DEPARTMENT OF BIOMEDICAL ENGINEERING
DEENBANDHU CHHOTU RAM UNIVERSITY OF SCIENCE & TECHNOLOGY
MURTHAL (SONEPAT) HARYANA

M. Tech. (Bio-Medical Engineering)

M.Tech (Bio-Medical Engineering)

1st Semester (Total Credits = 24)

Course No.	Subject Name	L	P	Credits
BME 501	Anatomy and Physiology for Engineers	4	-	4
BME 503	Biomaterials and Artificial Organs	4	-	4
BME 505	Biomedical Instrumentation	4	-	4
BME 507	Medical Imaging & Image Processing	4	-	4
BME 509	Microprocessor and Microcontroller for Medical Instrumentation	4	-	4
BME 511	Biomedical Instrumentation & Microcontroller Lab	-	2	2
BME 513	Medical Imaging and Image Processing Lab	-	2	2

2nd Semester (Total Credits = 24)

Course No.	Subject Name	L	P	Credits
BME 502	Biomechanics and Rehabilitation Engineering	4	-	4
BME 504	Advanced Biomedical Signal Processing	4	-	4
BME 506	Bio-Mathematics	4	-	4
BME 508	Advanced Tissue Engineering	4	-	4
BME 510	Medical Informatics and Telemedicine	4	-	4
BME 512	Advanced Biomedical Signal Processing Lab	-	2	2
BME 514	Biomechanics Lab	-	2	2

3rd Semester (Total Credits = 24)

Course No.	Subject Name	L	P	Credits
BME 601	Patient Safety, Ethics & IPR Issues	4	-	4
BME 603	Soft Computing Methods for Biomedical Engineer	4	-	4
BME 605	Advanced Biomedical Instrumentation	4	-	4
	Elective	4	-	4
BME 609	Industrial/ Hospital Training	-	2	2
BME 611	Dissertation Phase-I	-	4	4
BME 613	Seminar	-	2	2

4th Semester (Total Credits = 20)

Course No.	Subject Name	L	P	Credits
BME 602	Dissertation	-	-	20

BME 501 Anatomy and Physiology for Engineers

M.Tech. Semester – I (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit-I: **Organization of Human Body:** Anatomical position, terminology, regions and planes. Basic anatomy and physiology of cells, Tissues (epithelial, connective, muscle, nervous, blood, glands), Permeability of cell membrane, genesis of membrane potential excitation of cell.

Unit-II: Skeletal System: Functions of skeletal system, Anatomy of long bone, Bone histology, Naming all bones of axial and appendicular skeleton, Formation, growth and repair, Structural and functional classification of joints, Types of movement, Calcium homeostasis.

Unit-III: Muscular System: Functions of muscular system, Names of all major muscles, Origin, insertion and action, Sliding Filament Model, Neuromuscular junction, Structure (gross and microscopic), Physiology of muscle contraction, Muscle metabolism (ATP), Fiber types, Exercise physiology.

Unit-IV: Cardiovascular System: Functions of circulatory system, Heart structures (chambers, valves, and vessels), Circulatory routes (systemic, pulmonary, coronary and hepatic portal), Blood vessels and pressure, Blood components, function and typing, Blood clotting, Regulation and conduction (EKG). Blood- composition, blood groups, role of R.B.C and W.B.C.

Unit-V: Lymphatic/Immune System: Functions of lymphatic system, Structures (vessels, nodes, cells), Lines of defense, Humoral immune response, Cell mediated immune response, Immune cell types.

Unit-VI: Digestive System: Functions of digestive organs, Modes of mechanical digestion, Chemical digestion (hormones, enzymes, pH), Absorption and elimination, Name parts of GI Tract and accessory organs, Nutrition and metabolism (production of ATP).

Unit-VII: Excretory System: Functions of urinary system, Kidney, ureter, bladder, urethra, Microanatomy and function of nephron, Formation of urine-steps involved.

Unit-VIII: Respiratory System: General structure of respiratory system and functions- Lungs and Trachea, Respiratory Pathways, Functional aspects and mechanics of respiration, Mechanics and regulation of breathing, Gas exchange and gas laws, Hypoxia, effect of exercise.

Unit-IX: Nervous System: Functions of nervous system, Nerve cell anatomy, Neural physiology (action potential, synaptic transmission, Na/K pump), Brain anatomy and hemispheres, Spinal cord anatomy, reflex arc, PNS (autonomic and somatic), Sensory motor nerve functions.

Unit-X: Endocrine System: Functions of endocrine system, Naming organs/glands/cells and their hormones, Hormone types and target cells, Chemical messengers.

Unit-XI: Reproductive System: Functions reproductive systems, Male and female anatomy, Menstrual cycle, Meiosis/gamete production.

Unit-XII: Sensory System: Basic anatomy of special senses: Eye, Ear, Tongue, Nose and Skin, Properties and functions of nervous system with respect to sensory organs.

Textbooks/ References:

1. Charles E. Tobin, Basic Human Anatomy, Mc Graw Hill Publication.
2. J. H. Green An Introduction to Human Physiology.
3. H.B. Charles and B.N. Taylor; The Physiological Basis of Medical Practice. William and Wilkins, Baltimore, 1985.
4. C.A. Keele and Eric Neil; Samson Wright's Applied Physiology. ELBS, London, 1984.
5. S. West, E.R. Todd, W.S. Mason and H.J.T. Van Bruggen; Text Book of Biochemistry. Macmillan Co., 1976.
6. A.G. Guyton; Textbook of Medical Physiology; Saunders, Philadelphia, 1986.
7. Anatomy and Physiology in Health and Illness: Ross and Wilson (ELBS pub).
8. Human Physiology by A. Vander, J. Sherman and D. Luciano Mc Graw Hill.
9. Principles of Anatomy and Physiology: Tortora and Grabowski. (Haper Collin pub.).

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BME 503 Biomaterials and Artificial Organs

M.Tech. Semester – I (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit I:

Structure-property relations of biological materials - proteins, tissues Thin films, grafts and coatings - methods for modifying the surfaces of materials. Fabrics - characterization testing evaluation, Biological functional materials Latex products - hand gloves and other latex products. Tissue response to biomaterials - inflammation and wound healing, immunology, toxicity, foreign body response, blood compatibility, implant associated infection.

Unit II:

Good Manufacturing practice regulations, biomedical materials, quality assurance and quality control Labeling, Device failure, synthetic and biopolymers Bioerodible materials, Host reactions to biomaterials. Sterilization of Medical devices, Advances in Sterilization Technology of clean room, Polymeric materials for drug delivery systems, active and passive targeting, intelligent materials

Unit III:

Testing of blood-materials interaction, animal models, Degradation of material in biological environments, Chemical and biochemical degradation of polymers, Degradative effects of biological environment on metals and ceramics - corrosion, environmental stress cracking, Pathological classification and toxicity of biomaterials.

Unit IV Materials characterization - definition ; importance and application, Principles and general methods of compositional and structural characterization, techniques of X-ray, electron and neutron diffraction, EDAX, Thermal methods - DTA, TGA, DSC, DMA, temperature dependent rheology.

Unit V

Microscopy - optical, electron (TEM, SEM), Atomic force microscopy, optical profilometer and confocal laser scanning microscopy, Spectroscopy – UV-visible, fluorescence & phosphorescence IR, Raman and NMR spectroscopy, ESCA and Auger spectroscopy

Unit V: Artificial Organs:

Artificial Blood: Modern history of transfusion and blood substitutes, oxygen carrying artificial blood, Hb-based artificial blood.

Development aspects of artificial organs: Kidney, liver, heart, pancreas, liver etc.

