With effect from Academic Year 2017-18

SCHEME OF INSTRUCTION AND EXAMINATION
M.E. (BME) with specialization in Biomedical Electronics

I YEAR: SEMESTER I

<table>
<thead>
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<th>S.No.</th>
<th>Subject</th>
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<th>Scheme of Examination</th>
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I YEAR: SEMESTER II

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SCHEME OF INSTRUCTION AND EXAMINATION

M.E. (BME) with specialization in Biomedical Electronics

II YEAR: SEMESTER III

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* Minimum of two presentations to be given by the student. The supervisor will evaluate for 50 marks and the committee consisting of the Head, Chairperson, BOS and one expert will evaluate for 50 marks.

II YEAR: SEMESTER IV

| 1.   | Dissertation                    | --                                     | 6                     | Viva voce | Grade** | --     |

** Excellent/Very Good/Good/Satisfactory/Unsatisfactory
# LIST OF SUBJECTS FOR M.E. (BME) WITH SPECIALIZATION IN BIOMEDICAL ELECTRONICS

<table>
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<tr>
<th>S.No.</th>
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<td>Medical Sensors</td>
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<td>2</td>
<td>BME 502</td>
<td>Medi Embedded Systems</td>
<td>3</td>
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<td>3</td>
<td>BME 503</td>
<td>Electronic System Design</td>
<td>3</td>
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<td>4</td>
<td>BME 504</td>
<td>Diagnostic And Therapeutic Equipment</td>
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<td>5</td>
<td>BME 505</td>
<td>Advanced Biomedical Signal Processing</td>
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<td>Advanced Medical Imaging</td>
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R – Retained   M – Modified   A – Added Syllabus
BME 501 MEDICAL SENSORS

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 70 Marks
Sessionals 30 Marks

OBJECTIVES:
1. Design and implement instrumentation systems using Lab view.
2. Analyse instrumentation and sensing requirements through knowledge application.

OUTCOMES:
By the end of the course the student will be able to
1. Conceptualize and design instrumentation methods for complex medical systems through synthesis of information and instrumentation system modelling.
2. Generate instrumentation solutions through application of sensing principles and signal processing techniques.
3. Approach complex instrumentation problems through application of emerging sensing technologies and industrial and sensor network.

UNIT-I
Principles of transduction and measurement, Sensor Classification, Medically significant measurands-strain, force, pressure, acceleration, flow, volume, temperature and biopotentials. Functional specifications of medical sensors; static and dynamic characteristics of measurement systems. Primary sensors.

UNIT – II

UNIT-III
Reaction variation and electromagnetic sensors. Capacitive sensors, inductive sensors, LVDT, electromagnetic sensors. Signal conditioning, AC bridges, AC amplifiers, electrostatic shields, carrier amplifiers, phase-sensitive detectors, Medical Applications.

UNIT-IV

UNIT-V
Other sensors: Accelerometer transducers, Gyroscopes, Ph sensors, measurement of Conductivity, viscosity, conductivity, Humidity, signal conditioning and Medical Applications.

Suggested Reading:
BME 502  MEDI-EMBEDDED SYSTEMS

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 70 Marks
Sessionals 30 Marks

OBJECTIVES:
✓ To know the basic concepts of embedded systems.
✓ To know the concepts of Device drivers and Memory management.

OUTCOMES:
On completion of course student will have ability
✓ To design a system for real time processing
✓ To program different embedded systems for medical applications
✓ To apply formal design methodology to optimize various embedded electronic systems for medical applications

UNIT-I
Introduction to Embedded Systems, Examples of embedded system, their characteristics and their typical hardware components, Processor and Memory organization Structural Units in a processor, classification of embedded system, skills required for embedded system designer, Memory devices, Memory selection for an embedded system, Allocation of Memory to program segments and blocks and memory map of a system, Direct Memory access, Interfacing processor, memories and I/O devices.

UNIT-II
I/O devices, Timer and counting devices, Serial Communication devices using the ‘I2C’, ‘CAN’ and Advanced I/O Buses between the networked multiple Devices, host system or computer parallel communication between the networked I/O devices and advanced buses. Device drivers, Parallel port device drivers in a system, serial port device Drivers in a system, device drivers for internal programmable timing devices, interrupt servicing (handling) mechanism, Deadline and Interrupt Latency.

UNIT-III
Concepts of RTOS, I/O subsystems, network operating systems, real time and embedded operating systems, interrupt routines in RTOS, task scheduling models, multitasking, shared data problems, inter-process communication, starvation and dead lock.

