PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

- To prepare the graduates for pursuing research or gaining employment in a bioengineering or related profession.
- To enhance the skills of graduates to design a variety of electronic or computer based devices and software for applications including biomedical instrumentation, medical imaging, physiological measurement and biomedical signal processing.
- To enrich the graduates to make positive contributions in biomedical industries and/or other sectors.
- To facilitate the graduates to exhibit leadership skills, make decisions with societal and ethical responsibilities, function and communicate effectively in multidisciplinary settings.

PROGRAMME OBJECTIVES:

PO1 An ability to apply knowledge of mathematics, science, and engineering to solve problems at the interface of engineering and biology.

PO2 An ability to design and conduct experiments, as well as to analyze and interpret data from living systems; addressing the problems associated with the interaction between living and non-living materials and systems.

PO3 An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

PO4 An ability to function on multidisciplinary and diverse teams and provide leadership.

PO5 An ability to identify, formulate, and solve biomedical engineering problems.

PO6 An understanding of professional and ethical responsibility.

PO7 An ability to communicate effectively: by oral, written and graphic modes.

PO8 The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

PO9 A recognition of the need for and an ability to engage in life-long learning.

PO10 An exhibiting a knowledge of contemporary.

PO11 An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

PO12 An understanding of biology and physiology as related to biomedical engineering needs.
PROGRAM SPECIFIC OBJECTIVES (PSOs)

**PSO1:** To acquire and understand the basic skill sets required for Biomedical Engineering.

**PSO2:** To implement the techniques and tools of Bio Medical Engineering to address the needs of technology in healthcare domain.

**PSO3:** To address the problems associated with the interaction between living and non-living materials and systems.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES:

A broad relation between the programme objective and the outcomes is given in the following table:

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# ANNA UNIVERSITY, CHENNAI
# AFFILIATED INSTITUTIONS
# M.E. BIOMEDICAL ENGINEERING
# REGULATIONS – 2017
# CHOICE BASED CREDIT SYSTEM
# CURRICULA AND SYLLABI

## SEMESTER I

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## EMPLOYABILITY ENHANCEMENT COURSE (EEC)

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OBJECTIVES:
The main objective of this course is to demonstrate various analytical skills in applied mathematics and extensive experience with the tactics of problem solving and logical thinking applicable for the students in various engineering discipline. This course also will help the students to identify, formulate, abstract, and solve problems using mathematical tools from a variety of mathematical areas, including linear algebra, numerical solution of linear equations and differential equations, approximation of functions in terms of polynomials using interpolation, numerical differentiation and integration, linear programming and queueing models.

UNIT I VECTOR SPACE AND LINEAR TRANSFORMATION
Vector spaces – Subspaces – Linear spans – Linear independence and linear dependence – Basis and dimension – Linear transformation - Null space and range – Dimension theorem (no proof) – Matrix representation of linear transformation.

UNIT II NUMERICAL LINEAR ALGEBRA, INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION

UNIT III NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

UNIT IV LINEAR PROGRAMMING

UNIT V QUEUEING MODELS

OUTCOMES:
After completing this course, students should demonstrate competency in the following topics:

- Compute basic objects associated with vector spaces and linear transformation.
- Solve an algebraic or transcendental equation, linear system of equations using an appropriate numerical method.
- Construction of an approximate polynomial using interpolation methods, finding of the derivatives and evaluation of integrals numerically.
- Numerical solution of ordinary differential equations using single and multistep methods.
- Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- Exposing the basic characteristic features of a queuing system and acquire skills in analyzing queuing models.

The students should have the ability to use the appropriate and relevant, fundamental and applied mathematical knowledge, methodologies and modern computational tools.
REFERENCES:

BM5151 HUMAN ANATOMY AND PHYSIOLOGY

OBJECTIVES:
- To understand basics of Human Anatomy and Physiology.
- To study the organs and systems involved in body functions.

UNIT I INTRODUCTION OF HUMAN BODY

UNIT II BUILDING BLOCKS OF HUMAN BODY

UNIT III RESPIRATION, NUTRITION AND EXCRETORY SYSTEM

UNIT IV CARDIOVASCULAR AND ENDOCRINE SYSTEM

UNIT V NERVOUS SYSTEM AND SPECIAL SENSES

TOTAL: 45 PERIODS
OUTCOMES:
At the end of this course, the students should be able to:

- Qualitatively and quantitatively describe each system of the human body covered in this course: integumentary, skeletal, muscular, nervous, sensory, and endocrine and the components of these systems on the organ and cellular level.
- Apply this knowledge into biomedical engineering field.
- Integrate a basic knowledge of chemistry and biochemistry with human physiology

REFERENCES:

OBJECTIVES
- It provides a solid foundation in advanced biomedical signaling and imaging systems including up-to-date coverage of commercially relevant topics.
- It focuses on biomedical signals, processing the signals, and validate the methods and results for optimization of clinical applications
- To introduce techniques for automated classification and decision making to aid diagnosis

UNIT I SIGNAL, SYSTEM AND SPECTRUM

UNIT II TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION
Time series analysis – linear prediction models, process order estimation, non stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG and HRV signals, model based ECG simulator. Spectral estimation – Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals.

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

UNIT IV BIOSIGNAL CLASSIFICATION AND RECOGNITION
Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats and other biomedical applications
UNIT V TIME FREQUENCY AND MULTIVARIATE ANALYSIS
Time frequency representation, spectrogram, Time-scale representation, scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction-Wavelet packets, Multivariate component analysis-PCA, ICA

OUTCOMES:
At the end of this course, the students should be able to:
• Carry out multivariate component analysis.
• Explain biosignal classification

REFERENCES:

BM5101 BIOMEDICAL SENSORS AND INSTRUMENTATION

OBJECTIVES:
• To study the basic characteristics of measurement system.
• To study the different types of transducers, electrodes and signal conditioning circuits.
• To study the techniques used for measurement of various non electrical physiological parameters.
• To know the different types of display and recording devices.

UNIT I TRANSDUCERS
Characteristics- Static, Dynamic, Errors in the measurements, Classification of transducers -Resistive, Capacitive, Inductive, Photoelectric, piezoelectric and mechanoelectronics.

UNIT II ELECTRODES & AMPLIFIERS

UNIT III CHEMICAL AND OPTICAL TRANSDUCERS
PH, PO2, PCO2, HCO3 electrodes, Ion sensor, Anion and Cation sensor, Liquid and solid ion exchange membrane electrode, Enzyme electrode, Principle of fiber optic cable, fiber optic sensors, Photo acoustic sensors, PPG sensors.
UNIT IV  NON ELECTRICAL PARAMETERS MEASUREMENTS  9
Measurements of Respiration Rate, Temperature, Pulse rate, Blood pressure Measurements- Direct, Indirect, Blood flow Measurements – Invitro, Invivo, Gas flow measurements.