Recent developments in Biomaterials, Legal issues related to development of biomaterials, Natural materials for various biomedical applications.

Textbooks/ References:

1. Park J.B. & Lakes R.S., Biomaterials: An Introduction, Plenum Press, New York, 1992.
2. Silver F.H., Biomaterials, Medical Devices &Tissue Engineering: An Integrated approach, Chapman &Hall, 1994.
3. J B Park, *Biomaterials - Science and Engineering*, Plenum Press, 1984.
4. Biomedical Engineering Fundamentals-Joseph D. Bronzine (Publisher CRC)
5. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.
6. Biomaterials Science**:** An Introduction to Materials in Medicine**,** By Buddy D**.** Ratner**,** et**.** al**.** Academic Press**,** San Diego**,** 1996**.**

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BME 505 Biomedical Instrumentation

M.Tech. Semester – I (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit I: Introduction to Biomedical Instrumentation: The age of biomedical engineering, Development of biomedical instrumentation, Biometrics, Introduction to the main-instrument system, Components of the main instrument system, Physiological Systems of the body, Problems encountered in measuring a living system, Design for bio-medical problems, diagnosis of disease and therapeutic applications.

Unit II: Sources of Bioelectric potentials, Transducers and Electrodes: Resting and Action Potentials, Propagation of Action Potentials, Biochemical Transducers, The transducer and transduction principles, Active transducers, Passive transducers, Transducers for biomedical applications, The Bioelectric Potentials Electrode theory, Bio Potential Electrodes, Study of various types of electrodes used in ECG, EEG, ENG, EOG and EMG, Measurement of ECG, EEG, ENG, EOG and EMG signals along with their diagnostic applications.

Unit III: Basic Instrumentation system for Bio signals: Design of a differential Bio potential Amplifier, Instrumentation amplifier; Transfer function representation; Filters; Frequency response and noise reduction; Frequency aliasing. A to D conversion and Computer based instrumentation, Instrumentation schemes of ECG, EEG, EMG, EOG, and ENG and their functional circuits. Performance evaluation and testing by simulation techniques. Specifications.

Unit IV: Clinical laboratory instrumentation: Emerging trends in medical diagnostics and therapy, Clinical laboratory instrumentation, Blood cell counter and associated hematology system, Endoscopic diagnosis and foreign body removal, medical image rendering, blood gas analyzers, Design of haemodialysis Machine, Design of Electro surgical Generator or Cautery.

Unit V: Bio telemetry and Instrumentation: Introduction to biotelemetry, physiological parameters adaptable to biotelemetry, the components of biotelemetry system, implantable units, applications of telemetry in patient care.

Unit VI: X – ray and radioisotope instrumentation: Generation of Ionizing radiation, instrumentation for diagnostic X – rays, special techniques, instrumentation for the medical use of radioisotopes, radiation therapy. Physiological effects of electrical current, shock Hazards from electrical equipment, Methods of accident prevention. Digital Subtraction angiography system, Instrumentation in Dental Chair & Hand piece control, Interfacing of brailler with PC, Design of traction machine.

Unit VII: Measurements in the Respiratory System: The physiology of the respiratory system, Tests and instrumentation for the mechanics of breathing, Gas exchange and distribution, Respiratory diagnosing equipment (Spirometer).

Textbooks/ References:

1. Khandpur R.S., Hand book of Biomedical Instrumentation, TMH, 2003.
2. Tompkins, Biomedical Digital Signal Processing.
3. Leslie Cromwell**,** Fred J**.** Weibell**,** Pub**:** Erich A**.** Pfeiffer**.** Biomedical Instrumentation and Measurements**.**

4. Carr & Brown, Introduction to Biomedical Equipment, Pearson Education, 2005.
5. Webester J.G., Medical Instrumentation, 3rd Edition, John Wiley, 1997.
6. Encyclopedia of Medical Devices and Instrumentation Vol. I , II, III, IV by John G. Webster, Wiley Publication
7. Bio medical Engineering System By Manfred Clyner, John H. Milsum (McGraw Hill)
8. Biomedical Signal Analysis – A Case Study Approach By Rangaray M. Rangayyan, (John Wiley and Sons Inc)
9. Christensen's physics of Diagnostic Radiology by Thomas S. Curry, Jumer E. Dowdey, Robert C. Murry.
10. Medical Instrumentation Haughton by John C**.** Webster (Mifflis Co**.** Boston USA).
11. Bio-Medical Instrumentation – Dr. M. Arumugam, Anuradha Agencies, 2005.

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BME 507 Medical Imaging & Image Processing

M.Tech. Semester – I (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit I Introduction to Atom:

Review of atomic structure and atomic particles with their properties, nuclear transitions and radioactive nuclei.

Unit II Medical Imaging Modalities:

Electron transitions and the generation of X-rays; Characteristics of X-ray beam and interaction with matter. Generation and detection of X-rays (radiography techniques). Principle and Theory of computer tomography (CT) scanning, spiral CT scanning & (positron emission tomography) PET scan.

Physics of Nuclear Magnetic Resonance (NMR) imaging and its application in the field of diagnostics. Gamma camera, single photon emission computer tomography (SPECT) and other latest Medical imaging systems.

Physics of ultrasound imaging, uses in diagnosis, Image quality description & patient risk, Theory and applications of optical, thermography imaging.

Unit III Basics of Image Processing:

Basics physics of imaging systems, fundamental of image processing, Information content of an image, Digital Image representation, Elements of digital Image Processing System. Image Transforms-Discrete Fourier Transform and properties, Separable Image Transforms. Image Enhancement, Image Restoration, Image segmentation, Image Reconstructions from projections. Data compression techniques-DPCM, Vector quantisation, JPEG, MPEG, Wavelet Transforms. Brief description of digital image production in CT, MRI, Ultrasound, PET and SPECT.

Textbooks/References:

1. Albert Macouski, Medical Instrumentation, Prentice Hall
2. A Sorenson & Phelps, Physics of Nuclear Medicine, W.B. Saunders and Co., 1987.
3. Jain A.K., Digital Image Processing, PHI, 1989.
4. Hicho.Z. et.al. , Fundamentals of Medical Imaging, John Wiley.
5. Encyclopaedia of Medical Devices and Instrumentation Vol. I , II, III, IV by John G. Webster, Wiley Publication
6. Biomedical Signal Analysis – A Case Study Approach By Rangaray M. Rangayyan, (John Wiley and Sons Inc)
7. Digital Image Processing – Rafel C. Gonalez and Richard E. Woods (Pearson Education.
8. Digital Image Processing and Analysis – B, Chandaand D. Dutta Najumdar (Eastern Economy Edition)
9. Christensen's Physics of Diagnostic Radiology, Thomas, James, Robert C. Murry Lea & Febiger London 1990.
10. K. Kirk Shung, Michael B Smith, Benjamin Tsui, Principles of Medical Imaging, academic Press, inc., London, 1992.
11. Carr & Brown, Introduction to Biomedical Equipment, Pearson Education, 2005.

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BME 509 Microprocessor and Microcontroller for Medical Instrumentation

M.Tech. Semester – I (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit I Introduction to Microprocessors:

Basic instruction set and architecture of 8085 and 8086 microprocessor. Applications of 8085 and 8086 microprocessors.

Unit II Introduction to Microcontrollers:

Working and Architecture of 8237 DMA controller and 8259. Basic architecture and instruction set of 8051 and AVR microcontroller with their applications.

Unit III: Applications of Microprocessors & Microcontrollers in Medical Instrumentation:

High speed digital design, Multi-layer PCB design, Mixed signal processing, Interfacing sensors – Blood pH, PO_2, PCO_2, Temperature, Optical, Displacement, blood flow. User interface - Message display unit, direct host control, Remote host control, LAN, GPIB interface, Interrupt handling, Analog interface, Add-on interface. Internet enabled Instruments, Portable instruments design. Typical applications: Spectrophotometer, Blood cell counter, Densitometer, aeromist.