UNIT-IV

UNIT-V

Suggested Reading:
BM 503  ELECTRONIC SYSTEM DESIGN

Instruction  3 Periods per week
Duration of University Examination  3 Hours
University Examination  70 Marks
Sessionals  30 Marks

OBJECTIVES:
✓ To learn Analog and digital circuit design of circuits for biomedical applications.
✓ To learn the noise reduction techniques in medical equipment.

OUTCOMES:
✓ Apply fundamental knowledge of Electronic Design principles for product designing.
✓ Understand various Design rules in amplifier, power supply and filter designs.
✓ Analyze noise and its removed techniques.
✓ Use of latest controllers in product designing.

UNIT-I
Analog and digital circuit design of circuits for biomedical applications using operational amplifiers, active filters, data acquisition, conversion, and interface to microcomputers. Patient safety, patient isolation circuits. Operating principles of various types of patient isolation circuitry. Most suitable isolation circuit for a given application. Test isolation circuits.

UNIT-II
Data acquisition, Sample and Hold Conversion, Multi Channel acquisition, High speed sampling in ADC, Selection of drive amplifier for ADC performance, Gain setting and level shifting, ADC input protection, Multichannel channel applications for data acquisition systems, External protection of amplifiers, High speed ADC architectures.

UNIT-III
Interference and noise reduction techniques. Types of noise-Thermal noise, shot noise, excess noise, Burst, Internal noise in OPAMPs, Noise issues in high speed applications, Causes of noise and interference encountered in medical equipment. Manifestation of noise or interference. Techniques for minimizing the impact of noise or interference when using various types of medical equipment.

UNIT-IV
Hardware approach to digital signal processing, Coherent and non-coherent sampling, Digital signal processing techniques, FFT hardware implementation system – DSP hardware, ALU, Multipliers, accumulators, data address generators, serial ports, system interfacing ADC’s and DAC’s to DSPs. Interfacing IO ports to DSPs, DSP based cochlear implants.

UNIT-V
Use of telemetry in a medical environment. Available frequency bands and licensing requirements for RF telemetry environments. Typical telemetry methods used in medical applications. Common problems with telemetry installations.
Battery management procedures. Types of batteries used in medical equipment. Typical shelf life of common batteries. Applications for common batteries. Techniques to improve life of batteries. Test equipment for correct function after battery replacement.

Suggested Reading:
BME 504  DIAGNOSTIC AND THERAPEUTIC EQUIPMENT

Instruction  3  Periods per week
Duration of University Examination  3  Hours
University Examination  70 Marks
Sessionals  30 Marks

OBJECTIVES:
✓ To know about the basic medical equipment.
✓ Understanding the basic principles of Diagnostic and Therapeutic equipment.

OUTCOMES:
✓ Analyze different equipment to grasp the basic principles.
✓ Examine different equipment that are encountered in Medical fields.

UNIT – I Cardiac Life support Equipment
Cardiac Pacemakers - Need for Cardiac Pacemaker, Principle of operation, Classification of pacemakers, Cardiac Defibrillators -Need for a Defibrillator – Types of Defibrillator - Defibrillator analyzer. Cardiac Valves, different types Mechanical and Tissue types. Angioplasty. Balloon and Stent Angioplasty, Stents, different types – coil, slotted tubular, drug eluting stents

UNIT-II Anesthesia Machine and Respiratory Care Equipment
Need for Anesthesia – Anesthesia machine - Electronics in Anesthesia machine.
Ventilators - Need for a Ventilators, Classification of Ventilators, High frequency ventilators, Humidifiers, Nebulizers and Aspirators, Heart Lung machine. Sterilization techniques: Autoclave, Gas, Dry Heat, Radiation, Dry Steam sterilization

UNIT – III ICU & Life Support Equipment

UNIT – IV Haemodialyzers and Lithotripters
Haemodialyzers - Artificial Kidney, Dialyzers, principle of dialyzers, Membranes of the haemodialyzers, Types of Dialysis and merits and demerits.
Lithotripters - need of lithotripsy, types of lithotripter systems, techniques, applications and limitations. Endoscopy, Laparoscopy, Keyhole surgery

UNIT – V Diathermy and Radiotherapy
Clinical applications of electrotherapy, principle of surgical diathermy, surgical diathermy machine, safety aspects in Electro-Surgical diathermy Unit, short wave diathermy, ultrasonic diathermy, microwave diathermy, Pain relief through Electrical Stimulation Principles of Cryogenic technique and application,

Suggested Reading:
BME 505  ADVANCED BIOMEDICAL SIGNAL PROCESSING

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 70 Marks
Sessionals 30 Marks

OBJECTIVES:
✓ Demonstrate a systematic knowledge of the complex physical and physiological principles that underpin the measurement of biomedical signals.
✓ Have an advanced understanding of the principles of digital signal processing.