UNIT V  RECORDERS AND DISPLAY  9
Types of recorders, Ink jet, heated stylus, Photographic recorder, Multicolour dot scanners, CRO, storage type, long persistence, digital scope, magnetic tape recorders.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course, the students should be able to:
- Explain non electrical parameters measurements
- Identify and utilize the type of recorders and display
- Identify and Select chemical and optical transducers

REFERENCES:

BM5102  MEDICAL IMAGING SYSTEMS  L T P C
3 0 0 3

OBJECTIVES:
- To study the production of x-rays and its application to different medical Imaging techniques.
- To study the different types of Radio diagnostic techniques.
- To study the special imaging techniques used for visualizing the cross sections of the body.
- To study the imaging of soft tissues using ultrasound technique

UNIT I  PRINCIPLES OF RADIOGRAPHIC EQUIPMENTS  8
X-Ray tubes, cooling systems, removal of scatters, construction of image Intensifier tubes, angiographic setup, digital radiology, thermography, mammography

UNIT II  COMPUTER AIDED TOMOGRAPHY  10
Need for sectional images, Principles of sectional scanning, Method of convolution and Back Propagation, Methods of reconstruction, Artifacts, Principle of 3D imaging

UNIT III  RADIO ISOTOPIC IMAGING  9
Radiation detectors, Radio isotopic imaging equipment's, scanners, Principle of semiconductor detectors, Gamma ray camera, Positron Emission tomography SPECT.
UNIT IV ULTRASONIC SYSTEMS
Wave propagation and interaction in Biological tissues, Acoustic radiation, continuous and pulsed excitation, Transducers and imaging systems, Scanning methods, Principle of image generation.

UNIT V MAGNETIC RESONANCE IMAGING
Principles of MRI, Relaxation processes and their measurements, Pulse sequencing and MR image acquisition.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course, the students should be able to:
- Explain computer aided tomography
- Discuss ultrasonic systems
- Outline magnetic resonance imaging

REFERENCES:

BM5111 CLINICAL INSTRUMENTATION LABORATORY

OBJECTIVES:
To enable the students to know about the measurements and recording of Bioelectric and Bio Chemical Signals. To study the different preamplifiers used for amplifying the Bio Signals

LIST OF EXPERIMENTS
1. Operational Amplifier-various amplifier configurations
2. Study of Timer circuit, Study of FSK modulation and demodulation
3. Design and testing of Bio-Amplifiers
4. Record and analyze the ECG signal
5. Record and analyze the EMG signal.
6. Record and analyze the EEG signal.
7. Audiometer
8. Recording of various physiological parameters using patient monitoring system and telemetry units
9. Study and analysis of functioning and safety aspects of surgical diathermy
10. Bio-chemical measurements
11. Respiration rate measurement using spirometer
12. Blood count measurement using blood cell count meter
13. Blood pH measurement using pH meter

TOTAL: 60 PERIODS
OUTCOME:
Students will get the clear practical knowledge about the various basic amplifiers and their characteristics.

BM5291  APPLIED MEDICAL IMAGE PROCESSING  L  T  P  C
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OBJECTIVES:
- To develop computational methods and algorithms to analyze and quantify biomedical data
- To understand the fundamentals of medical image processing techniques.

UNIT I  IMAGE FUNDAMENTALS  9
Image perception, MTF of the visual system, Image fidelity criteria, Image model, Image sampling and quantization – two dimensional sampling theory, Image quantization, Optimum mean square quantizer, Image transforms – DFT, DCT, KLT, SVD.

UNIT II  IMAGE ENHANCEMENT AND RESTORATION  9
Histogram equalization and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contra harmonic mean filters, Homomorphic filtering, Color image enhancement. Image Restoration - degradation model, Unconstrained and constrained restoration, Inverse filtering- Wiener filtering

UNIT III  MEDICAL IMAGE REPRESENTATION  9
Pixels and voxels – algebraic image operations - gray scale and color representation- depth-color and look up tables - image file formats- DICOM- other formats- Analyze 7.5, NifTI and Interfile, Image quality and the signal to noise ratio

UNIT IV  MEDICAL IMAGE ANALYSIS AND CLASSIFICATION  9
Image segmentation- pixel based, edge based, region based segmentation. Image representation and analysis, Feature extraction and representation, Statistical, Shape, Texture, feature and image classification – Statistical, Rule based, Neural Network approaches

UNIT V  IMAGE REGISTRATIONS AND VISUALIZATION  9
Rigid body visualization, Principal axis registration, Interactive principal axis registration, Feature based registration, Elastic deformation based registration, Image visualization – 2D display methods, 3D display methods, virtual reality based interactive visualization.

TOTAL: 45 PERIODS

OUTCOMES:
- Students will be able to apply image processing concepts for medical images.
- Will be able to analyze Morphology, Segmentation techniques and implement these in images.
- Enables quantitative analysis and visualization of medical images of numerous modalities such as PET, MRI, CT, or microscopy
REFERENCES:

BM5201 DIAGNOSTIC AND THERAPEUTIC EQUIPMENTS

OBJECTIVES:
- To know the various biopotential recordings so as to enable students to record various biosignals.
- To know the various functional blocks present in cardiac care units so that the students can handle these equipments with care and safety.
- To develop an understanding of the physiotherapy and diathermy equipment so that the student can learn to operate.

UNIT I BIO POTENTIAL RECORDING
ECG, EEG, EMG, PCG, EOG, lead system and recording methods, typical waveform, frequency spectrum, abnormal waveforms. Evoked response.

UNIT II CARDIAC CARE UNITS
Pace makers - different types, batteries for pace makers. DC defibrillators, asynchronous and synchronous types, patient monitoring system, principles of bio telemetry.

UNIT III DIATHERMY AND STIMULATOR
Physiological effects of HF radiation, Depth of Penetration, short wave, Ultrasonic and microwave diathermy, Surgical diathermy, Galvani, Faradic stimulators, Interferential therapy, Electrical safety - Leakage current, Micro and macro electric shock, GFI units, Earthing Scheme, Electrical safety Analyser.

UNIT IV ASSIST DEVICES

UNIT V RECENT TRENDS
Principles and application of thermography, Detection circuits, Principles of cryogenic Technique and application, principles of Fiber optics cables, Endoscopy, Laparoscopy, principles of Lithotripsy.

TOTAL: 45 PERIODS
OUTCOMES:
By successfully completing this course, students will be able to:
- Develop measurement systems by selecting different types of electrodes, signal conditioning circuits for acquiring and recording various biopotential.
- Describe and explain specific parts in Cardiac care units. Describe important working mechanisms of assist devices.
- Get clear domain knowledge about various types of Medical stimulators, and recently developed equipments.

REFERENCES:
1. Albert M Cook and Webster J G – Therapeutic medical devices Prentice Hall Nee York 1982
7. Leslie Cromwell , Fred J.Weibell and Erich A.Pfeiffer - Biomedical Instrumentation Prentice Hall New Delhi 2000

BM5202 BIOMECHANICS

OBJECTIVES:
- To get the clear understanding of application of mechanics in medicine.
- To study the properties of blood, bone and soft tissues like articular cartilage tendons and ligaments,
- To gain necessary knowledge about accident and injuries.
- Introduction to basic structural analysis of medical implants

UNIT I INTRODUCTION
Introduction to bio-mechanics, relation between mechanics and Medicine, Newton's laws, stress, strain, shear rate, viscosity, visco elasticity, non Newtonian viscosity, soft tissue mechanics, mechanical properties of soft biological tissues. biofluid mechanics. Steps in analyzing a biomechanical problem – Graphical methods – contact forces – resolution of forces

UNIT II MECHANICS OF CIRCULATION
Flow properties of blood, effect of shear rate, hematocrit, temperature and protein content of blood, rheology of blood and micro vessels, dynamics of circulatory system, turbulence flow around prosthetic heart valves.
UNIT III  MECHANICAL PROPERTIES OF BONES

UNIT IV  MECHANICS OF THE JOINTS
Skeletal joints, skeletal muscles, basic considerations, basic assumption and limitations, forces and stresses in human joints, mechanics of the elbow, shoulder, spinal column, hip, knee and ankle. Structure of the Tibio femoral joint, patello femoral joint, knee joint motion – flexion, extension, rotation, Arthro-kinematics, stabilization and its contributors, positioning of the knee joints, locking/unlocking mechanism, Q-angle. Human locomotion, gait analysis and goniometry, Ergonomics, Foot Pressure measurements – Pedobarograph, Force platform, mechanics of foot. Total Hip Prosthesis: requirements, different types of components, Stress analysis & instrumentation, Knee Prosthesis.

