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.

I. PROGRAM OUTCOMES (POs) –

PO	Programme Outcomes
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

2. PROGRAM SPECIFIC OUTCOMES (PSOs) :

1. To acquire and understand the basic skill sets required for Medical Electronics Engineering.
2. To implement the techniques and tools of Medical Electronics Engineering to address the needs of technology in healthcare domain
3. To address the problems associated with the interaction between living and non-living materials and systems
4. To adapt to emerging information and communication Technologies to innovate an idea and identify the solutions

PEO/PO MAPPING

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
I	√	√	√	√	-	-
II	√	-	√	√	-	√
III	√	-	-	√	√	√
IV	-	-	√	-	-	√
V	√	-	√	√	√	-

Tentative

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M.E. MEDICAL ELECTRONICS
REGULATIONS – 2021
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.	MX4251	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 and Seminar	EEC	0	0	2	2	1
			TOTAL	**20**	**0**	**10**	**30**	**23**

Tentative

*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

Tentative

SEMESTER II, PROFESSIONAL ELECTIVES – II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BM4075	Wearable Technologies	PEC	3	0	0	3	3
2.	BM4076	Brain Computer Interface	PEC	3	0	0	3	3
3.	BM4071	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.	BM4073	Rehabilitation Engineering	PEC	3	0	0	3	3
7.	BM4074	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.	BM4072	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.	MU4253	Mixed Reality	PEC	3	0	2	5	4
5.	MX4012	3D Printing in Medicines	PEC	3	0	2	5	4

Tentative

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

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

Tentative

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.	MX4251	Medical Image Processing	3	0	2	4	I
8.	MX4201	Medical Electronics Device Design	3	0	0	3	I
9.	MX4202	Medical Imaging Systems and Radio Therapy	3	0	0	3	I
10.	BM4251	AI and Machine Learning	3	0	2	4	I
11.	MX4211	Medical Electronics Device Design Laboratory	0	0	4	2	I

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 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
TOTAL CREDITS							

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**

Tentative

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.

Tentative

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.

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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

Tentative

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.

Tentative

MX4101	BIOMEDICAL INSTRUMENTATION AND EQUIPMENT					
COURSE OUTCOME	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	1
CO2	2	2	2	2	2	1
CO3	2	2	2	2	2	2
CO4	3	2	2	2	2	2
CO5	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

Tentative

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

MX4102	**EMBEDDED SYSTEMS AND INTERNET OF THINGS FOR MEDICAL APPLICATION**

COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	3	1	3
CO2	2	1	1	2	-	-
CO3	3	1	3	2	-	2
CO4	3	2	3	3	2	3
CO5	3	2	3	3	2	3
AVG	**2.8**	**1.6**	**2.6**	**2.6**	**1.6**	**2.75**

Tentative

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

Tentative

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

BM4151	**BIOSIGNAL PROCESSING**					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	3	3	2
CO2	2	1	1	3	2	2
CO3	2	1	2	3	3	2
CO4	2	1	2	2	2	2
CO5	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.

Tentative

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.

BM4152	**HUMAN ANATOMY AND PHYSIOLOGY**					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	2	2	2
CO2	2	2	2	2	2	2
CO3	2	2	2	1	1	2
CO4	2	2	2	-	1	1
CO5	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

MX4111	**BIOMEDICAL INSTRUMENTATION LABORATORY**					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	2	2	2
CO2	2	2	2	2	2	2
CO3	2	2	1	2	1	2
CO4	2	2	2	1	2	1
CO5	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

BM4161	**BIOSIGNAL PROCESSING LABORATORY**					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	3	2	2
CO2	3	2	3	3	2	2
CO3	3	2	3	3	2	2
CO4	3	2	3	3	2	2
CO5	3	2	3	3	3	2
AVG	**3**	**2**	**3**	**3**	**2.2**	**2**

Indicative

MX4251 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

Tentative

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.

MX4251	**MEDICAL IMAGE PROCESSING (THEORY CUM PRACTICAL)**					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	2	2	2	1
CO2	2	1	2	3	2	1
CO3	1	1	2	2	1	1
CO4	3	-	2	3	3	2
CO5	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

45 PERIODS

Tentative

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:75 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.

MX4201	MEDICAL ELECTRONICS DEVICE DESIGN					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	2	2	1
CO2	2	2	2	1	2	1
CO3	2	2	2	1	1	1
CO4	2	2	1	1	2	2
CO5	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

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

Tentative

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.

MX4202	**MEDICAL IMAGING SYSTEMS AND RADIOTHERAPY**					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	1	2	1	2
CO2	2	2	1	2	2	1
CO3	2	2	2	2	1	1
CO4	2	2	1	2	2	1
CO5	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.