OUTCOMES:
By the end of the course the student will be able to
✓ Systematically apply advanced methods to extract relevant information from biomedical signal measurements.
✓ Assess the appropriateness of cutting-edge biomedical signal processing techniques for various problems in the field.
✓ Evaluate the effectiveness of techniques applied to biomedical signals against specific benchmarks.

UNIT-I Fundamentals of Discrete-Time signals and systems

UNIT-II Wavelets and applications

UNIT-III Cardiac signal processing (ECG)
ECG characteristics, sources of Noise (Baseline Wander, Power line interference, Muscle Noise Filtering and Artifacts), Preprocessing techniques, QRS Detection techniques, Wave Delineation, Data Compression, Heart Rate Variability, Spectral Analysis of Heart Rate Variability, Adaptive Noise cancellation, and applications.

UNIT-IV Neuro Muscular signal processing (EEG & EMG)
Characteristics of EEG and EMG, Evoked Potential Modalities Sources of Noise and artifacts in EEG recording, Preprocessing techniques, Noise reduction by Ensemble Averaging and Linear Filtering, Linear prediction theory, Auto regressive method, levinson algorithm, Model based analysis of EEG, EEG segmentation, Joint Time-Frequency Analysis. Spectral analysis, Modeling the EMG, Amplitude Estimation in the surface EMG, Spectral Analysis of the surface EMG.
Unit-V. ICA & PCA applications.
Geometry of mixing and unmixing, methods for blind source separation, Gaussian distribution, probability density function, mean, covariance, kurtosis, negentropy, and applications of ICA, including voice mixtures, EEG, fMRI, and fetal heart monitoring. PCA and applications, EMD process and applications.

Suggested Reading:
BME 506  ADVANCED MEDICAL IMAGING

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OBJECTIVES:
- To learn physical principles of Imaging Techniques and applications.
- To learn the protocol of procedures for different equipment.

OUTCOMES:
- Students will develop comprehensive knowledge of range of AMI systems and their relative Merits and advantages.
- To learn the complete working of MRI scanner.

UNIT-I
X ray Imaging: Introduction to Electromagnetic spectrum and their properties, Production of X-rays-X-ray tubes-Insert housing, filtration, grid, and collimation, -X-ray generator circuit design - Image production. Computed radiography Charge coupled device flat panel detectors - Direct and Indirect detection. Fluoroscopy - Chain components - peripheral equipment - Flat panel digital fluoroscopy

UNIT-II

UNIT-III
Magnetic Resonance Imaging: Introduction - principles of MRI - MRI instrumentation, magnets - gradient system - RF coils and receiver system. Relaxation processes, pulse sequence, image acquisition and reconstruction techniques, Image acquisition in magnetic resonance imaging - T1, T2, proton density weighted images, Artifacts in imaging Various types of pulse sequences for fast acquisition of imaging. Functional MRI - The BOLD effect - intra - and extra vascular field offsets, source of T2* effects, Creating BOLD contrast sequence optimization Sources and dependences of physiological noise in FMRI.

UNIT-IV
Ultrasound Scanner: Physics of ultrasound - Principles of image formation - Capture and display, Basic Ultrasound instrumentation, Imaging techniques and their modes of operation (A mode, B Mode, 2B, B/M, 4B , Gated Mode, 3D, 4D, M-Mode, Echocardiography).Design
of scan converters, Design of frame grabbers. High line and low line monitoring of ultrasound displays, Doppler Ultra sound and Color flow mapping of scan conversion (real time imaging) - image processing, Image artifact, Biological effects and Application in medicine.

UNIT-V

Nuclear Medicine - Radionuclide production - radiopharmaceuticals - Mechanism of localization - Physics of Gamma camera, basic Instrumentation, Anger scintillation camera - Design principles of operation - Image formation. Emission Tomography imaging - SPECT - Image acquisition and reconstruction - PET - Design and principles of operation - Two and three dimensional data acquisition - comparison of SPECT, PET and combined PET/ X-ray CT.