UNIT V  DESIGN OF MEDICAL IMPLANTS USING SOFTWARE

TOTAL : 45 PERIODS

OUTCOMES:
The study of mechanical properties of biological tissues and the properties of blood give us a wide understanding about its structure and when it undergoes wear and when it fails so many precautions can be given by ourselves to elders. Introduction to FEM and its medical applications. Human body boundary conditions for implants design and analysis. The knowledge gained will be helpful in doing research in properties of hard tissues like bones and to generate a mathematical mode of bone structure etc.

REFERENCES:
1. A Z Tohen and C T Thomas, Manual of Mechanical Orthopaedics
3. D Dawson & V. Wright, Introduction to Biomechanics of joints and joint replacement
5. D N Ghista, Biomechanics of Medical Devices, Macel Dekker, 1982
9. V.C. Mow and W. C. Hayes, Basic Orthopedic Biomechanics, Lippincott, Raven Publishers
OBJECTIVES:
- Achieve familiarity with some basic ethical framework and understand how these ethical frameworks can help us to think through contemporary questions in medical ethics.
- Students will be able to know about the legal and ethical principles and application of these principles in health care settings and gain knowledge about the medical standards that to be followed in hospitals.

UNIT I  INTRODUCTION TO MEDICAL ETHICS  8
Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor And The Patient, The Doctor And The Profession, Professional Independence, The Doctor And Society.

UNIT II  ETHICAL THEORIES & MORAL PRINCIPLES  9

UNIT III  HOSPITAL ACCREDITATION STANDARDS  9

UNIT IV  HOSPITAL SAFETY STANDARDS  10

UNIT V  MEDICAL EQUIPMENT SAFETY STANDARDS  9
General requirements for basic safety & essential performance of medical equipments. IEC 60601 standards—Base Standard—general requirement of electrical medical devices, Collateral Standards—EMC radiation protection & programmable medical device system, Particular Standards—type of medical device

OUTCOMES:
Upon completion of this course the student should be able to demonstrate a measurable increase in their knowledge, skills and abilities related to:
- Legal and professional guidelines for the health professions
- Public duties and consent
- Guidelines to obtain medical standards in hospitals
REFERENCES:
5. NilsHoppe and JoseMiola - Medical law and Medical Ethics - Cambridge University Press-2014
6. Physical Environment Online: A Guide to The Joint Commission’s Safety Standards is published by HCPro, Inc. 2010

BM5211 BIO SIGNAL AND IMAGE PROCESSING LABORATORY L T P C 0 0 4 2

OBJECTIVES:
- To study the various aspects of analysis of bio-signals and medical images.
- To develop algorithms for denoising, power spectral density and classification of bio signals.
- To develop image processing algorithms for segmentation, feature extraction and classification.

LIST OF EXPERIMENTS:
1. Design of FIR filter using MATLAB and DSP kit
2. Design of IIR filter using MATLAB and DSP kit
3. Analysis of ECG signal - Removal of artifacts like power line interference, baseline, electrode movement, wandering etc. and study of abnormalities in ECG pattern - using LABVIEW / MATLAB
4. Analysis of EEG Signal-Extraction of rhythms (delta, theta, alpha, beta and gamma waves), calculate Power spectral density in each rhythms using LABVIEW / MATLAB
5. Analysis of EMG Signal - Removal of artifacts like power line interference, baseline, electrode movement and calculate the muscle force using LABVIEW / MATLAB
6. Histogram Equalization, Non-linear filtering and edge detection for CT images.
7. Apply 2 D DFT, DCT and DWT transform for medical images (X – ray/CT/MRI).
8. Medical Image segmentation using watershed transform
9. Feature extraction and classification for medical image
10. Apply Image compression techniques for medical image.
11. Human Joint angle measurements using standard Goniometer
12. Human Joint angle measurements using electronic Goniometer
13. Performing Finite element loading analysis of knee joint in the following joint state
   o Full extension
   o Flexion (90 Degree flexion)
   o Squatting (40-50-degree flexion)

TOTAL:60 PERIODS

OUTCOMES:
- Ability to analyze any biosignal and to classify the abnormalities.
- Apply the techniques of medical image analysis to develop Computer aided detection systems.
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.

UNIT I INTRODUCTION TO REHABILITATION

UNIT II ORTHOTICS & PROSTHETICS IN REHABILITATION
Types of orthosis-FO,AFO,KAFO,HKAFO and prosthesis ,Partial Foot Prostheses- Foot-ankle assembly, Trans femoral Prostheses, Prosthetic Hand, Advance and automated prosthetics and orthosis, Externally powered and Controlled orthotics & prosthetics, -FES system, Restoration of Hand function, Restoration of standing and walking.

UNIT III MOBILITY AIDS
Electronic Travel Appliances (ETA) : Path Sounder, Laser Cane, Ultrasonic Torch, Sonic Guide, Light Probes, Nottingham Obstacle Sensors, Electro cortical Prosthesis, Polarized Ultrasonic Travel aids, Materials used for wheel chairs, Type of Wheel Chairs, design of wheel Chair, Walking frames, Parallel bars, Rollators, Quadripods, Tripods & walking sticks, Crutches.

UNIT IV AUDITORY AND SPEECH ASSIST DEVICES
Types of deafness, hearing aids, application of DSP in hearing aids, Cochlear implants, Voice synthesizer, speech trainer

UNIT V SENSORY AUGMENTATION AND SUBSTITUTIONS
Classification of Visual Impairments, Prevention and cure of visual impairments, Visual Augmentation, Tactile vision substitution, auditory substitution and augmentation, tactile auditory substitution, Assistive devices for the visual impaired

TOTAL: 45 PERIODS

OUTCOME:
The student will have the knowledge about various rehabilitation aids available and the issues associated with the use of these aids

REFERENCES:
OBJECTIVES:

- To understand the fundamental principles of genetics and to describe the experiments used to establish them.
- To develop skills in applying these principles to solve genetic problems and demonstrate how genetic analysis can be used to investigate aspects of biology.

UNIT I  GENETIC INHERITANCE  9
Organisation of DNA, Chromosomal inheritance, Eukaryotic genomes – repetitive and non-repetitive sequence, Genetic mapping - restriction cleavage, RFLP and SNPs.

UNIT II  DNA AND PHENOTYPE  9
DNA structure and replication, DNA sequencing, amplification and hybridisation. DNA Polymorphism, RNA transcription and processing, translation and its post translation modification. Regulation of gene expression.

UNIT III  ENGINEERING OF GENES  9
Gene isolation and manipulation, mutations, repair and recombination, site directed mutagenesis, in vivo techniques of genetic manipulation, tools for analysing gene expression and genetically modified organisms.

