SCHEME OF INSTRUCTION AND EXAMINATION

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

I YEAR: SEMESTER I

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Subject</th>
<th>Scheme of instruction periods per week</th>
<th>Scheme of Examination</th>
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<td>1.</td>
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<td>Lab-I</td>
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<td>8.</td>
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I YEAR: SEMESTER II

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<td>Core-VI</td>
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<td>Lab-II</td>
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## SCHEME OF INSTRUCTION AND EXAMINATION

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

### II YEAR: SEMESTER III

<table>
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<th>Scheme of instruction periods per week</th>
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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**
With effect from the academic year 2009-2010

**LIST OF SUBJECTS FOR M.E. (BME) WITH SPECIALIZATION IN BIOMEDICAL ELECTRONICS**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Syllabus Ref. No.</th>
<th>Subject</th>
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<tr>
<td>1</td>
<td>BM 501</td>
<td>Medical Sensors</td>
<td>3</td>
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<tr>
<td>2</td>
<td>BM 502</td>
<td>Advanced Medical Imaging</td>
<td>3</td>
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<tr>
<td>3</td>
<td>BM 503</td>
<td>Medi Embedded Systems</td>
<td>3</td>
<td>M</td>
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<tr>
<td>4</td>
<td>BM 504</td>
<td>Diagnostic And Therapeutic Equipment</td>
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<td>M</td>
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<td>5</td>
<td>BM 505</td>
<td>Advanced Biomedical Signal Processing</td>
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<td>R</td>
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<td>6</td>
<td>BM 506</td>
<td>Electronic System Design</td>
<td>3</td>
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<td><strong>ELECTIVE SUBJECTS:</strong></td>
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<td>1</td>
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<td>Physiology For Engineers (compulsory to students with ECE, EEE &amp; E&amp;IE backgrounds, and open to BME students)</td>
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<td>2</td>
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<td>Bioinformatics</td>
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<td>3</td>
<td>BM 522</td>
<td>Medical Informatics</td>
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<td>Advanced Biomaterials</td>
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<td>6</td>
<td>BM 525</td>
<td>Biotransport Processes</td>
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<td>7</td>
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<td>Hospital Administration &amp; Management</td>
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<td>BM 533</td>
<td>Tissue Engineering</td>
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<td>15</td>
<td>BM 534</td>
<td>Bio Nano Technology</td>
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<tr>
<td>1</td>
<td>BM 507</td>
<td>Lab-I-Transducers &amp; Biosensors Lab</td>
<td>3</td>
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<td>BM 508</td>
<td>Lab-II- Embedded Systems Lab</td>
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<td>BM 512</td>
<td>Dissertation</td>
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</table>

R – Retained    M – Modified    A – Added Syllabus

* The prerequisite for these subjects is **BM 520-Physiology For Engineers**

** The prerequisite for these subjects is **BM-523-Medical Instrumentation**
BM 501    MEDICAL SENSORS

Instruction  3 Periods per week
Duration of University Examination  3 Hours
University Examination  80 Marks
Sessionals  20 Marks

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.

UNIT-IV

UNIT-V

Suggested Reading:

BM 502 ADVANCED MEDICAL IMAGING

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 80 Marks
Sessionals 20 Marks

UNIT-I
Basic Medical Imaging Modalities- X-ray, CT, Ultrasound, MRI, PET-CT, SPECT-CT, Gamma Camera, Catheterization Lab. Aspects of light imaging, convolutions and transforms, photometry, lenses and depth of field, Image perception and 3D Imaging, Image acquisition, Display, Image processing operations, scanning & segmentation.

UNIT-II
CT: Basic concepts of CT, Non Spiral CT technology, Concepts of Spiral CT Scanner, Multi Slice spiral technology, Various Peripheral devices. Applications: Multiplanar Reconstruction, Maximum Intensity Projection, 3D, CT Angio, Osteo, Dental, Perfusion (Body & Neuro), Virtual Endoscopy, Cardiac CT (Calcium scoring, Coronary Angiography, Lesion Quantification).