Suggested Reading:
BME 551-1

TRANSDUCER & BIOSENSORS LAB

Instruction 3 Periods per week
Sessionals 50 Marks

1. Experiments on Electrodes- ECG, EEG, EMG

2. Study/Design/Fabrication and testing of:
   (i) ECG system
   (ii) EEG system
   (iii) EMG system
   (iv) GSR system

3. Signal conditioners for the following transducers:
   (i) Piezoelectric transducers
   (ii) Thermocouple
   (iii) Phonocardiography transducer
   (iv) Strain gauge
   (v) LVDT
   (vi) Plethysmographic transducer
   (vii) Capacitive transducer
   (viii) Electromagnetic flow transducer
   (ix) Optical transducer
BM 552-2

EMBEDDED SYSTEMS LAB

Instruction 3 Periods per week
Sessionals 50 Marks

1. Study of different microcontroller development systems
2. Digital interfaces
3. Analog interfaces
4. Keyboard interface
5. LCD Display: Alphanumeric mode
6. LCD Display: Graphic mode
7. PC interface: RS 232
8. PC interface: Ethernet
9. PC –Wireless LAN
10. EZPic Motherboard based experiments: Pic 18 F 452

Note:
The experiments to be conducted under this lab should include design/fabrication/ evaluation/technical reporting/case-studies/mini projects. The students should be encouraged to take up different challenging mini projects in this lab.
ELECTIVE SUBJECTS

BME 511

PHYSIOLOGY FOR ENGINEERS
(Compulsory to students with EEE, E&EI & ECE back grounds)

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 70 Marks
Sessionals 30 Marks

UNIT – I

UNIT – II

UNIT – III

UNIT – IV

UNIT – V

Suggested Reading:
2. Mount castle Textbook of medical physiology Better World Books, IN, USA
3. Walter F. Boron, Textbook of medical physiology, W.B. Saunders Company
4. Zipes, Jalife, Cardiac Electrophysiology ,
5. Eric R. Kandel, Principles of Neural Science, Elsevier science division
6. un Kimura, Electrodiagnosis in diseases of nerve and muscle, W.B. Saunders Company.
BM 512

BIOINFORMATICS

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OBJECTIVES:

✓ To give students an introduction to the basic techniques of bioinformatics.
✓ Emphasis will be given to the application of bioinformatics and biological databases to problem solving in real research problems.

OUTCOMES:

✓ The students will be able to describe the contents and properties of the most important bioinformatics databases, perform text- and sequence-based searches, and analyze and discuss the results in light of molecular biological knowledge
✓ The students will be able to explain the major steps in pairwise and multiple sequence alignment, explain the principle for, and execute pairwise sequence alignment by dynamic programming.
✓ The students will be able to predict the secondary and tertiary structures of protein sequences.

UNIT I

UNIT II
Algorithms: Algorithms and complexity, Biological algorithms, computer algorithms, The change problem, Correct, incorrect algorithms, Recursive algorithms, Iterative, recursive algorithms, Fast and slow algorithms, Big-O notation, Algorithm designing techniques- Exhaustive search, Branch-and-bound algorithms, Dynamic programming, Divide-and-conquer algorithms, Randomized algorithms, Gibbs sampling.

UNIT III
Computer algorithms for prediction of protein structures. DNA Sequence Comparison, Algorithms for alignment of sequences and structures of proteins and protein families, PAM, BLOSUM, Bayesian modeling and networks, Probabilistic models or Hidden Markov models, Needleman Wunch and Smith Waterman algorithms, Global sequence alignment, Scoring alignments, Local sequence alignment, Alignment with gap penalties. Multiple alignment, Gene prediction-Statistical and Similarity-based approaches. Spliced alignment.

UNIT IV
Genetic algorithms: Genetic algorithms for the prediction of multiple sequence alignment, Gene expression analysis, Hierarchical clustering, K-Means clustering, clustering and corrupted cliques. Evolutionary trees- Distance-based tree reconstruction, Reconstructing trees from additive matrices, Evolutionary trees and hierarchical clustering. Character-based tree reconstruction- Small parsimony problem, large parsimony problem.
UNIT V

Suggested Reading:
BME 513

MEDICAL INFORMATICS

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 70 Marks
Sessionals 30 Marks

UNIT-I:
Planning and designing of Hospital systems: Financial aspects, Equipment, Building, Organization of the Hospital, various medical services in a Hospital,
BME services and technical aspects: pole and responsibilities. Layout, Setting and Functions of Biomedical Engineering Department in a Hospital.
Biomedical Equipment Management: Procurement process, Training to Medical staff on technical capabilities, Biomedical Equipment maintenance procedures.