UNIT IV  HUMAN GENOME PROJECT  9
Human Genome Project (HGP) – an overview of the project, goals of the project, major scientific strategies & approaches used in HGP, physical mapping, gene ontology, gene annotation, techniques in HGP – microsatellite markers, STS, EST, DNA sequencing and DNA microarray, scientific & medical benefits of this project.

UNIT V  IMPACT OF GENETIC VARIATION  9
Population Genetics, Quantitative Genetics, Evolution Genetics.

OUTCOMES:

- Interpret different forms of inheritance patterns and identify them in genetic data
- Acquire in depth knowledge in evolutionary analysis of genetic sequence
- Interpret and critically evaluate the outcomes of statistical analysis associated with the research project
- Exploit relevant molecular genetic information with skill and confidence to conduct a research project involving the analysis of real molecular genetic data with minimal supervision

REFERENCES:

OBJECTIVE:
To develop an understanding of physics involved in various imaging modalities and the effect of radiation on human body.

UNIT I PRINCIPLES OF NUCLEAR PHYSICS

UNIT II PHYSICS OF INFRARED, MICROWAVE AND RADIO FREQUENCY
Production and properties - interaction mechanism of RF and microwaves with biological systems: Thermal and non-thermal effects on whole body, lens and cardiovascular systems - tissue characterization and Hyperthermia and other applications. Biomagnetism - Effects – applications- Infrared detectors—thermographic equipments—quantitative medical thermography— pyroelectric video camera—applications of thermography.

UNIT III LASER PHYSICS AND PHOTOMEDICINE
Characteristics of laser radiation, Laser speckle, biological effects, laser safety management Synthesis of vitamin D in early and late cutaneous effects, Phototherapy, photo hemotherapy, exposure level, hazards and maximum permissible exposures. Optical characteristics of biomolecules from the point of spectroscopy – principles of UV – Visible absorption – IR and FTIR absorption – Raman and Fluorescence spectroscopy – application with regard to characterization of biomolecules – blood oxygen, glucose measurements, monitoring drug concentration, cancer

UNIT IV DIAGNOSTIC ULTRASOUND
Ultrasonic waves – generation and detection of ultrasound –Beam characteristics—attenuation of ultrasound –specific acoustic impedance—reflection at body interfaces---Coupling medium ---interaction ultrasound with tissues—deleterious effects of Ultrasound- Safety levels of Ultrasound-real time scanners image clarity---Resolution ---axial and lateral resolution ---- Artifacts---Pulse echo imaging ----Obsterics abdominal investigations- Echo cardiograph (UCG) – The Doppler Effect-Doppler Shift---continuous wave Doppler system ---Pulsed wave Doppler systems - duplex scanning-display devices for ultrasonic imaging

UNIT V RADIOBIOLOGICAL EFFECT OF RADIATION
Target theory, single hit and multi target theory, cellular effects of radiation, DNA damage, chromosomal damage, Somatic effect : Radio sensitivity protocol of different tissues in human ,LD 50/30 effect, Genetic effect: Threshold of linear dose effect, relationship factors affecting frequency of radiation induced mutation, biological effect of microwave, RF wave and UV radiation.

TOTAL: 45 PERIODS

OUTCOMES:
• The students analyse the physics behind radiation used in medical techniques and acquires indepth knowledge about optics & ultrasound along with their effects of radiation
REFERENCES:

BM5072 BIO MATERIALS L T P C
3 0 0 3

OBJECTIVES:
- To introduce concepts of materials, surface and tissue placement in biomaterial functions
- To understand diverse elements controlling biological responses to materials
- To provide contemporary biomaterial principles

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

UNIT II MATERIALS IN MEDICAL DEVICES
Metals, Ceramics, Polymers and Biomimetic Materials, Composites. Material preparation, chemical composition, Properties, uses in medicine and biosciences and failure mechanisms.

UNIT III STERILIZATION OF BIOMATERIALS

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

UNIT V HARD AND SOFT REPLACEMENT
Cardiac Implants, Orthopedic Implants, Neuromuscular Implants, Transcutaneous Implants, Intraocular lenses.

TOTAL : 45 PERIODS
OUTCOMES:
The student will be able to
- Widen rational design approaches to biomaterials engineering
- Identify significant gap required to overcome challenges and further development
- Develop critical analyses of biomaterials through proposal writing and review.

REFERENCES:

BM5091 BIO STATISTICS

OBJECTIVES:
- To introduce strengths and limitations of measures of central tendency and measures of variability.
- To classify common statistical tests and tools.
- To distinguish between p-values and confidence intervals as measures of statistical significance.
- To interpret commonly used regression analysis.
- To evaluate commonly used statistical and epidemiologic measures.

UNIT I INTRODUCTION
Introduction to probability, likelihood & odds, distribution variability.

UNIT II STATISTICAL PARAMETERS
Statistical parameters p-values, computation and level chi square test and distribution.

UNIT III REGRESSION ANALYSIS
Regression, correction use of regression, multiple regression.

UNIT IV INTERPRETING DATA
Interpreting life tables clinical trails, epidemical reading and interpreting of epidemical studies, application in community health.

UNIT V META ANALYSIS
META analysis for research activities, purpose and reading of META analysis, kind of data used for META analysis

TOTAL :45 PERIODS
OUTCOMES:
- The student is able to explain the techniques used in statistical & regression analysis. Also the student is able to compare the various parameters used in statistical significance.

REFERENCES:

BM5002 ULTRASOUND PRINCIPLES AND APPLICATIONS IN MEDICINE  L T P C  3 0 0 3

OBJECTIVES:
- To teach the principles of ultrasonic’s and its interaction with tissue.
- Students will be able to know about the scanning techniques and real time scanners principles and application of these principles in health care settings & gain knowledge about the various applications of ultrasound in medicine.

UNIT I PRINCIPLES OF ULTRASONICS 9

UNIT II TISSUE-ULTRASOUND INTERACTION 9
Introduction, Absorption in biological tissues, Tissue-Ultrasound interaction cross sections, Theory of mechanisms for the absorption of ultrasonic longitudinal waves, Measurement of attenuation and Absorption Coefficients in tissues, Acoustic properties reflecting different levels of tissue organization, Molecular aspects of soft tissue mechanics, Structural contribution to bulk and shear acoustic properties of tissues. Relevance to tissue characterization, Ultrasound quantitation and tissue characterization

UNIT III SCANNING TECHNIQUES 9

UNIT IV REAL TIME ULTRASONIC SCANNERS 9
Different modes of display-A mode, B mode, M mode, B-scan System, The Principles of Ultrasound Motion Detection, Techniques for Measuring Target Velocity, Phase Fluctuation (Doppler Methods), Envelope Fluctuation Methods, Phase Tracking Methods, Envelope Tracking Techniques, Ultrasound Imaging Systems, Considerations Specific To Color Flow Imaging, Angle Independent Velocity Motion Imaging, Tissue Elasticity & Echo Strain Imaging, Performance Criteria, Use of Contrast Media, Real Time Echo, 2-D and 3-D Scanners, Color Doppler.
UNIT V  ULTRASONIC APPLICATIONS

Ultrasonic diagnosis in Abdomen, Breast, Thyroid, Heart, Chest, Eye, Kidney, Skull, Pregnant and Non Pregnant uterus, 3-Dimensional Ultrasonic Imaging of The Fetus, Advantages And Limitations of 3-Dimensional Ultrasound.