Textbooks/ References:

1. The 8051 Microcontroller and Embedded Systems by Muhammad Ali Mazidi, Jainice Gillispe (Pearson Education)
2. Microcontroller Handbook – Intel
3. The 8051 Microcontroller, Architecture, Programming and applications by Kenneth J. Ayala, (Penram International)
4. Programming and customizing 8051 Microcontroller by Myke Predco, TMH.
5. Micro controllers & its applications by B.S. Chhabra, Dhanpat Rai Pub. Co., India
6. 8051 μC, Scott Mackenizie, PHI, Englewood Cliffs, New Jersey.
7. Myke Predko,'Programnming & Customizing the 8051 Microcontroller,' Tata McGraw-Hill Pub. Co. Ltd., New Delhi.
8. Microprocessors and interfacing: Hall; TMH
9. The 8088 & 8086 Microprocessors-Programming, interfacing, Hardware & Applications :Triebel & Singh; PHI
10. Microcomputer systems: the 8086/8088 Family: architecture, Programming & Design: Yu-Chang Liu & Glenn A Gibson; PHI.
11. Advanced Microprocessors and Interfacing: Badri Ram; TMH.

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BME 511 Biomedical Instrumentation & Microcontroller Lab

M.Tech. Semester – I (Biomedical Engineering)

L	P			
0	2	Class Work	:	50 Marks
		P/VV	:	50 Marks
		Total	:	100 Marks
		Duration of Exam	:	03 Hours
		Credits	:	02

LIST OF EXPERIMENTS

1. Study of pulmonary function analyser using spirogram.
2. To study stress test analysis system (TMT) available in the laboratory
3. Designing of instrumentation amplifier using operational amplifier.
4. Using PC based Physiology Lab for Bio-signal analysis.
5. To determine Bradycardia and Tachycardia using ECG Trainer Kits.
6. To study and use Advance Biofeedback equipment available in the laboratory.
7. Circuitry explanation for patient leakage current.
8. To determine balancing condition for thermistor using wheat stone bridge.
9. To study of pressure changes using strain gauge transducer.
10. To Study defibrillator machine.
11. Design and realize synchronous/ asynchronous pacemaker using microcontroller.
12. To study and record ENG waveforms using ENG system available in the laboratory.
13. Study of Pacemaker with simulator circuit
14. To study different EEG waveforms using EEG Trainer kit.

Note: Ten experiments are to be performed selecting any seven experiments from the above list. Remaining three experiments may either be performed from the above list, or designed and set by the department as per the scope of the syllabus.

BME 513 Medical Imaging & Image Processing Lab

M.Tech. Semester – I (Biomedical Engineering)

L	P			
0	2	Class Work	:	50 Marks
		P/VV	:	50 Marks
		Total	:	100 Marks
		Duration of Exam	:	03 Hours
		Credits	:	02

LIST OF EXPERIMENTS

1. Background on MATLAB & the Image processing tool box.
2. Digital Image representation.
3. Histogram Processing & Function Plotting.
4. Study various Ultrasound modes- A mode, B mode, AB mode, C mode and M mode.
5. Spatial filtering in Ultrasound Images & Speckle noise removal.
6. Generating Frequency domain filter.
7. Weiner filtering in Medical Images.
8. Constrained Least square filtering.
9. Colour Image Representation in MATLAB
10. Background on compression Techniques.
11. To study the construction and working of X-Ray equipment.

Note: Ten experiments are to be performed selecting any seven experiments from the above list. Remaining three experiments may either be performed from the above list, or designed and set by the department as per the scope of the syllabus.

BME 502 Biomechanics and Rehabilitation Engineering

M.Tech. Semester – II (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit I: Introduction: Biomechanics**,** Kinesiology**,** Kinematics and Dynamics of Motion, Types of Motion**,** Kinematics Concepts, Vectors & Trigonometry, Position of Anatomical Axis & Corresponding Movements of the Body Part.

Unit II: Tissue Biomechanics: Mechanics of Hard Tissue, Musculoskeletal Soft Tissue Mechanics, Joint-articulating Surface Motion, Cochlear Mechanics, Vestibular Mechanics

Unit III: Biofluid Mechanics: Basic Concepts; Mechanics of Heart, Lungs, Blood Vessels, Heart Valves.

Unit IV: Gait and Sports Biomechanics: Gait Terminology, Analysis of Gait, Exercise Physiology, Factors Affecting Mechanical Work in Humans.

Unit V: Prosthetics and Orthotics: Classification, Upper Limb prosthesis, Lower Limb prosthesis, Spinal Orthosis, Recent Advances in Prosthesis and Orthosis; Neural Prosthesis

Unit VI: Rehabilitation Engineering: Introduction to Rehabilitation, Rehabilitation Team, Principles of Assistive Technology Assessment, Sensory Rehabilitation- Tactual, Auditory, Visual, Speech.

Textbooks/ References:

1. Biomechanics-Principles & Applications by Schnek & Bronzino, CRC Press
2. Biomedical Engineering Handbook by J D Bronzino, CRC Press
3. Introduction to Biomedical Engineering by John D Enderle, Academic Press Series
4. Applied Biofluid Mechanics by Lee Waite & Jerry fine, McGraw Hill
5. Biomechanics-Principles & Applications by Peterson & Bronzino, CRC Press
6. Cytoskeletal Mechanics: Models & Measurements by Mofrad & Kamm, Cambridge Press
7. Dynamics of the Vascular System by John Li, World Scientific Publishing Co.
8. Fung Y.C., Biomechanics,Springer Verlag,1984.
9. Text book of Rehabilitation by S Sunder, Jaypee Publishers
10. The Physics of Coronary blood Flow by M Zamir, Springer Publishers

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BME 504 Advanced Biomedical Signal Processing

M.Tech. Semester – II (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit I Bio-signals and their Characteristics:

Introduction**,** Characteristics of Bio - Signals**,** Types of Signals**,** Measurement**,** Transformation and reduction**,** computation of signal parameters that are diagnostically significant**,** stationary and non - stationary bio - signals**,** Application areas of Bio - Signals analysis, Signal Sampling and conditioning techniques, Digital signals and systems: Introduction, Classification of systems causal, time varying, time invariant, lumped. DFT properties-Frequency Domain Analysis of Signals, FFT Algorithms, Digital Filter Design.

Unit II Time Domain Modelling:

AR modelling, Spectral Estimation, Data Compression Techniques-Wavelet Transformation, Vector Quantization, Linear and Non Linear prediction of Biosignals, Waveform detection and Pattern Recognition.

Unit III Digital Signal Processing Techniques:

DSP fundamentals review, efficient computation of DSP, Wavelet transforms, Advanced DSP processor features and architecture [SHARC], Digital communication, biomedical applications, Neuro-electric waveform analysis, DSP for elderly / disabled people. Motor Control, Speech recognition, Speaker Identification & Verification.

