SOLAPUR UNIVERSITY, SOLAPUR
FACULTY OF ENGINEERING & TECHNOLOGY
STRUCTURE OF M.E (Part I &II)
BIOMEDICAL ENGINEERING DEPARTMENT

Semester- I Choice Based Credit System Syllabus (w.e.f.2015-16)

Sr.No	Subject	Teaching Scheme			Examination Scheme Credit		
		Lectures	Tutorials	Practical	Paper	Term work	Total
1	Human Physiology for Engineers	3	1	-	3	1	4
2	Biomedical Transducers and Sensors	3	-	2	3	1	4
3	Advanced Digital Signal Processing	3		2	3	1	4
4	Elective I	3	-	2	3	1	4
5	Elective II	3	1	-	3	1	4
6	Seminar –I	-	-	2	-	2	2
Total		15	02	08	15	7	22

Elective I Subjects
1) Embedded Systems in Biomedical Engineering
2) Biomaterials and Implants
3) Healthcare Data Base Management System
4) Nanotechnology

Elective II Subjects
1) Biological Transport Phenomenon
2) Biomedical Informatics
3) Rehabilitation Engineering

Semester-II

Sr. No	Subject	Teaching Scheme			Examination Scheme Credit		
		Lectures	Tutorials	Practical	Paper	Term work	Total
1	Biomedical Instrumentation and Circuit Design	3	-	2	3	1	4
2	Biomedical Image Processing & its application	3	-	2	3	1	4
3	Medical Imaging & its Techniques	3	1	-	3	1	4
4	Elective III	3	1	-	3	1	4
5	Elective IV	3	-	2	3	1	4
6	Seminar-II			2		2	2
Total		15	02	08	15	7	22

Elective III
1) Biorheology
2) Robotics in Biomedical Engineering
3) Neural Networks
4) Hospital Management and Information System

Elective IV
1) Pattern Recognition
2) Digital Speech Processing
3) Lasers and Fiber Optics for Therapy and Surgery

SOLAPUR UNIVERSITY, SOLAPUR
FACULTY OF ENGINEERING & TECHNOLOGY
STRUCTURE OF M.E (Part III & IV) W.E.F 2014-15
BIOMEDICAL ENGINEERING DEPARTMENT

Semester- III

Sr.No	Subject	Teaching Scheme/Hrs				Credits			
		L	T	P	Total	Credits (L)	Credits (T)	Credits (P)	Total Credits
1	Self Learning Subject	$	-	-		3.0	-	-	3.0
2	Lab Practice	-	-	2	2	-	-	1.0	1.0
3	Dissertation Phase –I: Synopsis Submission	-	-	4@	4@	-	-	3.0	3.0
4	Dissertation Phase –II Term Work*(ISE)	-	-	-	-	-	-	3.0	3.0
5	Dissertation Phase II Progress Seminar*(ESE)	-	-	6	-	-	-	6.0	6.0
Total		-	-	6	6	3.0	-	13.0	16

Note –

• $- Being a Self Learning Subject, student shall prepare for examination as per specified syllabus.
• *- For all activities related to dissertation Phase I (Synopsis Submission Seminar & progress seminar) student must interact regularly every week with the advisor.
• Synopsis submission seminar shall cover detailed synopsis of the proposed work. Student shall submit synopsis of the dissertation work only after delivering this seminar.
• Progress seminar shall be delivered capturing details of the work done by student for dissertation
• Student shall deliver all seminars using modern presentation tools. A hard copy of the seminar report shall be submitted to the department before delivering the seminar. A PDF copy of the report must be submitted to the advisor along with other details if any.

• Lab Practice shall include any of the below activities related to dissertation work and recommended by advisor. Student shall submit a report after completion of the activity to advisor– Software assignments, learning new software, hardware realization, literature survey, filed work, industrial training etc.
• @ Indicates contact hours of students for interaction with advisor.
• Details of modes of assessment of seminar and dissertation shall be as specified in 7(III) of PG Engineering Ordinance of Solapur University, Solapur

List Self Learning Subjects -

Sr.no	Self Learning subject
1	Computer Networking in Medicine
2	Telemedicine

Note –
• Student must select Self Learning Subject
• New Self Learning Subjects may be added as and when required

SOLAPUR UNIVERSITY, SOLAPUR
FACULTY OF ENGINEERING & TECHNOLOGY
STRUCTURE OF M.E (Part III & IV) W.E.F 2014-15
BIOMEDICAL ENGINEERING DEPARTMENT

Semester- IV

Sr.No	Subject	Teaching Scheme				Credits			
		L	T	P	Total	Credits (L)	Credits (T)	Credits (P)	Total Credits
1	Dissertation Phase III: Progress Seminar#(ISE)	-	-	6@	6@	-	-	4.0	4.0
2	Dissertation Phase IV Term Work#(ISE)	-	-	-	-	-	-	6.0	6.0
3	Final Submission of the Dissertation & Viva-Voce(ESE)	-	-	-	-	-	-	6.0	6.0
	Total	**-**	**-**	**6**	**6**	**-**	**-**	**16.0**	**16.0**

Note –
• #- For all activities related to dissertation Phase II student must interact regularly every week with the advisor.
• Progress seminar shall be delivered capturing details of the work done by student for dissertation
• Student shall deliver all seminars using modern presentation tools a hard copy of the report shall be submitted to the department before delivering the seminar a pdf copy of the report must be submitted to the advisor
• Student must submit a hard copy of project report to the department
• @ Indicates contact hours of students for interaction with advisor.
• Details of modes of assessment of seminar and dissertation shall be as specified in7(III) of PG Engineering Ordinance of Solapur University, Solapur

M.E. (Biomedical Engineering) Part-I
Human Physiology for Engineers

Lectures: 3 Hrs/Week **Theory: 3 Credit**
Tutorial: 1 Hrs/Week **Term Work: 1 Credit**

SECTION-I

Unit.1 **Cell**:
Structure & functions of cell, Cellular transport (active and passive) diffusion, osmotic pressure, Body fluid compartments 04

Unit 2 **Nerve & muscle:**
Structure & functions of Nerve& muscle, Membrane potential (mechanism of RMP, AP), Classification of nerve fibres , Mechanism of muscle contraction, Neuro – muscular transmission and processing of information. 06

Unit 3 **Blood:**
Blood & its composition, Physical & Physiological properties of blood cells, Cardio Vascular System – organization of CVS, Cardiac output and its regulation, Dynamics of heart Systemic and pulmonary circulation, Hemo-dynamics Peripheral circulation and its control, Blood pressure & its regulation, E.C.G 10

SECTION-II

Unit 4 **Respiratory system:**
Organization of Ventilation, diffusion, gas exchange, Measurement of lung volumes & capacities, Lung compliance, surfactant Oxygen & carbon dioxide transport, composition of alveolar air, Control of respiration. 08

Unit 5 **Central nervous system:**
Organization & functions Receptors, synapses, reflexes, Ascending & descending tracts , Cerebral cortex, cerebellum, hypothalamus, Autonomic nervous system, spinal cord, Posture & equilibrium. 10

Unit 6 **Special senses**:
Vision Optics, refractive errors, correction Hearing. 04

Text Books:
1. Textbook of Biomedical Physiology – A. C. Gayton

Reference Books:
1. Applied Physiology - C.A. Keeleand Eric Neil Samson, Wrights
2. The Physiological Basis of Medicine Practice - .Herbert Best Charles and Norman Tailor

M.E. (Biomedical Engineering) Part-I
Biomedical Transducers and Sensors

Lectures : 3 Hrs/Week **Theory: 3 Credit**
Practical : 2 Hrs/Week **Term Work: 1 Credit**