UNIT-II:
Database Management (DBMS): Introduction to Data structures, Elements, Arrays, Records, Sets, Tables, Singly and Doubly linked Data, Stacks, Queues and Trees, Need for a Database, Architecture of DBMS. Representation of Data, Physical Record Interface, Data models, Relational, Hierarchical and Network approach.

UNIT-III:
Operators: Relational, Logical and Boolean.

UNIT-IV:
Computerized Patient Database Management: Methods of History taking by Computers, Computerized Medical Record: Evaluation
Computers in Clinical laboratory: Database approach to Laboratory computerization/automation.

UNIT-V:
Practice: Case studies- Emergency handling systems, insurance handling, data analysis, IVRS applications, Telemedicine, Equipment maintenance management.

Suggested Reading:
BME 514

MEDICAL INSTRUMENTATION
(Compulsory to EEE & ECE backgrounds)

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 70 Marks
Sessionals 30 Marks

UNIT – I
Origin of biopotentials – ECG, EEG, EMG, EOG, ENG, ERG, EGG.

UNIT – II
Medical display devices and recorders. Basic requirements for the display and recording of biopotential signals. PMMC writing systems, General features of ink-jet, thermo-sensitive and optical recorders, Oscilloscopes- Medical, multi-beam & non-fade display systems.

UNIT – III

UNIT – IV
ECG: Block diagram & circuits, electrode placement, lead configuration, Types of ECG recorders.
Blood pressure measurement: Direct and indirect methods.
Blood flow measurement: Electromagnetic & Ultrasonic techniques.
Heart sounds: Origin, Phonocardiography.

UNIT – V
EEG- Block diagram & circuits, electrode placement, Evoked potentials and their measurement.
EMG-Block diagram & circuits, electrode placement, Nerve conduction velocity determination, EMG stimulators.

Suggested Reading:

BME 515

ADVANCED BIOMATERIALS

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 70 Marks
Sessionals 30 Marks

UNIT – I

UNIT – II
Biocompatibility and Tissue response: Biocompatibility Hierarchy- Ramifications in Implant Design and Applications. Host Reactions to particulate Biomaterials: Type of Reactions, Particle Surface; cell Surface and Signaling Mechanism, Chemical Mediators.

UNIT – III

UNIT – IV
Physiochemical Characterization of surface and interface on biomaterials and coatings,

UNIT – V
Applications of materials in medicine and Dentistry: Cardiovascular Applications, Dental Implants, Orthopedic Applications. Drug Delivery Systems, Sutures, Ophthalmologic Applications,

Suggested Reading:

UNIT- I

UNIT- II
Heat transfer systems. Modes of heat transfer, conduction, convection and radiation. Heat production, heat loss to the environment, role of blood circulation in internal heat transfer, models for heat transfer within the body.

UNIT- III

UNIT- IV

UNIT- V
Compartmental models. Approaches to pharmacokinetic modeling and drug delivery, one and two compartmental models. Physiological applications-intravenous injection, constant intravenous infusion, determination of regional blood flow volumes and blood flow rates.

Suggested Reading:
BME 517

HOSPITAL ADMINISTRATION & MANAGEMENT

Instruction: 3 Periods per week
Duration of University Examination: 3 Hours
University Examination: 70 Marks
Sessionals: 30 Marks

OBJECTIVES:
✓ To know the Information management in Hospitals.
✓ To learn the Equipment Maintenance Management

OUTCOMES:
Students will be equipped with
✓ Knowledge and skills necessary to competently manage a health care facility.
✓ Roles and Responsibilities of various departments present in the hospital.
✓ Skills required for Maintains the Biomedical Equipment.

UNIT – I

UNIT – II

UNIT – III

UNIT – IV

UNIT – V

Suggested Reading:

BME 518

PHYSIOLOGICAL CONTROL SYSTEMS

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OBJECTIVES:
- To study system concept and different mathematical techniques applied in analyzing any given system.
- To learn to do the analysis of given system in time domain and frequency domain.
- To develop an understanding of the fundamental principles behind control of various biological systems.
- To apply these analysis to study the biological systems.