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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.

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1			2	2	
CO2	1			2	2	
CO3	1			3	2	1
CO4	1		2	3	3	1
CO5	3		3	3	3	3
Avg	1.4		1	2.6	2.4	1

Tentative

MX4211 MEDICAL ELECTRONICS DEVICE DESIGN LAB 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

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.

MX4211	**MEDICAL ELECTRONICS DEVICE DESIGN LABORATORY**					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	2	2	1
CO2	2	2	2	1	2	1
CO3	2	2	2	1	1	1
CO4	2	2	1	1	2	2
CO5	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

Tentative

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)

Tentative

	• 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)

Tentative

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.

Tentative

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).

MX4001	NANOTECHNOLOGY AND ITS APPLICATIONS					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2		1	1
CO2	1	1			1	1
CO3	2	2	2			1
CO4	3	2	2	1		1
CO5	2	1	1	1		1
AVG	**2.2**	**1.5**	**1.75**	**1**	**1**	**1**

Tentative

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

MX4002	BIOMECHANICS					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	1	1	1
CO2	1	2	2	1		1
CO3	2	2	1	2		
CO4	3	3	2	2		1
CO5	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

Tentative

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.

MX4003	BIOMETRICS					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	2	2	2
CO2	2	2	2	1	1	1
CO3	2	2	2	2	2	2
CO4	2	2	1	2	1	1
CO5	2	2	2	2	3	3
AVG	**2**	**2**	**1.6**	**1.8**	**1.8**	**1.8**

Tentative

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.

Tentative

MX4004	**BIOMATERIALS**					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	2	2	1
CO2	2	2	2	1	2	1
CO3	2	1	1		1	1
CO4	2	2	2			1
CO5	2	2	1		2	1
AVG	**2.2**	**1.8**	**1.8**	**1.5**	**1.7**	**1**

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

Perspective

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.

MX4071	HUMAN ASSIST DEVICES					
COURSE OUTCOME	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1	1	3	2
CO2	1		1	1	3	1
CO3	1		1	1	3	1
CO4	1		2	1	2	3
CO5	1		2	2	1	3
AVG	**1**		**1.4**	**1.2**	**2.4**	**2**

MX4072 MEDICAL OPTICS L T P C
3 0 0 3

Tentative

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

Tentative

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. .

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1	1	2	1	-	-
CO2	1	1	1	-	-	1
CO3	2	1	2	-	-	2
CO4	2	1	2	1	-	2
CO5	2	1	2	1	-	2
Avg	(8/15)=**0.53**	(5/15)=**0.33**	(9/15)=**0.6**	(3/15)=**0.2**	-	(7/15)=**0.46**

BM4075 **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

Tentative

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.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	-	1	2	2	-	2
CO2	3	2	2	2	-	1
CO3	3	2	2	1	-	2
CO4	1	1	2	1	1	2
CO5	3	1	2	2	-	2
Avg	(10/4)=2.5	(7/5)=1.4	(10/5)=2	(8/5)=1.6	(1/1)=1	(9/4)=2.25

Tentative

BM4076 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 8

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.

Tentative

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.
6. Arnon Kohen, Biomedical Signal Processing, Vol I and II, CRC Press Inc, Boca Rato,
7. Florida.
8. Bishop C.M., Neural networks for Pattern Recognition, Oxford, Clarendon Press, 1995.
9. Andrew Webb, Statistical Pattern Recognition, Wiley International, 2nd Edition, 2002.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		3	2	1	1
CO2	1		3	2	1	1
CO3	2		3	2	1	2
CO4	2		3	2		2
CO5	2		3	2		2
Avg	1.95		3	2	1	1.95

BM4071 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

REFERENCES

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

Tentative

COURSE OUTCOMES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1				2	2	
CO2				2	2	
CO3	2			3	2	1
CO4	2		2	3	3	1
CO5	3		3	3	3	3
Avg	1.4		1	2.6	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

Tentative

UNIT I INTRODUCTION TO ROBOTICS 9

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

Sensors and Actuators

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

UNIT II MANIPULATORS & BASIC KINEMATICS 9

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

Navigation and Treatment Planning

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

UNIT III SURGICAL ROBOTS 9

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

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

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

UNIT V WEARABLE ROBOTS 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

REFERENCES

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

Tentative

MX4073	MEDICAL ROBOTICS					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1				1		
CO2				2		
CO3	2		2	2	2	2
CO4	2		2	2	3	2
CO5	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

Tentative

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:

1. *https://swayam.gov.in/nd2_arp19_ap60/preview*

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*

CO-PO MAPPING

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	1		1	3	3	1
CO2	1		1	3	3	1
CO3	1		1	3	3	1
CO4	1		1	3	3	2
CO5	1		1	3	3	1
Avg	5/5=1		5/5=1	15/5=3	15/5=3	6/5=1.2

Tentative

BM4073 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.

