICS OF NANOCOMPOSITES 9
Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9
Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and

their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

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

UNIT I IPR 9

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

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY 9

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS 9

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

UNIT V ENTREPRENEURSHIP DEVELOPMENT 9

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

TOTAL : 45 PERIODS

REFERENCES

1. Bouchoux, D.E., "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal", 3rd Edition, Delmar Cengage Learning, 2008.

2. Fleming, D.O. and Hunt, D.L., "Biological Safety: Principles and Practices", 4th Edition, American Society for Microbiology, 2006.

3. Irish, V., "Intellectual Property Rights for Engineers", 2nd Edition, The Institution of Engineering and Technology, 2005.

4. Mueller, M.J., "Patent Law", 3rd Edition, Wolters Kluwer Law & Business, 2009.

5. Young, T., "Genetically Modified Organisms and Biosafety: A Background Paper for Decision- Makers and Others to Assist in Consideration of GMO Issues" 1st Edition, World Conservation Union, 2004.

6. S.S Khanka, "Entrepreneurial Development", S.Chand & Company LTD, New Delhi, 2007.