SECTION-I

Unit 1 **Introduction:**
Generalized Instrumentation System, General properties of input transducer, Static and dynamic characteristics, Primary and secondary transducer, Active and passive transducer 02

Unit 2 **Displacement and Pressure Transducer:**
a. Resistive: Bonded and unbounded strain gauge
b. Inductive: self inductive and mutual inductive transducer, Rotary Variable Differential Transformer (RVDT), LVDT and phase sensitive detection system for LVDT
c. Capacitive: parallel plate and cylindrical plate transducer, Types (Change in area of plates, change in distance between plates, variation of dielectric constant)
d. Bourdon Tubes: C type, spiral type, helical type
e. Capsules using diaphragms: convex type, nested type.
f. Variable resistance transducer, Variable inductance transducer, Differential transformer transducer,
g. Variable capacitance transducers Piezoelectric transducers Electrodynamic&magnetostrictive transducers, Force balance transducers, Pressure measurement, 06

Unit 3 **Flow sensors:**
Electromagnetic flow meter, Ultrasonic Blood flow meter, Indicator dilution method, Laser Doppler flowmetryBlood flow measurement, Respiratory gas flow measurement, Bioelectric &Biomagnetic measurement, 03

Unit 4 **Clinical Thermometers:**
Rectal, Eusophageal, bladder temperature measurement, contact and noncontact tympanic thermometers 03

Unit 5 **Motion and Force Sensors:**
Contact and non-contact transducers, Linear and angular velocity measurements, Translational and angular acceleration measurements 03

Unit 6 **Fiber Optic Sensors:**
Step index, graded index and single mode fiber Fiber optic displacement Sensor 03

SECTION-II

Unit 7 **Radiation Sensors:**
Radiation Measuring devices (Vacuum thermocouple, Thermopile, Bolometer, Pyrometers), Photoemissive cells (vacuum type, gas filled type, photomultiplier tube), semiconductor photoelectric transducer (LDR, photodiode, phototransistor, phottothyristor, photovoltaic cell) 05

Unit 8 **Biosensors:**
a.Components of biosensors, methods of immobilization of biological component of a biosensor, Enzyme sensors (urea and glucose), affinity biosensor (catalytic biosensor), Chemical measurements, Chemical transducers, Biosensors such as Enzyme based biosensor, Immunosensors
Microbial sensors Amperometric biosensors Microelectronic biosensors for clinical applications Calometric biosensors Optimized biosensors for clinical application ISFET biosensor, A single chip biosensor Multibiosensor and it's Applications
Biosensors for diabetes mellitus Design and evaluation of a reversible fiber optic sensor for determination of oxygen Hydrogen and ammonia gas sensitive semiconductor structures in bioanalyzer 15

Text Books:
1. Electrical Measurements and measuring Instruments by A. K. Sawhney
2. Biomedical Transducers and Instruments by Tatsuo Togawa, Toshiyo Tamura, P. Ake Oberg
3. Biosensors- An Introduction by Brian Eggins

Reference Books:
1. Principle of Biomedical Engineering – SunderRajan V. Madihally
2. Sensors, Nanoscience and Biomedical Engineering and Instruments – Richard C. Dorf.
3. "Handbook of biosensors and electronic noses," Medicine, food and environment edited by Evikakress Rogers CRC press New York
4. "Biomedical transducers and instruments" -TatswTogawa,Toshiyo Tamura pake Oberg CRC Press new York
5. "Biomedical instruments Theory and design,"second edition, WaltezwelkowitzsiddentschMeltinAkay
6. "Applied biosensors", Donald L Wise Butterworth Toronto

Instrumentation Circuit and Design Lab
Module Practical's based on
1 Measurement of Op-Amp Parameters
2 Design and implementation of Biopotential Amplifier
3 Design and implementation of analog filters for Bio-signal conditioning
4 Design and implementation of Medical Thermometer
5 Acquisition and processing of Biosignals
6 Design and implementation of Digitally controlled Amplifier (LF13007)
7 Design and implementation of Digital Potentiometer (AD-8400)
8 Programmable Waveform Generator (XR-2240)
9 Study of Various Characteristics of sensors

Termwork:
Termwork consists of minimum of 5 practicals and a course project based on the topics suggested. Final certification and acceptance of the termwork ensures satisfactory performance of laboratory work.

M.E. (Biomedical Engineering) Part-I

Advanced Digital Signal Processing

Lectures: 3Hrs/Week **Theory: 3 credits**

Practical: 2 Hrs/Week **Term Work: 1 credit**

SECTION-I

Unit 1 **Design of Digital filter :** Design of fire filter, symmetric and anti symmetric, linear phase, optimum, equiripple, FIR Differentiators, Helbert – transformers, design of IIR filter – Impulse invariance bilinear transformation, matched transformation, frequency transformation, in along and gidgital domain, design of digital filters based on least square method 08

Unit 2 **Multirate Digital Signals Processing :** Decimation by a factor D, Interpolation, filter design and implementation, sampling rate conversion, applications of multirate signal processing. 08

Unit 3 **Power Spectral Estimation :** Parametric and non-parametric method for power spectral estimation, minimum variance. 04

SECTION-II

Unit 4 **Effect of finite resister length :** Effect on quantization, realization of FIR & IIR filters and Fourier transfer computation adaptive digital filters, its applications, application of DSP to speech processing. 08

Unit 5 **Data Compression Techniques:**
Lossy and lossless data reduction algorithm, ECG data compression using Turning point, AZTEC, FAN and Howffman coding technique. 04

Unit 6 **Introduction to Wavelet Transform:**
Introduction, comparison with STFT, Haar and Daubechies wavelet 04

Unit 7 **Biomedical Applications:**
Applications of DSP to Biomedical Signals. 04

Text Books:

1. Digital Signal Processing – John G. Proakis, Prentice Hall
2. Digital Signal Processing – A.V. Oppenheim & R.W. Schafer, PrenticeHall

Reference Book:

1. Theory and application of digital signal processing – L.R.Rainer and B.Gold.
2. Lab view based FPGA implementation, DSP system design – Nasser Kehtarnavaz

Advanced Digital Signal Processing

Module Practicals based on
1 Design of FIR filters
2 Design of IIR filters
3 Design of Adaptive filters
4 Data compression using Turning point Algorithm
5 Data compression using FAN.
6 Data compression using AZTEC.

7 Data compression using Hoffman.
8 Implementation of Haar Wavelet
9 Implementation of Daubechies Wavelet

Termwork:
Termwork consists of minimum of 6practicals based on the topics suggested. Final certification and acceptance of the termwork ensures satisfactory performance of laboratory work.

