RAJALAKSHMI ENGINEERING COLLEGE

An Autonomous Institution, Affiliated to Anna University, Chennai

DEPARTMENT OF BIOMEDICAL ENGINEERING

M.E. MEDICAL ELECTRONICS
REGULATIONS 2023

CHOICE BASED CREDIT SYSTEM (CBCS)

CURRICULUM AND SYLLABUS

DEPARTMENT VISION

To create a center of academic excellence in the field of Biomedical engineering through innovative research contributions and industrial oriented teaching and training for betterment in healthcare.

DEPARTMENT MISSION

- To motivate faculty members and students to explode their creativity to develop innovative products by utilizing modern technologies to serve the society
- To inculcate the industrial need of the biomedical engineers among the students through relevant training and value added courses.
- To produce technically intense engineers by practicing innovative teaching methodologies

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO I: To provide with enriched knowledge on medical electronics to study vital physiological signal measurements, imaging modalities, assist and rehabilitation devices to fulfil the needs of healthcare service providers, industries and society.

PEO II: To develop the skills to profoundly perform research, design and development of biomedical devices and allied integrated systems for better healthcare.

PEO III: To instigate students to work in collaboration with external expertise/resources and practice the profession in alignment with global professional standards and ethical practices.

PROGRAMME OUTCOMES (POs):

PO 1: An ability to independently carry out research /investigation and development work to solve practical problems

PO 2: An ability to write and present a substantial technical report/document

PO 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

PO 4: Analyze, model, design and realize biomedical devices, systems, components or processes.

PO 5: Apply mathematical foundations, science and engineering to provide solutions for health care systems.

PO 6: Obtain broad education necessary to understand the impact of biomedical engineering solutions in global, economic, environmental and social context.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO 1: Apply advanced technology for measurement and interpretation of data acquired from biological system addressing the problems associated with the interaction between living and non-living materials and systems

PSO 2: Specify, architect and prototype health-care solutions by applying biosignal and medical image processing techniques on modern hardware and software platforms for applications with real time constraints.

PSO 3: Provide sustainable solutions in health care and its allied fields by imbibing managerial and techno-social values.

PSO 4: Knowledge of social & environmental awareness along with ethical responsibility to achieve a successful career addresses the real world applications using optimal resources as an entrepreneur.

CREDIT DISTRIBUTION

Category	CREDITS AS PER SEMESTER				Credits Total
	I	II	III	IV	
Foundation Course	4	-	-	-	**4**
Professional Core Courses	12	16	-		**28**
Professional Elective Courses	3	6	3		**12**
Research Methodology and IPR	3	-	-	-	**3**
Open Electives	-	-	3	-	**3**
Employability Enhancement Courses (EEC)	-	1	8	12	**21**
Total	**22**	**23**	**14**	**12**	**71**

CURRICULUM

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	Contact Periods	L	T	P	C
THEORY COURSES							
1	MX23111	Anatomy & Physiology of Human Body	3	3	0	0	3
2	MX23112	Research and Patenting Methodology for Bioengineers	3	3	0	0	3
3	MX23113	Advanced Biomedical Equipment	3	3	0	0	3
4	MX23A1X	Professional Elective I	3	3	0	0	3
5	AC23111	English for Research Paper Writing	3	3	0	0	0
LAB INTEGRATED THEORY COURSES							
1	MX23131	Biosignal Acquisition and Processing	5	2	1	2	4
2	MH23132	Applied Mathematics for Electronics Engineers	5	3	0	2	4
LABORATORY COURSE							
1	MX23121	Biomedical Instrumentation Lab	4	0	0	4	2
		TOTAL	**29**	**20**	**1**	**8**	**22**

SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	Contact Periods	L	T	P	C
THEORY COURSES							
1	MX23211	Optimization Techniques in Biomedical Applications	3	3	0	0	3
2	MX23212	Advanced Microcontrollers and Prototype Development	3	3	0	0	3
3	MX23B1X	Professional Elective II	3	3	0	0	3
4	MX23C1X	Professional Elective III	3	3	0	0	3
5	AC23211	Constitution of India	3	3	0	0	0
LAB INTEGRATED THEORY COURSES							
1	MX23231	Medical Imaging and Processing Techniques	5	3	0	2	4
2	MX23232	Biophotonics	5	3	0	2	4
LABORATORY COURSES							
1	MX23221	Artificial Intelligence and Machine learning Laboratory	4	0	0	4	2
2	MX23222	Technical Seminar on research topics	2	0	0	2	1
		TOTAL	**31**	**21**	**0**	**10**	**23**

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	Contact Periods	L	T	P	C
THEORY COURSES							
1		Open Elective I	3	3	0	0	3
2	MX23D1X	Professional Elective IV	3	3	0	0	3
LABORATORY COURSES							
1	MX23321	Project Work – Phase I	12	0	0	12	6
2	MX23322	Training in Healthcare Sector	4	0	0	4	2
		TOTAL	**22**	**6**	**0**	**16**	**14**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	Contact Periods	L	T	P	C
LABORATORY COURSE							
1	MX23421	Project Work - Phase II	24	0	0	24	12
		TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL CREDITS: 71

PROFESSIONAL ELECTIVES

ELECTIVE I

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	MX23A11	Nanotechnology and Applications	3	0	0	3
2	MX23A12	Finite Element Methods for Biomechanical Analysis	3	0	0	3
3	MX23A13	Medical Information system	3	0	0	3
4	MX23A14	Tissue Mechanics	3	0	0	3

ELECTIVE II

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	MX23B11	Biofluid mechanics	3	0	0	3
2	MX23B12	Principles of Genetic Analysis	3	0	0	3
3	MX23B13	Rehabilitation & Assistive Technology	3	0	0	3
4	MX23B14	Quality Control and Waste Management in Healthcare	3	0	0	3

ELECTIVE III

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	MX23C11	Medical Device Development –Concept to Market	3	0	0	3
2	MX23C12	Physiological Control Systems	3	0	0	3
3	MX23C13	Biostatistics	2	0	0	2
4	MX23C14	Structure and Functions of Biomaterials	3	0	0	3
5	MX23C15	Speech processing	1	0	0	1

ELECTIVE IV

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	MX23D11	Brain Computer Interface	2	0	0	2
2	MX23D12	Internet of Medical Things	2	0	0	2
3	MX23D13	Biomedical Applications in Aviation & Space Environment	1	0	0	1
4	MX23D14	Ethics and Standards in Healthcare	1	0	0	1
5	MX23D31	Medical Textiles	1	0	2	2

VALUE ADDED COURSES

S.No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
1	MX23V31	Introduction to 3D printing	2	0	0	2	0
2	MX23V32	Introduction to SCI Lab and R-Lab	2	0	0	2	0
3	MX23V33	Introduction to SAS programming language	2	0	0	2	0
4.	MX23V34	Modelling using COMSOL	2	0	0	2	0

SEMESTER I

MX23111 ANATOMY & PHYSIOLOGY OF HUMAN BODY L T P C
3 0 0 3

OBJECTIVES

- To define the terminology, anatomy and physiology, and pathology of each body system and how they interrelate to maintain homeostasis.
- To understand the organs and systems involved in body functions.
- To apply this knowledge into biomedical engineering field.

UNIT I INTRODUCTION TO HUMAN ANATOMY & PHYSIOLOGY 8

Organization of human body-Anatomical planes, positions, and sections- Cell: Structure and organelles structure – Functions of Each component in the cell- tissues and its types – Cell membrane Transport, Resting membrane potential and ionic basis of potentials, Recording of Action potentials, - Homeostasis.

UNIT II BUILDING BLOCKS OF HUMAN BODY 8

Muscular System: Types of Muscle – Structure & Functions of Skeletal Muscle.
Skeletal System: Structure, Type and Functions of Bone - Axial and Appendicular Skeleton. Joints: Definition, Types, and functions. Cartilage: An overview – types and functions.
Skin and Appendages.

UNIT III ENERGY PRODUCING SYSTEMS IN HUMAN BODY 10

GI Tract: Organization of structures and functions of GI tract - Accessory Organs of GI Tract: Salivary glands, Liver, Pancreas, Gall bladder, Teeth and Tongue. Ingestion, Digestion and Absorption – Factors regulating Movements and Digestion in GI tracts.
Respiratory System: Organization structures and functions of respiratory system – Mechanism of Breathing – Respiratory Volumes, Measurements and Artificial Respiration.

UNIT IV TRANSPORTER AND EXCRETORY SYSTEM 10

Blood: Components of blood, blood grouping and typing
Cardiovascular System: Blood vessel - internal structure - Cardiac Muscle: Structure and functions – Structure and Components of Heart - Conducting System of Heart – Heart Sounds– Blood Pressure – Regulation of Blood Pressure and Measurements.
Urinary System: Structure of Kidney, Nephron, Ureter and Urinary bladder. Urine formation and Micturition reflex.

UNIT V CONTROLLING AND COORDINATING SYSTEMS IN HUMAN BODY 9

Nervous system: Organization of Nervous system. Structure, Types and Properties of Neurons - Action potential of Neuron - Neuroglial Cells - Brain, Lobes and Cortical Areas – Spinal cord arrangement and Plexus formation. Autonomic Nervous System: Divisions and control on each system - Reflex Mechanism. Special Senses: Structure of Eye and Ear – Functions and clinical conditions of Eye & Ear.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Use correct terminology to discuss the chemistry, cell structure, and tissues of the human body.
- Describe basic structural and functional elements of human body
- Explain organs and structures involving in system formation and functions.
- Explain the role of each body system in maintaining homeostasis.
- Identify and explain the structure and functions of each body system.

REFERENCES:

1. Anatomy & Physiology, Gary A.Thibodeau, Kevin T.Patton – 7th Edition, Mosby Publisher 2009.
2. The Human Body, Gillian Pocock & Christopher D.Richards, Oxford University Press, 2009.
3. Guyton 'Text book of Medical Physiology – WB Jaunder company Philadelphia - 10th edition 2002.
4. Tobin C.E., "Basic Human Anatomy", McGraw – Hill Publishing Co., Ltd., Delhi 1997.
5. Gibson.J. "Modern Physiology & Anatomy for Nurses", Blackwell SC Publishing 1981.
6. Essential of Human Anatomy and Physiology, Elaine.N.Marieb Eight Edition, Pearson Education, New Delhi, 2007.

MX23112 RESEARCH AND PATENTING METHODOLOGY FOR BIOENGINEERS **L T P C**

3 0 0 3

OBJECTIVES

- To give an exposure to the major
- Aspects of research and research approaches.
- To develop the report writing skills and technical paper writing skills.
- To understand rules and regulation pertaining to IPR
- To know ethical issues in medical research
- To develop the oral presentation skills.

UNIT I BASICS OF RESEARCH **9**

Objectives of research-motivation in research- types of research-research approaches – significance of research- research methods Vs methodology – criteria for good research. Research problem- selecting the problem- necessity of defining the problem- literature review – importance of literature review in defining a problem – critical literature review – identifying gap areas from literature review.

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UNIT II RESEARCH DESIGN IN HEALTHCARE **8**

Meaning of research design-need–features of good design- important concepts relating to research design- different types – developing a research plan- Method of data collection– collection of data- observation method- interview method- questionnaire method –

processing and analyzing of data- processing options- types of analysis – interpretation of results. Clinical and sub-clinical research, Product testing and evaluation on human and or animals.

UNIT III PATENTING MEDICAL DEVICES 10

Introduction to intellectual property right (IPR), Need for IPR, international organizations, agencies and treaties, Law of IPR related to patents for biological products, Categories of patent in national and international level, Medical patents, Technological updates in medical devices – need, prior-art-search and drafting

Case study: The students has to search one US (preferred) / Indian patent with respect to their area of interest and can present the flow of the patent and provide conclusive remark

UNIT IV ETHICAL CONCERNS IN MEDICAL IPR 8

Ethics in Medical Research, Clinical trials and patenting – transparency, consent, equitable sharing of benefits, Moral responsibilities of biomedical engineers and pharmaceuticals, Animal use and related ethics in biomedical research

Case study: The impact of intellectual property regulation on global medical technology innovation

UNIT V REPORT WRITING AND PRESENTATION 10

Types of report – research report, research proposal, technical paper- significance different steps in the preparation – lay out, structure and language of typical reports, Clinical research and plagiarism.