TOTAL: 45 PERIODS

OUTCOMES:
- In-depth knowledge about the Ultrasound imaging systems and its interaction with living systems.
- Ability to specify method of ultrasonic scanning method for imaging different organs
- Proficient knowledge about Real time Scanners and their applications.

REFERENCES:
UNIT III FEATURE EXTRACTION METHODS
Time/Space Methods – Fourier Transform, Wavelets, AR, MA, ARMA models, Bandpassfiltering, Template matching, Kalman filter, PCA, Laplacian filter – Linear and Non-Linear Features

UNIT IV FEATURE TRANSLATION METHODS

UNIT V APPLICATIONS OF BRAIN-COMPUTER INTERFACES

TOTAL: 45 PERIODS

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

- Acquire the brain signal in the format required for the specific application
- Preprocess the signal for signal enhancement
- Extract the dominant and required features
- Classify the signal for applications

REFERENCES:
OBJECTIVES:
- To understand basics of Tissue Engineering
- To understand fundamentals of cell mechanisms
- To teach the Physical & biological principles that serve as the scientific basis for understanding the interactions of biological molecules and cells with biomaterials employed for the fabrication of permanent implantable prostheses and as matrices for tissue engineering.
- To understand application of Tissue Engineering

UNIT I  BASICS OF TISSUE ENGINEERING  9

UNIT II  FUNDAMENTALS OF CELL MECHANISMS  9

UNIT III  BIOMATERIALS IN TISSUE ENGINEERING  9

UNIT IV  STEM CELLS IN TISSUE ENGINEERING  9
Introduction of Stem cells – Hemopoetic Stem cells - Embryonic Stem cells - Adult stem cells – Cancer Stem cells – Cord Blood cells – Induced Pluripotent Stem cells - Stem cell identification - Surface markers & FACS analysis – Differentiation, Dedifferentiation and Immortalization – Application of stem cells in tissue Engineering.

UNIT V  TISSUE ENGINEERING APPLICATIONS  9

TOTAL : 45 PERIODS

OUTCOMES:
By successfully completing this course, students will be able to:
- Discuss the importance of tissue engineering in the field of biomedical engineering Explain the mechanisms involved in interaction of different materials with cells and tissues
- Explain different methods involved in characterization and preparation of biomaterials in tissue engineering.
- Apply the knowledge in creating new models in drug delivery systems using synthetic and natural scaffolds
- Explain different types of stem cells and its application in tissue engineering
- Develop new approaches to build new tissues using tissue engineering techniques
REFERENCES:

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<th>TELEHEALTH TECHNOLOGY</th>
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OBJECTIVES:
- To teach the key principles for telemedicine and health.
- To enable the students with the knowledge of telemedical standards, mobile telemedicine and its applications.

UNIT I  TELEMEDICINE AND HEALTH
History and Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Tele health, Tele care, Organs of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

UNIT II  TELEMEDICAL TECHNOLOGY

UNIT III  TELEMEDICAL STANDARDS

UNIT IV  MOBILE TELEMEDICINE
Tele radiology: Definition, Basic parts of teleradiology system: Image Acquisition system Display system, Tele pathology, multimedia databases, color images of sufficient resolution, Dynamic range, spatial resolution, compression methods, Interactive control of color, Medical information storage and management for telemedicine- patient information medical history, test reports, medical images diagnosis and treatment. Hospital information system - Doctors, paramedics, facilities available. Pharmaceutical information system.
UNIT V  TELEMEDICAL APPLICATIONS
Telemedicine access to health care services – health education and self-care. · Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability., Telemedicine access to health care services– health education and self-care, Business aspects - Project planning and costing, Usage of telemedicine

TOTAL: 45 PERIODS

OUTCOMES:
- Technologies applied in multimedia using telemedicine
- Protocols behind encryption techniques for secure transmission of data.
- Applications of telehealth in healthcare

REFERENCES:

BM5073  NANO TECHNOLOGY AND APPLICATIONS

OBJECTIVES:
- To know basic nanotechnological principles and characterization methods
- To understand the essential features of biology and nanotechnology that are converging to create the new areas of bionanotechnology and nanomedicine.

UNIT I  INTRODUCTION OF NANOPARTICLES
Overview of nanotechnology from medical perception, different types of nanobiomaterials and nanostructure interactions. Synthesis, characterization, and properties smart nanomaterials, Surface modification, biofunctionalization of nanomaterials. Nanocarriers (e.g. liposomes, polymer capsules, polymer nanoparticles, porous materials, nanogels, dendrimers, microemulsions, inorganic nanoparticles, carbon nanotubes, lipoproteins, solid lipid nanoparticles)

UNIT II  PROTEIN AS NANOSTRUCTURES
Protein based nanostructures building blocks and templates – Proteins as transducers and amplifiers – nanobioelectronic devices and polymer nanocontainers – microbial production of inorganic nanoparticles – magnetosomes.
UNIT III DNA AS NANOSTRUCTURES
DNA based nanostructures – Topographic and Electrostatic properties of DNA – Hybrid conjugates of gold nanoparticles – DNA oligomers – use of DNA molecules in nanomechanics

UNIT IV NANOPARTICLES IN DIAGNOSIS
Introduction to nanoparticles in diagnostics— nuclear imaging, optical imaging, PET, Micro PET, cardiovascular disease studies, imaging and therapy of thrombosis, emerging Ethical issues and toxicology of nanomaterials.

UNIT V NANOTHERAPEUTICS
Nanoparticles as carriers in drug delivery- design, manufacture and physiochemical properties, transport across biological barriers, nanotechnology in Cancer therapy, lung infectious disease, bone treatment, nano particles for oral vaccination and skin disease.

TOTAL: 45 PERIODS

OUTCOMES:
The student will be able to:
● Follow the newest findings in the area of nanomedicine and implement the perspectives in own research.
● Explain nanoparticles in diagnosis
● Discuss nanotherapeutics

REFERENCES:

MX5071 PATTERN RECOGNITION TECHNIQUES AND ITS APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:
● To know about Supervised and unsupervised Learning.
● To study about feature extraction and structural pattern recognition.
● To explore different classification models
● To understand Fuzzy Pattern Classifiers

UNIT I PATTERN CLASSIFIER

UNIT II CLUSTERING
Clustering for unsupervised learning and classification – Clustering concept – Hierarchical clustering, Partitional clustering- k-means algorithm – Validity of Clusters.
UNIT III  FEATURE EXTRACTION AND STRUCTURAL PATTERN RECOGNITION  9

UNIT IV  HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE  9

UNIT V  RECENT ADVANCES AND APPLICATIONS  9
Fuzzy logic – Fuzzy Pattern Classifiers – Case Study Using Fuzzy Pattern Classifiers CAD system in breast cancer detection, ECG signal classification, Fingerprint recognition, cell cytology classification

TOTAL: 45 PERIODS

OUTCOMES:
Upon Completion of the course, the students will be able to classify the data and identify the patterns
- Extract discriminatory features and select the features from given data set.

REFERENCES:

BM5003  HOSPITAL PLANNING, ORGANIZATION AND MANAGEMENT  L T P C
OBJECTIVES:
- With an objective of imbibing a professional approach amongst students towards hospital management.
- The subject encompasses management principles, staffing and marketing processes, discussing their significance and role in effective and efficient management of health care organizations.

UNIT I  FORMS OF ORGANISATION  8
Sole proprietorship, Partnership, Company-public and private sector enterprises, Principles of management, Evolution of management.

