SCHEME OF INSTRUCTION AND EXAMINATION

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

I YEAR: SEMESTER I

S.No.	Subject	Scheme of instruction periods per week		Scheme of Examination		
		L/T	D/P	Duration (Hours)	Maximum Marks	
					Univ. Exam	Sessionals
1.	Core-I	3	--	3	80	20
2.	Core-II	3	--	3	80	20
3.	Core-III	3	--	3	80	20
4.	Elective-I	3	--	3	80	20
5.	Elective-II	3	--	3	80	20
6.	Elective-III	3	--	3	80	20
7.	Lab-I	--	3	--	--	50
8.	Seminar-I	--	3	--	--	50
Total		**18**	**6**	**--**	**480**	**220**

I YEAR: SEMESTER II

1.	Core-IV	3	--	3	80	20
2.	Core-V	3	--	3	80	20
3.	Core-VI	3	--	3	80	20
4.	Elective-IV	3	--	3	80	20
5.	Elective-V	3	--	3	80	20
6.	Elective-VI	3	--	3	80	20
7.	Lab-II	--	3	--	--	50
8.	Seminar-II	--	3	--	--	50
Total		**18**	**6**	**--**	**480**	**220**

SCHEME OF INSTRUCTION AND EXAMINATION

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

II YEAR: SEMESTER III

S.No.	Subject	Scheme of instruction periods per week		Scheme of Examination		
		L/T	D/P	Duration (Hours)	Maximum Marks	
					Univ. Exam	Sessionals
1.	Project Seminar and Dissertation	--	6	--	--	100*
Total		**--**	**6**	**--**	**--**	**100**

* 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

S.No.	Syllabus Ref. No.	Subject	Periods per Week	Revision of syllabus
		CORE SUBJECTS:		
1	BM 501	Medical Sensors	3	R
2	BM 502	Advanced Medical Imaging	3	R
3	BM 503	**Medi Embedded Systems^^**	3	**M**
4	BM 504	Diagnostic And Therapeutic Equipment	3	R
5	BM 505	**Advanced Biomedical Signal Processing^^^**	3	**M**
6	BM 506	Electronic System Design	3	R
		ELECTIVE SUBJECTS:		
1	BM 520	Physiology For Engineers (compulsory to students with ECE, EEE & E&IE backgrounds, and open to BME students)	3	R
2	BM 521	Bioinformatics	3	R
3	BM 522	Medical Informatics	3	R
4	BM 523	Medical Instrumentation (compulsory to students with ECE & EEE backgrounds, and open to BME & E&IE students)	3	R
5	BM 524	Advanced Biomaterials	3	R
6	BM 525	Biotransport Processes	3	R
7	BM 526	Hospital Administration & Management	3	R
8	BM 527	Physiological Control Systems	3	R
9	BM 528	Electromagnetic Biointeraction	3	R
10	BM 529	Biostatistics	3	R
11	BM 530	Medical Image Processing	3	R
12	BM 531	Enterprise Management	3	R
13	BM 532	Medical Product Design	3	R
14	BM 533	Tissue Engineering	3	R
15	BM 534	Bio Nano Technology	3	R
16	BM 535	Medical Optics	3	R
17	BM	**Lasers in Medicine^**	**3**	**A**
		DEPARTMENTAL REQUIREMENTS:		
1	BM 507	Lab-I-Transducers & Biosensors Lab	3	R
2	BM 508	Lab-II- Embedded Systems Lab	3	R
3	BM 509	Seminar -I	3	R
4	BM 510	Seminar-II	3	R
5	BM 511	Project Seminar and Dissertation	6	R
6	BM 512	Dissertation	6	R

R – Retained M – Modified A – Added Syllabus

^ Lasers in Medicine is introduced has new Elective.
^^ Medi Embedded Systems syllabus is revised.
^^^ Advanced Biomedical Signal Processing syllabus is revised.

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

Resistive sensors. Potentiometers, Strain gages, RTDs, Thermistors, LDR. Signal conditioning. Wheatstone bridge, balance and deflection measurements. Instrumentation amplifier. Interference types and reduction. Shield grounding. Isolation amplifiers.