M.E. (Biomedical Engineering) Part-I

Embedded Systems in Biomedical Engineering

Lectures: 3Hrs/Week **Theory: 3 credits**

Practical : 2 Hrs/Week **Term Work: 1 credit**

SECTION-II

Unit 1 **Introduction:**

Introduction to Embedded Systems ,Examples of embedded system , their characteristics and their typical hardware components , Software Embedded into a system embedded software architecture , Processor and Memory organization Structural Units in a processor, Processor Selection for an embedded system, complex system design and processors, design process, formalization of system design, classification of embedded system, skills required for embedded system designer, Memory devices, Memory selection for an embedded system, Allocation of Memory to program segments and blocks and memory map of a system, Direct Memory access, Interfacing processor, memories and I/O devices. 08

Unit 2 **Devices and Buses for Device networks:**

I/O devices, Timer and counting devices, Serial Communication devices using the 'I2C','CAN' and Advanced I/O Buses between the networked multiple Devices, host system or computer parallel communication between the networked I/O Multiple Devices using the PCI, PCI-X and advanced buses. 08

Unit 3 **Device Drivers and Interrupts Servicing Mechanism:**

Device drivers, Parallel port device drivers in a system, serial port device Drivers in a system, device drivers for internal programmable timing devices, Interrupt servicing (handling) mechanism, Deadline and Interrupt Latency. 06

SECTION-II

Unit 4 **Program Modeling concepts in Single and Multiprocessor:**

Modeling process for software analysis before implementation, models for event control programs and multiprocessors systems, software development process lifecycle, analysis, design and implementation, software testing, project management and maintenance. 10

Unit 5 **Real Time Operating System and inter-process communications:**

Concepts of RTOS, I/O subsystems, network operating systems, real time and embedded operating systems, interrupt routines in RTOS, task scheduling models, multitasking, shared data problems, inter-process communication, starvation and dead lock. 10

Text Books:

1. The 8051 microcontrollers-Kenneth J Ayala
2. Rajkamal, Embedded systems-architecture, programming and design, TataMcGraw Hill.
3. SriramIyer&PankajGupta,EmbeddedRealtime systems programming,Tata McGraw Hill

Reference Books:

1. Embedded Microcomputer Systems- Real time Interfacing -Valvano Frank Vahid,ToneyGivargis-Embedded System Design: A unified Hardware/Software Introduction John Wiley publication
2. David E. Simon -An Embedded Software Primer Pearson Education
3. Muhammad A Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education

Termwork:

Termwork consists of minimum of 5 practicals and a course project based on the topics suggested. Final certification and acceptance of the termwork ensures satisfactory performance of laboratory work.

M.E. (Biomedical Engineering) Part-I

Biomaterials and Implants

Lectures: 3Hrs/Week **Theory: 3 credits**
Practical : 2 Hrs/Week **Term Work: 1credit**

SECTION-I

Unit 1 **Introduction:**
Introduction of biomaterials. Classification of biomaterials 02

Unit 2 **Physiological Defense Mechanisms of the body against biomaterials:**
Inflammation and wound healing, Blood clotting system, Immune system, Complement system. 04

Unit 3 **Properties and applications of biomaterials:**
Tantalum, Platinum and other noble metals. 05

Unit 4 **Biopolymers:**
Collagen, Elastin, Mucopolysaccharides, proteoglycans, cellulose and other derivatives, chitin, other polysaccharides. 05

Unit 5 **Cardiovascular Implants and Extracorporeal Devices:**
Vascular implants, cardiac pacemakers, blood substitutes, extracorporeal blood circulation devices 05

SECTION-II

Unit 6 **Biomaterials in Opthalmology:**
Contact Lenses, optical implants, drainage tubes in glaucoma, vitreous implants, acrylate adhesives, artificial tear 05

Unit 7 **Dental Materials:**
Tooth composition and mechanical properties, Impression materials, bases, liners and varnishes for cavities, fillings and restorative materials, materials for deep cavities, oral implants, use of collagen in dentistry 05

Unit 8 **Techniques for characterization of surface properties of biomaterials:**
Electron Spectroscopy for Chemical Analysis(ESCA), Secondary Ion Mass Spectrometry (SIMS), Surface Infrared Techniques, Transmission Electron Microscope(TEM), Scanning Electron Microscope(SEM), Scanning Tunneling Microscope(STM), Atomic Force Microscope (AFM), Surface Enhanced Raman Spectroscopy (SERS), High Resolution Electron Energy Loss Spectroscopy (HREELS) 10

Text Books:

1. An Introduction to Materials in Medicine by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons
2. Biomaterails by Sujata V. Bhat
3. Polymers: Biomaterials and Medical Applications, Encyclopedia Reprint Series, Editor: Jacqueline I. Kroschwitz.

Reference Books:

1. Biomaterials an Introduction by J. B. Park

M.E. (Biomedical Engineering) Part-I

Healthcare Data Base Management System

Lectures: 3Hrs/Week **Theory: 3 credits**
Practical : 2 Hrs/Week **Term Work: 1 credit**

SECTION-I

Unit 1 **Introduction to Data Base Management Systems:**
Database system applications, database system versus file system, view of data, data models, database language, Database users and administrators, Transaction management, database system structures, Application Architectures 08

Unit 2 **Hospital Information System:**
Introduction, Functional capabilities of a computerized HIS, Need for computerization in hospitals, Security of computer records, Cost effectiveness of information processing by computer, Sources of data for decision making, Modes of decision output to physician, Regenstrief computerized medical record system, Computer DBMS in obstetricsgynecology, Computer based morbidity registers 08

Unit 3 **Computerized Patient Data Base Management:**
Introduction, History-taking by computer, Dialogue with the computer, Methods of history taking by computers, Patient data base management by computers. Computerized medical record –Evolution. 04

SECTION-II

Unit 4 **Computers in Clinical Laboratory:**
Introduction, Data base approach to Laboratory Computerization, Automated Clinical Laboratories, Automated Methods in Hematology, Chromosome Analysis by computer, Computerized Electrocardiography (ECG), Assessment of performance of ECG computer programs, Computerized Electroencephalography, Computerized Electromyography. 08

Unit 5 **Computer Assisted Medical Decision-Making:**
Introduction, General Model of CMD, Algorithmic Methods, Statistical pattern classification, Decision Analysis, Fuzzy set theory, Production Rule Systems, Cognitive Models, Internist, QMR, KES, A rule based decision aid for TIA. Computers in the care of Critically Ill Patients: Automated computer Assisted Fluid and Metabolic balance, Pulmonary Function Evaluation, Cardiovascular Physiologic Evaluation. 06

Unit 6 **Computer Assisted Therapy:**
Introduction, Digitalis Therapy, Evaluation of Patient response, Assessing Digitalis Toxicity, Computers for care of renal disorders, Computer based cancer Chemotherapy protocol advisor- ONCOCIN, Automated Drug delivery, Electromyogenic Controlled Limbs.Computer Aids for the Handicapped: Introduction, Mobility, Blind and Visually Handicapped, Computer aids for the deaf, computer speech generation and recognition. 08

Text Books:

1. Data Base Management Systems (3rd) Raghu Ramakrishnan, JohanisGehrkMcGrawhill

Reference Books:

1. Computers in Medicine – Dr. R. D. Lele Tata Mcgraw Hill
2. Medical Informatics a Primer – Mohan Bansal TMH publications

M.E. (Biomedical Engineering) Part-I

Nanotechnology

Lectures: 3Hrs/Week **Theory: 3 credits**

Practical : 2 Hrs/Week **Term Work: 1 credit**

SECTION-I

Unit 1 **Fundamentals of Science behind Nanotechnology:**
Electron , Atom & Biosystems,Ions , Molecules, Metals. Electrical Conduction,Molecular Recognisation, & Quantum,Ohm's Law, Optics,.Mechanics and Quantum Ideas, 04

Unit 2 **Fullerenes:**
Crystal Formation, Sintering,Combustion Flame Synthesis, Organic Synthesis Method, Super Critical Oligomerization, Solar Process, Electric Arc Process. 06

Unit 3 **Carbon NanoTubes (CNT) :**
Synthesis of CNT, Laser Ablation Process,Electric Arc Discharge Process, CVD, HIPCO Process, Surface Mediated growth of Vertically Aligned Tubes, Physical Properties of CNTs, Morphology of CNT. 06

Unit 4 **Nanostructuring Methods:**
Vacuum Synthesis, Gas Evaporation Tech, Condensed Phase Synthesis, Sol Gel Processing, Polymer Thin Film, Atomic Lithography, Plasma Compaction,.Electro-deposition, 06