UNIT II  PRINCIPLE OF HOSPITAL MANAGEMENT:  10
Importance of management and Hospital, Management control systems. Forecasting techniques decision-making process

UNIT III  STAFFING  6
Staffing pattern in hospitals, Selection, Recruiting process, Training of staff, Organizational structures, Career development
UNIT IV MARKETING AND MANAGEMENT 10
Basic concepts marketing, Principles of social marketing, Social marketing in health sector, Consumer behavior and research health, Advertising in Health Sector, Relevance of e-marketing of Health care services

UNIT V COMPUTER IN HOSPITAL 11
System Development life cycle, Reasons to use computers in hospital, main categories of information systems in hospitals

TOTAL: 45 PERIODS

OUTCOME:
• The student acquires knowledge of the principles and practices essential for managing a hospital organization.

REFERENCES:

BM5004 FINANCE MANAGEMENT IN HOSPITALS L T P C
3 0 0 3

OBJECTIVES:
• The objective of this subject is to expose the students to decision making by corporate board in the areas of finance function.
• To provide an understanding of the basic principles and processes involved in the accounting system of a hospital.

UNIT I INTRODUCTION 4

UNIT II ACCOUNTING TECHNIQUES 10

UNIT III COSTING IN HOSPITALS 10
Nature & Scope of Cost Accounting – Cost analysis & Classification - Cost Calculation, significance of internal billing in Hospital - Necessary for internal & external controlling cost, cost unit calculation.

36
UNIT IV MANAGEMENT ACCOUNTING
Budgeting & Budgetary control – Cost – Volume – Profit analysis.

UNIT V FINANCING DECISIONS

OUTCOMES:
- The students is equipped with concepts, technical and analytical tools for optimal management of financial resources.
- Also the course helps to develop skills in analyzing accounting statements for decision-making in a hospital setting and practice the preparation of final accounts

REFERENCES:
1. GR Kulkarni, P Satyashankar, Libert Anil Gomes, Financial Management for Hospital

BM5005 HUMAN RESOURCES MANAGEMENT IN HOSPITAL

OBJECTIVES:
- This subject acquaints the students with major functions of HRM aligned with the business strategy.
- The subject encompasses the concept of best fit employee, training & executive development, sustaining employee interest and performance appraisal.

UNIT I PERSPECTIVES OF HUMAN RESOURCE MANAGEMENT

UNIT II THE CONCEPT OF BEST FIT EMPLOYEE

UNIT III TRAINING & EXECUTIVE DEVELOPMENT
Types of Training methods and their benefits - Executive development Programme - common
practices - Benefits, self-development - knowledge Management.

UNIT IV SUSTAINING EMPLOYEE INTEREST

UNIT V PERFORMANCE APPRAISAL

OUTCOMES:
Upon the completion of this course, the student is well acquainted with the knowledge about the significance and role in effective and efficient management of human resources in health care organizations

REFERENCES:

BM5006 HOSPITAL ARCHITECTURE

OBJECTIVES:
To expose the students to planning and operation of hospitals in a detailed manner which will include all facets of hospital planning activities covering every department that is involved both in clinical care as well as supportive services.

UNIT I INTRODUCTION TO HEALTH CARE SYSTEM
International and National level policy framework for healthcare facilities – Types of healthcare facilities based on public and private ownership, bed size and type of health care services based on outpatient, inpatient and diagnostic care - Organizational, function and structure of the hospital.

UNIT II HOSPITAL PLANNING
Principles of planning, regionalization, hospital planning team, planning process, size of the hospital, site selection, hospital architect, architect report, equipping a hospital, interiors & graphics, construction & commissioning, planning for preventing injuries, electrical safety.

UNIT III PLANNING & DESIGNING OF DIFFERENT SERVICES IN HOSPITALS
Planning and designing of administrative services, medical and ancillary services, nursing services, supportive services, public areas and staff services, hospital services
UNIT IV    STANDARDS AND NORMS FOR HOSPITALS  9
Design and construction standards for the hospitals namely BIS –India and JCAHO, AIA and NHS–
general guidelines and standard for out-patient area, in-patient area and diagnostic area in the
hospitals. Voluntary & Mandatory standards, General standards, Mechanical standards, Electrical
Standards, Standard for centralized medical gas system, Standards for biomedical waste.

UNIT V   FACILITIES FOR SUPPORTIVE SERVICES  9
Transport, Information system, Communication, Food services, Mortuary, Heating Ventilation and Air
Conditioning, Medical gases, House Keeping, Laundry.

TOTAL: 45 PERIODS

OUTCOMES:
The student will be able to follow the newest findings in the area of hospital planning, health
consultancy, hospital waste and implement the perspectives in constructing hospital standards.

REFERENCES:
2.  Purnima Sharma, Sangeet Sharma, Nerendra Malhotra, Jaideep Malhotra. llStep by Step
3.  S.K.Gupta, S.kant, R.Chandrashekhar, S.Satpathy , 'Modern trends in planning and designing
4.  Sa Tabish, Hospital and Nursing Homes planning, Organisation and Management, Jaypee
Brothers-Medical publishers, New Delhi, 2003

BM5007    HEALTH POLICY AND EQUIPMENT MANAGEMENT    L T P C
          3 0 0 3

OBJECTIVES:
• To expose the students for planning and operation of hospitals in a detailed manner which will
include all facts of hospital planning activities covering every department that is involved both in
clinical care as well as supportive services.
• To introduce the equipment maintenance management skills and how to protect equipment from
electromagnetic interferences.

UNIT I    HEALTH SYSTEM  9
Health organization of the country, the state and cities, health financial system, teaching cum
research hospitals, General Hospital, PHC reference system, Ambulataory Care.

UNIT II   NATIONAL HEALTH POLICY  9
Need for evaluating a health policy, need for providing primary health care, Health education, health
insurance, health legislation, inter sectoral cooperation.

UNIT III   EQUIPMENT MAINTENANCE MANAGEMENT  9
Organizing the maintenance operation, biomedical equipment procurement procedure, proper
selection, compatibility, testing and installation, purchase and contract procedure, trained medical
staff, on proper use of equipment and operating instructions. Maintenance job planning, preventive
maintenance, maintenance budgeting, contract maintenance.
UNIT IV  LOGISTIC SUPPORT & RELIABILITY
Maintenance equipment and Tools, failure analysis, spare parts and maintenance materials. Reliability fundamentals.

UNIT V  EMI IN HOSPITAL EQUIPMENTS
Principles of EMI, computation of EMI, Method of suppressing and isolating the unit from interference.

TOTAL: 45 PERIODS

OUTCOMES:
The student becomes an expert in
- Explaining the various health policies
- Planning activities at health care centres.
- Equipment installation service & calibration needs

REFERENCES:

MX5093  COMPUTER BASED MEDICAL INSTRUMENTATION

OBJECTIVES:
- To teach PC hardware and its related interfacing
- To give a complete overview of 80186, 80286, 80386 and 80486 microprocessors.
- To understand the basics of computerized data acquisition and programming.
- To enrich the students knowledge with biometrics and network security.