Oral presentation – planning, preparation, practice- making presentation – answering questions-use of visual aids-quality and proper usage-Importance of effective communication with illustrations

Case study with a seminar presentation on a topic relevant to present clinical need with a reference from peer reviewed journal

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Undertake research projects.
- A project and design related approach
- Identify patentable products / procedure
- Implement research skills with ethics and moral code
- Write technical papers and publish them in journals / conferences

REFERENCES:

1. Coley.S.M and Scheinberg C.A 1990, Proposal writing, Newbury-Sage Publications.
2. Leedy.P.D, Practical research planning and Design, 4th edition, MW Macmillan publishing company.
3. Day Ra, 1989 “How to write and publish a scientific paper”, Cambridge University Press.
4. Earl Babbie, 1994, The practice and Social Research, Wordsworth Publishing Company.

5. Mike Martin and Roland Schinzinger, Ethics in Engineering, McGraw Hill, New York, 2005
6. Charles E Harris, Michael S Pritchard and Michael J Rabins, Engineering Ethics Concepts and Cases, Thompson Learning, 2000.

MX23113 ADVANCED BIOMEDICAL EQUIPMENT L T P C
3 0 0 3

OBJECTIVES

- To learn about the functions of the equipment associated with cardiac care unit and pulmonary analyzers.
- To know about the various functional blocks in the neurology instruments.
- To develop an understanding of the physiotherapy equipment and the electrical safety in the hospital environment.
- To introduce special diagnostic techniques.
- To understand the problems in common biomedical equipment in hospitals when it is not working and provides a suitable solution.

UNIT I CARDIAC CARE UNIT AND PULMONARY ANALYSERS 9

Cardiac Pacemakers-different types and their comparison, Defibrillators- classification, Implantable defibrillators, patient monitoring system, Biotelemetry.
Regulation of Breathing - Pulmonary volume measurements - Nitrogen Gas Analyser, Ventilators, Case study.

UNIT II NEUROLOGY INSTRUMENTS 9

Evoked response - Need, Auditory, Visual and Somato sensory, Depth recording, Stereotaxy unit and its advancement , EEG controlled Anaesthetic monitor, Case study.

UNIT III DIATHERMY EQUIPMENT AND PATIENT SAFETY 9

Physiological effects of HF radiation, Depth of Penetration, Short wave, Ultrasonic and microwave diathermy, Surgical diathermy, Electrical safety-IEC-60601 standard, Physiological effects of current, Leakage current, Micro and macro electric shock, GFI units, Earthling Scheme, Electrical safety Analyser.

UNIT IV SPECIAL DIAGNOSTIC TECHNIQUES 9

Need for heart lung machine, functioning of bubble, disc type and membrane type oxygenators, finger pump, roller pump, electronic monitoring of functional parameter. Regulation of Water and Electrolyte Balance, Artificial Kidney, Hemo dialysis - Peritoneal dialysis, different types of Dialyzer, Lithotripsy, Principles of Cryogenic technique and application, Endoscopy, Laparoscopy, Applications of IoT in Healthcare.

UNIT V BIOMEDICAL EQUIPMENT TROUBLESHOOTING 9

Troubleshooting- ECG Machine, EEG Machine-Troubleshooting- defibrillator, electrosurgical unit-Troubleshooting- anaesthesia machine, Troubleshooting- endoscope, incubators - Troubleshooting- oxygen concentrators, sphygmomanometers, suction machine.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Describe and explain specific parts in Cardiac care unit and assist devices.
- Familiarize with neurology and renal instruments in hospital
- Solve design related problems in diathermy and test the electrical safety of medical equipment in the hospital environment.
- Gain knowledge on special diagnostic techniques.
- Identify the problems in common biomedical equipment in hospitals when it is not working and provide a suitable solution.

REFERENCES:

1. Albert M Cook and Webster J G – Therapeutic medical devices Prentice Hall Nee York1982
2. Khandpur R.S Hand Book of Biomedical Instrumentation – Tata McGraw Hill publication, New Delhi 2nd edition 2003 J.Weibell
3. Cromwell Leslie, Fred Erich A.Pfeiffer - Biomedical Instrumentation Prentice Hall NewDelhi 2000
4. John Webster. Medical Instrumentation.- Application and Design. John Wiley and Sons.Inc., New York. Third edition 2003.
5. John Denis Enderle, Joseph D. Bronzino, Susan M. Blanchard, ‗Introduction to Biomedical Engineering: ‘Academic Press, 2005, 2nd Edition ISBN 0122386620, 9780122386626.
6. Geddes LA and Baker L.E Principals of Applied Biomedical Instrumentation, 3rd Edition, John Wiley and sons, Newyork 1989
7. Nicholas Cram & Selby Holder, “Basic Electronic Troubleshooting for Biomedical Technicians”, 2nd edition, 2010, TSTC Publishing.
8. Dan Tomal& Neal Widmer, “Electronic Troubleshooting”, 3rd edition, 2004, McGraw Hill.
9. Richard Fries, “Reliable Design of Medical Devices”, 2nd edition, 2006, CRC Press.

AC23111	ENGLISH FOR RESEARCH WRITING	L T P C
	Common to all branches of M.E. /M.Tech / MBA	**3 0 0 0**

UNIT I INTRODUCTION TO RESEARCH WRITING 9

Research – Types of Research - Selecting the Primary resources - Categorizing secondary sources - Discovering a researchable area and topic – Need Analysis - Research Question- Focussing on the Research Problem- Developing Research Design – Framing the Hypothesis – Identifying the Scope of the Research - Writing – General and Academic Writing

UNIT II LANGUAGE OF WRITING 9

Active reading – text mining – use of academic words – jargons – ambiguities – use of expression – use of tense - proper voices – third person narration – phraseology – use of foreign words – use of quotes – interpreting quotes.

UNIT III THE FORMAT OF WRITING 9

Types of Journals - different formats and styles - IEEE format - Structure – Margins - Text Formatting - Heading and Title - Running Head with Page Numbers - Tables and illustrations - Paper and Printing - Paragraphs - Highlighting – Quotation – Footnotes

UNIT IV ORGANISING A RESEARCH PAPER 9

Title- Abstract – Introduction – Literature review - Methodology - Results –Discussion – Conclusion - Appendices - Summarising - Citation and Bibliography

UNIT V PUBLISHING PAPER 9

Finding the Prospective publication or Journal - analysing the credits - Reviewing - Revising – Plagiarism Check - Proof reading - Preparing the Manuscript- Submitting - Resubmitting - Follow up - Publishing

Total 45 Hrs

OUTCOMES:

On completion of the course the students will be able to

- Understand the basic structure of research work
- Apply proper use of language in writing paper
- Comprehend different formats of journal paper
- Follow the process of writing a research paper and write one
- Emulate the process of publishing journal paper and publish papers

REFERENCES:

1. Adrian Wallwork: “English for Writing Research Papers”, Springer Science Business Media, Second Edition, LLC 2011
2. Stephen Howe and Kristina Henrikssion: “Phrasebook for Writing Papers and Research in English”, The Whole World Company Press, Cambridge, Fourth edition 2007
3. The Modern Language Association of America: “MLA Handbook for Writers of Research Papers” 8th Edition, The Modern Language Association of America, 2016
4. Rowena Murray: The Handbook of Academic Writing: A Fresh Approach, Sarah Moore Open University Press, 2006
5. Stephen Bailey: Academic Writing: A Practical Guide for Students Routledge Falmer: 2003
6. Joseph M. Moxley: Publish, Don't Perish: The Scholar's Guide to Academic Writing and Publishing, Praeger Publishers, 1992

MX23131 BIOSIGNAL ACQUISITION AND PROCESSING L T P C

2 1 2 4

OBJECTIVES

- To know the various functional blocks present in biosignal acquisition system
- To understand the different biopotential characteristics and recording methods
- To gain in depth knowledge about wavelet detection
- To develop a thorough knowledge on classification of biomedical signals

- To understand thoroughly multivariate analysis To develop an understanding of the nonelectrical parameters measurements

UNIT I BIOMEDICAL TRANSDUCERS AND AMPLIFIERS 9

Categories and Characteristics of Transducer, Signal conditioning units, Multichannel data acquisition system, various types recorders, necessity for low noise pre amplifiers, Difference amplifier, Chopper amplifier, Different types of electrode and its equivalent circuits.

UNIT II BIOPOTENTIAL RECORDING 9

ECG, EEG, EMG, PCG, EOG, ERG lead system and recording methods, typical waveform, frequency spectrum, abnormal waveform, block schematic of ECG recorder and other Bio potential recorder

UNIT III ADAPTIVE FILTERING AND WAVELET DETECTION 9

Filtering – LMS adaptive filter, adaptive noise cancelling in ECG, improved adaptive filtering in FECG, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

UNIT IV BIO SIGNAL CLASSIFICATION AND RECOGNITION 9

Signal classification and recognition – Statistical signal classification, linear discriminate function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats.

UNIT V EEG and EMG SIGNAL ANALYSIS 9

Stimulation, recording and postprocessing of brain signals – sleep, cognitive functions, brain control interface, diabetic neuropathy

Muscle stimulation and interpretation of EMG data in relation to motor control, force and fatigue, nerve conduction velocity study

Time frequency representation, Data reduction techniques - Wavelet packets, Multivariate component analysis - PCA, ICA

LIST OF EXPERIMENTS:

1. Preprocessing of Biosignals
2. Spectrum analysis of Biosignals
3. Analysis of ECG signals.
4. Band separation and spectrum of EEG signals
5. Feature extraction in EMG signals
6. Biosignal analysis in virtual instrumentation platform.

TOTAL: 45+30=75 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Identify the electrodes for bio signal acquisition
- Interpret the different types of lead system to measure ECG
- Understand the methods of Adaptive Filtering and Wavelet Detection for feature extraction
- Classify various biosignals and Recognition using different algorithms

- Record and analyze EEG and EMG signals acquired from clinically used machines

REFERENCES:

1. Geddes LA and Baker L.E Principals of Applied Biomedical Instrumentation , John Wiley and sons New York 1975
2. Webster J.G Medical Instrumentation application and design – John Wiley and sons New York 3rd edition 1999
3. Arnon Cohen, Bio-Medical Signal Processing Vol I and Vol II, CRC Press Inc., Boca Rato, Florida 1999.
4. Rangaraj M. Rangayyan, 'Biomedical Signal Analysis-A case study approach', Wiley-Interscience/IEEE Press, 2002
5. Khandpur R.S Hand Book of Biomedical Instrumentation – Tata Mc Graw Hill publication New Delhi 2nd edition 2003

Assessment

CAT 1 and 2 are usual pattern that will be conducted for 60 and 30 marks respectively

CAT 3 is based on the real time recording and signal processing work carried out in the lab. Clinically used and FDA approved machines are available in the lab. Students need to identify a problem and come out with a suitable solution. They will be evaluated by a presentation, 20 pages report / international conference presentation. Marks allotted – 60

MH23132 APPLIED MATHEMATICS FOR ELECTRONICS ENGINEERS (Data Analysis Lab with R) **L T P C**

3 0 2 4

OBJECTIVES

- To develop the ability to use the concepts of fuzzy logic for solving problems that arrives in the field of engineering and technology.
- To understand statistical models for forecasting
- To understand Random process and Markov models
- To formulate and construct a mathematical model using linear programming in real life situation;
- To analyse data by clustering methods

UNIT-I FUZZY LOGIC **9**

Classical logic – multivalued logics – fuzzy propositions – fuzzy quantifiers.

UNIT-II LINEAR STATISTICAL MODELS **9**

Scatter diagram, Linear regression and correlation. Least squares method. Rank correlation. Multiple regression and multiple correlation, Analysis of variance (one way, two way with as well as without interaction).

UNIT-III RANDOM PROCESS AND MARKOV MODELS **9**

Random Process- Stationary processes –Evolutionary Process- Markov Process – Discrete

Parameter Markov chain – Chapman Kolmogorov theorem (without proof) -State transitions- state probabilities - properties – steady state analysis – absorbing chains – Case study : Markov Analysis of Dynamic memory allocations, Markov models for Manufacturing production capability.