SECTION-II

Unit 5 **Characterization of Nanostructures:**
Transmission Electron Microscope, Scanning Electron Microscope, Microwave Spectroscopy, Raman Microscopy, X ray Diffraction. 04

Unit 6 **Calculations in Nanotechnology:**
Particle Size Distribution, Particle Size & Measurement Methods, Fluid Particle Dynamics, Particle Collection Mechanisms and efficiency. 05

Unit 7 **NanoBiology:**
Interaction between Biomolecules & Nanoparticle Surface, Influence of Electrostatic Interactions in the binding of Proteins with The Electronic effects of bimolecule - Nanoparticle,Nanoparticles. Different Types of Inorganic materials used for the synthesis,Interaction, of, Hybrid Nano-bio assemblies,Cellularnanostructures,self-assembly of colloidal nanostructures of biological relevance, bioactive nanoparticles (respiratory surfactants, magnetic nanoparticles), Nanoparticles for drug delivery (including solid lipid nanoparticles, synthetic and biopolymeric nanoparticles) 06

Unit 8 **Application of Nanotechnology in Medicine:**

• Bioengineered nano sensors
• Nanotechnology in Tissue Engineering,\
• Drug Delivery in Nanotechnology.
• Bioimplants 07

Text Books:

1. Nanostructuring Operations in NanoScale Science and Engineering-KalRanganathan Sharma, McGraw-Hill Companies,
2. Nanotechnology: Basic Calculations for Engineers and Scientists .LouisTheodore, A John Willy & Sons
3. Nanotechnology: A Gentle Introduction to the Next Big Idea-By Mark Ratner,Daniel Ratner
4. Nano-The Essentials, Understanding Nanoscience and Nanotechnology,T.Pradeep
5. Introduction to NanoTechnology- Charles P. Poole, Jr. and Frank J. Owens, JohnWiley& Sons,2003

Reference Books:

1. Nanotechnology: Basic and Emerging technologies . Michael Wilson ,Chapman & Hall/CRC-Rs,3311.93
2. Principal of NanoTechnology-Molecular Based Study of Condensed Matter in Small Systems .G .Ali Mansoori
3. NanoTechnology Assessment and Prospective -Schmid et al.,Springer

M.E. (Biomedical Engineering) Part-I

Biological Transport Phenomenon

Lectures: 3Hrs/Week **Theory: 3 credits**
Tutorial: 1 Hrs/Week **Term Work: 1 credit**

SECTION-I

1 **Momentum Transfer and overall Balances:**
Fluid Statics, General molecular transport equations for momentum, heat and mass transfer, Viscosity of fluids, Overall balances: mass balance/continuity equation, energy balance, momentum balance, shell momentum balance and velocity distribution in laminar flow, design equation for laminar and turbulent flow in pipes, compressible flow of gases. 06

2 **Momentum Transfer – Principle and Applications:**
Flow past immersed objects, packed and fluidized beds, Non-Newtonian fluids, Differential equations of continuity, momentum transfer (motion), use of these equations, other solution methods for differential equation of motion, boundary layer flow and turbulence, dimensional analysis in momentum transfer. 08

3 **Heat Transfer : Steady state and Unsteady state:**
Steady State: Mechanisms of heat transfer, conduction – through solids in series, steady state conduction and shape factors, Forced convection - heat transfer inside pipes, heat transfer outside various geometries, natural convection heat transfer, boiling and condensation, heat exchangers, radiation heat transfer (basic and advanced), heat transfer to non-Newtonian fluids, special heat transfer coefficients, dimensional analysis in heat transfer, numerical methods for steady state heat transfer in two dimensions.
Unsteady State: Derivation of basic equation, simplified case for systems with negligible internal resistance, unsteady state heat transfer in various geometries, finite difference methods, chilling and freezing of food and biological materials, differential equation of energy change, boundary layer flow and turbulence in heat transfer. 08

SECTION-II

4 **Mass Transfer:**
Mass transfer and diffusion, molecular diffusion in gases, liquids, biological solutions and gels, and solids, numerical methods for steady state molecular diffusion in two dimensions. 06

5 **Unsteady State and Convective Mass Transfer:**
Unsteady state diffusion, convective mass transfer coefficients, for various geometries, mass transfer to suspensions of small particle, molecular diffusion plus convection and chemical reaction, diffusion of gases in porous solids and capillaries, numerical methods for unsteady state molecular diffusion, dimensional analysis in mass transfer, boundary layer flow and turbulence in heat transfer. 08

6 **Separation Processes:**
Evaporation, Drying, Humidification, Absorption, Distillation, Adsorption, Ion Exchange, Leaching, Crystallization, Membrane processes, Settling, Centrifugation and Size Reduction. 06

Text Books:

1. D. O. Cooney, Biomedical Engineering Principles Vol. 1,2 Marcel Decker New York
2. E.N. Lightfoot, Transport Phenomena in Living Systems, NIT Press, 1978

Reference Books:

1. C. H. Best and N. B. Taylor, the Physiology Basis of Medical Practice William &Wikins, Baltimore, 1985

M.E. (Biomedical Engineering) Part-I

Biomedical Informatics

Lectures: 3Hrs/Week **Theory: 3 credits**
Tutorial: 1Hr/week **Term Work: 1 credit**

SECTION-I

1 **Introduction:**
Origins of Biomedical Informatics, Relationship of biomedical informatics to other fields, Biomedical Data acquisition, storage and use of Computer based medical records. 06

2 Patient care systems and Patient Monitoring Systems 04

3 **Data Mining:**
Introduction to data mining, basic aspects of data measurement, types of variables, Visualization and data exploration, Clustering algorithm. 06

4 **Fitting Models:** Basic principles of fitting models to data, Classification Algorithms, Regression Algorithms 06

SECTION-II

5 **Information Retrieval:** Basic principles of Information Retrieval and Search, document classification algorithms, document clustering algorithms 08

6 **Information Management:**
Management of Information in Healthcare Organizations, Public Health Informatics, Health Information Infrastructure, consumer health informatics, Telehealth and mhealth and future of Biomedical Informatics. 12

Text Books:

1. Public Health Informatics and Information Systems by D.A. Ross, A.R. Hinman, K. Saarlas, and W.H. Foege (Hardcover – Oct 16, 2002)

Reference Books:

1. Androwich, I.A., Bickford, C.J., Button, P.S., Hunter, K.M., Murphy, J., and Sensmeier, J. (2002) Clinical Information Systems: A Framework for Reaching the Vision. Washington, DC: ANA Publishing

M.E. (Biomedical Engineering) Part-I

Rehabilitation Engineering

Lectures: 3Hrs/Week **Theory: 3 credits**
Tutorial: 1Hr/week **Term Work: 1 credit**

SECTION-I

1 **Introduction:**
Introduction to Rehabilitation Engineering. Qualitative and quantitative description of the action of muscle in relation to the human movement. 05

2 **Introduction to rigid body Dynamics:**
Introduction to rigid body dynamics. Dynamics of multi link system using Newtonian langrangian approaches. Forward and Inverse dynamics of multi joint muscle driven system. 08

3 **Basics of Mechanics:**
Stress strain curve, constitutive equation and field equation encountered in fluids,, viscoelasticity. 08

SECTION-II

4 **Anatomy:**
Dissection of cadaver, Kinesiology and muscle function application of mechanics to describe the material properties of living tissues. 06

5 **Biomechanics:**
Interrelationship between biomechanics and physiology in medicine. Surgery, body injury and design of prosthesis. 06