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

Self-generating sensors. Thermoelectric sensors, thermocouples, piezoelectric sensors, photovoltaic sensors. Signal conditioning. chopper and low-drift amplifiers, Noise in op-amps. Digital sensors. Telemetry and data acquisition.

UNIT-V

BioMicroElectroMechanical Systems (BioMEMS). Principles, design, fabrication and application of micro- and nano-devices to instrument and control biological molecules, living cells, and small organisms. Development of micro fabricated systems, lab-on-a-chip, and micro- and nano-biosensors.

Suggested Reading:

1. John G. Webster, *Medical Instrumentation-Application and Design*, John Wiley and Sons Inc., 3rd Ed., 2003.
2. Richard S.C. Cobbold, *Transducers for Biomedical Measurements: Principles and Applications*, John Wiley & Sons, 1974.
3. Ramon Pallas-Areny and John G.Webster, *Sensors and signal conditioning*, John Wiley and Sons, 1991.

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 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

Basics of digital angiography - Image processors for digital angiography - processor architecture - Digital subtraction angiography. Mammography - X-ray tube design - X-ray generator and photo timer system - Image production. Digital mammography.X-Ray computed tomography - Basic principles Tomographic acquisition and reconstruction-Historical Development - scanner - image formation principles - conversion of x-ray data in to scan image - 2D image reconstruction techniques - Iteration and Fourier methods. Applications - CT Angio, Osteo , Dental, Perfusion (Body & Neuro), Virtual Endoscopy, Coronary Angiography).

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:

1. S Webb, "The Physics of Medical Imaging", Adam Highler, Bristol Published by CRC Press, 1988
2. A C Kak, "Principle of Computed Tomography", IEEE Press New York, 1988
3. Hykes, Heorick, Starchman, Ultrasound physics and Instrumentation MOSBY year book, 2nd Ed., 1992.
4. Stewart C.Bushong, Magnetic Resonance Imaging- physical and biological principles, MOSBY, 2nd Ed., 1995.
5. Zhi-Pei Laing and Paul C.Lauterbur, Principles of Magnetic Resonance imaging –A signal processing perspective, Metin Akay (Editor), IEEE press, New York, 2000.

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

Embedded Systems: Basic concepts, requirements, categories, Hardware architecture, Software architecture, Communication software. Development-Design technology, IC technology, processor based technology, Design life style , Processor development. Embedded operating system –Types. Microprocessor vs. Microcontroller.

UNIT-II

Special Features of Embedded System: Integration and testing –BDM, JTag, Nexus, ICE, Performance Testing. Debugging Tools-RDM emulator, Logic analyzer, Watch dog Timer. Host based debugging – Remote Debuggers, Debug Kernels. Partition decisions –Hardware & Software Duality. ASIC interrupt response cycle, Functions Calls & Stack Frames.

UNIT-III

Communications Interface Standards: Serial interfaces- RS-232, 422,485.IEEE 1394 (Firewire), USB - Interfacing between PC and Peripherals, IRDA (Infrared Data Association)-Mobile Phones, PDA &PC, CAN (Controller Area Network)-Serial Communication Protocols, Bluetooth Protocol using Radio Technology, Ethernet-Use of Internet Protocols, LCD &Keypad Controllers.

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

Applications: Process control systems, Instrumentation, Network information appliances, Smart cards, RF Tags. Case study-8051 microcontroller architecture, DSP architecture.Rabbit Microcontroller-Architecture, Programming.

Suggested Reading:

1. Arnold S. Berger, *An introduction to Processes, Tools and Techniques*, CMP books, 2005.
2. Dr.K.V.K.K.Prasad*, Embedded Real time Systems*, Dreamtech Press, 2003.
3. Dreamtech Software team, *Programming for embedded systems*, Wiley Dreamtech India Pvt. Ltd., 2002.
4. Jean J. Labrosse, *Micro C/OS-II- The real time Kernel*, CMP books, 2002.

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 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

Intensive Coronary Care UNITs - Central Monitoring system, Pre and post operative monitoring, Gas distribution system in the ICU, Drug Delivery Systems, Intelligent Drug Delivery, Neurological instrumentation, CPAP .Advanced Life Support Systems - Cardiac Life Support Equipment, Pediatric Advanced Life support & Neonatal Resuscitation

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,

Radio Therapy: Principles of radiotherapy, Cobalt UNIT, Treatment planning system. Types of radiation detectors, biological effects of radiotherapy.