STUDENT LEARNING OUTCOMES:
- Analyze the concepts that are generally useful in all other engineering disciplines.
- Apply quantitative approaches for the analysis of physiological system.
- Ability to create simple models of physiological systems.
- Ability to understand complex physiological models.

UNIT-I
Physiological Systems with feedback, modeling of physiological systems, model based noise reduction and feature extraction. Physiological control systems analysis. Differences between engineering and physiological control systems, Mathematical modeling, linear models of physiological systems, distributed parameter and lumped parameter models

UNIT-II
Static analysis of physiological systems, Determination of steady state operating point, Steady state analysis, Regulation of cardiac output, Chemical regulation of ventilation. Time domain analysis of linear control systems. Transient response analysis- dynamics of neuromuscular reflex motion. Frequency domain analysis of linear control systems, frequency response of circulatory control and glucose insulin regulation.

UNIT-III

UNIT-IV
Modeling the nerve action potential, voltage clamp experiment and its interpretation, model for the strength duration curve, modeling skeletal muscle contraction, cross bridge theory of muscle contraction, linear model of muscle contraction, applications of skeletal muscle contraction, modeling myoelectric activity

UNIT-V

Suggested Reading:

BME 519

**ELECTROMAGNETIC BIOINTERACTION**

- **Instruction**: 3 Periods per week
- **Duration of University Examination**: 3 Hours
- **University Examination**: 70 Marks
- **Sessionals**: 30 Marks

**UNIT-I**
Electromagnetic Spectrum, Exposure and absorption parameters, International guidelines, Currents induced in standing human being for vertically polarized plane wave exposure conditions, contacts hazards in VLF to HF band, thermal implications of high SARs. Coupling of human body to RF magnetic fields, Radio Frequency protection guide (RFPG).

**UNIT-II**

**UNIT-III**
Role of Experimental Techniques and Instrumentation in bioelectromagnetics: Irradiation systems for bioeffects experiments, Far-field exposure techniques, Instrumentation, Measurements of internal fields and radiofrequency absorption in biological systems, Instruments for measuring Specific Absorption Rates.

**UNIT-IV**
EM energy absorption in human and animals: Measurement techniques, Free space irradiation conditions, Ground effects, SAR exposure assessment and safety guidelines. Biological effects and Health implications: Effects due to extremely LF and 60 Hz fields.

**UNIT-V**
Biological effects of millimeter wave radiation: Experimental approaches, frequency specific effects, genetic systems, cellular and sub cellular effects. Electromagnetic methods for medical applications.

**Suggested Reading:**
BME 520

BIOSTATISTICS

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 70 Marks
Sessionals 30 Marks

OBJECTIVES:
- To introduce basic statistical methods like curve fitting, correlation and regression.
- To provide the knowledge of probability distributions like normal, Poisson and tests of significance.

OUTCOMES:
At the end of the course students will be able
- To apply various probability distributions to solve practical problems, to estimate unknown parameters of populations and apply the tests of hypotheses.
- To Perform regression analysis and to compute and interpret the coefficient of correlation

UNIT- I
Concepts of Biostatistics. Basic statistical measures, measures of central tendency, measures of dispersion, variance, standard deviation, properties of probability, probability distributions, sampling distributions.

UNIT- II
Estimation and hypothesis testing, confidence intervals for data, t distribution, determination of sample size for estimating means and proportions. Hypothesis testing for a single population mean/proportion difference between two population means/proportions, sample size to control type I and type II errors.

UNIT- III
Analysis of variance. The completely randomized design, random sized complete block design, repeated measures design.

UNIT- IV
Regression and correlation. Simple linear regression model, regression equation, the correlation model, multiple linear regression model, multiple regression equation, multiple correlation model, additional techniques of regression analysis.

UNIT- V
Chi-square distribution, tests of good fit, independence, homogeneity, non-parametric statistical procedures, regression analysis.

Suggested Reading:
BME 521

**MEDICAL IMAGE PROCESSING**

**Instruction**
3 Periods per week  

**Duration of University Examination**
3 Hours  

**University Examination**
70 Marks  

**Sessionals**
30 Marks  

**OBJECTIVES:**  
✓ Have a clear understanding the principles of Digital Image processing machinery.  
✓ Learn and understand image enhancement in spatial and frequency domain.  

**OUTCOMES:**  
✓ Good understanding of the mathematical foundations for digital manipulation of images: image acquisition; preprocessing; segmentation.  
✓ Understand the image restoration, compression, systa, recognition, representation and dissertation.  