Data reduction Techniques, Power spectrum analysis, Sampling Theorem, aliasing Nyquist criteria, ADC's and DAC's. Convolution, Auto-correlation and cross-correlation. Study and application of Matlab signal processing toolbox on various real bio - medical signals**.**

Textbooks/ References:

1. Cohen, Biomedical Signal Processing, Vol 1&2, CRC Press, 1986.
2. Tompkins W.J., Biomedical Digital signal Processing, Prentice Hall, 1993.
3. Smart sensors By Chapman (ISA handbook)
4. Electrical Transducer Nomenclature & Terminology, 1975 (Reaffirmed 1982), ISA
5. Sensors handbook By Solomon
6. Biosensors By Brayan Eggins
7. Fiber optics sensors By Eric, Vdd (Wilen Intev Science)
8. Digital Signal Processing By Proakis, PHI Publications.
9. Digital Signal Processing By Openhein Schafer
10. Digital Signal Processing By Rabinar Gold
11. Wavelet Transform by Raghuveer M. Rao, Ajit S. Bopardikar (Pearson Education).
12. Signal Analysis by R**.** P**.** Singh, Second edition Tata McGraw **–** Hill.

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BME 506 Bio-Mathematics

M.Tech. Semester – II (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit-I: Introduction the scope and purpose of statistics, types of data, estimation and measurement, errors **.** Descriptive and summary statistics, means, SD**,** SEM**,** Median**,** centiles**,** outliers**,** missing data**.** Elements of Probability**.** Measurements, Probabilities and distributions**.** Conditional probabilities**.** Bayes theorem**.** ROC curves**.** Diagnostic use of probabilities**.** Methods of uncertainty reasoning**.**

Unit-II: Estimation, hypothesis testing: Confidence limits for means, t-distribution, chi-square distribution. Confidence limits for variances, t-tests, comparisons of variances Comparisons of several means: Analysis of Variance, A priori tests, A posteriori tests Two and three-way analysis of variance, Analysis of covariance.

Unit-III: Statistical Quality Control: Introduction, control charts of all types, ISO 9000 series & their importance, OC curves, advantages & limitations of SQL in industries.

Unit-IV: Random Variables & theoretical distributions: Discrete & continuous frequency distributions, stochastic process, Markovian chain, simulation techniques.

Unit-V: Reliability Theory: Theory of reliability, maintainability, availability, failure distribution, state dependent systems, series & parallel connection, redundancy of systems.

Unit-VI: Linear Programming Problems: Introduction & formations of the problems, graphical method, simplex method, duality concept in LPP & solution of the dual.

Unit-VII: Regression and correlation: Simple and multiple regression, nonlinear fitting, correlation nonparametric statistics, goodness of Fit tests, resampling methods, role of Computer in solving biostatistical problems.

Unit-VIII: Mathematical modeling and solution of biomedical problems namely respiratory rate, blood flow, cardiac output and impedance diffusion, ultra filtration etc. Operational research applied to the description of physiological systems and signal processing by interfacing instrumentation. Perturbation technique in dealing with the problems of thermodynamics.

Textbooks/ References:

1. Mathematical Biology: Murray, J.D. Vol. I, II,Springer- 2007.
2. A Brief on Tensor Analysis: James Simmonds, Springer-Verlog, 2005
3. A quick introduction to *tensor analysis*: Ruslan Sharipov
4. Numerical methods by S. S. Sastry, (Pearson Education)
5. Statistical methods by S. P. Gupta.
6. George Dassios, Dimitrios I Fotiadis, Christos V Massalas, Kiriakie Kiriaki, Mathematical Methods in Scattring Theory and Biomedical Technology, Chapman 7 Hall/CRC; 1 edition 1998.
7. Reliability & Maintainability Engg. By Charles E. Ebeling, (Pearson Education Mc- Graw Hill).
8. Operations Research by S. D. Sharma, Kedar Nath Ram Nath Company,Meerut.

9. Modern Medical Statistics: A Practical Guide by Brian S. Everitt, published by Edward Arnold, 2003.
10. Biostatistics by S. Prasad, S.Chand.
11. Biostatistics by Negi, K.S., Rastogi Publisher.
12. Introduction to Biostatics by P.K. Banerjee ,S.Chand.
13. Basic Statistics: A Primer for the Biomedical Sciences by Olive Jean Dunn, and Virginia A. Clark, Wiley - Interscience, 3rd edition, 2001.
14. Biomedical Statistics with Computing by M. H. Reigier, et al, John Wiley & Sons, 1982

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BME 508 Advanced Tissue Engineering

M.Tech. Semester – II (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

UNIT I

Introduction, structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing. Cell culture- Different cell types, progenitor cells and cell differentiations, different kind of matrix, cell-cell interaction. Aspect of cell culture: cell expansion, cell transfer, cell storage and cell characterization, Bioreactors.

UNIT II

Molecular biology aspect- Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, and Cell surface markers.

UNIT III

Introduction to biomaterials and scaffolds, Criteria of modifying biomaterials as tissue engineering scaffolds, Properties and types of scaffolds, Different methods employed in the synthesis of scaffolds, animal cell biology, stem cells, organization of cells into tissues, tissue microenvironment, tissue injury and wound healing 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver.

UNIT IV

Basic immunology, response of body to foreign materials. Animal cell culture on scaffolds, consequences, optimization strategies and important considerations for Skin, Liver, Bone, Cartilage, Nerve and Vascular tissue engineering; Case study and regulatory issues-cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues.

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Textbooks/ References:

1. Bernhard Palsson, Sangeeta Bhatia ,*Tissue Engineering*, Pearson Prentice Hall, 2003

2. Robert. P.Lanza, Robert Langer & William L. Chick, *Principles of tissue engineering*, Academic press,1997

3. Gordana Vunjak-Novakovic, R. Ian Freshney, *Culture of Cells for Tissue Engineering*, WIS, 2006

4. B. Palsson, J.A. Hubbell, R.Plonsey & J.D. Bronzino, *Tissue Engineering*, CRC-Taylor & Francis

5. Joseph D., Bronzino *The Biomedical Engineering –Handbook*, CRC; 3rd edition , 2006

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.

2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 510 Medical Informatics and Telemedicine

M.Tech. Semester – II (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit I Introduction to Medical Informatics:

Introduction to medical informatics, historical review of development of computers and informatics, structure of medical informatics, Application and importance of Medical informatics**,** Natural language processing, Knowledge and Models**,** Information and Communication Systems**,** Medical Computer Systems - Systematization of Computer Applications.

Unit II Management of Medical data:

Classification of medical data and information**,** uncertainty of medical data, examples of classification systems. Database management, development of database management system for a hospital environment.

Unit III Security Issues:

Security Issues in Computer and Internet: Different types of security hazards and methods for prevention of these hazards. Information Safety and Security in Health Care Information Systems.

Unit IV Applications of Computers in Medical Field:

Computers in Clinical Laboratory: Role and Applications of different equipments employing computer in medical laboratory. Computers for Critically ill/handicapped: Role and Applications of different devices for handicaps and severely ill patients.

Health Care Information Systems: Introduction**,** Electronic Patient Record**,** Electronic referral - consulting system**,** Primary Care Systems**,** Clinical Departmental Information Systems**,** Clinical Support Systems**,** Nursing Information Systems.

Evaluation of health information systems and Technology. Introduction to Bio-informatics and computational biology.

Unit V Introduction to Telemedicine:

Role of Telemedicine in healthcare, current applications of Telemedicine, medical peripheral devices, clinical education, hand held computers (PDA), Computer assisted surgery - Robotics, and computer assisted drug delivery.