UNIT-IV LINEAR PROGRAMMING 9

Formulation – graphical solution – simplex method – two phase method - transportation and assignment models.

UNIT-V DATA ANALYSIS AND INTERPRETATION 9

Cluster analysis :Clustering by partitioning methods, hierarchical clustering, overlapping clustering, K-Means Clustering-Profiling and Interpreting Clusters - Factor analysis: Factor analysis model, Extracting common factors, determining number of factors, Factor scores.

CONTACT PERIODS: 45

LIST OF EXPERIMENTS

1	Introduction to R, Functions, Control flow and Loops
2	Working with Vectors and Matrices
3	Reading in and Writing Data
4	Working with Data
5	Graphics in R
6	Differentiation and Integration
7	Simulation
8	Linear model
9	Data Frame – Factor analysis
10	Cluster analysis

CONTACT PERIODS: 30

TOTAL: 45+30=75 PERIODS

OUTCOMES:

On completion of the course, students will be able to

- Solve problems that arise in the field of Engineering and technology using fuzzy logic concepts.
- Analyze linear statistical models
- Analyze random process and Markov models
- Make decisions using the principles of optimality on the problems of dimensionality.
- Analyze data using cluster and factor analysis

Text Book(s):

1. Taha H.A., “Operations Research: An introduction”, Pearson Education, Asia, New Delhi, Ninth Edition, 2012
2. Hwei Hsu, “Schaums Outline of Theory and Problems of Probability, Random Variables and Random Processes”, Tata Mcgraw Hill Edition, New Delhi, 2017.
3. Al-Begain. H., and Bargiela, A., Eds. (2016), Seminal Contributions to Modelling and Simulation. Springer.

4. M. W. Carter, C. C. Price and G. Rabadi, “Operations research a practical introduction ” second edition, 2019. CRC Press.
5. D.A. Belsey, E. Kuh and R.E. Welsch ,”Regression Diagnostics , Identifying Influential Data and Sources of Collinearety”
6. M.R. Anderberg, “Cluster Analysis for Applications”, Academic Press.
7. George J. Klir and Yuan, B., Fuzzy sets and fuzzy logic, Theory and applications, Prentice Hall of India Pvt. Ltd.

Reference Books(s) / Web links:

- Richard Johnson, Miller & Freund’s Probability and Statistics for Engineers, 7th Edition, Prentice – Hall of India, Private Ltd., New Delhi (2007).
- http://library.lol/main/5B975EF87B5E4F3500CCB5A8621B76C3
- Tata, H.A., Operations Research, An introduction, 7th edition, Pearson education editions, Asia, New Delhi.
  http://library.lol/main/E3AA251DD5BF0EAF1D5005717559F374
- Veerarajan T, Probability, statistics and random process with queueing theory and queueing networks, 4th edition, McGraw - Hill Publishing Company Limited

  http://library.lol/main/8FF43A47B3EC14F57E48780AEE40BEB3

MX23121	BIOMEDICAL INSTRUMENTATION LAB	L T P C
		0 0 4 2

OBJECTIVES

- To design and build any bio signal acquisition system.
- To study the methods of physiological parameter measurement
- To learn about the biotelemetry and electrical Isolation method.
- To study the various aspects of bio signals and amplifiers.
- To understand the performance of surgical diathermy.

LIST OF EXPERIMENTS:

1. Recording and analysis of Electrocardiogram
2. Recording of EMG for different stress on the muscle.
3. Recording and analysis of Electroencephalogram
4. Plotting of human auditory response using audiometer.
5. Measurement of Electrical activity of skin.
6. Determination of Pulmonary Function Using Spirometer.
7. Study of Surgical diathermy and Short Wave Diathermy
8. Measurement of Evoked Potential.
9. Design and analysis of bio-amplifier using circuit simulation tools.
10. Design and testing of Bio-Amplifiers
11. Measurement of Vital parameters using patient monitoring system
12. Electrical safety testing of medical equipment

13. Mini project (Should include hardware and software).

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Record various physiological parameters.
- Design the amplifier for Bio signal measurements.
- Test and Analyze the various measurements related to electrical safety of medical equipment.
- Analyze the Surgical diathermy unit.
- Measure and analyze the function of human auditory and respiratory systems.

SEMESTER II

MX23211 OPTIMIZATION TECHNIQUES IN BIOMEDICAL APPLICATIONS L T P C

3 0 0 3

OBJECTIVES

- To introduce engineering optimization problems.
- To understand different search methods for single variable optimization.
- To know about multivariable optimization.
- To learn swarm based intelligence.
- To study advanced optimization techniques.

UNIT I SINGLE VARIABLE OPTIMIZATION 9

Basic concept of optimization - Mathematical formulation of optimization problems - Optimality criteria, bracketing methods – exhaustive search method, bounding phase method – region elimination methods – interval halving, Fibonacci search, golden section search, point estimation method – successive quadratic search, gradient based methods.

UNIT II MULTIVARIABLE OPTIMIZATION 9

Optimality criteria, unconstrained optimization – solution by direct substitution, unidirectional search – direct search methods evolutionary search method, simplex search method, Hook-Jeeves pattern search method, gradient based methods – steepest descent, Cauchy's steepest descent method, Newton's method, conjugate gradient method – constrained optimization. Kuhn-Tucker conditions.

UNIT III SWARM INTELLIGENCE 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- Artificial Bee Colony (ABC) Optimization - Fish Swarm – Bacteria foraging.

UNIT IV ADVANCED NON-LINEAR OPTIMIZATION 9

Genetic Algorithms -Working principle-Genetic operators-Numerical problem-Simulated Annealing – Tabu Search – – Numerical problem - Neural network based optimization-Optimization of fuzzy systems-fuzzy set theory-computational procedure.

UNIT V BIOMEDICAL APPLICATIONS 9

Obesity level prediction from patient's physical condition and eating habits, heart failure detection from clinical and lifestyle information, medical report summarization, polycystic ovary syndrome diagnosis, early detection of chronic obstructive pulmonary disease, breast cancer diagnosis, diagnosing schizophrenia using EEG, arrhythmia classification using ECG signals, heartbeats detection using ECG, classification of EMG signals.

TOTAL PERIODS : 45

COURSE OUTCOMES

1. To analyze various engineering optimization problems.
2. To apply single variable optimization techniques in real life problems.
3. To apply multi variable optimization techniques in real life problems.
4. To develop swarm based intelligence techniques for biomedical applications.
5. To design non-linear optimization techniques for biomedical applications.

REFERENCES

1. S. S. Rao, "Optimization Theory and Applications", Second Edition, New Age International (P) Limited Publishers, 1995.
2. Marco Dorigo and Thomas Stutzle, "Ant Colony optimization", Prentice Hall of India, New Delhi, 2004.
3. Kenneth A DeJong,"Evolutionary Computation A Unified Approach", Prentice Hall of India, New Delhi, 2006
4. David E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Addison Wesley Longman Publishing, New York, USA, 1989.
5. Janmenjoy Nayak, Asit Kumar Das, Bighnaraj Naik, Saroj K. Meher AND Sheryl Brahnam Nature-Inspired Optimization Methodologies in Biomedical and Healthcare, Intelligent Systems Reference Library (ISRL, volume 233) 2023.

MX23212 ADVANCED MICROCONTROLLERS AND PROTOTYPE DEVELOPMENT **L T P C 3 0 0 3**

OBJECTIVES

- To expose the students to the fundamentals of microprocessor architecture.
- To introduce the advanced features in microprocessors and microcontrollers.
- To enable the students to understand various microcontroller architectures.

UNIT I HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM 9

CPU Architecture - Bus Operations – Pipelining – Brach predication – floating point unit Operating Modes –Paging – Multitasking – Exception and Interrupts – Instruction set – addressing modes.

UNIT II HIGH PERFORMANCE RISC ARCHITECTURE – ARM 9

Arcon RISC Machine – Architectural Inheritance – Core & Architectures – Registers – Pipeline – Interrupts – ARM organization – ARM processor family – Co-processors ARM instruction set- Thumb Instruction set – Instruction cycle timings – The ARM Programmer's model – ARM Development tools – ARM Assembly Language Programming – C programming – Optimizing ARM Assembly Code – Optimized Primitives.

UNIT III ARM APPLICATION DEVELOPMENT 9

Introduction to DSP on ARM –FIR filter – IIR filter – Di screte fourier transform – Exception handling – Interrupts – Interrupt handling schemes- Firmware and bootloader – Embedded Operating systems – Integrated Development Environment- STDIO

Libraries – Peripheral Interface – Application of ARM Processor – Caches – Memory protection Units – Memory Management units – Future ARM Technologies.

UNIT IV MOTOROLA 68HC11 MICROCONTROLLERS 9

Instruction set addressing modes – operating modes- Interrupt system- RTC-Serial Communication Interface – A/D Converter PWM and UART.

UNIT V PIC MICROCONTROLLER 9

CPU Architecture – Instruction set – interrupts- Timers- I2C Interfacing –UART- A/D Converter –PWM and introduction to C-Compilers.

OUTCOMES:

On completion of the course the students will be able to

- Design and implement programs on 8086 microprocessor.
- Work with suitable microcontroller for a specific real world application
- Design Memory Interfacing circuits.
- Design filters using ARM processors
- Design and implement 8051 microcontroller based systems.

TOTAL: 45 PERIODS

REFERENCES:

1. Andrew N.Sloss, Dominic Symes and Chris Wright " ARM System Developer's Guide Designing and Optimizing System Software" , First edition, Morgan Kaufmann, Publishers, 2004.
2. Steve Furber , "ARM System –On –Chip architecture", Addision Wesley, 2000.
3. Daniel Tabak , "Advanced Microprocessors", Mc Graw Hill. Inc., 1995
4. James L. Antonakos , " The Pentium Microprocessor", Pearson Education, 1997.
5. Gene .H.Miller, "Micro Computer Engineering", Pearson Education, 2003.
6. John .B.Peatman , "Design with PIC Microcontroller", Prentice Hall, 1997.

AC23211 CONSTITUTION OF INDIA L T P C

3 0 0 0

OBJECTIVES

- To inculcate the values enshrined in the Indian constitution.
- To create a sense of responsible and active citizenship.
- To make the students aware of the Constitutional and the Non- Constitutional bodies
- To help the students understand the relationships exist between union and states
- To make the students understand the sacrifices made by the freedom fighters.

UNIT-I INTRODUCTION 9

Historical Background - Constituent Assembly of India - Philosophical foundations of the Indian Constitution - Features - Basic Structure – Preamble.

UNIT-II UNION GOVERNMENT - EXECUTIVE, LEGISLATURE AND JUDICIARY 9

Union and its territory - Citizenship - Fundamental Rights - Directive Principles of State Policy (DPSP) - Fundamental Duties. President - Vice President - Prime Minister - Central Council of Ministers - Cabinet Committees - Parliament: Committees, Forums and Groups - Supreme Court.

UNIT-III STATE GOVERNMENT & UNION TERRITORIES: STATE GOVERNMENT : EXECUTIVE, LEGISLATURE AND JUDICIARY 9

Governor - Chief Minister - State Council of Ministers - State Legislature - High Court - Subordinate Courts -Panchayati Raj – Municipalities-Union Territories - Scheduled and Tribal Areas.

UNIT-IV RELATIONS BETWEEN UNION AND STATES 9

Relations between Union and States - Services under Union and States. Cooperative Societies - Scheduled and Tribal Areas - Finance, Property, Contracts and Suits - Trade and Commerce within Indian Territory – Tribunals.

UNIT-V CONSTITUTIONAL BODIES AND AMENDMENTS 9

Introduction to Constitutional & Non-Constitutional Bodies-Elections - Special Provisions relating to certain classes - Languages - Emergency Provisions - Miscellaneous - Amendment of the Constitution - Temporary, Transitional and Special Provisions - Short title, date of commencement, Authoritative text in Hindi and Repeals. Schedules of the Constitution of India - Appendices in the Constitution of India.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course students will be able to

- Appreciate the philosophical foundations of the Indian Constitution.
- Understand the functions of the Indian government.
- Apprehend and abide by the rules of the Indian constitution.
- Comprehend the functions of state Government and Local bodies.
- Gain Knowledge on constitution functions and role of constitutional bodies and amendments of constitution.