6 **Modeling:**
Models of material behavior, measurement and characteristics of tendons, skin, muscles, bones. 08

7 **Rheology:**
Blood rheology and its flow in the circulatory system. 02

Text Books:
1. Rehabilitation Medicine – Dr. S. Sunder Jaypee Medical publications New Delhi
Reference Books:
1. Physical rehabilitation – Susan D. O'Sullivan, Thomas J Smitz. 5th edition

M.E. (Biomedical Engineering) Part-II

Biomedical Instrumentation and Circuit Design

Lectures: 3 Hrs/Week **Theory: 03 credits**

Practical : 2 Hrs/Week **Termwork: 01**

SECTION-I

1 **Biophysical Signals:**
Generation of action potential, Biophysical signals such as ECG, EEG and EMG. Electrodes and acquisition system. Clinical aspects of Biophysical signals. Heart Rate Variability, Computer Tomography and Impedance Cardiography. 08

2 **Patient Monitoring System:**
Measurement of Heart rate, Blood pressure, Temperature and Respiration rate and Apnea detector, Telemetry, Impedance Plethysmography. 08

3 **Analysis and design of Transducers:**
Analysis and design of transducers such a Optical, Photoelectric, electrical, mechanical, Electromechanical, Thermoelectric, etc. 06

SECTION-II

4 **Analytical Instruments:**
Principle of Photometry, Spectrophotometer, Colorimeter, Flamephotometer, Blood cell counter, Blood Gas Analyser. 08

5 **Life Saving Equipments:**
Cardiac Pacemaker, Defibrillator, Ventilator, Hemodialysis machine. 06

6 **Patient Safety:**
Electrical Safety measures. Micro and macro leakage currents. Electrical power distribution in hospital and isolation techniques. Electrical hazards, grounding and earthing in the hospitals. 06

Books:

1. Handbook of Biomedical Instrumentation – R. S. Khandpur, Tata McGraw-Hill
2. Medical Instrumentation‘s : Application and Design ‚J. G. Webster,

Reference Books:

1. Introduction of Biomedical Equipment Technology- Carr Brown (Pearson Education)
2. Introduction of Biomedical Engineering – Joseph Bronzino (CRC Press)
3. Encyclopedia of medical devices and Medical Instrumentation - J. G. Webster Vol I II III IV (John Villey)
4. Principle of Biomedical Engineering – SunderRajan V. Madihally
5. Biomedical Engineering Design Handbook 2nd Edition, Vol I and II – Myer Kutz McGraw Hill

Biomedical Instrumentation and circuit design Lab

Module Practicals based on

1 Introduction to NI Labview and Data Acquisition.
2 Design of apnea detector.
3 Analysis of ECG, EEG and others signals.
4 Analysis of Defibrillator Waveforms.
5 High speed data acquisition using VLSI kits
6 Design of nerve and muscle stimulator.
7 Design of pulse generator for Cardiac Pacemaker.
8 NI Labview for monitoring and controlling Embedded Systems
9 Pulse width modulation using VLSI kit

Termwork:

Term work consists of minimum of six practicals and a course project based on the topics suggested. Final certification and acceptance of the Term work ensures satisfactory performance of laboratory work.

M.E. (Biomedical Engineering) Part-II

Biomedical Image Processing and its applications

Lectures: 3 Hrs/Week **Theory: 3 credits**
Practical: 2 Hrs/Week **Term Work: 1 credit**

SECTION-I

1 Introduction to Imaging systems:
Objects and images, The digital image processing system, Applications of digital image processing. 03

2 **Imaging systems:**
The human visual pathway, Photographic film, Other sensors, Digitizing an image, The quality of a digital image, Color images, Computer-based activities 05

3 **Medical images obtained with ionizing radiation:** Medical imaging modalities, Images from x-rays, Images from γ-rays, Dose and risk. Medical images obtained with non-ionizing radiation: Ultrasound imaging, Magnetic resonance imaging, Picture archiving and communication systems (PACS). 05

4 **Fundamentals of digital image processing,** The gray-level histogram, Histogram transformations and look-up tables. Image enhancement in the spatial domain: Algebraic operations, Logical (Boolean) operations , Geometric operations, Convolution-based operations, Image enhancement in the frequency domain : The Fourier domain, The Fourier transform , Properties of the Fourier transform, Sampling, Cross-correlation and autocorrelation, Imaging systems – point spread function and optical transfer function, Frequency domain filters, Tomographic reconstruction. 10

SECTION-II

5 **Image restoration:** Image degradation, Noise, Noise-reduction filters, Blurring, Modeling image degradation, Geometric degradations, Morphological image processing: Mathematical morphology, Morphological operators, Extension to grayscale images. Image segmentation: Introduction to segmentation, Thresholding, Region-based methods, Boundary-based methods. 07

6 **Feature recognition and classification:** Object recognition and classification, Connected components labeling, Features, Object recognition and classification, Statistical classification, Structural/syntactic classification, Applications in medical image analysis. Three-dimensional: visualization: Image visualization , Surface rendering, Volume rendering, Virtual reality. 07

7 **Medical applications of Imaging:** Computer-aided diagnosis in mammography, Tumor imaging and treatment, Angiography, Bone strength and osteoporosis, Tortuosity. 06

Text Book:

1. Digital Image Processing for Medical Applications, GEOFF DOUGHERTY, Cambridge University Press.

Reference Books:

1. Medical Image Processing, Reconstruction and Restoration, Jiri Jan**,** Taylor & Francis

Biomedical Image Processing and its applications Lab

Module Practicals based on

1 Introduction to NI Labview and Data Acquisition
2 Real time Biomedical Image acquisition
3 Analysis of MRI / CT scan images and many more
4 Biomedical Image Compression
5 Filtering in Frequency domain
6 Filtering in Spatial Domain
7 Skeletonisation
8 Dilation
9 Erosion

Termwork:

Termwork consists of minimum of six practicals based on the topics suggested. Final certification and acceptance of the Termwork ensures satisfactory performance of laboratory work.

M.E. (Biomedical Engineering) Part-II

Medical Imaging and its Techniques

Lectures: 3 Hrs/Week **Theory: 3 credits**
Tutorial :- 1 Hrs /week **Term Work: 1 credit**

SECTION-I

1 **X-Ray:**
Interaction of Radiation with Matter, Particle Interactions, X- and Gamma Ray Interactions, Attenuation of X- and Gamma Rays, Absorption of Energy from X- and Gamma Rays, Imparted Energy, Equivalent Dose, and Effective Dose, Production of X-rays, X-ray Tubes, X-ray Tube Insert, Tube Housing, Filtration, and Collimation, X-ray Generator Function and Components, X-ray Generator Circuit Designs, Timing the X-ray Exposure in Radiography, Factors Affecting X-ray Emission, Power Ratings and Heat Loading, X-ray Exposure Rating Charts, Digital Radiography, Computed Radiography, Charged-Coupled Devices (CCDs), Flat Panel Detectors, Digital Mammography, Digital versus Analog Processes, Implementation, Patient Dose Considerations. 10

2 **Computers in Medical Imaging:**
Storage and Transfer of Data in Computers, Analog Data and Conversion between Analog and Digital Forms, Components and Operation of Computers, Performance of Computer Systems, Computer Software, Storage, Processing, and Display of Digital Images. 06

3 **Computed Tomography**:
Basic Principles, Geometry and Historical Development, Detectors and Detector Arrays , Details of Acquisition, Tomographic Reconstruction, Digital Image Display, Radiation Dose, Image Quality, Artifacts. 06