UNIT-III

UNIT-IV
Gamma Camera: Physics of Gamma camera, basic Instrumentation, Imaging techniques, SPECT & Whole Body studies. Applications of Gamma camera in Cardiology, Nephrology, Neurology etc., Ultrasound Scanner: Principles of Ultrasound, Basic Ultrasound instrumentation, Imaging techniques (A mode, B Mode, 2B, B/M, 4B, Gated Mode, 3D, 4D, M-Mode, Echocardiography), Image recording devices, Image artifact, Biological effects.

UNIT-V
PET: Fundamentals of PET scanner & PET- CT, Crystal technology, Cyclotron principle, Hot Lab equipments. Applications of PET: Cardiology, Neurology & Cardiology.

Suggested Reading:
BM 503  MEDI-EMBEDDED SYSTEMS

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 80 Marks
Sessionals 20 Marks

UNIT-I

UNIT-II

UNIT-III

UNIT-IV
Process, task, thread, ISR. Operating system services-goals structures. Kernel. Process Management, Memory management, device management. File systems. Input-output sub systems, task scheduling models. Round Robin, preemptive, real time scheduling. Inter process communication and synchronization. Semaphores, priority inversion, dead lock, message queues, mail boxes, pipes, virtual sockets, RPCs

UNIT-V

Suggested Reading:
With effect from the academic year 2009-2010

BM 504  DIAGNOSTIC AND THERAPEUTIC EQUIPMENT

Instruction  3  Periods per week
Duration of University Examination  3  Hours
University Examination  80 Marks
Sessionals  20 Marks

UNIT – I

UNIT – II
Cardiac Valves, different types – Mechanical and Tissue types.
Sterilization techniques: Autoclave, Gas, Dry Heat, Radiation, Dry Steam sterilization.
Lithotripsy Systems. Techniques and Equipment

UNIT – III
Intensive Coronary Care UNITs: Central Monitoring system, Drug Delivery Systems, Intelligent Drug Delivery, Neurological Instrumentation, Respiratory Care UNIT Equipment, Nebulizers, Mechanical Ventilators, CPAP.

UNIT – IV
Perfusion Equipment, Anaesthesia, Ventilators, Heart Lung machine, Fumigators

UNIT – V

Suggested Reading:
BM 505 ADVANCED BIOMEDICAL SIGNAL PROCESSING

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 80 Marks
Sessionals 20 Marks

UNIT-I
Fundamentals of Discrete-Time signals and systems


UNIT-II
The Electroencephalogram(EEG)


UNIT-III
Wavelets


UNIT-IV
The Electromyogram (EMG)

The electrical Activity of Muscles, Amplitude Estimation in the surface EMG, Spectral Analysis of the surface EMG, Conduction velocity Estimation, Modeling the EMG, EMG Signal Decomposition

UNIT-V
The Electrocardiogram(ECG)

Heart Rhythms, Heart beat Morphologies, Noise and Artifacts, Baseline Wander, Power line interference, Muscle Noise Filtering, QRS Detection, Wave Delineation, Data Compression, Heart Rate Variability, Acquisition and RR Interval conditioning, Spectral Analysis of Heart Rate Variability.

Suggested Reading:
4. Roberto Cristi, Modern Digital Signal Processing
BM 506

ELECTRONIC SYSTEM DESIGN

Instruction: 3 Periods per week
Duration of University Examination: 3 Hours
University Examination: 80 Marks
Sessionals: 20 Marks

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


Suggested Reading:
With effect from the academic year 2009-2010

BM 507-1  TRANSUCER & 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 507-2  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

BM 520 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 80 Marks
Sessionals 20 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
4. Zipes, Jalife, Cardiac Electrophysiology ,
5. Eric R. Kandel, Principles of Neural Science, Elsevier science division
6. Yon Kimura, Electrodiagnosis in diseases of nerve and muscle, *W.B. Saunders Company*
BM 521  BIOINFORMATICS

Instruction

Duration of University Examination
University Examination
Sessionals

3 Periods per week 3 Hours 80 Marks 20 Marks

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:
BM 522 MEDICAL INFORMATICS

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 80 Marks
Sessionals 20 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: role 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:

UNIT-IV:

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

Suggested Reading:
With effect from the academic year 2009-2010

BM 523 MEDICAL INSTRUMENTATION (Compulsory to EEE & ECE backgrounds)

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 80 Marks
Sessionals 20 Marks

UNIT – I
Origin of biopotentials – ECG, EEG, EMG, EOG, ENG, ERG, EGG.
Biosensors – Enzyme–based biosensors, immuno sensors, microbial sensors.