TEXT BOOKS:

1 M Lakshmikanth “Indian Polity”, McGraw Hill Education, 5th edition 2017.
2 Durga Das Basu, “Introduction to the Constitution of India “, Lexis Nexis, New Delhi., 21st edition, 2013.

REFERENCE BOOKS / WEB LINKS:

1 Sharma, Brij Kishore, “Introduction to the Constitution of India”, Prentice Hall of India, New Delhi, 7th edition, 2015.
2 Subhash Kashyap, “Our Constitution: An Introduction to India’s Constitution and Constitutional Law”, National Book Trust India, 1994.
3 Mahendra Prasad Singh and Himanshu Roy, “Indian Political System”, Pearson India, 4th edition, 2017.

MX23231 MEDICAL IMAGING AND PROCESSING TECHNIQUES L T P C

3 0 2 4

OBJECTIVES

- To study the x-ray, CT and ultrasound imaging techniques.
- To study the different types of Radio diagnostic techniques.
- To study the special imaging techniques used for visualizing the cross sections.
- To understand the fundamentals of medical image processing techniques.
- To develop computational methods and algorithms to analyze and quantifybiomedical data

UNIT I X – RAYS, CT AND ULTRASOUND IMAGING 9

Principle and production of soft X – Rays, X- ray machine and digital radiography, principles of Angiography and Fluoroscopic Techniques, digital subtraction angiography, mammography.
CT principle- Multi section Radiography, Computerised Axial Tomography, Type of Detection, image reconstruction, Spiral CT and 3D imaging.
Ultrasonic frequency for medical application, different modes of Display A, B and M, ultrasonic probes, Real time echo and 2D scanner.

UNIT II 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 GammaCamera, PET, SPECT, PET/CT, PET/MRI.

UNIT III BASICS OF IMAGE PROCESSING 9

Pixels and voxels – algebraic image operations - gray scale and color representation-depth colour and look up tables - image file formats- DICOM- other formats- Analyze 7.5, NifTI and Interfile, Image quality , two dimensional sampling theory, Image quantization, Image transforms — 2D-DFT and other transforms. Image enhancement – point operation, Histogram modeling, spatial operations.

UNIT IV MEDICAL IMAGE ANALYSIS AND CLASSIFICATION 9

Image segmentation- pixel and edge based, Image representation and analysis, Feature extraction, Statistical, Shape and Texture based- Classification using Neural Network Approaches- Machine learning and Deep learning techniques.
Case study: Interpretation and classification of cross-sectional images.

UNIT V IMAGE REGISTRATIONS AND COMPRESSION TECHNIQUES 9

Principal axis registration, Interactive principal axis registration, Feature based registration, Introduction- Image compression models, Lossless and lossy compression methods, Image compression standards.

AR and VR applications in medical imaging.

Case study: Implementation of registration in image processing

TOTAL: 45 PERIODS

LAB EXPERIMENTS:

1. Preprocessing of medical images.
2. Spatial and Frequency domain filtering.
3. DFT,DCT,DWT analysis of biomedical images
4. Segmentation of ROI in medical images.
5. Feature extraction in medical images
6. Medical image registration

TOTAL: 45+30 = 75 PERIODS

OUT COMES:

On completion of the course the students will be able to

- Obtain domain knowledge in understanding various Medical Imaging techniques
- Design various tomography units taking into consideration the various safety procedures
- Analyze medical images.
- Apply various segmentation techniques for medical image classification
- Design suitable algorithm for classification.

REFERENCES:

1. Chesney D.N~ and Chesney M.O., X-Ray Equipments for Students Radiographer,Blackwell Scientific Publications, Oxford, 1971
2. Alexander, Kalender and Linke, Computer Tomography, John Wiley, Chich~ster,1986.
3. Steve Webb, The Physics of Medical Imaging, Adam Hilger, Philadelpia, 1988.
4. Peggy. W, Roger.D.Ferimarch, MRI for Technologists, Mc Graw Hill Publications,New York, 1995.
5. Wolfgang Birkfellner, 'Applied Medical Image Processing — A Basic course', CRCPress, 2011.
6. Atam P. Dhawan, 'Medical Image Analysis', Wiley Interscience Publication, NJ, USA2003.
7. R.C.Gonzalez and R.E.Woods, 'Digital Image Processing', Second Edition, PearsonEducation, 2002.

MX 23232 **BIOPHOTONICS** **L T P C**

3 0 2 4

OBJECTIVES

- To understand optical properties of tissues
- Learn fluorescence application in biomedical engineering
- Learn optoelectronic technique for diagnosis and treatment

UNIT I BASICS OF LIGHT-MATTER INTERACTION 9

Nature of light and matter, Refraction, reflection, interference, diffraction, intensity, phase, polarization, scattering, Raman effect, fluorescence, Light transport inside the tissue, Optical microscopy – fluorescence, confocal and multi photon.

UNIT II FLUORESCENCE TECHNIQUES 9

Fluorescence Spectroscope, Fluorescence Resonance Energy Transfer (FRET) Imaging, Fluorescence Lifetime Imaging Microscopy (FLIM), Fluorophores as Bioimaging probes – endogenous fluorophores, exogenous fluorophores, two-photo fluorophores, Tissue imaging,

UNIT III LASERS IN MEDICINE 9

Introduction, Laser physics, medical lasers, Laser interaction with tissue, photoabalative process, application of Lasers in Diagnosis and Imaging, Laser surgery and therapy, thermal interaction between laser and Tissue. Integrated laser-fiber systems and their applications in medicine - cardiovascular disease, Gastroenterology, thoracic surgery, Neurosurgery and Oncology, Laser safety fundamentals

UNIT IV NANOPHOTONICS FOR BIOTECHNOLOGY AND NANOMEDICINE 9

Near-field bio imaging – nano particles for optical diagnostics and targeted therapy – semiconductor quantum dots for bio imaging – up-converting nanophores for bio imaging – biosensing. polariton guiding by sub wavelength metal grooves. Sub wavelength aperture plasmonics – plasmonic wave guiding – applications of metallic nanostructures.

UNIT V OPTOELECTRONICS AND PHOTONIC DEVICES 9

Types of photo detectors, Photoconductors, Single junction under illumination: photon and carrier-loss mechanisms, photo diodes, photo transistors and CCD, Optical biosensors, Fiber-Optic Biosensors, Interferometric Biosensors, Surface Plasmon Resonance Biosensors, Optical tweezers.

Practical session 30

1. Manipulation of light and measuring its properties
2. Analysing optical characteristics using UV-absorption spectroscope
3. Opto-electronics for measuring intensity
4. Coupling Fiber optical cables for biosensing applications

TOTAL: 45+30=75 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Explain optical interaction in human system
- Apply fluorescence technique for microscopic and imaging applications
- Choose different laser for various medical applications
- Able to relate nanotechnology and optics for biomedical application
- Design suitable opto-electronic sensor

REFERENCES:

1. Paras N. Prasad, Introduction to Biophotonics, Wiley Interscience, 2003
2. Paras N. Prasad, Nanophotonics, Wiley-Interscience 2004.
3. Pallab Bhattacharya, Semiconductor optoelectronic devices, PHI Pvt. Ltd., New Delhi, 2009.
4. Lakowicz J.R., Principles of Fluoroscence Sepectroscopy, Springer, 2006.
5. Mertz J., Introduction to Optical Microscopy, Roberts & Co., Publishers, 2009.
6. Müller M., Introduction to Confocal Fluorescence Microscopy, SPIE Press, 2006.

MX23221 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING L T P C

LABORATORY 0 0 4 2

COURSE OBJECTIVES:

1. To understand various artificial intelligence algorithms.
2. To understand various machine learning algorithms.
3. To analyze various kinds of application using AI & ML concepts.
4. To develop AI & ML based algorithms for biomedical applications.
5. To design a computer aided system for biomedical applications.

LIST OF EXPERIMENTS:

1. Implementing a fuzzy inference system.
2. Implementing Artificial Neural Networks for an application using python.
3. Implementation of Decision Tree.
4. Implementation of single layer Perceptron.
5. Implementation of multi layer Perceptron with back propagation.
6. Implementation of face recognition using SVM classifier.
7. Implementation of KNN and K-means algorithms.
8. Automated detection and diagnosis of disease from medical images.
9. Mini project – Develop a biomedical application using tensorflow / keras.

TOTAL : 60 PERIODS

Lab Specifications: The lab can be implemented using Python

COURSE OUTCOMES:

1. To implement various artificial intelligence algorithms in real life problems.
2. To implement various machine learning algorithms in real life problems.
3. To compare various kinds AI & ML algorithms.
4. To construct AI & ML based algorithms for biomedical applications.
5. To develop a computer aided system for biomedical applications.

REFERENCES:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, Third Edition, 2015.
2. Nils J. Nilsson, Artificial Intelligence: A New Synthesis (1 ed.), Morgan-Kaufmann, 1998. ISBN 978-1558605350.
3. Andreas C. Müller and Sarah Guido," Introduction to Machine Learning with Python: A Guide for Data Scientists", O'Reilly Media, Inc, 2016.

Web links for virtual lab:

1. https://www.coursera.org/lecture/python-machine-learning/introduction-4f2So

https://nptel.ac.in/courses/106/106/106106139/

MX23222 TECHNICAL SEMINAR ON RESEARCH TOPICS L T P C
0 0 2 1

OBJECTIVES:

- To develop the ability to understand a research topic and formulate suitable Approach

Every student, individually, shall undertake the Project work - under a qualified faculty (faculty members with Ph.D. or P.G. with a minimum of 3 years of teaching experience). Prior to phase1 of the work, student must work on the related papers and understand the existing work. Once a work is allotted to the student, he/shall do the ground work, like literature survey, understanding various technologies, data collection procedure and analysis of result. Students are supposed to identify required software, modelling technique or hardware required for the project and get ready to implement from third semester. Students must give seminar every week and discuss various points from the research papers/literatures. Finally, a brief report may be prepared along with a presentation for making evaluation towards grading.

TOTAL: 30 PERIODS

OUTCOMES:

- On Completion of this course student will be in a position to take up the project work from the beginning of second year.
- Students will also be ready with relevant software/technology required for the project

SEMESTER III

MX23321	PROJECT WORK - PHASE I	L	T	P	C
		0	0	12	6

OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

Every student, individually, shall undertake the Project work - Phase I during the third semester under the supervision of a qualified faculty (faculty members with Ph.D. or P.G. with a minimum of 3 years of teaching experience). The Project work can be undertaken in an industrial / research organization or Institute in consultation with the faculty guide and the Head of the Department. In case of Project Work at industrial / research organization, the same shall be jointly supervised by a faculty guide and an expert from the organization. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Controller of Examinations.

TOTAL: 180 PERIODS

OUTCOMES:

On Completion of the project work student will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

MX23322	TRAINING IN HEALTHCARE SECTOR	L	T	P	C
		0	0	4	2

OBJECTIVES

- Exposed to various electronic/electrical equipment used in hospitals/medical industry
- Provide access to healthcare Professionals to get a better understanding of their work

ASSESSMENT:

- Students need to complete training in any leading Multi-speciality hospital or medical electronics industry for a period of 20 days.
- The students should give a presentation and extensive report (duly acknowledged by hospital/industry personnel) to their respective course co-ordinators
- Finally Viva-Voce to be conducted along with an External Examiner, constituted by Controller of Examinations

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Execute a given task by co-ordinating with various professionals and technologies.
- Propose regulatory norms and changes in the current scenario for the benefit of the society

SEMESTER IV

MX23421	PROJECT WORK - PHASE II	L	T	P	C
		0	0	24	12

OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.
- To prepare the students to write technical paper.

Every student, individually, shall undertake the Project work - Phase II during the fourth semester. The Project work - Phase II shall be a continuation work of the Project work - Phase I. The Project work can be undertaken in an industrial / research organization or Institute in consultation with the faculty guide and the Head of the Department. In case of Project Work at industrial / research organization, the same shall be jointly supervised by a faculty guide and an expert from the organization. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester in the prescribed format. In addition to that the student has to publish their work either in an international conference / journal. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Controller of Examinations.