SECTION-II

4 **Nuclear Magnetic Resonance:**
Magnetization Properties, Generation and Detection of the Magnetic Resonance Signal, Pulse Sequences, Spin Echo, Inversion Recovery, Gradient Recalled Echo, Signal from Flow, Perfusion and Diffusion Contrast, Magnetization Transfer Contrast,Magnetic Resonance Imaging (MRI), Localization of the MR Signal, k-space Data Acquisition and Image Reconstruction, Three-Dimensional Fourier Transform Image Acquisition, Image Characteristics, Angiography and Magnetization Transfer Contrast, Artifacts, Instrumentation, Safety. 10

5 **Ultrasound:**
Characteristics of Sound, Interactions of Ultrasound with Matter, Transducers, Beam Properties, Image Data Acquisition, Two-Dimensional Image Display and Storage, Miscellaneous Issues, Image Quality and Artifacts, Doppler Ultrasound, System Performance and Quality Assurance,

Acoustic Power and Bioeffects. 06

6 **Clinical aspects of Medical Images:**
Extraction of anatomical information from the medcialimgeas such as Xray,
CT, MRI abd Ultrasound images. 04

Text Books:
1. Essential Physics of Medical Imaging (Second Edition)
Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. LeidholdtJr, John M. Boone
2. Physics of Medical Imaging -Steve Webb Taylor & Francis
Reference Books:
1. Manuals of various imaging modalities.

M.E. (Biomedical Engineering) Part-II

Biorheology

Lectures: 3 Hrs/Week **Theory: 3 credits**
Tutorial: 1Hr/Week **Term Work: 1 credit**

SECTION-I

1 **Introduction:**
Introduction to rheology and recap of basic equations of continuum mechanics (kinematics of deformation and stress analysis). 06

2 **Constitutive equations:**
General theory of constitutive equations. 05

3 **a. Tissue and cell elasticity:**
Continuum approach (linear theory, nonlinear theory, strain energy function, prestress; examples)
b. Tissue and cell elasticity:
Microstructural approach (microstructural models of living tissues), statistical approach (thermodynamics of elastic deformation, rubber elasticity), examples. 10

SECTION-II

4 **Tissue and cell viscoelasticity:**
Phenomenological approach (stress relaxation, creep, hysteresis, frequency and temperature effects), examples. 05

5 **Linear viscoelasticity:**
Continuum approach, lumped models, empirical models (power law, fractional calculus), structural damping, examples. Microstructural and molecular approach, polymer chain dynamics, examples. 06

6 **Elements of nonlinear viscoelasticity:**
Examples of empirical, semiempiroical and molecular approaches in studies of living tissues. 06

7 **Elements of tissue plasticity and viscoplasticity:**
(permanent deformation, hysteresis, yield stress), empirical and lumped models of plastic and viscopalstic behavior of living tissues. 04

Text Books :

1. Fung, Y. C. Biomechanics – Mechanical Properties of Living Tissues, 2nd edition, Springer: New York, 1993.
2. Fung, Y. C. Biomechanics – Motion, Flow and Growth, Springer: New York, 1990.
3. Fung, Y. C. Biodynamics – Circulation, Springer, 1984.
4. Fung, Y. C., N. Perrone, and M. Anliker (editors). Biomechanics – Its Foundations and Objectives, Prentice-Hall: Englewood Cliffs, NJ, 1972.
5. Mow, V. C., F. Guilak, R. Tran-Son-Tay, and R. Hochmuth (editors). Cell Mechanics and Cellular Engineering, Springer: New York, 1994.
6. Mofrad, M. R. K., and R. D. Kamm (editors). Cytoskeletal Mechanics: Models and

Measurements. Cambridge University Press: New York 2006.

Reference Books:

1.. M. R. King (editor). Principles of Cellular Engineering: Understanding the Biomolecular Interface. Elsevier Academic Press, 2006.
2. Abé, H., K. Hayashi, and M. Sato (editors). Data Book on Mechanical Properties of Living Cells, Tissues, and Organs, Springer: Tokyo, 1996.
3. Silver, H. F. Biological Materials: Structure, Mechanical Properties, and Modeling of Soft Tissues, New York University Press: New York, 1987.10. Ward, I. M. Mechanical Properties of Solid Polymers, 2ndedition, Wiley: Chicester, 1983
4. Turner, A., Jr. Mechanical Behavior of High Polymers, Interscience: New York, 1984.
5. Erich, F. R. (editor). Rheology – Theory and Applications, Vol. 1 -Academic Press, 1956

M.E. (Biomedical Engineering) Part-II

Robotics in Biomedical Engineering

Lectures: 3 Hrs/Week **Theory: 3 credits**
Tutorial: 1Hr/Week **Term Work: 1 credit**

SECTION-I

1 **Introduction to robotics and its Applications in Biomedical Engineering:**
Classification, Specification, Robot programming, Surgical application, Rehabilitation application, Clinical application. 06

2 **Control of actuators in Robotic Mechanisms:**
Closed loop control in a position servo, Control of robotic joint, Stepper Motors, Brushless DC motors, Direct drive actuator, Hydraulic actuators, Pneumatic systems, Servo amplifiers. 08

3 **Robotic Sensory Devices**
Non-optical position sensors, Optical position sensors, Robot calibration using an optical incremental encoder, Instability resulting from using an incremental encoder, Velocity sensors, Accelerometers, Proximity sensors, Touch and slip sensors, Force and torque sensors. 08

4 **Robot Arm kinematics**
Direct kinematics problem, Inverse kinematics solution.
Robot Arm Dynamics
Lagrange's equation, Kinetic and Potential energy, Generalised force, Lagrange-Euler dynamic model, Dynamic model for Two-Axis Planar articulated Robot & three axis SCARA robot, Direct and Inverse dynamics, Recursive Newton-Euler formulation, Dynamic model of One-axis robot(Inverted Pendulum). 09

5 **Workspace analysis and trajectory planning Robot Vision**
Digitization of image, Image segmentation, Edge detection, Shape analysis, Iterative Processing, Algorithms for image processing, Structured Illumination, Derivation of depth measurement using laser (Ranging by triangulation), Problems based on template matching, Shape analysis, region labelling, run length encoding, Perspective & inverse perspective transformations. 08

6 **Fuzzy logic control**
Fuzzy control: what is needed, Crisp values vs. Fuzzy Values, Fuzzy Sets: Degree of Membership and Truth, Fuzzification, Fuzzy Inference Rule Base, Defuzzification, Application of Fuzzy logic in Robotics. 06

Text Books:
1. Richard D. Klafter, Thomas A. Chmiclewski and Michael Negin, "Robotic Engineering: an integrated approach," Prentice-Hall India,India, 2003.
2. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, "Robotics: Control, Sensing, Vision, and Intelligence," McGraw Hill, Singapore, 1987.
Reference Books:
1. Robert J. Schilling, "Fundamentals of Robotics: Analysis and Control," Prentice-Hall India,

India, 2005.
2. Saeed B. Niku, “Introduction to Robotics: Analysis, Systems, Applications,” Pearson, India, 2003.
3. John J. Craig, “Introduction to Robotics: Mechanics and Control,” Third Edition, Pearson, India, 2009.