Unit VI Computers & Artificial Intelligence:

Medical decision - support systems, Medical Expert System. Rationales for computer - aided decision making**,** Decision models - quantitative models**,** qualitative models**,** Knowledge Based systems - characteristic features of KBS**,** knowledge representation in KBS**,** Artificial intelligence methods

Textbooks/ References:

1. Computers in Medicine: Progress in medical informatics – R.D.Lele, Tata McGraw Hill 2005.
2. J**.** H**.** van Bemmel and M**.** A**.** Musen (eds**.)**, Handbook of Medical Informatics**.** Bohn Stafleu Van Loghum**,** Houten 1997.
3. Enrico Coiera**:** Guide to Medical Informatics**,** the Internet and Telemedicine**.** Chapman & Hall Medical**,** London 1997**.**
4. Bronzino JD**,** The Biomedical Engineering Handbook**,** IEEE Press**,** 2000

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 512 Advanced Biomedical Signal Processing Lab

M.Tech. Semester – II (Biomedical Engineering)

L	P			
0	2	Class Work	:	50 Marks
		P/VV	:	50 Marks
		Total	:	100 Marks
		Duration of Exam	:	03 Hours
		Credits	:	02

1. To study different types of biosensors available in the laboratory.
2. Design a low pass filter and plot graph of gain versus frequency.
3. Design a high pass filter and plot graph of gain versus frequency.
4. Design a band pass filter and plot graph of gain versus frequency.
5. Study data reduction techniques using Digiscope.
6. Using digiscope study waveform generation and power spectrum analysis.
7. Designing of IIR and FIR filters using digiscope.
8. To study different ADC & DAC systems available in the laboratory.
9. Study the cross correlation, auto correlation and convolution functions using digiscope.
10. Develop a MATLAB program to perform synchronized averaging for a noisy signal.
11. Write a MATLAB program to compute RMS value at each instant for the EMG signal.
12. Write a MATLAB program to compute the wavelet coefficients for EEG signal using continuous wavelet transform.
13. Write a MATLAB program for performing discrete wavelet transform of the various bio-signals.

Note: Ten experiments are to be performed selecting any seven experiments from the above list. Remaining three experiments may either be performed from the above list, or designed and set by the department as per the scope of the syllabus.

BME 514 Biomechanics lab

M.Tech. Semester – II (Biomedical Engineering)

L	P			
0	2	Class Work	:	50 Marks
		Theory	:	50 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	02

1. Stress strain analysis of lower limb using BIOPAC.
2. Stress strain analysis of upper limb using BIOPAC.
3. To study the hardness of given bone using hardness tester/UTM.
4. To determine the moment of Inertia of a stepped pulley or a flywheel**.**
5. To study recording and analysis of EMG signals using Biopac MP-100 system available in the laboratory.
6. To verify Bernoulli's Theorem**,** for fluid flow through pipes**.**
7. To study cardio- EMG analysis using ergometry and TMT system available in the laboratory.
8. To study muscle force using dynamometer**.**
9. To study EMG signal analysis using Advance Biofeedback system available in the laboratory.
10. To determine the center of gravity of human body.

Note: Ten experiments are to be performed selecting any seven experiments from the above list. Remaining three experiments may either be performed from the above list, or designed and set by the department as per the scope of the syllabus.

BME 601 Patient Safety, Ethics & IPR Issues

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit I: Introduction to Biomedical Ethics:

Sources of Medical Law and Ethics, Nature and sources of medical ethics, Sources of medical law, Value theory Risk and Reliability-Decision theory, Injury and damage control, Epidemiology of accidents, Human tolerance to energy inputs, Biomedical & Biomechanics aspects of long term exposure to hazardous environment. Standards, Ethics & IPR issues related to biomedical engineering.

Unit II: Medical Legal Issues:

The law in relation to abortion, the ethics of abortion, Reproductive Technology and surrogacy, the law in relation to end of life issues, the ethics of end of life issues and Research.

Unit III: Device regulation standards:

Classifications and requirements of Medical devices, Harmonized standards, CE approval, Quality Assurance and Quality Control – Definition of quality, quality management, principles of TQM, measures for Quality Control. Safety & Testing of Medical devices – patenting norms and related issues.

Unit IV: Maintaining professional standards:

Maintaining standards and regulation, presenting evidence and reports, the Coroner's court, the General Medical Council, rights of Doctors.

Textbooks/ References:

1. Patents by N.R. Subbaram, Pharma Book Syndicate, Hyderabad, 2003.
2. Singh K, Intellectual Property Rights on Biotechnology, BCIL, New Delhi.
3. Ronald Munson's *Intervention and Reflection: Basic Issues in Medical Ethics 5th Ed.*
4. Ethics of Health Care: An Introductory Textbook by Benedict M. Ashley, Kevin D. O'Rourke, Georgetown University Press; 3rd edition, 2002
5. Introduction to Bio-Medical Engineering by John D. Enderle, Susan M. Blanchard & Elsevier (Academic) press, 2nd edition, 2005.

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 603 Soft Computing Methods for Biomedical Engineers

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit I: Introduction to MATLAB: Introduction, Desktop, Environment, Matrices, MATLAB features & Advanced Data Objects, Toolboxes-Data Acquisition, Image Processing, Signal Processing, Neural Network, Genetic Algorithm, Partial Differential (FEM, FDTD), Optimization, Fuzzy logic, Simulink, Wavelets. Introduction - LAB VIEW.

Unit II: Introduction & Fuzzy Systems: Introduction to Soft Computing Concepts, Fuzzy sets, Membership functions, Extension principle and Fuzzy relations, Composition of Fuzzy relations, Fuzzy Relation Equations, Arithmetic Operations on Fuzzy numbers, Fuzzy if-then rules, Fuzzy reasoning, Fuzzy inference systems, Types of Fuzzy rule based models, Decision making in Fuzzy Environment, Fuzzy Multi criteria analysis, Fuzzy linear programming. Fuzzy Neural Networks. Problems of learning and formalization, Development of Fuzzy models with specific reference to Bio-medical Engineering.

Unit III: Artificial Neural Networks: Introduction to Neural networks. First model of NN, Kinds of learning rules of NN, types of neural networks, error back propagation methods, application in classification of bio-signals and Matlab implementation.

Unit IV: Genetic Algorithms: Foundations of Genetic Algorithms, various operation of GA, GA programming.

Unit V: EMI/EMC with Matlab Simulations: Introduction, Natural and Nuclear sources of EMI / EMC, Conducted EM noise on power lines, Conducted EMI from equipments, Immunity to conducted EMI detectors and measurements, Grounding, shielding, Bonding and EMI filters, EMI suppression techniques.

Textbooks/ References:

1. Fuzzy sets and system, G Klir, PHI.
2. Keeman V, Learning and soft computing, MIT, 2001.
3. J. S. R. Jang, C. T. Sun and E. Mizutam Neuro-Fuzzy and soft Computing, PHI, 2004, Pearson Education, 2004.
4. Engineering Electromagnetic Compatibility by Dr. V.P. Kodali, IEEE Publication, Printed in India by S. Chand & Co. Ltd., New Delhi, 2000.
5. Introduction to Electromagnetic Compatibility, Ny, John Wiley, 1992, by C.R. Pal.
6. Rudrapratap Singh "Getting Started with Matlab", Oxford University Press.
7. Sanjay Gupta, Joseph John, "Virtual Instrumentation using LabVIEW", Tata McGraw Hill Publishing Company Limited, New Delhi.
8. "An Introduction to Fuzzy Control, D. Driankov, H.Hellendoorn & M. Reinfrank. Pub: Narosa Pub. House, New Delhi.

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 605 Advanced Biomedical Instrumentation

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit I: Instrumentation and Measurement: Evolution of medical instrument, components of a medical instrumentation system, Problems encountered in a measuring system, Biofeedback instrumentation. Measurement system-specification of instruments, static & dynamic characteristics of medical instruments. statistical analysis - reliability, accuracy, fidelity, speed of response, linearization technique, data acquisition system.

Unit II: Impedance Techniques: Detection of physiological parameters using impedance techniques: Impedance and current distribution, bipolar and tetra polar circuits, skin impedance, galvanic skin response measurement, total body impedance, cardiac output, neural activity, respiratory activity, impedance plethysmography.