TOTAL: 360 PERIODS

OUTCOMES:

On Completion of the project work student will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

PROFESSIONAL ELECTIVES

ELECTIVE I

MX23A11 NANOTECHNOLOGY AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVES

- To learn the basic scientific concepts underpinning nanoscience
- To have a depth knowledge about the properties of materials and biomaterials at the atomic/molecular level
- To determine specifically the fabrication and characterization tools used in nanotechnology such as various microscopies, surface modifications and molecular level construction methods
- To learn the multidisciplinary aspects of nanotechnology
- To realize the emerging role of nanotechnology in society, the regulatory framework within which it operates and the ethical issues it raises.

UNIT I INTRODUCTION 6

Definition of nanotechnology, Objective and goal of Nanotechnology, Importance of Nanoscale, revolution of Nanotechnology, Silicon based Technology.

UNIT II NANOMATERIALS 12

Different forms of Nanomaterials – nanocomposite, carbon nanotubes, nanowires, nanoplates and nanorods. Preparation of nanomaterials-Plasma arcing, Chemical Vapor Deposition, Solgels techniques, Electrode position, Ball milling and Laser method, Natural nanomaterials, Applications of nanomaterials-Insulation materials, Machine tools, Phosphors, Batteries, High power magnets Medical implants.

UNITIII EXPERIMENTAL TECHNIQUES 10

Fabrication – lithography, Characterisation – X- ray diffraction (XRD), Scanning electron Microscopy, Atomic force microscopy, Scanning Tunneling microscopy (STM), Scanning probe microscopy (SPM), Optical and Raman spectroscopy.

UNIT IV NANOSCIENCE 10

Nanomachine, nanorobots, nanodevice, nanomedicine – regenerative and replacement medicine, nanopharmacology, Nanotechnology in defence, environmental application.

UNIT V R & D IN NANOTECHNOLOGY 7

Nanotechnology current and future perspectives, research areas in nanotechnology, development of nanotechnology in India, Ethical issues and socioeconomic challenges in nanotechnology

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- To describe the general principles of physics, chemistry, electronics and biology that play a role on the nanometer scale

- To explain in detail the materials and their properties at the atomic and nanometer level, including an understanding of the intimate relationship between material scale (nanostructure) and the properties/functionality of materials
- To identify the essential concepts used in nanotechnology, synthesis, fabrication and characterization
- To have a sound grounding knowledge in multidisciplinary areas of nanoscience
- To demonstrate the socioeconomic impact of nanotechnology and ethical issues associated with it.

REFERENCES:

1. Nanobiotechnology – Concepts, Applications and Perspectives – 2004. Edited by CM, Niemeyer , C.A. Mirkin. Wiley – VCH.
2. Nanoparticle Assemblies and Superstructures. By Nicholas A. Kotov.2006 -CRC.
3. Nano: The Essentials: T. Pradeep. McGraw – Hill education – 2007.
4. Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact. 2005 - By Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer. Wiley – VCH.

MX23A12 FINITE ELEMENT METHODS FOR BIO MECHANICAL ANALYSIS L T P C

3 0 0 3

OBJECTIVES:

- To understand Mathematical Modeling of field problems in Engineering
- To gain knowledge in beam elements and scalar problem in 2D
- To learn about higher order elements
- To analyse nonlinear problems

UNIT I GENERAL INTRODUCTION 10

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems –Variational Formulation of Boundary Value Problems – Ritz Technique –Natural and Essential Boundary conditions - Basic concepts of the Finite Element Method. One Dimensional Second Order Equations – Discretization – element types- Linear and Higher order Elements –Derivation of Shape functions and Stiffness matrices and force vectors - Assembly of Matrices- solution of problems from solid and bio mechanics- Structural, stress, and strain analysis of the human body and/or artificial implants.

UNIT II BEAM ELEMENTS AND SCALAR PROBLEM IN 2D 9

Fourth Order Beam Equation –Transverse deflections - Natural frequencies of beams and longitudinal vibration. Second Order 2D Equations involving Scalar Variable – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems in Bio mechanics - Quadrilateral elements

UNIT III APPLICATIONS TO FIELD PROBLEMS 9

Higher Order Elements, Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One, two and three dimensions – Serendipity elements – Numerical integration and application to plane stress problems transformation in *and* coordinates- Jacobian of transformation-order of convergence- numerical integration – example problems- shape functions in natural coordinates- rectangular elements-Lagrange family- Serendipity family- rectangular prisms- tetrahedral elements-

UNIT IV ISOPARAMETRIC FORMULATION AND MISCELLANEOUS TOPICS 8

Introduction to elasticity equations – stress strain relations – plane problems of elasticity – element equations Plane stress, plane strain and axisymmetric problems – stress-strain-time or constitutive equations for soft connective tissue components Modelling and force analysis of musculoskeletal systems– Stress calculations - Plate and shell elements – Introduction to flow problems- solution of problems in fluid mechanics- numerical examples -plates and shells

UNIT V NON-LINEAR ANALYSIS 9

Introduction to Non-linear problems - some solution methods- computational procedure simple material nonlinearity, stress stiffening, contact interfaces- problems of gaps and contact- geometric non-linearity- modeling considerations- Impact analysis. Mechanical properties of biological and commonly used biomedical engineering materials - Critical reviews of finite element analysis in biomechanical research.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- To develop Mathematical Modeling of field problems in Biomedical Engineering.
- To analyse the field problems in Biomechanics.
- To have profound knowledge in higher order elements.
- To do force analysis of musculoskeletal systems.
- To undertake finite element analysis based biomechanical research

REFERENCES:

1. Seshu. P. “Textbook of Finite Element Analysis” Prentice Hall of India, 2003.
2. J.N. Reddy, “Finite Element Method” Tata McGraw Hill, 2003.
3. S.S. Rao, “The Finite Element Method in Engineering “Butter worth heinemann, 2001.
4. Reddy, J.N, “An Introduction to the Finite element Method”, McGraw – Hill, 1985.

MX23A13 MEDICAL INFORMATION SYSTEM L T P C

3 0 0 3

OBJECTIVES

- To gain a solid understanding of the fundamentals of health informatics so as to maximize the use of information and systems in the delivery of efficient, high quality health care.

- To introduce students to the research and practice of health informatics

UNIT I MEDICAL INFORMATICS 9

Historical highlights and Evolution of Medical informatics, Hospital Information System – its characteristics and functional online and offline modules, Medical data storage and retrieval techniques — Steganography Evidence Based Medicine, Bioethics.

UNIT II ELECTRONICS PATIENT RECORDS AND STANDARDS 9

Electronic Patient Record, Medical data formats, – Medical Standards – HL7 – DICOM - IRMA - LOINC – PACS, HIPAA. - Medical Standards for Vocabulary - ICD 10, DRGs, MeSH, UMLS, SNOMED - Healthcare Organization – JCAHO

UNIT III SOFT COMPUTING 9

Fuzzy logic — its applications in Medicine, Physiological System Modelling and Simulation, Virtual hospital, Virtual Reality and Multimedia Applications in Medicine, Surgical Simulation, Clinical Expert Systems.

UNIT IV e – HEALTH SERVICES 9

Patient flow analysis, Scheduling problems, Workflow integration, User interfaces in health care, Health Grid, Big Data in hospitals, e-Health services, Fault-tolerance, scalability, and robustness, Security and confidentiality in medicine, Clinical decision support, Clinical software development, Medical start-ups.

UNIT V INTERNET AND JAVA PROGRAMMING 9

Introduction to Java Programming in medicine- Web site and web page design of Hospital Information Systems – Developing front-end, back-end and Client – Server interface programs in Java Environment – Data bases SQL, Medical networks

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Describe the historical roots of today's Information Technology systems
- Discuss informatics as used in Public Health
- Identify and demonstrate the various tools used in Information Technology
- Coordinate and collect those tools into systems, and have the ability to describe how those tools can be used in systems
- Investigate solutions in Information Technology by using web and other researchtools ƒ Analyze current healthcare information systems

REFERENCES:

1. Ramachandra Lele, Computers in Medicine Progress in Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005
2. Herbert Schildt, The Complete Reference – JAVA, Tata McGraw Hill Publishing Company, New Delhi, 2005
3. Mohan Bansal M S, Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005
4. H M Dietel, Internet and World Wide Web, AB Goldberg publishers, New Delhi, 2007

5. Ranjan Parekh, Principles of Multimedia, Tata McGraw Hill Publishing Company, New Delhi, 2006
6. Tay Vaughan, Multimedia – Making it Work, Tata McGraw Hill Publishing Company, New Delhi, 2006
7. Raif Steinmetz, Multimedia – Computing, Communications and Applications, Pearson Education, New Delhi, 2007
8. Deitel, "Java How to Program", Pearson Education / PHI, 2006.
9. A S Godbole A Kahate, "Web Technologies, TCP/IP to Internet Application Architectures", TMH 2007

MX23A14 TISSUE MECHANICS L T P C
3 0 0 3

OBJECTIVES

- To get a thorough knowledge about the synthetic tissue materials and its interactions
- To understand the modeling aspects of biological structure
- To gain a thorough knowledge on biomaterials used for transplantation

UNIT I INTRODUCTION TO MECHANICS 9

Tissue mechanics - Structure and organization of tissues – development of tissue –stress, strain - time dependent and time independent behaviour of tissues – constitutive equations – mechanical properties of tissues – macroscopic rheology.

UNIT II FUNDAMENTALS OF CELL MECHANISMS 9

Cell adhesion, Cell migration and Cell aggregation – Cell growth and Cell cycle – mechanics of biomembranes – cytoskeleton and cell cortex –microrheological properties – mechanotransduction.

UNIT III MODELING OF TISSUES 9

Mechanical models for biological structures, Types of models – rigid body model, deformable continuum model, lumped parameter model and statistical models, Deformable material model, Development of a model for artery.

UNIT IV BASICS OF TISSUE ENGINEERING 9

Introduction to Tissue Engineering – Tissue exchange and diffusion of simple metabolites – Tissue Equivalent - Wound Healing Process - Biocompatibility and toxicity assessment.

UNIT V CASE STUDY AND PRESENTATION 9

Case study – tissue structure, functions, interactions, modelling (with different assumptions and approaches) and biomechanical characterisation, Clinical applications.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Apply basics of tissue mechanics in tissue engineering

- Explain the different types of models
- Describe the different biological material properties
- Explain tissue engineering
- Implement the design for practical applications

REFERENCES:

1. Fung, Y. C. *Biomechanics: Mechanical Properties of Living Tissues*. New York, NY: Springer-Verlag, 1993. ISBN: 9780387979472.
2. Stephen C. Cowin Stephen B. Doty, Tissue Mechanics, Springer,
3. W. Mark Saltzman Tissue Engineering – Engineering principles for design of replacement organs and tissue –- Oxford University Press inc New York, 2004.
4. Robert. P.Lanza, Robert Langer & William L. Chick, Principles of tissue engineering Academic press.
5. Joseph D. Bronzino, The Biomedical Engineering –Handbook, CRC press.
6. G.A. Holzapfel, " Biomechanics of Soft Tissue", Biomech Preprint Series Paper No. 7 November 2000.

PROFESSIONAL ELECTIVE II

MX23B11	BIOFLUID MECHANICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To get a thorough knowledge about the basic fluid mechanics concepts essential for analyzing the biofluids.
- To understand the flow mechanics of different circulatory systems.
- To gain a thorough knowledge on devices used for measurement of flow of fluids

UNIT I INTRODUCTION 9

Newton's laws, Stress, Strain, Elasticity, Hooks-law, viscosity, Newtonian fluid, Non-Newtonian fluid, Viscoelastic fluids, vascular tree, Relationship between diameter, velocity and pressure of blood flow, Resistance against flow.

Viscoelasticity - Viscoelastic models, Maxwell, Voigt and Kelvin Models, Response to Harmonic variation, Use of viscoelastic models, Bio-Viscoelastic fluids: Protoplasm, Mucus, Saliva, Synovial fluids.

UNIT II FLOW PROPERTIES 9

Intrinsic Fluid Properties, Hydrostatics, Macroscopic Balances of Mass and Momentum, Microscopic Balances of Mass and Momentum, Bernoulli Equation, Dimensional Analysis. Fluid Mechanics in a Straight Tube, Boundary Layer Separation.