SUGGESTED READING:

1. John G. Webster (Editor-in-Chief), Encyclopedia of Medical Devices and Instrumentation Vol.1 to Vol.4, John Wiley and Sons, 1988.
2. Khandpur R. S., Handbook of Bio-Medical Instrumentation, Tata McGraw Hill, 2nd Ed., 2003.
3. Joseph Bronzino (Editor-in-Chief), Handbook of Biomedical Engineering, CRC Press, 1995.
4. Harry Bronzino E, Handbook of Biomedical Engineering and Measurements, Reston, Virginia.
5. Joseph J.Carr and John M.Brown, Introduction to Biomedical equipment technology, John Wiley and sons, New York, 1997

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

Concepts of system, signal. Sampling Process. Impulse Response. Z-Transform, Discrete Transfer function, Discrete Fourier Transform(DFT), Fast Fourier Transform(FFT). Medical Applications

UNIT-II The Electroencephalogram(EEG)

Applications, Signal Processing, Modeling and Artifacts. Nonparametric and Model-based spectral analysis, EEG segmentation, Joint Time-Frequency Analysis. Evoked Potential Modalities, Noise Characteristics, Noise reduction by Ensemble Averaging and Linear Filtering, Single-Trail Analysis and adaptive Analysis Using Basis Functions

UNIT-III Wavelets

Continuous Wavelet Transform. Discrete wavelet transform. Reconstruction. Recursive multi resolution decomposition. Types of wavelets-Haar wavelet, Daubechies wavelet, Biorthogonal wavelet. Coislet wavelet, Morlet wavelet, Mexican Hat wavelet, Symlet wavelet. Medical applications

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:

1. Leif Sornmo and Pablo Laguna, Bioelectrical Signal Processing in Cardiac and Neurological Applications, Academic Press, 2005
2. Willis J. Tompkins, Biomedical Digital Signal Processing, Prentice-Hall, 1993.
3. Rangaraj M. Rangayyan, Akay Metin(Editor),Biomedical Signal Analysis: A Case Study Approach, Wiley Interscience, 2001.
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

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:

1. Halit Eren, *Electronic portable instruments-Design and applications*, CRC Press, 2004.
2. Robert B. Northrop, *Analysis and application of analog electronic circuits to biomedical instrumentation*, CRC Press, 2004.
3. Reinaldo J . Perez, *Design of medical electronic devices*, Academic press, 2002.

BM 507-1 **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 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

A. General Physiology: Introduction-Evolutionary aspects and thermodynamics of living systems. Cellular physiology-digital and analog molecules and patterning of activity, active and passive process, optimization principles, macromolecular self assembly, molecular homeostasis. DNA, RNA, chromosomes, Gene. Genetic inheritance and epigenetics. Gene expression and its regulation: Endogeneous feed-forward circuitry and stochastic models. Intracellular physiology-structure and function. Transport across cell membrane.

B. Nerve Physiology: Genesis of membrane potentials, Nernst equation, Goldman-Katz equation, cable properties, local, analog signaling. Action potentials, Digital/propagative signaling. Hodgkin-Huxley model, differential equation of action potentials. Electrophysiology of cell membrane, experimental studies(Voltage clamp and patch clamp methods)

C. Muscle Physiology: Types of muscle fibers-Structure and function. Neuro-muscular junction, Excitation-contraction coupling, Molecular basis of muscle contraction, motor UNIT and muscle contraction. Smooth, cardiac and skeletal muscles, Biophysics of musculoskeletal systems, Experimental study of electrical activity.

UNIT – II

Cardiovascular system: Introduction to cardiovascular physiology. Functional anatomy of heart and vessels. Electro Physiology of heart. Electrocardiogram and magneto cardiogram. Cardiac cycle. Blood as a non-Newtonian fluid. Dynamics of circulation, regional circulations. Cardiac output and methods of estimation. Control systems; neural and humoral regulation. Applied aspects.