Unit III: Biomedical Amplifiers: Special features of bioelectric amplifiers, safety requirements, realization of bioelectric amplifiers, carrier amplifiers, chopper amplifiers, phase sensitive detector, isolation amplifiers, and instrumentation amplifiers.

Unit IV: Recording and Processing Systems: Recording of bioelectric events-Analog recording system, digital recording and data logging including the use of micro-processor and flash memory chips. Recording of ECG, EMG, ENG, EOG & EEG signals.

Unit V: Patient monitoring systems: Holter monitor and cardiac stress test. Components of patient monitoring system, sources of artifacts & their implication, organization and equipments used in ICCU & ITU. Computer assisted patient monitoring system. Patient safety and electromedical equipments.

Textbooks/ References:

1. Cromwell, Weibell & Pfeiffer, Biomedica*l* Instrumentation & Measurement, Prentice Hall, India: 2nd. Edn. 2003
2. J. Webster, Bioinstrumentation, Wiley & Sons.2004.
3. Joseph Bronzino, Biomedical Engineering & Instrumentation, PWS Engg. Boston.3rd Edn.
4. John Enderle, Bioinstrumentation, Morgan & Claypool Publisher 2006.
5. R. S. Khandpur Handbook of Bio-Medical Instrumentation, Tata McGraw Hill, 2003
6. Carr & Brown, Introduction to Biomedical Equipment Technology, Pearson Education, Asia.4th Edn.

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

Elective

BME 607 Fibre Optics and Laser for Medical Applications

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

UNIT-I Introduction to Fiber Optics: Principles of light, Introduction, EM spectrum, Internal & External Reflections, Snell's law, Optical Fiber Numerical Aperture, Fresnel Reflection, Fiber Optic Properties, Basic Fiber Optic Construction, Attenuation & Losses

UNIT-II Optical sources & Photo Detectors: Creation of Photons, LED, ILD, Photodetectors- Characteristics, Types of Photodiodes, Photodiode Parameters, Detector Noise, Speed of Response, SNR.

UNIT-III Connectors, Splices & Couplers: Introduction, splices: mechanical, fusion, protection of splice, connectors: SMA, STC, bionic etc, coupling: passive, Stan, TEE types.

UNIT-IV Modulation scheme for Fiber Optics Transmission: Introduction, Digital Modulation and Analog Modulation Schemes, Multiplexing.

UNIT-V Laser Systems: Types of lasers: Solid state lasers, Gas lasers, Dye lasers, Lasers used in medical practice- Principle, Instrumentation, Advantages, Limitations, Laser Safety Aspects, etc.

UNIT-VI Laser-Tissue Interactions: Light and Matter, Terminology : spectral band designations, energy & power,irradiant & radiant exposure, fluence, thermal diffusion fibers & contact tips, Interaction Mechanisms- Photochemical Interaction, Thermal Interaction, Photoablation, Plasma-Induced Ablation, Photodisruption.

UNIT-VII Applications of Lasers in Medicine: Application in general surgery, dermatology, ophthalmology, cardiovascular & chest surgery, dentistry, neuro surgery, otolaryngology & head and neck surgery, tumor surgery, gynecology, orthopedics, gastroenterology.

Textbooks/ References:

1. Laser Tissue Interactions- Fundamentals and Applications by Marfolf H Niemz, Springer Publishers
2. Therapeutic Lasers -Theory and Practice by G. David Baxter, Churchill Livingstone Publications.
3. Medical Lasers and Their Safe Use by David H Shiney, Stephen and L. Trokel, Springer-Verlag Publications.
4. Intermediate Physics for Medicine and Biology by Russell K Hobbie and Bradley J Roth, Springer Publishers
5. Fiber Optics Communication by Senior
6. Optical Communication by Keiser

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 615 Bio-nanotechnology

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

UNIT I

Introduction to Bio-Nanotechnology, Cellular nanostructures, self-assembly of colloidal nanostructures of biological relevance, bioactive nanoparticles (respiratory surfactants, magnetic nanoparticles),

UNIT II

Nanoparticles for drug delivery (including solid lipid nanoparticles, synthetic and biopolymeric nanoparticles), carbon nanotubes, polymeric nanofibers, Implications in neuroscience, tissue engineering and cancer therapy,

UNIT III

Environmental and safety aspects of bio-nanotechnology. Introduction to Nanotechnology, Multilayer Thin Film: Polyelectrolyte multilayers, coated colloids, smart capsules, LbL self-assembly, Colloids and Colloid Assemblies for Bio-nanotechnology.

UNIT IV

Nanoengineered biosensors, Fiber Optic Nano-sensors in medical care, Semiconductor and Metal Nanoparticles: Synthesis and Applications, Nanotechnology in Tissue Engineering, Microemulsions and Drug Delivery in Nanotechnology.

Textbooks / References:

1. Gero Decher, Joseph B. Schlenoff, Multilayer Thin Films, Wiley-VCH Verlag GmbH & Co. KGaA, 2003
2. David S. Goodsell, Bionanotechnology : Lessons from Nature, Wiley-Liss , 2004.
3. Kenneth J. Klabunde , Nanoscale Materials in Chemistry. , John Wiley & Sons, Inc., 2001

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 617 Biological Control System

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

UNIT I

Introduction to Technological Control System, Transfer functions, Mathematical Approaches, System Stability, Feedback Concept and Stability Analysis.

UNIT II

Introduction to Biological Control System, similarities and differences, Transfer of substances between compartments, Biological receptors, characteristics, Transfer function model, Bio feedback.

UNIT III

Regulation of acid-base balance, Endocrine Control, Regulation of Extra cellular Water and Electrolyte. Introduction to Various Process Controls like Cardiac Rate, Blood Pressure, Respiratory Rate and Blood Glucose Regulation. Pharmaco Modelling- Drug distribution System, Regulation of Interstitial Fluid Volume and Precontrol in Material Exchange. CO_2 regulations.

UNIT IV

Modelling of Human Thermal Regulatory System, Parameters Involved, Control System Models etc. Biochemistry of Digestion. Type of Heat Loss from the Body, Model of Heat Transfer between Subsystems of Human Body like Skin, Core, etc., and System within Body, Body Environment etc.

UNIT V

Respiratory control system, Modelling of O_2 Uptake, Mass Balancing by Lungs, Gas Transport Mechanism of Lungs, O_2 and CO_2 Transport in Blood and Tissue. Introduction to Eye Tracking and Control. Cardio Vascular Control System, Servo mechanism, pupil control system.

UNIT VI

Matlab in Control Applications. Desing of Biomedical Control Systems, few Case Studies.

Text/ Reference Books:

1. Rushmer, "Medical Engineering" Academic Press, New York, 2001.
2. Ibrell and Guyton, "Regulation and Control in Physiological System" Schwan, "Biological Engineering, CRC Press, 2002.
3. Milhorn, "The Applictions of Control Theory to Physiological System" J.H. Milsum, "Biological Control System" W. B. Saunders Co, (Japanese Edition), Translated by Isamu Suda, Tokyo, 1969.
4. B.C. Kuo, "Automatic Control System" Prentice Hall of India 2004.
5. D.O. Cooney, "Biological Engineering Principles" Marcel Dekker, Inc. 2002.
6. Matlab, "Users Manual".

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 619 Diagnostic Imaging And Radiation Biology

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

UNIT I

Review of atomic structure and atomic particles : electrons, protons, neutrons, positrons, neutrinos, etc.; Classification of elements as per the periodic table; Atomic transitions - electron transitions and the generation of x-rays; Nuclear transitions and radioactive decay of nuclei.