Physical, Chemical and Rheological properties of blood. Fahraeus -Lindquist effect and inverse effect, distribution of suspended particles in a narrow rigid tube. Nature of red blood cells in tightly fitting tubes, hematocrit in very narrow tube.

UNIT III FLUID MECHANICS OF CARDIOVASCULAR SYSTEM 9

Cardiovascular system. Mechanical properties of blood vessels, Analysis of Thin-Walled Cylindrical Tubes. Analysis of Thick-Walled Cylindrical Tubes. Pressure and flow in the systemic circulation, coronary circulation, cerebral and renal circulations and in the microcirculation. Windkessel Models for the Human Circulation, Continuum Models for Pulsatile Flow Dynamics, Hemodynamic Assessment of Prosthetic Heart Valves.

UNIT IV RESPIRATORY MECHANICS 9

Alveoli mechanics, Gas Exchange in the Lungs, Interaction of Blood and Lung P-V curve of Lung, Pulmonary Circulation, Flow in Collapsible Vessels. Airway resistance, Physics of Lung diseases.

UNIT V FLOW MEASURING DEVICES 9

Flow measuring and monitoring systems manometers, orifice meter, venture meter and rotameter Measurement of viscosity using extrusion rheometer, plate and cone viscometer, coaxial cylinder viscometer

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Understand the fundamentals of fluid mechanics.
- Explain the physical and rheological properties of biofluids.
- Describe the circulatory mechanics associated with prosthetic heart valves.
- Explain the gaseous exchange of lungs and its properties.
- Explain the different techniques available for flow measurement

REFERENCES:

1. Fung, Yuan-cheng. Biomechanics: circulation. Springer, 1997
2. D -Caro, C. G., R. C. Schroter, T. J. Pedley, and W. A. Seed. "The mechanics of the circulation." (2011).
3. Biomechanics by Nihath ozkaya, D.A Mc Donald, Blood flow in arteries, Edward Arnold ltd, 1998.
4. Fluid mechanics and machinery, C. P. Kothandaraman and R. Rudramoorhy, New Age International Publishers, 3rd Ed (2012).

MX23B12 PRINCIPLES OF GENETIC ANALYSIS L T P C

3 0 0 3

OBJECTIVES

- To describe methods both used in and resulting from the sciences of genetics and molecular biology, or to applications resulting from this research and may be done to Identify genetic/inherited disorders
- To make a differential diagnosis in certain somatic diseases such as cancer. Genetic analyses of cancer include detection of mutations, fusion genes, and DNA copy number changes.

UNIT I INHERITANCE - GENETIC ANALYSIS 9

Basic principles of Heredity, Pattern of inheritance, Mendelian principles of Inheritance Chromosomal basis of inheritance, Chromosome mapping by recombination, Genetics of Bacteria and viruses.

UNIT II DNA AND PHENOTYPE 9

F DNA structure and replication- DNA sequencing, DNA Amplification, DNA Hybridisation and DNA Polymorphism, RNA transcription and processing, Protein synthesis and regulation of gene expression. Pedigree analysis & Applications, From Gene to Phenotype, molecular mechanism behind phenotypic expressions

UNIT III GENOME STRUCTURE AND GENETIC ENGINEERING 9

Gene isolation and manipulation, Genomics, mutations, Types of Mutations, molecular basis of Mutation, repair and recombination, site directed mutagenesis, large-scale chromosomal changes and genetic polymorphism.

UNIT IV GENETIC PROCESSES 9

Gene function, Genetic organization, Genetic regulation, Genetic morphology of normal and cancer cells, Genetic basis of development

UNIT V IMPACT OF GENETIC VARIATION 9

Population Genetics, Quantitative Genetics, Evolution Genetics and their impact in variation

OUTCOMES:

On completion of the course the students will be able to

- Analyze the concept of inheritance
- Undertake research works in tissue Engineering.
- Apply molecular mechanism
- Understand Gene function and Genetic organization
- Apply the concept of Quantitative Genetics

TOTAL: 45 PERIODS

REFERENCES:

1. Watson. J. etal, “Molecular Biology of the Gene “, 5th Edition, Pearson Publication, 2004.
2. Griffiths, Wesslers, Lewontin, Bart Gel, Suzuki, Miller “Introduction to Genetics Analysis”, – W.H Freeman & company, New York 8th Edition - 2005.
3. Glick, B.R and J.J Pasternak “Molecular Biotechnology”, Principles and application of Recombinant DNA” 3rd Edition ASM Press, 2003
4. Karp, Gerald.“ Cell and Molecular Biology”. Concepts and Experiments, 4th Edition, John Wiley Sons, 2005.
5. Weaver. R.F. “Molecular Biology “ 3rd Edition, McGraw – Hill, 2005.
6. Tom Strachan, Andrew P Read “Human molecular Genetics” 3rd Edition, Garland Publishing – 2004.

MX23B13 REHABILITAION & ASSISTIVE TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To develop an understanding of the various rehabilitation aids so as to enable the student to design and apply them with confidence, to help the challenged people.
- To give various information about rehabilitation medicine and Advocacy.

UNIT I INTRODUCTION TO REHABILITATION 9

Definition - Impairments, disabilities and handicaps, Primary and secondary disabilities, Activities of daily living, Appropriate Technology, Residual function. Rehabilitation team-members and their function, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation. Rehabilitation care –Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects.

UNIT II ORTHOTICS & PROSTHETICS IN REHABILITATION 9

Types of body powered and externally powered limb prosthetics, Lower limb, Upper limb orthotics, Materials for prosthetic and orthotic devices, mobility aids, wheel chair. Functional Electrical Stimulation – restoration of upper limb and lower limb functions. Hybrid Assistive Systems (HAS). Gait analysis, Assessment of mobility rehabilitation, Bionic arm.

UNIT III VISUAL AIDS 9

Sensory Substitution systems for visual impairment, Ultra sonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually challenged, Text voice converter, screen readers. Low vision aids.

UNIT IV AUDITORY AND SPEECH ASSIST DEVICES 9

Types of deafness, hearing aids, application of DSP in hearing aids, Cochlear implants, Voice synthesizer, speech trainer,Brain plasticity, Sensory Substitution systems for auditory and speech impairment.

UNIT V REHABILITATION MEDICINE AND ADVOCACY 9

Architectural design features for motor and visual disability for day-to-day life. Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspects of rehabilitation – Disability evaluation, provision available in education, job and in day-to-day life.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Gain profound knowledge in various rehabilitation aids.
- Develop aids for hand, standing and walking function.
- Make assist devices for the visual impaired
- Apply DSP in hearing aids.
- Design rehabilitation aids

REFERENCES:

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

MX23B14	QUALITY CONTROL AND WASTE MANAGEMENT IN HEALTHCARE	L T P C 3 0 0 3

OBJECTIVES

- To understand how safety is important for health care systems.
- To gain knowledge about shocks and leakage current.
- To know about radiological equipment safety.
- To create awareness about various types of biomedical waste.
- To know the different treatments of biomedical wastes.

UNIT I QUALITY ASSURANCE AND SAFETY IN HEALTH CARE 9

Define quality- need for standardization & quality management, quality assurance, safe medical devices – device requirements - devices for varying age – initial inspection – maintenance. Safe handling and operation, reporting, bed rails, flawed mechanics, removable parts and packaging. Risk management, types of responsibilities, delegating, procurement, status and other publications, overall responsibility.

UNIT II ELECTRICITY, GAS, FIRE AND SAFETY 9

Macroshock and microshock, current, voltage and conductance, earth and protection classes, earth fault circuit breakers and isolation transformers, leakage currents, electrical safety codes and standards-medical devices, biological effects of electromagnetic fields, susceptibility to water. Gas technology, fire, thermal injuries

UNIT III SAFETY IN MEDICAL IMAGING AND VENTILATION 9

Quality assurance and image improvement in diagnostic radiology with X-rays, specific quality assurance tests for X-rays. MRI safety, Risks in ventilators, anaesthetic machines, oxygen treatment, treatment with Nitric oxide, pressure chamber treatment, Incubators and monitoring.

UNIT IV INTRODUCTION OF BIOMEDICAL WASTE 9

Definition of Biomedical Waste, General and Hazardous health care waste – Colour Coding and types of containers for disposal of medical waste, Segregation, Collection & Disposal. Types of biomedical waste -Infectious waste, Genotoxic waste, Waste Sharps, Liquid Biomedical Waste, Radioactive wastes, Metals, Chemicals & drugs.

UNIT V TREATMENT OF BIOMEDICAL WASTE 9

Autoclave, Hydroclave, Microwave, Chemical Disinfection, Solidification and stabilization, Bioremediation, Thermal Conversion Technologies, accumulation and storage of hazardous waste, land disposal of hazardous waste, other treatment and disposal method. Common Hazardous Waste Treatment facilities (TSDF)

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- To develop quality management system in the working environment.
- To implement electrical safety codes and standards in the working environment.
- To apply safety measures while working with radiological equipment.
- To categorize the biomedical wastes.
- To apply different methods to dispose biomedical wastes.

REFERENCES:

1. Bertil Jacobson and Alan Murray, —Medical Devices use and safety, Reed Elsevier India Pvt. Ltd, New Delhi, 2001.
2. Steve Webb, —The Physics of Medical Imaging, Taylor & Francis, New York, 1988.
3. G.D.Kunder, S.Gopinath, A.Katakam, —Hospital Planning, Design and Management,Tata McgrawHil publishers, New Delhi, 1998.
4. Tchobanoglous G., Theisen H., Viquel S.A., “Integrated Solid Waste Management: Engineering, Principles and Management issues”, Tata McGraw Hill Publishing Company Ltd., New Delhi.
5. V. J. Landrum, Medical Waste Management and disposal, Elsevier, 1991, ISBN: 978-0-8155-1264-6.
6. https://www.who.int/water_sanitation_health/medicalwaste/en/guidancemanual1.pdf

PROFESSIONAL ELECTIVE III

MX23C11 MEDICAL DEVICE DEVELOPMENT – CONCEPT TO MARKET L T P C

3 0 0 3

OBJECTIVES

- To give an exposure to the basic concept of engineering design
- To make the students understand various clinical requirements
- To make the students understand the various steps and constraints involved in developing medical device

UNIT I BASICS ON PRODUCT DEVELOPMENT 9

Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development

process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research

UNIT II IDENTIFICATION OF CLINICAL NEEDS 9

Market survey, Conceptualising the solution to clinical requirement, Researching the disease state – anatomy, physiology, pathophysiology, epidemiology, present pathways, setbacks, Feasibility screening – finance, technical and market, New technologies – brainstorming, literature and R&D forums, Ways of implementation.

UNIT III ENGINEERING SOLUTION TO CLINICAL NEEDS 9

Document sketching, Modeling – software and physical, Model for all strategies, Testing and clinical correlation, Material selection – sensors, actuators, Instrumentation circuit design, Interface selection, Output visualisation and calibration

Case study: To identify a real time problem and to propose suitable engineering solution

UNIT IV REGULATORY AND ETHICAL ISSUES 9

Regulations and standards involved in the design – CE mark and FDA, Regulatory bodies in India, Biocompatibility of the test probes, ISO 14155 standards for clinical investigations, Steps for getting FDA approval, Function and role of ethical committee, Medical ethics proposed by ICMR.

UNIT V MARKETING STRATEGY 9

Post market Surveillance and its role in design, Various tools – Process control chart, bathtub curve, Weibull plot, Measles chart, Pareto analysis, Exploring various contacts – early adopters, focus groups, conference, Vigilance, Promotion through media, Comparison with existing products – merits and demerits.

TOTAL: 45 PERIODS

OUTCOMES

On completion of the course the students will be able to

- Analyse various strategies in product development
- Identify clinical need
- Provide engineering solution for medical applications
- Abide regulatory and ethical norms
- Develop product that suits market requirements

REFERENCES::

1. Peter J. Ogrodnik, Medical Device Design Innovation from Concept to Market, Elsevier, 2013
2. Des O'brien, Medical Device Regulations Roadmap: A Beginners Guide, 2017
3. Richard C. Fies, Handbook of Medical Device Design, CRC Press, 2000.