**UNIT-I**  
Digitized image functions, Dirac distributions, convolution, Fourier transform, Images as linear system. Image digitization, sampling, Quantization, color images. Digital image properties, Metric and topological properties, Histogram visual perception, Image quality, Noise. Data structures for image analysis, data representation, traditional and hierarchical data structures.  

**UNIT-II**  

**UNIT-III**  
Thresholding and Segmentation. Detection methods, optimal thresholding, multi-spectral thresholding. Edge based segmentation, Region based segmentation, Matching, Advanced optimal border and surface detection approaches.  

**UNIT-IV**  

**UNIT-V**  
Mathematical morphology. Basic morphological concepts, Morphological principles: Binary dilation and erosion, Gray scale dilation and erosion, skeletons and object marking, graundometry, Morphological segmentation and water sheds.  

**Suggested Reading:**  
BME 522

ENTERPRISE MANAGEMENT

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 70 Marks
Sessionals 30 Marks

UNIT-I
Indian Industrial Environment-Competence, Opportunities and Challenges, entrepreneurship and economics growth, Small Scale Industry in India, Objectives, Linkage among small, Medium and heavy Industries, Types and forms of enterprises.

UNIT-II
Identification and Characteristics of entrepreneurs, Emergence of First generation entrepreneurs, environmental influence and women Entrepreneurs, Conception and evaluation of ideas and their sources. Choice of Technology-Collaborative interaction for Technology development.

UNIT-III
Project formulation, analysis of market demand, demand - supply gap, Financial and Profitability analysis and technical analysis, project financing in India. Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques. Human aspects of project management, Assessment of tax burden.

UNIT-IV
Behavioral aspects of entrepreneurs: Personality - determinants, attributes and models, leadership concepts and models, values and attitudes, Motivation aspects, change behavior, Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix

UNIT-V

Suggested Reading:
BME 523

MEDICAL PRODUCT DESIGN

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OBJECTIVES:
- Understand the basic design rules in designing the Medical Products.
- To learn the Medical device directives.

OUTCOMES:
- To know the regulations and standards used in designing the Medical Products.
- Examine the various options that can be used in design a Medical Product.

UNIT-I

UNIT-II
Specifying and designing the product. Engineering requirements-design specification, risk management, intellectual property-patents, human factors, Hardware design-component selection, design of experiments, software design-object oriented design, software coding.

UNIT-III
Testing and data analysis. Basis and types of testing, hardware verification and validation-standard tests, software verification and validation, reliability evaluation, analysis of test results-failure rate, Mean Time Between Failures (MTBF).

UNIT-IV
Manufacturing and Maintenance process. Good manufacturing process (GMP), the GMP Regulation, Design for manufacturability, manufacturing process, Quality systems regulation, configuration management, Quality system audit, analysis of field data.

UNIT-V
Medical device regulations and standards. Food and Drug Administration, Medical device directives ISO 9001 series of standards, Domestic standards, International standards.

Suggested Reading:
BME 524

TISSUE ENGINEERING

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 70 Marks
Sessionals 30 Marks

UNIT – I
Growth and Differentiation, Organisation of cells into Higher ordered structures, Dynamics of cell-ECM interactions, Matrix molecules and Their ligands, Inductive Phenomena, Cell Determination and Differentiation, Mechanical and Chemical determination of Tissue Development, Animal Cell Culture, Regulations of cell Behaviours cellular proteins, Growth factors, Tissue Assembly in Micro Gravity, In vivo Synthesis of Tissues and Organs.

UNIT – II

UNIT – III
Approaches to transplanting Engineered cells and Tissues, Cryopreservation, Immunomodulation, Immunoisolation, Engineering challenges in immunoisolation, Fetal tissue Engineering, Pluri potent stem cells, Gene Therapy.

UNIT – IV

UNIT – V

Suggested Reading:
BME 525

BIO NANO TECHNOLOGY

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 70 Marks
Sessionals 30 Marks

OBJECTIVES:
✓ To impart the Basic knowledge by new technology.
✓ To learn MEMS fabrication technology.

OUTCOMES:
✓ To understand the different application of new technology in Medical domain.
✓ To know the factors and safety features while using new particles.

UNIT-I MEMS & NEMS:
Definition of MEMS, materials for MEMS (Silicon, Polymers and metals) and their properties, Deposition processes, Photolithography, and etching processes, Limitations of MEMS, NEMS, difference between MEMS and NEMS, properties of NMES, fabrication processes, applications.