UNIT II

Characteristics of x-ray beams; Interaction with matter; Attenuation and interaction of x-rays in the human body; Films and fluoroscopic screens;

UNIT III

Detrimental effects of radiation; Radiation safety and dosimetry; Overview of generation of radioisotopes,radioisotopes,radiotherapy

Physics of Nuclear Magnetic Resonance and its application in the field of diagnostic medicine.

UNIT IV

Wave fundamentals,generation of ultrasound,Interaction of Ultrasound with tissue; Physics of ultrasound imaging; Uses in diagnosis.

Textbooks / References:

1. Richard P. Feynman, Robert B. Leighton, Matthew Sands: Feynman lectures on physics, Vol 2 & 3 Narosa Pub., 1986.
2. Albert Macovski: Medical imaging systems, Prentice-Hall, Englewood Cliffs, 1983.
3. W.R.Hendee &E.R. Ritenour, Medical Imaging Physics,3rd edition,Mosbey year Book,Inc.,1992.

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 621 Biomedical Entrepreneurship

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

Unit I: Introduction:

Meaning, definition and functions of an entrepreneur, qualities of a good entrepreneur, role of entrepreneur in economic development of a country, Government measures and policy in developing entrepreneurship and promotion of small scale industries. Problems faced by SSI related to marketing, management of new products, power, finance, raw material, capacity, rehabilitation of sick units.

Unit II: Financial Institutions:

Commercial banks and term lending in India, role of different financial agencies in promoting entrepreneur viz. Finance Corporation of India, State Financial Corporation, Industrial Development bank of India, Unit Trust of India.

Unit III: Role & responsibilities of a Biomedical Engineer in society:

Duties of a biomedical engineer, scope areas and opportunities for Entrepreneurship in Biomedical Engineering.

Textbook/ References:

1. Entrepreneurship of Small Scale Industries-Deshpande Manohar D. (Asian Publishers, New Delhi).
2. Environment and Entrepreneur- Tandon B.C. (Asian Publishers-New Delhi).
3. Emerging Trends in Entrepreneurship in Entrepreneurship Development Theories & Practices-Singh P. Narendra (Int. Founder, ND).
4. Entrepreneur, Banker & Small Scale Industries-Bhattacharya Hrisnikes.

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 623 Hospital Management

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

UNIT I: Organisation and Planning of the Hospital: Organisational structure: Governance, Duties and responsibilities of the governing board, Management structure: Duties, responsibilities and functions of the CEO, Hospital information System: Benefits, Organisation, Layout, Survey, Financial planning, Equipment planning.

UNIT II: Medical and Auxiliary Services: Emergency services, Clinical laboratories, Radiological services, Diagnostic radiology, Radiation therapy department, Nuclear Medicine, Surgical Department, Physical Medicine and Rehabilitation, CATH lab, OT: Design and related equipments.

UNIT III: Nursing Services: General nursing unit, Central Nurse Station, Paediatric nursing unit, Isolation rooms, Intensive Care Unit(ICU), Coronary Care Unit(CCU), Newborn nurseries.

UNIT IV: Engineering and Biomedical Engineering Department: Engineering department: Functions, Location, Design, Organization, Maintenance management. Biomedical Engineering department: Functions, Designs, Space facilities, Utilities, Hospital wiring system.

UNIT V: Hospital Services: Electrical system, Air conditioning services, Centralised gas system, Communication systems, Transportation, CSSD.

UNIT VI: Safety and Security in the Hospital: Hospital safety rules, Security and loss prevention, Fire safety, Bomb threat, Alarm systems, Disaster and Disaster preparedness plan, Safety codes for electrical and medical equipments, Medical standards for hospitals and equipments.

Text Books/ References

1 G.B. Kunder and Gopinath, "Hospital Planning, Design and Management", Tata McGraw Hill.

2 S. L. Goel and R.Kumar, "Principles of Hospital Administration and Planning", Deep and Deep Publications.

3 Barry Feinberg, "Applied Clinical Engineering", Prentice Hall.

4 John Webster and Albert Cook, "Clinical Engineering Principles and Practices", Prentice Hall.

5 H. David Banta, Bryan Luce, "Health Care Technology and its Assessment", Oxford Medical Publications.

6 B M. Sakarkar, "Principles of Hospital Administration and Planning", Jaypee Publications.

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 625 Ergonomics

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

UNIT I

Introduction to Ergonomics and its application; Man-Machine-Environment System; Anthropometry and joint motions; Work Posture, Environmental factors and human performance.

UNIT II

Designing of Controls and Displays, Control panel Organization; Principals of product design; Problem solving;

UNIT III

Frequent types of injuries related to work place design, repetitive motion, and cumulative trauma disorders, preventing ergonomics related injuries by redesigning the work place.

UNITIV

Seminar on ergonomics related issues in Medicine.

Textbooks/ References

1. E.J. McCormick : Human Factors in Engineering and Design, Tata Mcgraw-Hill, 1976.
2. O.P. Astrand & R. Kaare : Textbook of Work Physiology, McGraw Hill, 1970.
3. W.T. Singleton : The Body at Work: Biological Ergonomics, Cambridge University Press, 1982.
4. E.R. Tichauer : The Biomechanical Basis of Ergonomics, Wiley, 1978.
5. R.D. Huchingson : New Horizons for Human Factor Design, McGraw-Hill, 1981

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 627 Surface Engineering of Surgical Tools & Medical Devices

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

UNIT I

Introduction to surface engineering, Need for surface engineering of Medical implants and equipment. Surface Modification of Biomaterials, Wettability in Biomaterials Science and Modification Techniques, Atomic Scale Machining of Surfaces. Anodization, Titanium Dioxide Coatings in Medical Device Applications

UNIT II

The Effect of Shape and Surface Modification on the Corrosion of Biomedical Nitinol Alloy Wires exposed to Saline Solution.Cardiovascular Interventional and Implantable Devices ; Surface Engineering Artificial Heart Valves to Improve Quality of Life and Lifetime using Modified Diamond-like Coatings, Diamond Surgical Tools, Dental Tool Technology. Nanocrystalline Diamond: Deposition Routes and Clinical Applications Advanced techniques of modifying implant material surfaces (like Laser Surface Treatmen, PVD, CVD, ion implantation etc.)

UNIT III

Environmental Engineering Controls and Monitoring in Medical Device Manufacturing, Biomaterial-Cell-Tissue Interactions In Surface Engineered Carbon-Based Biomedical Implants and Devices, Machining Cancellous Bone Prior to Prosthetic Implantation, Bonelike Graft for Regenerative Bone Applications. Titanium and Titanium Alloy Applications in Medicine.

Textbooks/ References:

1. Jürgen Breme, C. James Kirkpatrick, Roger Thull: Metallic Biomaterial Interfaces, Wiley-VCH; 1 edition , 2008
2. D.M. Brunette, P. Tengvall, M. Textor, P. Thomsen: Titanium in Medicine: Material Science, Surface Science, Engineering, Biological Responses and Medical Applications; Springer; 1st edition; 2001
3. Jan Eirik Ellingsen, S. Petter Lyngstadaas: Bio-Implant Interface: Improving Biomaterials and Tissue Reactions: CRC Press, 2003:
4. Gerhard Rakhorst, Rutger Ploeg; Biomaterials In Modern Medicine: The Groningen Perspective ;World Scientific Publishing Company; 1 edition 2008

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 629 Bioelectricity & Bioelectromagnetism

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

UNIT I

Action potential of excitable cells: Quantitative description, Hodgkin-Huxley model, significance of parameters in Hodgkin-Huxley equations; Voltage-clamp experiments: design, and analysis of results; Factors determining the initiation, amplitudes, and kinetic properties of action potentials.