UNIT I  PC HARDWARE AND OVERVIEW
System Unit - Overview of Mother Boards - Processors, Memory, Adapter cards, Ports, Power supply - BIOS – DOS interaction, POST, Functional and Architecture Block diagram of a PC, Mother Board logics - Memory and I/O map

UNIT II  PERIPHERAL INTERFACING AND CONTROLLERS
Keyboard and Mouse Interfaces - Memory types - RAM - SDRAM and RDRAM, Cache memory, ROM and its types, Flash memory, CMOS semiconductor memory - Adapter Cards - Sound Card, Modem card, Video card, Network Card - I/O slots - ISA, PCI and AGP bus slots - Ports - Serial and Parallel ports, USB, FireWire port, MIDI, SCSI, IrDA, Bluetooth – Connectors - System Bus, ISA, EISA, PCI, AGP and PCI bus - Disk controllers

UNIT III  PROCESSORS AND MEMORY
80X86 Processors - Architectures and Memory management - Overview of 80X86 based Mother boards
UNIT IV COMPUTERISED DATA ACQUISITION AND PROGRAMMING
Plug-in-data acquisition and Control Boards, - Data acquisition using GPIB and Serial Interfaces and Programming in C - DSP in Medical applications

UNIT V CAD IN MEDCAL INSTRUMENTATION

TOTAL :45 PERIODS

OUTCOMES:
- Exposed to PC hardware as well as various microprocessor family
- Hardware behind data acquisition
- Scope of virtual reality in health care
- Develop an insight knowledge about the biometrics and network security

REFERENCES:

MX5092 BIO MEMS 3 0 0 3

OBJECTIVES:
To understand
- Various MEMS fabrication techniques.
- Different types of sensors and actuators and their principles of operation at the micro scale level.
- Application of MEMS in different field of medicine.

UNIT I MEMS AND MICROSYSTEMS
Typical MEMs and Microsystems, materials for MEMS - active substrate materials- Silicon and its compounds, Silicon piezoresistors, Gallium Arsenide, quartz, polymers. Micromachining-photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA
UNIT II MECHANICAL AND THERMAL SENSORS AND ACTUATORS
Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermomechanics, fracture and thin film mechanics. Mechanical sensors and actuators – beam and cantilever – microplates, strain, pressure and flow measurements. Thermal sensors and actuators- actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flow sensor

UNIT III ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATORS
Parallel plate capacitor, pull in effect, Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Properties of piezoelectric materials, Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.

UNIT IV MICROFLUIDIC SYSTEMS
Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in microconduits, in submicrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, dielectrophoresis, microfluid dispenser, microneedle, micropumps-continuous flow system, micromixers

UNIT V APPLICATION OF BIO MEMS
CAD for MEMS, Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR), DNA hybridization, Electronic nose, Bio chip.

TOTAL: 45 PERIODS

OUTCOMES:
Students will be able to
- Understand the operation of different types of sensors and actuators at microscale level
- Understand the design issues at microscale level
- Choose the material for any application
- Apply the concepts to the design of different types of micro systems
- Apply the knowledge of CAD tools for MEMS design

REFERENCES:
2. Ellis Meng, —Biomedical Microsystemsll, CRC Press,Boca Raton, FL, 2011.
OBJECTIVES:
The students should be made to:
- Understand the concepts of finite element methods for biomechanical analysis
- Study beam elements and scalar problem in 2d
- Understand applications to field problems

UNIT I  GENERAL INTRODUCTION

UNIT II  BEAM ELEMENTS AND SCALAR PROBLEM IN 2D

UNIT III  APPLICATIONS TO FIELD PROBLEMS

UNIT IV  ISOPARAMETRIC FORMULATION AND MISCELLANEOUS TOPICS
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
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.

OUTCOMES:
At the end of this course, the students should be able to:
- Explain isoparametric formulation
- Discuss isoparametric elements
- Critique finite element analysis in biomechanical research
REFERENCES:

BM5094 BIOMEDICAL OPTICS L T P C
3 0 0 3

OBJECTIVES:
The objectives of this course are
- To provide a possibility for the student to acquire knowledge about the physical properties of light and its impact and interaction with biological tissue in terms of optical properties, instrumentation in photonics, through the use and design of appropriate optical components
- To understand the engineering and practical applications of optics related to diagnostics, sensing and therapeutics of the human body.

UNIT I OPTICAL PROPERTIES OF THE TISSUES 9
Refraction, Scattering, absorption, light transport inside the tissue, tissue properties, Light interaction with tissues, opto-thermal interaction, fluorescence.

UNIT II INSTRUMENTATION IN PHOTONICS 9
Instrumentation for absorption, scattering and emission measurements, excitation light sources – high pressure arc lamp, solid state LEDs, Lasers, optical filters, solid state detectors – optical detectors - time resolved and phase resolved detectors.

UNIT III SURGICAL APPLICATIONS OF LASERS 9
Laser in tissue welding, lasers in dermatology, lasers in ophthalmology, otolaryngology, Urology, Lasers in Neurosurgery, Laser Treatment of Breast Tumors, Therapeutic Applications of Lasers in Gastroenterology.

UNIT IV DIAGNOSTIC APPLICATIONS 9
Optical coherence tomography, Elastography, Fluorescence Imaging, Raman Imaging, FLIM, X-Ray Diagnostic Techniques, Speckle Correlometry, Near-Field Imaging in Biological and Biomedical Applications

UNIT V THERAPEUTIC APPLICATIONS 9
Phototherapy, Photodynamic therapy (PDT) - Principle and mechanism - Oncological and non-oncological applications of PDT - Biostimulation effect – applications.

TOTAL: 45 PERIODS

OUTCOME:
Able to know the various optical properties of tissue as well as application of lasers in medical fields

REFERENCES:
OBJECTIVES:
- To learn the theory and implementation of neural networks
- To introduce neural computing as an alternative knowledge acquisition/representation paradigm,
- To explain its basic principles and their relationship to neurobiological models,
- To describe a range of neural computing techniques and their application areas.

UNIT I  BASIC CONCEPTS OF NEURAL COMPUTING
Biological Neurons and their Artificial models, Models of artificial Neural Networks, Learning and Adaptation, Neural Network Learning Rules, Single Layer Perceptron Classifiers.

UNIT II  BPN AND BAM

UNIT III  OTHER NEURAL NETWORKS

UNIT IV  GENETIC ALGORITHMS & IMPLEMENTATION TECHNIQUES

UNIT V  ADVANCES AND APPLICATIONS

TOTAL: 45 PERIODS

OUTCOMES:
- Able to demonstrate an understanding of the principles of Neural Networks and a knowledge of their main areas of application;
- Ability to design, implement and analyse the behaviour of simple neural networks.
- Ability to use a neural network to solve real-world problems.

REFERENCES:
OBJECTIVES:
The students should be made to:
- Study the sterilization methods
- Understand the importance of disposal of waste
- Learn the controls applied to waste management

UNIT I INTRODUCTION
Introduction, definition of general and hazardous health care waste and diseases, Infectious waste, genotoxic waste, waste sharps, biomedical waste categories categorization and composition of Biomedical waste

UNIT II PRINCIPLES OF STERILIZATION
Disease Transmission - Disinfection methods – Sterilization - steam sterilizing (Auto claving) - Microwave (Non-burn treatment technology). Mechanical Treatment & Chemical Disinfections

UNIT III DISPOSAL OF WASTE
Disposal methods - Incinerator - Hazardous waste, radioactive waste, liquid waste destruction - landfill.

UNIT IV CONTROLS APPLIED TO WASTE MANAGEMENT
Environmental pollution, its causes, consequences, mitigation and remedies. Emission control, Instrumentation and monitoring, Crematories

UNIT V ENVIRONMENTAL SAFETY, RISKS & PUBLIC ISSUES.