MX23C12 PHYSIOLOGICAL CONTROL SYSTEMS L T P C

3 0 0 3

OBJECTIVES

To understand and appreciate the value and application of

- Physiological models
- Vital organs
- Modeling dynamically varying physiological system
- Methods and techniques to analyze and synthesis dynamic models
- Develop differential equations to describe the dynamic models, simulate and visualize dynamic responses of physiological models using software.

UNIT I INTRODUCTION 9

System Concept, System Properties, Piece-Wise Linear Approximation, Electrical Analog for Compliance, Thermal Storage – model of a human torso, Mechanical Systems – model for muscle contraction, Step response of a Resistance/Compliant Systems, Pulse Response of First Order System – dye dilution.

UNIT II TRANSFER FUNCTION 9

System as an Operator, illustration of use of Transfer Function, Bio Engineering of a Coupled System, Example of Transformed Signals – response of a thermometer, the Impedance Concept, Prediction of Performance – transfer function of a lung model, the identification problem, circuit model of higher order systems.

UNIT III PERIODIC SIGNALS 9

Sinusoidal Functions, Sinusoidal Analysis of Instrumentation System, Evaluation of Transfer Function from Frequency Response, Relationship between Phase Lag and Time Delay – illustration with Pupillary control system, Transient Response of an Under damped Second Order system, General Description of Natural Frequency Damping, Physical Significance of Under Damped Responses – under damped response of post systolic operations in aortic arch.

UNIT IV BIOFEEDBACK SYSTEMS 9

Characterization of Physiological Feedback Systems – Hypophysis-adrenal system, Uses and Testing of System Stability.

UNIT V SIMULATION OF BIOLOGICAL SYSTEMS 9

Simulation of Skeletal muscle servomechanism, thermo Regulation, cardiovascular control System, Respiration controls, Occulo Motor System, Endocrine control system and Modeling of receptors.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Understand the first order systems.
- Model dynamically varying physiological system
- Analyse Periodic signals

- Characterize physiological feedback systems.
- Develop Physiological models using simulation methods.

REFERENCES:

1. William B. Blesser, A System Approach to Biomedicine, McGraw Hill Book Co, New York, 1969.
2. ManfreoClynes and John H. Milsum, Biomedical Engineering System, McGraw Hill and Co, New York, 1970.
3. Douglas S. Rigg, Control Theory and Physiological Feedback Mechanism, The William and Wilkins Co, Baltimore, 1970 .
4. Richard Skalak and Shu Chien, Hand Book of Biomedical Engineering, McGraw Hill and Co, New York, 1987.
5. Michael C.K. Khoo, "Physiological Control System" - Analysis, Simulation and Estimation"- Prentice Hall of India, New Delhi, 2001.

MX23C13 BIOSTATISTICS L T P C

2 0 0 2

OBJECTIVE

- The objective of Biostatistics is to advance statistical science and its application to problems of human health and disease, with the ultimate goal of advancing the public's health.

UNIT I STATISTICAL PARAMETERS 10

Statistical parameters p-values, computation, level chi square test and distribution and hypothesis testing -single population proportion, difference between two population proportions, single population variance, ratio of two population variances and tests of goodness of fit, tests of independence, tests of homogeneity

UNIT II REGRESSION AND CORRELATION ANALYSIS 10

Introduction, regression model, sample regression equation, evaluating the regression equation, using the regression equation, correlation model, correlation coefficient

UNIT III INTERPRETING DATA 10

Interpreting life tables, clinical trials, epidemical reading and interpreting of epidemical studies, application in community health.

TOTAL: 30 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Estimate statistical parameters.
- Evaluate regression and correlation models.
- Apply biostatistics in community health

REFERENCES:

1. Wayne W. Daniel, “Biostatistics-A Foundation for Analysis in the Health Sciences” John Wiley & Sons Publication, 6th Edition.
2. Marcello Pagano and Kimberlee Gauvreu “Principles of Biostatistics”, Thomson Learning Publication, 2006.
3. Ronald N Forthofer and EunSul Lee “Introduction to Biostatistics”, Academic Press
4. Animesh K. Dutta “Basic Biostatistics and its Applications” 2006.

MX23C14 STRUCTURE AND FUNCTIONS OF BIOMATERIALS L T P C

3 0 0 3

OBJECTIVE

- To develop a comprehensive understanding of biomaterials, including their diverse applications
- To achieve a thorough understanding of metallic and ceramic biomaterials, covering their inherent characteristics, diverse applications, and suitability for biomedical purposes.
- To acquire a thorough understanding of polymer biomaterials, encompassing their synthesis, structure, applications, sterilization techniques, surface modifications to enhance biocompatibility
- To understand the development and application of functional materials, including DNA-based active materials, for organ preservation and transportation.
- To design and assess biomaterial implants across multiple anatomical regions for thrombogenicity and tissue compatibility.

UNIT I INTRODUCTION 9

Introduction to biomaterials, uses of biomaterials, biomaterials in organs & body systems, materials for use in the body, performance of biomaterials

UNIT II METALLIC AND CERAMIC BIOMATERIALS 9

Introduction, Stainless steel, Cobalt-Chromium alloy, Titanium alloys, Titanium-Nickel alloys, Dental metals, Corrosion of metallic implants, Manufacturing of implants, Nonabsorbable /relatively bioinert bioceramics, biodegradable/resorbable ceramics, bioreactive ceramics, deterioration of ceramics, bioceramic manufacturing techniques

UNIT II POLYMERIC AND COMPOSITE BIOMATERIALS 9

Introduction, polymerization and basic structure, polymers used as biomaterials, sterilization, surface modifications to for improving biocompatibility, Structure, bounds on properties, anisotropy of composites, particulate composites, fibrous composites, porous materials, biocompatibility and synthetic biodegradable polymers, collagen

UNIT IV DEVELOPMENT AND PRESERVATION OF BIOMATERIALS 9

Development of functional materials, DNA based active materials, Phase behavior, nonfreezing storage-hypothermic, freeze-thaw technology, freeze-drying, vitrification, Organ preservation and transportation.

UNIT V ARTIFICIAL TISSUE AND TESTING 9

Engineering of microvascular prosthesis, Testing with Tissue Culture, Testing with Soft Tissues and Testing at non Thrombogenic surface and implants of Biomaterial in Cardiac, Orthopaedics , Muscular and Ocular region.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Demonstrate a broad comprehension of biomaterials and their extensive array of applications.
- Apply in-depth understanding of metallic and ceramic biomaterials, including their intrinsic properties and versatile applications within biomedical contexts.
- Implement knowledge of polymer biomaterials in practical scenarios, including synthesis, structural considerations, and optimization for specific biomedical applications.
- Utilize understanding of functional materials, including DNA-based constructs, to innovate in the domain of organ preservation and transportation.
- Exhibit proficiency in designing and evaluating biomaterial implants across diverse anatomical regions, with a focus on minimizing thrombogenic risks and ensuring tissue compatibility.

REFERENCES:

1. J.H.U.Brown (Ed), Advances in Bio Medical Engineering, Academic Press 1975.
2. Rosario Pignatello, Biomaterials science and engineering, InTech, 2011
3. Andrew F.VonRacum, Hand Book of Bio Medical Evaluation, Mc-Millan Publishers, 1980.
4. Jacob Cline, Hand Book of Bio Medical Engineering, Academic Press in Sandiego, 1988.
5. Jonathan Black, Biological Performance of Materials- Fundamentals of bio compatibility, 4th Edition, CRC Press 2005.
6. Larry L. Hench and Julian R.Jones, Biomaterials, Artificial organs and Tissue Engineering, 2005.
7. Buddy D.Ratner,Allan S .Hoffman, Frederick J. Schoen, Jack E. Lemons, Biomaterial
8. Science; An Introduction to Materials in Medicine,2nd Edition, Elsevier Academic Press, San Diego,2004

MX23C15 SPEECH PROCESSING L T P C

1 0 0 1

OBJECTIVES:

The students should be

- Introduced to speech production and related parameters of speech.
- To understand coefficients and other coefficients in the analysis of speech and different speech modeling procedures such as Markov and their implementation issues.

UNIT I SPEECH SIGNAL AND FEATURES 7

Speech Fundamentals: Articulatory phonetics – production and classification of speech sounds; acoustic phonetics – acoustics of speech production; Features - feature extraction and pattern comparison techniques, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization, Multiple Time – Alignment Paths.

UNIT II SPEECH MODELING AND RECOGNITION 8

Statistical models for speech recognition - Vector quantization models, Gaussian mixture model, Discrete and Continuous Hidden Markov model in for isolated word and continuous speech, Distance measures for comparing speech patterns - Log spectral distance, cepstral distances, weighted cepstral distances, Dynamic Time Warping for Isolated Word Recognition.

TOTAL: 15 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Model speech production system and describe the fundamentals of speech.
- Choose an appropriate statistical speech model and compare different speech parameters.

REFERENCES:

1. Lawrence Rabiner and Biing-Hwang Juang, Fundamentals of Speech Recognition, Pearson Education, 2003.
2. Daniel Jurafsky and James H Martin, Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Pearson Education, 2002.
3. Frederick Jelinek, Statistical Methods of Speech Recognition, MIT Press, 1997.

Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, Processing and Perception of Speech and Music, Wiley- India Edition, 2006.

PROFESSIONAL ELECTIVE IV

MX23D11 BRAIN COMPUTER INTERFACE L T P C

2 0 0 2

OBJECTIVES:

- To introduce the basic concepts of brain computer interface
- To study the various signal acquisition methods
- To study the signal processing methods used in BCI

UNIT I INTRODUCTION TO BCI 10

Fundamentals of BCI – Electrophysiological sources **-** Sensorimotor activity –Neuronal activity in motor cortex and related areas- Electric and magnetic fields produced by the brain- signals reflecting brain metabolic activity- Mu rhythm, Movement Related Potentials –

Slow Cortical Potentials - P300 Event related potential - Visual Evoked Potential – Activity of Neural Cells - Multiple Neuro mechanisms.

UNIT II BCI TYPES AND SIGNAL PROCESSING 10

Structure of BCI system – Classification of BCI: Invasive, Non-invasive and Partially invasive BCI- Brain signal acquisition, Signal Pre-processing, Artifacts removal.

UNIT III DATA ANALYSIS AND BCI APPLICATIONS 10

Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Regression - Linear, Polynomial, Multilayer neural networks, Support vector machine. Applications of BCI- Functional restoration using Neuroprosthesis- Functional Electrical Stimulation, Visual Feedback and control - External device controllers. Ethical issues in BCI research.

TOTAL: 30 PERIODS

OUTCOMES:

- Capable of acquiring the brain signal in the format required for the specific application
- Well prepared for preprocessing the signal for signal enhancement
- Ability to extract the dominant and required features and classify the signal for applications

REFERENCES:

1. Jonathan Wolpaw, Elizabeth Winter Wolpaw, Brain Computer Interfaces: Principles and
2. Practice, Edition 1, Oxford University Press, USA, 2012.
3. Special Issue on Brain Control Interfaces, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 14, June 2006.
4. Rajesh PN Rao, Brain computer Interface – An introduction, Cambridge University Press, First Edition 2013.

MX23D12 INTERNET OF MEDICAL THINGS L T P C

2 0 0 2

OBJECTIVES

- To learn how the general Internet as well as Internet of Things works.
- To understand the computing tools used for Internet of Things.
- To know the applications of IoT in healthcare.

UNIT I BASICS OF IOT & NETWORKING 10

IoT-An Architectural Overview, Devices and gateways, Local and wide area networking, Building a network – Requirements - Layering and protocols - Internet Architecture – Network software – Performance ; Link layer Services - Framing - Error Detection - Flow control, Fundamentals of Wireless Communication Technology

UNIT II COMPUTING AND IOT 10

Introduction to Mobile Computing – Characteristics of Mobile computing – Structure of Mobile Computing Application. MAC Protocols – Cloud computing - Introduction to Raspberry Pi – Implementation of IoT with Raspberry Pi – IoT applications.

UNIT III IOT IN HEALTHCARE 10

3C Model- Community Practice – Partner Eco System- Architecture –Tools and Templates, Wearable Technologies and IOT - Electronic tattoos - Smart lenses for diabetics - Bio-monitoring drugs - AliveCor - eCall - Remote monitoring - Aging in place - Wireless patient Monitoring - Virtual consultation.