UNIT-II Introduction to Nanotechnology:
Nanomaterials, Fullerenes and carbon forms. Nanoparticles and Colloids, structure and bonding in nanoparticles, Nanomaterials fabrication by Bottom-up and Top down approaches, Classification of nanodevices based on the characteristics, Quantum dots and their properties.

UNIT-III Carbon nanotubes:
Carbon nanoparticles, types of carbon nanotubes, single-walled, multi-walled, torus, nanobud, properties of carbon nanotubes, and synthesis by Arc discharge, laser ablation, chemical vapor deposition techniques

UNIT-IV Nanomedicine:

UNIT-V Bio molecular nanotechnology:
Nanorobots and their application, nanosensors based on biomolecules such as DNA and proteins, nanoparticles for gene delivery systems, Computational genes, Biosensors for Glucose and measurement, Optical biosensors and their application.

Suggested Books:
2. Neelina Malsch, Biomedical nanotechnology by CRC press release, Malsch TechnoValuation, Utrecht, The Netherlands
BME 526

MEDICAL OPTICS

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UNIT I Introduction to Optical Fibers
Basic optical laws and definitions, optical fiber modes and configuration, single mode fibers, graded index fiber structure, fiber materials, attenuation, signal distortion in optical waveguides, pulse broadening in graded index waveguides.

UNIT II Optical properties of tissues
Tissue properties – refractive indices, scattering and absorption properties, light transport inside the tissue, light interactions with a strongly scattering tissue – continuous wave light, short light pulses, diffused photon density waves, Temperature rise and tissue damage – optothermal and opt acoustic effects. Fluorescence speckles.

UNIT III Instrumentation in Photonics
Instrumentation for absorption, scattering and emission measurement, excitation light sources – high pressure arc lamp, solid state LEDs, LASERs, optical filters, polarizer’s, solid state detectors, time resolved and phase resolved detectors

UNIT IV Biophotonic Diagnostics
Near IR spectroscopy for biological glucose analysis, flowcytometry – basic operation, optical response – applications – optical biosensors – principles, biorecognition, optical transduction – Bioimaging – cellular, tissue imaging and in vivo imaging. Introduction to Optical Coherence Tomography

UNIT V Biophotonic Therapy
Photodynamic therapy – basic principle, photo sensitizers, mechanism of photodynamic action, applications – Laser tissue welding, lasers in dermatology, neurosurgery, ophthalmology, urology.

Suggested reading books
BME 527
LASERS IN MEDICINE

Instruction: 3 Periods per week
Duration of university examination: 3 Hours
University Examination: 70 Marks
Sessional: 30 Marks

OBJECTIVES:
✓ To understand basic elements of Laser-Tissue interaction.
✓ Understand the nature of light, light spectrum and laser waredeiny
✓ Understand the basic principles and types of Fiber optics.

OUTCOMES:
✓ Learn laser safety and inspection control in Medical Practice.
✓ Learn how to successfully interpret laser use in treatment and diagnosis.
✓ Understand the wide advantages pf using laser in medical practice.

UNIT I: INTRODUCTION TO OPTICAL FIBERS
Basic optical laws and definitions, optical fiber modes and configuration, single mode fibers, graded index fiber structure, fiber materials, attenuation, signal distortion in optical waveguides, pulse broadening in graded index waveguides.

UNIT II: LIGHT AND MATTER
Reflection and Refraction, Absorption, Scattering, turbid media, Photon Transport Therapy, Measurement of optical Tissue Properties.

UNIT III: INTERACTION MECHANISM
Photochemical interaction-Photo Dynamic Therapy, Biostimulation
Photoablation – Model of photoablation, cytotoxicity of UV Radiation
Plasma induced ablation- Model of Plasma induced ablation, Analysis of Plasma parameters,
Photodisruption- Plasma formation, Shockwave Generation, Cavitation, Jet formation

UNIT IV: MEDICAL APPLICATIONS OF LASERS
Lasers In Ophthalmology, Dentistry, Gynecology, Urology, Neurosurgery, Angioplasty and Cardiology, Dermatology, Orthopedics, gastroenterology, Otolaryngology and Pulmonology.

UNIT V: LASER SAFETY
Laser hazards, skin hazards, eye hazards, Associated hazards from high power lasers, laser safety standards and hazard classification, viewing laser radiation, eye protection, laser calculations and measurements

Suggested Reading:
1. Markolf H.Niemz,laser-tissue interactions fundamentals and applicatrions, springer