OUTCOMES:
At the end of this course, the students should be able to:
- Explain Disposal methods
- Discuss health care waste management
- Explain environmental pollution

REFERENCES:
OBJECTIVES:
- To provide basic knowledge on the concept of Healthcare Quality management towards continuous improvement of patient care.
- To make the students aware of the role of biomedical engineer in hospitals, especially in the management of electrical supply, maintenance of electrical safety.

UNIT I  STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS
Define Quality- Need for Standardization & Quality Management, TQM in Health care organization- Quality assurance methods, QA in (Medical Imaging & Nuclear medicine) Diagnostic services — Classification of equipments

UNIT II  REGULATORY REQUIREMENT FOR HEALTH CARE
FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, Other regulatory Codes.

UNIT III  HOSPITAL SAFETY
Security & Safety of Hospital - Property, Staff & Patients, Radiation safety, Safety precautions, hazardous effects of radiation, allowed levels of radiation, ICRP regulations for radiation safety, Disposal of Biological waste.

UNIT IV  ELECTRICAL & FIRE SAFETY
Sources of shocks, macro & micro shocks - Hazards, monitoring and interrupting the Operation from leakage current- Elements of fire, causes of fire, Action to be taken in case of fire in a Hospital.

UNIT V  ASSESSING QUALITY HEALTH CARE
Patient Safety Organization- Governmental & Independent, Measuring Quality care – Evaluation of hospital services – six sigma way, Quality Assurance in Hospitals Sop’s – Patient Orientation for Total Patient Satisfaction. 5S techniques

TOTAL: 45 PERIODS

OUTCOMES:
The purpose of this course is to help students to develop knowledge and insight into the procedures used in quality control and assurance activities as well as safety measures to be followed in hospitals.

REFERENCES:
1. B.M.Sakharkar, Principles of Hospital administration and Planning, JAYPEE Brothers, Medical Publishers (P) Ltd.
6. Sharon Myers “Patient Safety & Hospital Accreditation - A Model for Ensuring Success” Springer Publishers 2012
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

UNIT II TRANSFER FUNCTION

UNIT III PERIODIC SIGNALS
Sinusoidal Functions, Sinusoidal Analysis of Instrumentation System, Evaluation of Transfer Functions from Frequency Response, Relationship between Phase Lag and Time Delay Transient Response of an Undamped Second Order system, General Description of Natural Frequency Damping, Physical Significance of Under Damped Responses.

UNIT IV FEEDBACK

UNIT V SIMULATION OF BIOLOGICAL SYSTEMS
Simulation of Skeletal muscle servomechanism, thermo Regulation, cardiovascular control System, Respiration controls, Occulo Motor System, Endocrine control system and Modeling of receptors.

OUTCOMES:
The student will have knowledge in the analysis of any physiological systems through the models

REFERENCES:
OBJECTIVES:
- To introduce the fundamentals concepts of wavelet transforms.
- To study system design using Wavelets
- To learn the different wavelet families & their applications.

UNIT I INTRODUCTION TO WAVELETS
9
Introduction to Multiirate signal processing- Decimation and Interpolation, Quadrature Mirror Filters, Subband coding, Limitations of Fourier transform, Short time Fourier transform and its drawbacks, Continuous Wavelet transform, Time frequency representation, Wavelet System and its characteristics, Orthogonal and Orthonormal functions and function space

UNIT II MULTiresOLUTION CONCEPT AND DISCRETE WAVELET TRANSFORM
9
Multiresolution formulation of wavelet systems- signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter banks-Analysis and Synthesis, 1D and 2D Discrete wavelet transform, Wavelet Packets, Tree structured filter bank, Multichannel filter bank, Undecimated wavelet transform.

UNIT III WAVELET SYSTEM DESIGN
9
Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, Design of Daubechies orthogonal wavelet system coefficients, Design of Coiflet and Symlet wavelets.

UNIT IV WAVELET FAMILIES
9

UNIT V WAVELET APPLICATIONS
9
Denoising of Signals and Images, Image enhancement, Edge detection, Image Fusion, Image compression, Wavelet based feature extraction, Analysis of phonocardiogram signals, Analysis of EEG signals, Speech enhancement for hearing aids

TOTAL: 45 PERIODES

OUTCOME:
The students will be able to apprehend the detailed knowledge about the Wavelet transforms & its applications.

REFERENCES:
OBJECTIVES:
- To understand the basic principles of Wearable Physiological Monitoring Systems
- To Study various types of wearable systems
- To Learn to design sensors/electrodes for recording various vital parameters
- To Learn to design a wearable computer & Wireless Body Area Networks

UNIT I INTRODUCTION

UNIT II SMART SENSORS & VITAL PARAMETERS
Vital parameters monitored and their significances, Bio-potential signal recordings (ECG, EEG, EMG), Dry Electrodes design and fabrication methods, Smart Sensors – textile electrodes, polymer electrodes, non-contact electrodes, MEMS and Nano Electrode Arrays, Cuff-less Blood Pressure Measurement, PPG, Galvanic Skin Response (GSR), Body Temperature Measurements, Activity Monitoring for Energy Expenditure, Respiratory parameters.

UNIT III TECHNOLOGIES USED FOR A WEARABLE DEVICE
Students will comprehend the functions and very basic principles of different sensors, micro-motors and communication channels that are used in wearable devices. These include accelerometers, optical sensor, GPS, various input methods, Power Requirements, Wearable Systems Packaging, Batteries and charging, Wireless Communication Technologies and Protocols, Receiver Systems (Redrafting may be needed)

UNIT IV WIRELESS BODY AREA NETOWRKS

UNIT V DATA PROCESSING AND VALIDATION
Classification Algorithms, Data Mining and Data Fusion, Signal Processing Algorithms in wearable Applications, Issues of wearable physiological monitoring systems, Statistical Validation of Parameters, Certifications of Medical Devices and Patenting.

OUTCOMES:
At the end of the course, students should be able to:
- Explain the basics of wearable system
- Use smart sensors to monitor vital parameters
- Design wireless body area networks
- Apply classification algorithms
REFERENCES:
5. Kate Hartman, Make: Wearable Electronics: Design, Prototype and wear your own interactive garments, Maker Media
Then the master’s in Biomedical Engineering is the programme you’re looking for! This multidisciplinary programme does not exclusively train students to find merely technological answers to technical questions, but calls for biomedically engineered solutions that are in balance with economical and ethical considerations, as well. Study credits. Consultancy in a wide range of functions, from product design to safety regulations. Notified bodies, Regulatory Affairs Managers, screening new products for a CE-mark, patent offices... 3. Having successfully completed programme units in higher education with a minimum of 54 ECTS-credits where English was the language of instruction. Enrolling in this programme. The Master’s in Biomedical Engineering is a two-year programme comprising 120 credits. The programme is taught entirely in English and leads to a Master of Science (MSc) degree. You can start each year in September and February. What is Biomedical Engineering? Biomedical engineers create technical solutions to medical problems by integrating scientific and engineering concepts and methodology. Technology plays an important role in prevention, diagnosis, therapy and rehabilitation. Biomedical research leads to new techniques for repairing damaged tissue, such as bone and skin. The programme includes an internship and culminates in a thesis based on a research project. The general curriculum is as follows: 30 credits of compulsory courses by specialization.