TOTAL: 30 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Identify the components required to build different types of networks
- Build basic wireless and mobile networks
- Identify various applications of IoT in health care

REFERENCES:

1. Olivier Hersent , David Boswarthick , Omar Elloumi, The Internet of Things: Key Applications and Protocols , John Wiley and Sons Ltd,2012.
2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan , From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Elsevier Ltd, 2014.
3. https://www.cognizant.com/whitepapers/how-the-internet-of-things-is-transforming-medical-devices-codex1945.pdf

MX23D13 BIOMEDICAL APPLICATIONS IN AVIATION & SPACE ENVIRONMENT L T P C 1 0 0 1

OBJECTIVES

- Understand Alien environments of Aviation and Space
- Understand the physiological challenges for Sustenance of Life, Safety and Protection
- Study application Engineering and Technology for Human Survival, Safety, Protection and Enhancement of Human Performance.

UNIT I BASICS OF AVIATION & SPACE ENVIRONMENTS 7

Physical conditions of Aviation and Space Environment, Physiological responses of human body for stressors of Aviation and Space environments – Hypoxia-Altitude stress, Hi-G & Micro-G Stress, Hi & Lo Thermal Stress, Vibration, Humidity, Auditory & Visual effects, Exposure to Radiation, Time differences and Bio-Rhythm effects, Types of Aircraft and Space dwelling vehicles, Aerospace Toxicology and Microbiology, Women in Aviation and Space.

UNIT II TECHNOLOGICAL SOLUTIONS 8

Limitations of Physiological techniques and tools for assessment and evaluation of physiological parameters and functions, Special non-invasive techniques and Instrumentation – HRV, Densitometry, Impedance measurements etc. Study of various Systems for Life support, Safety and Protection, Resources, Food and Waste management , Equipment design considerations for Aviation and Space environments , Airworthiness, Flight Certification and Safety Regulations , Design of Dummies and Simulators , Accident Investigation , Bio-Telemetry, Health-Care Data Communication and Management.

TOTAL: 15 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Identify the Physiological problems of Aviation and Space environments
- Gain knowledge on special Biomedical engineering tools and techniques for Life support, Safety and Protection
- Adopt suitable techniques and arrive at innovative technological solutions

REFERENCES:

1. "Aerospace Medicine" edited by Kelly J. Humphries and Jeffrey R. Davis
2. "Aviation Medicine and the Airline Passenger" by John Ernsting and David King
3. "Biomedical Engineering Principles in Sports" by Gustavo V. Barbosa-Cánovas and José Miguel Aguilera
4. Handbook of Aviation and Space Medicine 2019 by Green Publisher Taylor & Francis.
5. https://ntrs.nasa.gov/api/citations/19680027898/downloads/19680027898.pdf

MX23D14 ETHICS AND STANDARDS IN HEALTHCARE L T P C

1 0 0 1

OBJECTIVES

- To create awareness on core values that shape their professional as well as personal life
- To understand various social issues, industrial standards, code of ethics and role of professional ethics in Medical field

UNIT I HUMAN VALUES AND MEDICAL ETHICS 8

Morals, Values and Ethics – Integrity – Work Ethic – Service Learning – Respect for Others – Living Peacefully – caring – Commitment – Empathy – Self-Confidence – Character – Spirituality, Introduction to Yoga and meditation for professional excellence and stress management.

Privacy and Confidentiality - Informed Consent - Gender, Culture, and Race - Ethical Issues in Human Enhancement - International Public Health Policy and Ethics

UNIT II REGULATORY REQUIREMENT FOR HEALTH CARE 7

CE and FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, Other regulatory Codes, - Regulatory Bodies of India-Medical Council of India - Pharmacy Council Of India, Indian Nursing Council - Dental Council of India, Homeopathy Central Council

TOTAL: 15 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Apply the core values professionally for the betterment of society and to improve one-self.
- Comply within regulatory norms to resolve issues arising in product development.

REFERENCES:

1. Lawrence E. Harrison, Samuel P. Huntington , "Culture Matters: How Values Shape Human Progress", Basic Books Publications, 2001
2. Michael Boylan, "Medical Ethics", 2nd Edition, John Wiley & Sons Inc, 2014

MX23D31 MEDICAL TEXTILES L T P C

1 0 2 2

OBJECTIVES

- To understand the technologies of medical textiles
- To understand the general property of fabric materials
- To know the various medical application of textiles.

UNIT I INTRODUCTION TO MEDICAL TEXTILES 7

Characteristics of textile fibers - structures of natural and man-made fibers – physical, chemical and morphological structures, Molecular conformations – planar zig-zag, helical, lamellar, and sphrulite conformations. Medical textiles – An overview, classification: Implants, Non implants, Extra corporeal, Health care and hygiene

UNIT II MEDICAL TEXTILE SCIENCE AND COATING IN MEDICAL TEXTILES 8

Medical textile products, processes and their applications - sutures - bandages - surgical implants - non-surgical implants - extracorporeal devices - health care products - hygiene product - non-woven technology - medical textile testing. Testing methods and International standards. Fabric coating: properties - polymer coatings - coating methods - medical applications -lamination: methods and applications. Safety issues, effectiveness, types, recommendations, production & testing.

INDUSTRIAL TRAINING 15

Students will undergo two weeks of Training related to medical textiles in any industries or R&D centres. After successful completion of the training the students should produce the certificate from the industries or research centres. In addition to that each student will be required to submit a detailed report explaining their observation and learning and Viva-Voce will be conducted.

TOTAL: 15+15 = 30 PERIODS

OUTCOMES:

On completion of the course the students will be able to

- Choose different sensors and technology for specific applications
- Design and implement wearable sensors in the textiles using modern technology.

REFERENCES:

1. Volkmar T. Bartels, “Handbook of Medical Textiles”, Woodhead Publishing, 2011.
2. SubhashAnand, “Medical textiles and biomaterials for healthcare”, Woodhead, 2006.
3. Van Langenhove, L. (2007), Smart textiles for medicine and healthcare, Wood head publishing Ltd, UK

VALUE ADDED COURSES

MX23V31	INTRODUCTION TO 3D PRINTING	L T P C
		0 0 2 0

OBJECTIVE

- The students will understand the importance 3-D printing technology for developing biological structures and learn Computational Fluid dynamics to analyze various biomechanisms.

LIST OF EXPERIMENTS

1. Plastic based cell structure – to know cell physiology, cell interaction**.**
2. To create an organ like kidney by scaffolding many tissues with its allied properties
3. To perform hemodynamic analysis using CFD in any blood vessel
4. To model urinary bladder and analyze outlet with known accumulation.

TOTAL: 30 PERIODS

LAB REQUIREMENTS FOR A SET OF 9 STUDENTS

1. Computers with CFD or any modelling software – 9 Nos.
2. 3D Printer – 2 Nos

OUTCOMES:

On completion of the course the student will be able to

- Design and print artificial biological structures using 3 – D printing technology.
- Model and analyze various biomechanisms using Computational Fluid Dynamics.

REFERENCES:

1. Muralidhar, K., and Sundararajan, T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 1995.
2. Prodip Niyogi, Chakrabarty, S.K., Laha, M.K. Introduction to Computational Fluid Dynamics, Pearson Education, 2005.
3. Joan Horvath, Mastering 3D Printing, APress, 2014.

MX23V32 INTRODUCTION TO SCI LAB AND R-LAB L T P C

0 0 2 0

OBJECTIVES

- To practice the basics of Scilab and R - Lab.
- To practice image processing and signal processing using Scilab.
- To analyse data using spread sheet.
- To do statistical analysis using R -Lab.

LIST OF EXPERIMENTS:

1. Reducing the number of colors in an image without dithering.
2. Image segmentation using Snake algorithm.
3. Simulation and processing of biosignals.
4. For the given input data perform import operation and handle mixed data set on the spread sheet.
5. Perform data import operations using read function for the following data formats: SPSS, Stata, SAS, Octave, Minitab, Systat.
6. Perform standard deviation and enable plot operation for the imported data and represent it graphically using scatter plot, box plot,ggplot2 operators.
7. Basics of R-lab
8. Vectors and Assignments
9. Reading Data, Statistical Graphics, Estimating Mean and SD from the median and Range in R
10. Probability Distributions
11. Matrices
12. R data interfaces- R- CSV File
13. R data interfaces- R- Excel File
14. R data interfaces- R- Excel File
15. R charts and graphs- Line Graphs

TOTAL: 30 PERIODS

LAB REQUIREMENTS FOR A SET OF 9 STUDENTS

Computers installed with Scilab and R – Lab (open source software) with Internet. – 9 Nos.

OUTCOMES:

On completion of the course the student will be able to

- Implement image and signal processing using Scilab.
- Implement statistical analysis using R – Lab.

REFERENCES:

1. http://cloud.scilab.in/
2. https://www.physionet.org/
3. R for Data Science by Hadley Wickham (Author), Garrett Grolemund.
4. The book of R is written by Tilman M. Davies
5. R For Dummies by Andrie de Vries, Joris Meys
6. Discovering Statistics Using R by Andy Field, Jeremy Miles, Zoe Field
7. R for Everyone by Jared lander.

MX23V33 INTRODUCTION TO SAS PROGRAMMING LANGUAGE L T P C

0 0 2 0

OBJECTIVE

- To introduce the use of the SAS programming language for the analysis of biomedical data. After an introduction to the SAS environment on a PC, SAS will be used to write programs for reading and processing data.

LIST OF EXPERIMENTS:

1. Introduction to SAS: - SAS environment - program syntax - structure of data, types of data - reading in and displaying data - running program, generating log and output.
2. Reading in Data - list input, comma and tab delimited data, data from Excel, column input, informats - reading data from external file - problems in reading data.
3. Describing Data - PROC PRINT, MEANS, UNIVARIATE, SPLOT, PROC FREQ, SPLOT, CORR, REG.
4. Working with SAS Datasets - sub-setting and merging datasets.
5. Use SAS procedures for basic statistical inference: Chi-square tests, T-Tests, ANOVA, Regression, etc.

TOTAL: 30 PERIODS

LAB REQUIREMENTS FOR A SET OF 9 STUDENTS

Computers installed with SAS Software (open source software) with Internet. – 9 Nos.

OUTCOMES:

On completion of this practical course student will be able to

- Write programs for reading and processing data.
- Implement statistical analysis of biomedical data using SAS language.

REFERENCES:

1. Delwiche and Slaughter: The Little SAS Book, 5th edition
2. Cody and Smith: Applied Statistics and the SAS Programming Language, 5th Edition.

MX23V34 MODELLING USING COMSOL L T P C

0 0 2 0

OBJECTIVES

- To Practice the basics of COMSOL Multiphysics
- To Simulate physical problems using modelling

LIST OF EXPERIMENTS

1. Introduction to simulation workflow in COMSOL.
2. Creating the Geometrical Objects
3. Specifying Material Properties and Defining Physics
4. Meshing Basics
5. Running a simulation
6. Post processing the results
7. Modelling of fluid through a pipe using Fluid Flow
8. Modelling of deformation of a rod using Structural Mechanics

9. Modelling of electrical resistivity of a rod using AC/DC Module
10. Modelling of heat transfer in solids

TOTAL: 30 PERIODS

LAB REQUIREMENTS FOR A SET OF 9 STUDENTS

Computers installed with COMSOL 5.5 Version – 9 Nos

OUTCOMES:

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

- Model the required geometry of the problem
- Simulate and analyse the physics using modelling

REFERENCES:

1. Learn How to Use COMSOL Multiphysics® in a Guided Session.
2. The AC/DC Module User's Guide (comsol.com)
3. doc.comsol.com/5.4/doc/com.comsol.help.sme/StructuralMechanicsModuleUsersGuide.pdf
4. doc.comsol.com/5.4/doc/com.comsol.help.heat/HeatTransferModuleUsersGuide.pdf
5. doc.comsol.com/5.4/doc/com.comsol.help.cfd/CFDModuleUsersGuide.pdf
6. doc.comsol.com/5.3a/doc/com.comsol.help.cfd/CFDApplicationLibraryManual.pdf