UNIT – III

Overview of respiratory physiology. Ventilation, Biophysics of transport across respiratory membrane. Perfusion and diffusion limited process. Ventilation, alveolar, shunt and dead space equations.Ventilation perfusion inequalities. Biophysics of transport of gases in blood. Applied aspects.

UNIT – IV

Renal system: Overview of renal physiology. Clearance equation and biophysics of filtration, reabsorption and secretion.Counter-current multiplication and exchange, acid base balance, Regulation of body temperature. Applied aspects. Endocrine and Reproductive systems.

UNIT – V

Nuerophysiology: Overview, sensory system, signal generation, conduction processing and transduction. Synapse, signal integration at spinal cord, brain stem, sub-cortical and cortical levels. Motor systems, planning, programming and execution. Cognitive functions. Language, speech, thought, sleep, learning and memory. Experimental study of electrophysiology. Near field and far field potentials, EEG, Nerve conduction studies and evoke potentials

Suggested Reading:

1. Best and Taylor, Physiological basis of Medical practice, *The Living Body*, B.I. Publication, 1980.
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 521 BIOINFORMATICS

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

UNIT I

Prediction of protein molecular function and structure: Primary sequence of a protein and its analysis, Secondary , Tertiary and quaternary structures and their prediction methods, Fold recognition methods , Homology /comparative modeling of proteins, Energy calculations, local and global minimization, Energy Minimizations: Conjugate, steepest and Powell , Molecular dynamics and simulation studies.

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

Neural Networks: Biological neurons and neural networks. Networks of artificial neurons. Learning in single layer and multi-layer perceptrons. Back-propagation. Radial basis function networks: Algorithms and applications. Committee machines. Self-organizing maps: algorithms and applications. Learning vector Quantization. Machine Learning, Statistical learning, Decision trees. Inductive logic programming, Computation learning, Unsupervised learning, temporal difference learning, Delayed reinforcement learning, Explanation based learning.

Suggested Reading:

1. Bioinformatics – *Sequence and Genome Analysis*. David W. Mount.
2. Beale and T.J. Jackson, *Introduction to Neural Networks*, IOP Publishing Company, 1990.
3. Baeck, D.B. Fogel and Z. Michalewicz ,*Genetic Algorithms*, IOS Press, 1997.

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: 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:

Data Modeling Techniques: Relational, Hierarchical and Network normalization techniques for Data handling. Relational, Distributed and Other types of Databases. Data Indexing and Structuring Techniques, Integrity and Security of Databases, Information Searching and Retrieval.

Operators: Relational, Logical and Boolean.

UNIT-IV:

Hospital Information Systems: Need for Computerization in Hospitals. Functional capabilities of a computerized Hospital Information System. Cost effectiveness of Information processing by a Computer, Security of Computer Records, Source of Data for decision making.

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:

1. G.D. Kunders, *Hospitals Planning, Design and Management*, Tata McGraw-Hill Publications, New Delhi, 2003.
2. Date C.J, *An Introduction to Database Systems*, Addisson Wesley, 1998.
3. 3. J.D Ullman, *Principles of Database Systems*, Galgotia Publications, 1990.
4. R.D.Lele, *Computers in Medicine*, Tata McGraw- Hill Publications, New Delhi, 1988.

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.

Bio-potential Electrodes: Half cell potential, Offset voltage. Types of External, Internal and Microelectrodes. Electrochemical transducers. Potentiometric sensors, Ampero-metric sensors, Electro-Chemical gas sensors.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

Analytical Instrumentation. Methods of Chemical analysis, Absorption, Photometry: Emission photometry, Fluorometry. Chromatography for blood gas analysis. Colorimeters, Spectrophotometers, Electrophoresis, auto analyzer.

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:

1. John G. Webster, *Medical Instrumentation-Application and Design*, John Wiley and Sons Inc., 3rd Ed., 2003.
2. Khandpur R.S., *Hand Book of Biomedical Instrumentation*, Tata McGraw Hill Pub Co. Ltd., 2nd ed., New Delhi, 2003.
3. Joseph J. Carr and John M. Brown, *Introduction to Biomedical Equipment Technology*, Pearson Education, 2001.