M.E. (Biomedical Engineering) Part-II

Neural Networks

Lectures: 3 Hrs/Week **Theory: 3 credits**
Tutorial: 1Hr/Week **Term Work: 1credit**

SECTION-I

1 **Introduction to Neural Networks:**
Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN. 06

2 **Essentials of Artificial Neural Networks:**
Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity, Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules 06

3 **Single Layer and Multi Layer Feed forward Neural Networks:**
Introduction, Classification of Perceptron Models: Discrete, Continuous and Multi-Category, Training and classification using Discrete Perceptrons: Algorithadn examples. Linearly separable classifications. Multicategory single layer perceptron networks. Lineralynonseparable pattern classification, Delta learning Rule, Feed forward recall and error backpropagation training. Learning factors. Kolmogorov Theorem, Learning Difficulties and Improvements. 10

4 **Associative Memories:**
Basic concept, Linear Associator, Recurrent Autoassociative memory, BidriectionalAssoociative memory, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function.
Architecture of Hopfield Network: Discrete and Continuous versions, Storage and Recall Algorithm, Stability Analysis. 09

5 **Classical & Fuzzy Sets and Fuzzy Logic System Components:**
Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions, Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods. 08

6 **Neural network applications:**
Process identification, control, fault diagnosis. Fuzzy logic applications: Fuzzy logic control and Fuzzy classification. 04

Text Books:

1. S. Rajasekharan and G. A. Vijayalakshmipai, “Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications”, PHI Publication, 2004.
2. John Yen and Reza Langan, “Fuzzy Logic: Intelligence, Control and Information”, Pearson Education, 2004.

Reference Books:

1. Simon Haykin, “Neural Networks- A comprehensive foundation”, Pearson Education, 2001.
2. S.N.Sivanandam, S.Sumathi,S. N. Deepa “Introduction to Neural Networks using MATLAB 6.0”, TMH, 2006.
3. James A Freeman and Davis Skapura, Neural Networks Pearson Education, 2002.
4. Timothy J. Ross, “ Fuzzy Logic With Engineering Applications”, McGraw-Hill Inc. 1997.

M.E. (Biomedical Engineering) Part-II

Hospital Management and Information System

Lectures: 3 Hrs/Week **Theory: 3 credits**
Tutorial: 1Hr/Week **Term Work: 1 credit**

SECTION-I

1 **Introduction to Management**
Process of Management and Basic Management Principles, Role of Hospital Administrator. 05

2 **Computers in Medicine:**
Computers in Biomedical Applications, Role of computers in data collection and analysis, computer aided decision making, computer based medical record. 05

3 **Planning and designing:**
Planning and design considerations of various dept. like OT, OPD, CSSD, Nursing unit, ICUs, Pathology, Radiology, Pharmacy and others. 12

SECTION-II

4 **Hospital Safety and Management:**
Security and Safety of hospital property, staff and patients. Importance of Disaster management, medical codes. 04

5 **Patient safety:**
Electrical beds, double insulation system, patient isolation, grounding, rectification of ground faults. 04

6 **Hospital Services:**
Clinical services, Suppotive services, Auxillary services and Ancillary services. 08

7 **Legal Aspect:**
Health Insurance, Quality assurance, Medico legal aspects, Medical Ethics. 04

Text Books:
1. Electrical safety in Healthcare facility – H. H. Roth
2. Hospital Planning, Design and Management - Kunders

Reference Books:
1. Biomedical Ethics for Engineers- Domiel A Vallero
2. Computer in Medicine – R. D. Lele

M.E. (Biomedical Engineering) Part-II

Digital Speech Processing

Lectures: 3Hrs/Week **Theory: 3 credits**
Practical:- 2 Hrs/week **Term Work: 1 credit**

SECTION-I

1 **Classification of Speech Sounds:**
Introduction, mechanism of speech production. Acoustic phonetics: vowels, diphthongs, semivowels, nasals, fricatives, stops and affricates. 06

2 **Fundamentals of Digital Speech processing:**
Time dependent processing of speech, short-time energy and average magnitude, short-time average zero crossing rate. 08

3 **Time Domain Model for Speech Processing:**
Introduction, Time dependent processing of Speech. Short Time Energy and average magnitude. Short Time Average Zero-Crossing Rate, Speech vs. Silence Discrimination Using Energy and Zero Crossing. Pitch period estimation using parallel processing approach, short-time autocorrelation function. Brief Applications of temporal processing of speech signals in synthesis, enhancement, hearing applications and clear speech. 08

SECTION-II

4 **Frequency Domain Methods for Speech Processing:**
Introduction, definitions and properties: Fourier transforms interpretation and Linear Filter interpretation, sampling rates in time and frequency. Filter bank summation and overlap add methods for short-time synthesis of speech, sinusoidal and harmonic plus noise method of analysis/synthesis. 10

5 **Homomorphic Speech Processing:**
Introduction, homomorphic system for convolution, the complex cepstrum of speech, homomorphicvocoder. 06

6 **Applications of Speech Processing:**
Brief applications of speech processing in voice response systems hearing aid design and recognition systems. 06

Text Books:
1. Digital Processing of Speech Signals, L. R. Rabiner and R. W. Schafer, Pearson Education Asia, 2004.
Reference Books:
1. Discrete Time Speech Signal Processing, T. F. Quatieri, Pearson Education Asia, 2004.
2. Speech and Audio Signal Processing: Processing and Perception of Speech and Music, B. Gold and N. Morgan,John Wiley, 2004

M.E. (Biomedical Engineering) Part-II

Lasers and Fiber Optics for Therapy and Surgery

Lectures: 3 Hrs/Week **Theory: 3 credits**
Practical:- 2 Hrs/week **Term Work: 1 credit**

SECTION-I

1 **Introduction :**
Historical background. Medical Lasers: Introduction, Laser physicsfundamentals, principles, advances, Medical Lasers-fundamentals, principles, advances. Medical Laser Systems-fundamentals, principles. Laser safety-fundamentals. Laser interaction with tissue-principles; laser assisted diagnostics-principles, applications of lasers in diagnosis and imaging-advances, laser surgery and therapy-principles-photothermal& photomechanical mechanisms, thermal interaction between laser and tissueadvances. 12

2 **Single Optical Fibres:**
Introduction, historical background, optical fibers-fundamentals, light transmission in optical fibers-principles, optical properties of optical fibersadvances, fabrication of optical fibers-principles, optical fibers for UV, visible, IR light-principles, power transmission through optical fibersprinciples, modified fiber ends and tips-principles, fiber lasers-advances. 08

SECTION-II

3 **Optical Fibre Bundles:**
Introduction, non-ordered fiber optic bundles for light guides-fundamentals & principles, ordered fiberoptic bundles for imaging devices-fundamentals & principles, fiberscopes and endoscopes-fundamentals, fiber optic imaging systems-advances. 07

4 **Applications of Lasers in Therapy and Diagnosis:**
Introduction, laser assisted diagnosis and therapy-fundamentals, interaction of laser beams and materials-principles. 06

5 **Clinical Applications of Fiber Optic Laser System:**
Introduction, fiberoptic laser systems in cardiovascular disease, gastroenterology, gynecology, neurosurgery, oncology, ophthalmology, orthopedics, otolaryngology (ENT), urology, and flow diagram for laser angioplasty & photodynamic therapy. Endoscopy 09

Text Books:
1. Lasers and Optical Fibers in Medicine – AbrahimCatzir Academic press 1998.
Reference Books:
1. Therapeutic Lasers – G David Baxter – Churchill Living stone publications
2. Medical Laser and their safe use – David H Shiny Stiffen and L Trokel Springer Publications
3. Element of Fiber optics – S. L. Wymer Regents PHI

M.E. (Biomedical Engineering) Part-II

Pattern Recognition

Lectures: 3 Hrs/Week **Theory: 3 credits**
Practical:- 2 Hrs/week **Term Work: 1 credit**

SECTION-I

1 **Introduction :**
Applications of Pattern Recognition, Pattern Recognition (PR) overview, pattern recognition typical system, classification, patterns & features extraction with examples, Statistical decision theory. 05