UNIT II

Passive membrane electrical properties: Cellular resistance, capacitance, time constant and space constant, methods of measurement; Importance in cellular excitation and signaling: Impulse propagation.

UNIT III

Electrophysiology of synaptic transmission: Prejunctional and postjunctional electrical events; time courses of transmitter-activated membrane currents and potentials in skeletal and smooth muscle; Electrical models of the skeletal and smooth muscle membranes.

Unit IV: Introduction to Bioelectromagnetism, the Concept of Bioelectromagnetism; Anatomical and Physiological basis of Bioelectromagnetism; Importance and History of Bioelectromagnetism.

Unit V: Bioelectric Sources and Conductors and their Modelling, Electric and Magnetic Measurement of the Electric Activity of Neural Tissue and Heart, Measurement of the Intrinsic Electric Properties of Biological Tissues. Other Bioelectromagnetic Phenomena

Textbooks/ References:

1. B. Katz: Nerve, Muscle, and Synapse, Mc-Graw Hill, New York, 1966.
2. J.G. Nicholls, A.R. Martin & B. Wallace: From Neuron to Brain, 3rd ed., Sinauer, Sunderland, 1992.
3. J.J.B. Jack, D. Noble & R.W. Tsien : Electric Current Flow in Excitable Cells, Oxford University Press, 1983.
4. R.D. Barr & R.L. Plonsey: Bioelectricity: A Quantitative Approach, Academic Press, N.Y., 1988.
5. E.R. Kandel & J. Shwartz (ed.) : Principles of Neural Science, 3rd ed., 1991
6. Robert Plonsey, Roger C.Barr, Bioelectricity:A Quantative Approach, Springer; 3rd ed.
7. Malmivuo, J. and Plonsey, R. Bioelectromagnetism: Principles and Applications of Bioelectric and Biomagnetic Fields, Oxford University Press, New York, 1995.
8. Intermediate Physics for Medicine and Biology by Russell K. Hobbie & Bradley J. Roth, fourth edition, Springer, 2007.

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME-631 Advanced Cell & Molecular Biology

M.Tech. Semester – III (Biomedical Engineering)

L	P			
4	0	Class Work	:	50 Marks
		Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam	:	03 Hours
		Credits	:	04

UNIT I

Organization of viral, prokaryotic and eukaryotic genomes: Cot curves, repetitive and unique sequences, kinetics and sequence complexities, satellite DNA, DNA melting and buoyant density ; Organelle genomes, Rearrangement and amplification of DNA in the genome.

UNIT II

DNA replication models, DNA polymerases - mode of action, DNA damage, DNA repair and recombination. RNA polymerases and reverse transcriptase: structure and mechanism of action.

UNIT III

Enzymes involved in DNA modifications, methylases, demethylases, DNases, DNA gyrase, Topoisomerase, Organization structures and function of ribonucleoproteins, Protein synthesis: Genetic code, mechanism and regulation of protein synthesis,

UNIT IV

Development, Molecular basis of development in animals and plants , Homeobox gene expression and Pattern formation in development, DNA methylation, gene expression, chromosomal inactivation and sex determination , Oncogenes, proto-oncogenes and etiology of cancer.

Textbooks / References:

1. B. Alberts, A.Johnson, J.Lewis and M.Raff, *Molecular Biology of the Cell*, Garland Science; 5th edition.

2. H. Lodish, A Berk, C.A. Kaiser and M.Krieger, *Molecular Cell Biology*, W. H. Freeman**,** 6th edition, 2007.

Note:

1. In the semester examination, the examiner will set eight questions in all, covering the entire syllabus. The students will be required to attempt only five questions.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

BME 609 Industrial/ Hospital Training

M.Tech. Semester – III (Biomedical Engineering)

L	P			
0	2	Class Work	:	50 Marks
		Practical	:	50 Marks
		Total	:	100 Marks
		Duration of Exam	:	03 Hours
		Credits	:	02

At the end of 2nd semester each student would undergo four weeks Professional Training in an Industry/ Institute/ Professional / Organization/ Research Laboratory etc. working in the area of Biomedical Engineering with the prior approval of the Training and Placement Officer of the University & Chairman of the Department and submit in the department a typed bounded report along with a certificate from the organization.

The typed report should be in a prescribed format made available by the M.Tech coordinator.

The report will be evaluated in the III Semester by a Committee consisting of three teachers from different specialization to be constituted by the Chairperson of the Department. The basis of evaluation will primarily be the knowledge and exposure of the student towards different processes and the functioning of the organization.

The student will interact with the committee through presentation to demonstrate his/her learning.

Teachers associated with evaluation work will be assigned 02 periods per week load.

BME 611 Dissertation Phase-I

M.Tech. Semester – III (Biomedical Engineering)

L	P			
0	4	Class Work	:	100 Marks
		Total	:	100 Marks
		Credits	:	04

The primary objective of this course is to develop in student the capacity for analysis & judgment and the ability to carry out independent investigation in design /development through a dissertation work involving creativity, innovation and ingenuity. The work must start with comprehensive literature search and critical appreciation thereof so as to select research problem the student wishes to work on.

Each student will carry out independent dissertation under the supervision of some teacher(s) who will be called Supervisor(s). In no case more than two supervisors can be associated with one dissertation work.

The dissertation involving design/ fabrication/ testing/ computer simulation/ case studies etc. which commences in the III Semester will be completed in IV Semester. The evaluation of the dissertation phase–I besides approval of the dissertation topic of the students will be done by a committee constituted as under:

Chairperson of Department	: Chairperson
M Tech Coordinator/ Sr. Faculty	: Member Secretary
Respective dissertation supervisor	: Member

The student will be required to submit two copies of his/her report to the department for record (one copy each for the department and participating teacher).

BME 613 Seminar

M.Tech. Semester – III (Biomedical Engineering)

L	P			
0	2	Class Work	:	50 Marks
		Total	:	50 Marks
		Credits	:	02

The objectives of the course remain:

- To learn how to carry out literature search
- To learn the art of technical report writing
- To learn the art of verbal communication with the help of modern presentation techniques

A student will select a topic in emerging areas of Engineering & Technology and will carry out the task under the supervision of a teacher assigned by the department.

He/ She will give a seminar talk on the same before a committee constituted by the chairperson the department. The committee should comprise of 2 or 3 faculty members from different specializations. The teacher(s) associated in the committee will each be assigned 2 hours teaching load per week.

However, supervision of seminar topic will be in addition to the regular teaching load.

BME 602 Dissertation

M.Tech. Semester – IV (Biomedical Engineering)

L	P			
0	6	Class Work	:	50 Marks
		Practical	:	100 Marks
		Total	:	150 Marks
		Credits	:	20

The dissertation started in III Semester will be completed in IV Semester and will be evaluated in the following manner.

Internal Assessment

Internal Assessment (class work evaluation) will be effected as per ordinance through interim report, presentation and discussion thereon by the following committee of three persons:

Chairperson of Department	: Chairperson
M Tech Coordinator/ Sr Faculty	: Member Secretary
Respective dissertation supervisor	: Member

External Assessment

Final dissertation will be assessed by a panel of examiners consisting of the following:

Chairperson of Department	: Chairperson
Respective Supervisor(s)	: Member(s)
External expert	: To be appointed by the University

Note: The External Expert must be from the respective area of specialization. The Chairperson & M Tech Coordinator with mutual consultation will divide the submitted dissertations into groups depending upon the area of specialization and will recommend the list of experts for each group separately to the Vice Chancellor for selecting the examiners with the note that an external expert should be assigned a maximum of FIVE dissertations for evaluation.

The student will be required to submit THREE copies of his/her report to the M Tech Coordinator for record and processing.