BM 524 ADVANCED BIOMATERIALS

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

UNIT – I

Surgical principles of biomaterials Implantation: Introduction, Principal Considerations for experimental surgical Procedures and Material Selection. Physiological models for evaluation of Implantable Devices-An Engineer's Choice. Implantable Biomaterials in Plastic, Reconstructive and Esthetic Surgery.

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

Biodegradability, Resorption and Stability: Biodegradable suture materials, Factors affecting Biodegradation Phenomena, Intrinsic Factors –Substituent Effect, Morphological Effect, Annealing Effect. Extrinsic Factors – Effect of media pH, Effect of Electrolytes, Effect of External Stress Applied.

UNIT – IV

Physiochemical Characterization of surface and interface on biomaterials and coatings,
Methods of surface characterization, Surface and Interface structure. Investigations- Transmission Electron Microscopy, Ion Beam Techniques. Characteristics of Plasma Gas Discharge. Plasma Systems and Processes.

UNIT – V

Applications of materials in medicine and Dentistry: Cardiovascular Applications, Dental Implants, Orthopedic Applications. Drug Delivery Systems, Sutures, Ophthalmologic Applications, Bioelectrodes, Biomedical Sensors and Biosensors.

Suggested Reading:

1. Buddy D.Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, Eds, *Biomaterials Science – An Introduction to Materials in Medicine*, Academic Press, 1996.
2. Donald L. Wise, Debra J. Trantolo, David E. Altobelli, Michael .J. Yaszemski, Joseph D. Gresser, Edith R. Schwartz (Editors), *Hand book of Biomaterials and Bioengineering*, Parts A&B, Marcel Dekker Inc, 1995.

BM 525 BIOTRANSPORT PROCESSES

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

UNIT- I

Basic concepts of transport processes. Relationship between flow and effort variables. Chemical balances, force balances, general flow balances, Kirchhoff's laws, Conservation of mass, conservation of energy, momentum balance.

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

Mass transfer principles. Mass balance, molecular diffusion, Transport through cell membranes. Mass transfer in kidneys, models of nephron function, gas transport mechanisms in the lungs and blood. Modelling of oxygen and inert gas uptake in the lungs.

UNIT- IV

Mass transfer in artificial kidney devices, modeling of patient-artificial kidney system. Comparison of natural and artificial lungs. Models for blood oxygenation, analysis of gas transport in membrane oxygenators.

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:

1. Arthur T. Johnson, *Biological process Engineering- An analogical approach to fluid flow, heat transfer, mass transfer applied to Biological systems*, John Wiley and Sons, 1999.
2. David O. Cooney, *Biomedical Engineering Principles-An introduction to fluid, heat and mass transport processes*, Marcel Dekker Inc., 1976.

BM 526 HOSPITAL ADMINISTRATION & MANAGEMENT

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

UNIT – I

Administration of Hospital Systems: Teaching-cum-Research Hospitals. General Hospital. Specialist Hospitals. P.H.C.– Role, Layout and Functions.Hospital Services: Emergency; Outpatient; supporting; auxiliary; Dietary; Drugs and Medical Supply. Nursing Services. Records Management. BME Services in Hospitals: Role and Responsibilities:

UNIT – II

Hospital Planning. Technical Considerations: Size and kind of Hospitals; Principles of Planning – Selection; Location; Site and Orientation. Budgeting, Equipment Plans. Power Supply. Air-conditioning and Water Supply requirements. Elevators, Ambulance, Fire Fighting and Safety services. Disposables. Hospital Infection and Control.

UNIT – III

Computers and Information Management in Hospitals: Computer Aided Hospital management – Applications: Admission/Discharge Records. Patient Billing. In-patient medical records. Pharmacy Management. Operation Theaters and ICCU. OPD Registration, Purchase and Inventory Control.

UNIT – IV

Electrical factors in Hospital Design, Layout and Centralisation of Technical Services: Electrical Power Supply: Reliability, Three Phase Systems. Voltage stabilisation. Proper location of Air Conditioners, Elevators, Transformers, other electrical machinery and Electrical Shielding techniques to prevent 50Hz power supply interference on sensitive Electro Medical / Diagnostic / Monitoring / Therapeutic Equipment. Standby power supply arrangements.Centralisation: Commonality of technical services and centralisation for optimum utility of equipment and staff. Efficient operation and cost effectiveness.