2 **Probability:**
Introduction, probability of events, random variables, joint distributions and densities, moments of random variables, estimation of parameters from samples, minimizing risk estimators. 02

3 **Statistical decision making:**
Introduction, baye's theorem, multiple feature, conditionally independent feature, decision boundaries, unequal costs of error, estimation of error rates, the leaving one out technique, characteristic curves, estimating the composition of populations. 06

4 **Non-parametric decision making:**
Introduction, histograms kernel & window estimators nearest neighbor classification techniques, adaptive decision boundaries, adaptive discriminant functions, minimum squared error discriminant functions. 05

5 **Clustering**:
Introduction, hierarchil clustering, partitional clustering. Formulations of unsupervised learning problems, Clustering for Unsupervised Learning and classification. 04

SECTION-II

6 **Artificial Neural Networks:**
Introduction, Nets without and with Hidden layers, Back propagation algorithm, Hopfield nets. 06

7 **Processing of Waveforms and Images:**
Introduction Gray level scaling transformations, equalization, Geometric scaling and interpolation, smoothing transform, edge detection, laplacian and sharpening operators, line detection and template matching, logarithmic gray level scaling. 08

8 **Image analysis:**
Introduction, scene segmentation and labeling, counting objects, perimeter measurement, projections, texture, color, system design , classification of WBCs image sequences, image compression. 08

Text Books:

1. Pattern Recognition and Image Analysis – Earl Gose, Richard Johnsonbaugh, Steve Jost, PHI Learning PVT. LTD. New Delhi
2. Pattern Classification – Richard O. Duda, Peter E, Hart & David, G Stork John Wiley .

Reference Books:

1. Robert Schalkoff, Pattern Recognition; Statistical Structural and Neural approach John Wiley and sons INC 1992.

M.E. (Biomedical Engineering) Part-I

Seminar-I **Seminar :02 credits**

Guidelines for Seminar

o Seminar should be based on thrust areas in Biomedical Engineering

o Students should undergo literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the topic and compile the report in standard format and present in front of Panel of Examiners appointed by the Head of the Department/Institute of respective Program.

o Seminar assessment should be based on following points

- Quality of Literature survey and Novelty in the topic
- Relevance to the specialization
- Understanding of the topic
- Quality of Written and Oral Presentation

M.E. (Biomedical Engineering) Part-II

Seminar-II

Term Work: 02 credits

Guidelines for Seminar

o Seminar should be based on thrust areas in Biomedical Engineering

o Students should undergo literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the topic and compile the report in standard format and present in front of Panel of Examiners appointed by the Head of the Department/Institute of respective Program.

o Seminar assessment should be based on following points

- Quality of Literature survey and Novelty in the topic
- Relevance to the specialization
- Understanding of the topic
- Quality of Written and Oral Presentation

M.E. (Biomedical Engineering) Part-III

Self Learning Subject

Telemedicine

Theory: 3 credits

SECTION-I

1 **Introduction:**
History of telemedicine, Block diagram of telemedicine system, Definition of telemedicine, Tele health, Tele care, organs of telemedicine, scope, Benefits, and limitations of telemedicine.

2 **Type of information**:
Audio, Video, Still images, Text and data, fax,Medical information storage and management for telemedicine- patient information medical history, test reports, medical images diagnosis and treatment. Hospital information- Doctors, paramedics, facilities available. Pharmaceutical information
Type of communications and network, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave. Different Modulation techniques.
Types of antennas depending on requirements, Integration and operational issues: - system integration, store –and - forward operation, Real-time Telemedicine.

3 **Data Exchange:**
Network Configuration, circuit and packet switching, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN). Video Conferencing.

SECTION-II

4 **Data Security and Standards:**
Encryption, Cryptography, Mechanisms of encryption, phases of Ecryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7.

5 **Ethical and legal aspects of Telemedicine:**
Confidentiality, and the law, patient rights and consent, access to medical Records, Consent treatment, jurisdictional Issues, Intellectual property Rights

6 **Applications of Telemedicine:**
i. Tele radiology: Definition, Basic parts of teleradiology system: Image Acquisition system Display system, Communication network, Interpretation section.
ii. Tele pathology: multimedia databases, color images of sufficient resolution: Dynamic range, spatial resolution, compression methods, Interactive control of color, Controlled sampling security and confidentiality tools.
iii. Tele catriologyTeleoncology, Telesurgery and its applications

Text Books:
1. Olga (EDT) Ferrer – Roca, M.Sosa (EDT) Iudicissa Hand book of Telemedicine IOS press

Reference Books:
1. A.C. Norris, Essentials of Telemedicine and Telecare John Sons & Ltd, 2002
Reference http://jntu.ac.in/dap/syl.html

M.E. (Biomedical Engineering) Part-III

Self Learning Subject

Computer Networking in Medicine

Theory: 3 credits

SECTION-I

1 **Data Communications**
Components, Direction of Data flow
Networks - Components and Categories, types of Connections,
Topologies, Protocols and Standards – OSI model, TCP/IP Protocol

2 **Data Transmission**
Transmission Media– Coaxial Cable – Fiber Optics – Line Coding –
Modems – RS232 Interfacing sequences
Circuit Switching, Throughput, bandwidth, T1, ISDN, DSL

3 **Data Link Layer**
Types of errors ,Error detection and correction Methods - Block Codes,
Cyclic Codes, checksum
Data link Control Protocols - stop and wait , go back-N ARQ , selective
repeat ARQ, HDLC.
Wired and wireless LAN/WAN, connecting LANs, backbone networksLAN

SECTION-II

4 **Network Layer**
Internetworks – Packet Switching and Datagram approach – IP addressing
methods – Subnetting – Routing – Distance Vector Routing – Link State
Routing – Routers.

5 **Transport Layer**
Duties of transport layer, Multiplexing, Demultiplexing, Sockets, User
Datagram Protocol (UDP), Transmission Control Protocol (TCP) -
Congestion Control, Quality of services (QOS).

6 **Application Layer**
Domain Name Space (DNS), SMTP, FTP, HTTP, WWW, SNMP

7 **Security Concepts**
System security in general, Authentication, Authorization, Confidentiality,
Integrity, Cryptography

Text Books:
1. Computer Network – Behrouz A. Forouzan, McGraw Hill.
Reference Books:
1. Computer Networks – Andrew S. Tanenbaum

M.E. (Biomedical Engineering) Part-III

Seminar

Term work:- 16 credits

Guidelines for Seminar

o Seminar should be based on thrust areas in Electrical Engineering

o Students should undergo literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the topic and compile the report in standard format and present in front of Panel of Examiners appointed by the Head of the Department/Institute of respective Program.

o Seminar assessment should be based on following points

- Quality of Literature survey and Novelty in the topic
- Relevance to the specialization
- Understanding of the topic
- Quality of Written and Oral Presentation

M.E. (Biomedical Engineering) Part-III

Dissertation (I)

Dissertation- I : 16 credits

Guidelines for Dissertation

o Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt the solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

o Dissertation I should be assessed based on following points

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization
- Clarity of objective and scope

o Dissertation I should be assessed through a presentation by a panel of internal examiners appointed by the Head of the Department/Institute of respective Program.

M.E. (Biomedical Engineering) Part-IV

Dissertation (II)

Dissertation- II : 16 credits

Guidelines for Dissertation

o Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt the solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation II

o Dissertation II should be assessed based on following points

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Quality of work attempted
- Validation of results
- Quality of Written and Oral Presentation

o Dissertation II should be assessed through a presentation jointly by Internal and External Examiners appointed by the Solapur University.

Students should publish at least one paper based on the work in reputed International / National Conference (desirably in Refereed Journal)