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:
BM 524  ADVANCED BIOMATERIALS

Instruction  3 Periods per week
Duration of University Examination  3 Hours
University Examination  80 Marks
Sessionals  20 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. Protein and Cell interactions with biomaterials. Protein conformations, the Conformation Stabilization Forces.

UNIT – III

UNIT – IV

UNIT – V

Suggested Reading:

BM 525  BIOTRANSPORT PROCESSES

Instruction  3 Periods per week
Duration of University Examination  3 Hours
University Examination  80 Marks
Sessionals  20 Marks

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:
BM 526  
HOSPITAL ADMINISTRATION & MANAGEMENT

Instruction  
Duration of University Examination  
University Examination  
Sessionals  
3 Periods per week  
3 Hours  
80 Marks  
20 Marks

UNIT – I  
Hospital Services: Emergency; Outpatient; supporting; auxiliary; Dietary; Drugs and Medical Supply.  
Nursing Services. Records Management.  
BME Services in Hospitals: Role and Responsibilities:

UNIT – II  

UNIT – III  

UNIT – IV  
Centralisation: Commonality of technical services and centralisation for optimum utility of equipment and staff. Efficient operation and cost effectiveness.

UNIT – V  
Functional Organisation of a BME/Clinical Engineering Department. Layout and Setting of Clinical Engineering Lab, Workshop. Test and Servicing Equipment. Staff, In-house R & D.

Suggested Reading:  
With effect from the academic year 2009-2010

BM 527 PHYSIOLOGICAL CONTROL SYSTEMS

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 80 Marks
Sessionals 20 Marks

UNIT-I

Concepts of system analysis, physiological control systems analysis. Mathematical modeling, linear models of physiological systems, static analysis of physiological systems, Determination of steady state operating point, Steady state analysis, Regulation of cardiac output, Chemical regulation of ventilation.

UNIT-II


UNIT-III


UNIT-IV

Non-linear analysis of physiological control system. Phase plane analysis, non-linear oscillators, Describing function method, and Models of Neuronal dynamics. Spontaneous variability, non-linear control systems with delayed feed back, coupled non-linear oscillators, time varying physiological closed loop systems, Propagation of system noise in feedback loop.

UNIT-V


Suggested Reading:

With effect from the academic year 2009-2010

BM 528  ELECTROMAGNETIC BIOINTERACTION

<table>
<thead>
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<th>Instruction</th>
<th>3 Periods per week</th>
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<tbody>
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<td>80 Marks</td>
</tr>
<tr>
<td>Sessionals</td>
<td>20 Marks</td>
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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:
With effect from the academic year 2009-2010

BM 529  BIOSTATISTICS

Instruction  3 Periods per week
Duration of University Examination  3 Hours
University Examination  80 Marks
Sessionals  20 Marks

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:

BM 530  MEDICAL IMAGE PROCESSING

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 80 Marks
Sessionals 20 Marks

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:
With effect from the academic year 2009-2010

**BM 531 ENTERPRISE MANAGEMENT**

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 80 Marks
Sessionals 20 Marks

**UNIT-I**

Indian Industrial Environment-Competence, Opportunity 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:**

With effect from the academic year 2009-2010

BM 532  MEDICAL PRODUCT DESIGN

Instruction  3 Periods per week
Duration of University Examination  3 Hours
University Examination  80 Marks
Sessionals  20 Marks

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:

BM 533  
TISSUE ENGINEERING

Instruction  
Duration of University Examination  
University Examination  
Sessionals  
3 Periods per week  
3 Hours  
80 Marks  
20 Marks

UNIT – I
Growth and Differentiation, Organisation of cells into Higher ordered structures, Dynamics of cells-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 :
BM 534 BIO NANO TECHNOLOGY

Instruction 3 Periods per week
Duration of University Examination 3 Hours
University Examination 80 Marks
Sessionals 20 Marks

UNIT-I
**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-II
**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-III
**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-IV

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