UNIT – V

Bio-Medical Equipment Maintenance Management: Procurement Procedures: Proper Selection, Safety, Spares, Evaluation, Testing and Installation. Purchase and Contract Procedures. Training of medical staff on technical capabilities and proper use of Biomedical equipment.Biomedical Equipment Maintenance: Procedures & Policy, Mandatory Requirements. Maintenance Procedures.Preventive Maintenance and Periodical Servicing Procedures: Servicing Schedules. Fault Diagnosis. Repairs and Modifications. Maintenance of Log Books. Implementation of Electrical Safety Codes and Standards, Stores Management. 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:

1. Goel S.L., and Kumar R., *Hospital Administration and Management* Vol. 1,2,3, Deep and Deep, New Delhi.
2. G.D. Kunders, *Hospitals Planning, Design and Management*, Tata McGraw-Hill, 2003.

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

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

Relative stability, Stability analysis of pupilary light reflex, model of Cheyne-Stokes breathing. Identification of physiological control systems, parametric estimation, identification of closed loop system, optimization of physiological control, single parametric optimization, constrained optimization, and adaptive control of physiological variables.

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

System identification in physiology, modeling of sensory receptors and pupil control system. Modeling cardiovascular system, Modeling blood flow, systemic blood flow and coronary circulation. Behavior of the immune system, linearized model of immune response to disease.

Suggested Reading:

1. Michael C.K. Khoo, *Physiological Control Systems-Analysi,s Simulation and Estimation*, IEEE Press Series in Biomedical Engineering, 2000.
2. Suresh R. Devasahayam, *Signals and Systems in Biomedical Engineering-Signal Processing and Physiological Systems Modeling*, Kluwer Academic/Plenum Publishers, 2000.

BM 528 ELECTROMAGNETIC BIOINTERACTION

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

EM bio engineering: Extremely LF,EM fields, dielectric heating, broadcast radiation, MW ovens, EM fields in medicine, electrical properties of biological substances, Interaction mechanisms. Application of the finite-differences time domain and the SINC-function Fast Fourier Transform method of moments.

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:

1. Gandhi Om.P, Biological effects and medical applications of Electromagnetic Energy Biophysics and Bioengineering series, Prentice Hall Advanced reference series, Englewood cliffs, New Jersey,1990
2. Franceschetti G, Om P Gandhi and Matini Grandlfo,Electromagnetic biointeraction,Plenum Press, New York,1989.

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:

1. Stanton A. Glantz, *Primer of biostatistics,* Mc Graw Hill , 2nd Ed.
2. Wayne S. Daniel, *Biostatistics: A foundation for analysis in the health sciences*, John Wiley & Sons, 6th Ed.,.

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

Image Enhancement. Contrast manipulation, histogram equalization, Laplacian derivatives, Sobel and Klisch operators, rank operators –textural analysis. Image pre processing – pixel brightness transformations, Geometric transformations, local pre processing, Image restoration. Imaging filters.

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

Restoration. Deterministic, geometric linear filtration, inverse filtering, power spectrum equalization, stochastic. Wiener filtering. Registration, anatomy based, object based, scene based.

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:

1. John C Russ, *The image processing handbook*, CRC and IEEE press –1999.
2. Milan Sonka, Vaclav Hlavac,Roger Boyle*, Image processing, analysis and machine vision*, 2nd edition,Brooks/Cole publishing Co., 1999.
3. Jayaram, Kudupa and Gabor,T Herman, *3D imaging in medicine*, 2nd edition, CRC press, 2000.
4. Craig A.Hindley, *Practical image processing in C*, John Wiley and Sons 1991.

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, 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

Property Rights: intellectual property rights- Nature of I.P- Protection of I.P rights- Kinds of Intellectual Property Rights- International conventions of Intellectual property rights- Patent treaty 1979, GATT 1994, TRIPS & TRIMS- International organisation for protection of IPR- WTO, WIPO, UNESCO.

Patents: Meaning of patent- commercial significance- obtaining of patent- patentable subject matter- rights and obligations of patentee- specification- registration of patents – compulsory licensing and licenses of rights- Revocation.