C03: Apply the types of therapeutic exercises to benefit the society

C04: Design and apply different types Hearing aids, visual aids and their application in biomedical field and hence the benefit of the society.

C05: 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.

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

Tentative

BM4074 **TELEHEALTH 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

Tentative

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.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	-	-	-	-
CO2	1	1	1	-	-	-
CO3	1	1	-	-	-	-
CO4	2	2	2	3	3	3
CO5	2	2	2	1	2	3
Avg	(8/15)=**0.53**	(7/15)=**0.46**	(5/15)=**0.3**	(4/15)=**0.27**	(5/15)=**0.3**	(6/15)=**0.4**

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.

MX4005	HEALTH CARE, HOSPITAL AND EQUIPMENT MANAGEMENT					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	2		2	2
CO2	1	1	2		1	1
CO3		1	1			1
CO4		1	1			1
CO5		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

Tentative

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

MX4006	ULTRASOUND IN MEDICINE					
COURSE OUTCOME	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	2	1	1
CO2	2	2	2	2	2	2
CO3	2	2	1	2	2	2
CO4	2	3	2	3	3	2
CO5	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

Tentative

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

MX4007	**BIOETHICS AND STANDARDS**					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	2		2	2
CO2	1	1	2		1	1
CO3		1	1			1
CO4		1	1			1
CO5			1		2	2
AVG	**1**	**1**	**1.4**	**0**	**1.66**	**1.4**

BM4072 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,

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1		1	
CO2	1	2	1		1	
CO3	1	2	1		1	
CO4	1	2	1		1	
CO5	1	2	1		1	
Avg	1	2	1		1	

Tentative

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

MX4008	**TISSUE ENGINEERING AND IMMUNO ENGINEERING**					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	1	2	1	2
CO2	2	2	1	1	1	2
CO3	2	2	2	1	2	1
CO4	2	2	2	1	2	1
CO5	2	2	2	3	2	2
AVG	**2**	**2.2**	**1.6**	**1.6**	**1.6**	**1.6**

Test Drive

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.

Tentative

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

MX4009	MEDICAL EQUIPMENT					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			2	2	2	
CO2			3	1	2	
CO3			2	2	2	
CO4	1		2		1	2
CO5	2		2	2	1	2
AVG	**1.5**		**2.2**	**1.75**	**1.6**	**2**

Tentative

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

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

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.

Regulative

MX4010	BIOMEMS AND ARTIFICIAL ORGANS					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	2	1	2
CO2	2	2	1	2	2	1
CO3	2	2	2	2	2	2
CO4	2	2	2	1	1	2
CO5	**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

Tentative

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)

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

Tentative

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.

MX4011	PHYSIOLOGICAL MODELING					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	1	2	2	1
CO2	2	2	2	2	1	2
CO3	2	2	2	2	2	2
CO4	2	2	2	2	2	2
CO5	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

Tentative

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

MX4074	**PATTERN RECOGNITION TECHNIQUES AND APPLICATIONS**					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1			2	2	
CO2	1			2	2	
CO3	2			3	2	
CO4	2			3	1	2
CO5	2		2	3	3	2
AVG	**1.6**		**2**	**2.6**	**2**	**2**

MU4253	**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,

Tentative

	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.
6.	Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
7.	Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2nd Edition, 2006.
8.	William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008

MAPPING OF CO'S WITH PO'S

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1		2	1	2	1	
CO2	1	2	3	2		2
CO3	2	3	2	2	2	1
CO4	2	2	2	3	3	3
CO5	3	1	1	1	1	2
Avg						

Tentative

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

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.

MX4012	**3D PRINTING IN MEDICINES**					
COURSE OUTCOME	**PROGRAMME OUTCOMES**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1		2	1	
CO2	2	1		2	1	
CO3	3	2		2	2	
CO4	3	2		1	2	2
CO5	3	2	2	3		2
AVG	**2.6**	**1.6**	**2**	**2**	**3**	**2**

Tentative

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.

Tentative

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

Tentative

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.

Tentative

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 மலர் க்காட்சி
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 போர் வைகொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி

Tentative

கொடுத்தது, அரசர் பண்புகள்

2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச் சாலையை 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. சுற்றுச் சூழல் 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 வளர்ச்சித்துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

Tentative