Suggested Reading:

1. Vasant Desai, *Dynamics of Entrepreneurial development and Management*, Himalaya Publishing house, 1997.
2. Prasanna Chandra, *Project planning, analysis, selection, implementation and review*, Tata Mc-Graw Hill, 1995.
3. Sudha G.S., *Organizational behaviour*, National publishing house, 1996.
4. Cornish W.R., *Intellectual property; Patents, Copyright, Trademarks and Allied Rights* , Sweet & Maxwell Publications.

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

Medical devices. Overview of product .Product definition process. Quality function deployment process. Materials-Biocompatibility, International regulatory efforts. Device category and choice of test programs. Biological control tests. Test for biological evaluation.

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:

1. Richard C.Fries, *Reliable design of medical devices*, Marcel Dekker Inc., 1997.
2. Richard C.Fries, *Handbook of medical device design*, Marcel Dekker Inc., 2001.

BM 533 TISSUE ENGINEERING

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

Organotypic and Histiotypic Models of Engineered Tissues, Quantitative aspects of Tissue Engineering: Basic Issues in Kinetics, Transport and Mechanics, Patterning of cells and their environment, Cell Interactions with Polymers, Matrix Effects , Polymer Scaffold Processing, Biodegradable Polymers .

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

Applications: Breast Reconstruction, Cardiovascular Systems-Blood Vessels, Small diameter Vascular Grafts, Cardiac Prosthesis. Cornea. Endocrinology and Metabolism-Bioartificial Pancreas, Parathyroid.

UNIT – V

Musculoskeletal System-Structural Tissue Engineering, Bone Regeneration through Cellular Engineering. Gastrointestinal System –Alimentary tract, Liver, Hepato Assist liver support system, Linage Biology and liver. Hematopoitic Systems-Red Blood Cell Substitutes, Lymphoid Cells, Hemapoietic Stem Cells. Kidney and Genitourinary system-Renal Replacement Devices, Genitourinary System.

Suggested Reading :

1. Robert P. Lanza, Robert P. Langer, Joseph P. Vacanti, *Principles of Tissue Engineering*, Academic Press, 2nd ed. 2000.
2. Farshid Guilak, David L. Butler, Steven A. Goidstein, *Functional Tissue Engineering*, Springer Verlag, 2004.
3. Frederick H. Silver, *Biomaterials, and Medical Devices & Tissue Engineering: An integrated approach*, Chapman & Hall, London, 1994.

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 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:

Medical use of Nanomaterials, Drug delivery systems. Cancer treatment, Surgery. Drug tracking systems. Targeted drug delivery systems. Applications of Nanomaterials in Medical imaging. Neuro-electronic interfaces.

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:

1. Lynn E. Foster, Foreword by George Allen, Foreword by Joe Lieberman, Nanotechnology: Science, Innovation, and Opportunity, Nanomedicine: Basic Capabilities, Vol. 1 by Robert A. Freitas Jr. 1999 Rev
2. Neelina Malsch , Biomedical nanotechnology by CRC press release, *Malsch TechnoValuation, Utrecht, The Netherlands*
3. Gero Decher, Joseph B. Schlenoff, Multilayer Thin Films, Wiley-VCH Verlag GmbH & Co. KGaA, 2003
4. David S. Goodsell, Bionanotechnology : Lessons from Nature, Wiley-Liss , 2004.
5. Kenneth J. Klabunde , Nanoscale Materials in Chemistry. , John Wiley & Sons, Inc., 2001

BM 534 **MEDICAL OPTICS**

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

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

1. Keiser, Optical *Fiber Communication Systems*, Mc Graw Hill Ltd., 1983
2. Ed., Tuan Volume Dinh, "Biomedical Photonics Handbook", CRC Press, 2003.
3. Leon Goldman, "The Biomedical Laser Technology and Clinical Applications", Springer Verlag, 1981.
4. Leon Goldman and R. James Rockwell, "Lasers in Medicine", Gordan & Breach, Science Publishers Inc, 1971
5. Koebmer K R, "Lasers in Medicine", John Wiley & Sons, 1980
6. Paras N Prasad, "Introduction to Biomedical Photonics", John Wiley. 2003