West Bengal University of Technology
Bio-Medical Engineering
Detailed Syllabus

Structure
3rd Semester

A. THEORY:

A. THEORY							
	Code	**Subjects**	**Contacts (periods/week)**				**Credit points**
			L	T	P	Total	
1.	M-302	Mathematics	3	1	0	4	4
2.	BME-301	Biophysical Signals & Systems Simulation	3	1	0	4	4
3.	EE-301	Circuit Theory & Networks	3	1	0	4	4
4.	BME-302	Human Physiology-I	3	1	0	4	4
5.	EE-302	Electrical & Electronic Measurement	3	1	0	4	4
Total of Theory						**20**	**20**

B. PRACTICAL:

B. PRACTICAL							
	Code	**Subjects**	**Contacts (periods/week)**				**Credit points**
			L	T	P	Total	
1.	EE-391	Circuit Theory & Networks Lab	0	0	3	3	2
2.	EE-392	Electrical & Electronic Measurement Lab	0	0	3	3	2
3.	BME-391	Physiology practical	0	0	3	3	2
Total of Practical						**9**	**6**
Total of 3rd Semester						**29**	**26**

West Bengal University of Technology
Bio-Medical Engineering
Detailed Syllabus

4th Semester

THEORY

SL NO.	CODE	THEORY	CONTACT PERIODS PER WEEK			TOTAL	CREDITS
			L	T	P		
1	BME-401	Biomaterials	3	1	0	4	4
2	BME-402	Biomechanics	3	1	0	4	4
3	BME-403	Biophysics	3	1	0	4	4
4	EC-405	Digital Electronic Circuit	3	1	0	4	4
5	CS-408	Introduction to Programming	3	1	0	4	4
		TOTAL THEORY				**20**	**20**

PRATICAL

SL NO.	CODE	PRACTICAL	CONTACT PERIODS PER WEEK			TOTAL	CREDITS
			L	T	P		
1	BME-491	Biomedical Engg. Lab-1	0	0	3	3	2
2	EC-495	Digital Electronic Circuit Lab	0	0	3	3	2
3	CS-498	Programming Practice Lab	0	0	3	3	2
		Total Practical				**9**	**6**

Total of Semester: **29** **26**

C. SESSIONALS							
1.	HU-481	**TECHNICAL REPORT WRITING & / LANGUAGE PRACTICE LABORATORY**		0	0	3	2
Total of Sessionals						**3**	**2**
Total of Semester -						**32**	**28**

5th Semester

A. Theory							
	Code	Subjects	Contacts periods per week				Credit points
			L	T	P	Total	
1.	BME-501	Biosensors and Transducers	3	1	0	4	4
2.	BME-502	Biomedical Instrumentation	3	1	0	4	4
3.	BME-503	Analytical and Diagnostic Equipments	3	1	0	4	4
4.	BME-504	Medical Imaging-I	3	1	0	4	4
5.	BME-505	Communication Circuits & Systems	3	1	0	4	4
6.	CS-516	Data Structure and Algorithm	3	1	0	4	4
Total of Theory						**24**	**24**

B. Practical							
	Code	Subjects	Contacts periods per week				Credit points
			L	T	P	Total	
1.	BME-591	Biomedical Engg. Lab-II	0	0	3	3	2
2.	BME-592	Communication Circuits & Systems Lab.	0	0	3	3	2
3.	CS-586	Data structure Lab	0	0	3	3	2
Total of Practical						**9**	**6**
Total of 5th Semester						**33**	**30**

6th Semester

West Bengal University of Technology
Bio-Medical Engineering
Detailed Syllabus

A. Theory:

A. Theory							
	Code	**Subjects**	**Contacts periods per week**				**Credit points**
			L	T	P	Total	
1.	BME-601	Therapeutic Equipments	3	1	0	4	4
2.	BME-602	Biomedical Signal Processing	3	1	0	4	4
3.	BME-603	Biomedical Imaging -II	3	1	0	4	4
4.	BME-604	Hospital Engineering & Information System	3	1	0	4	4
5.	EI-611	Microprocessor and Applications	3	1	0	4	4
Total of Theory						**20**	**20**

B. Practical:

B. Practical							
	Code	**Subjects**	**Contacts periods per week**				**Credit points**
			L	T	P	Total	
1.	BME-691	Medical Instruments Lab -I	0	0	3	3	2
2.	BME-692	Biomedical signal processing Lab	0	0	3	3	2
3.	EI-681	Microprocessor and Applications Lab	0	0	3	3	2
Total of Practical						**9**	**6**
C. Sessional							
	BME-681	Group Discussion & Seminar	0	0	3	3	2
Total of 6th Semester						**32**	**28**

7th Semester

A. Theory:

A. Theory							
	Code	**Subjects**	**Contacts periods per week**				**Credit points**
			L	T	P	Total	
1.	BME-701	Biosignal Processing	3	0	0	3	3
2.	BME-702	Artificial Organs & Rehabilitation Engineering	3	0	0	3	3
3.	BME-703	Power and Control system	3	1	0	4	4
3.	HU-702	Industrial Management	3	0	0	3	3
4.	BME-704	Elective-I	3	0	0	3	3
Total of Theory						**16**	**16**

B. Practical:

B. Practical							
	Code	**Subjects**	**Contacts periods per week**				**Credit points**
			L	T	P	Total	
1.	BME-791	Bio-signal processing Lab	0	0	3	3	2
2.	BME-792	Medical Instruments Lab - II	0	0	3	3	2
Total of Practical						**6**	**4**
C. Sessional							
	BME-781	Seminar-I	0	0	3	3	2
	BME-782	Project-I	0	0	3	3	2
Total of 7th Semester						**28**	**24**

* Elective-I 1. LASERS and Fiber Optics in medicine, 2. Medical informatics & expert systems,
3. Transportation in living system, 4. Neural Network and Fuzzy Logic Control

8th Semester

A. Theory:

A. Theory							
	Code	**Subjects**	**Contacts periods per week**				**Credit points**
			L	T	P	Total	
1.	BME-801	Medical Image Processing	3	1	0	4	4
2.	BME-802	Modeling of physiological system	3	0	0	3	3

3.	HU-801	Values & Ethics of Profession	3	0	0	3	3
4.	BME-803	Elective-II	3	0	0	3	3
Total of Theory						**13**	**13**

B. Practical:

B. Practical							
	Code	**Subjects**	**Contacts periods per week**				**Credit points**
			L	T	P	Total	
1.	BME-891	Medical Instruments & System lab	0	0	3	3	2
2.	BME-892	Medical Image Processing Lab	0	0	3	3	2
Total of Practical						**6**	**4**
C. Sessioonal							
	BME-881	Project-II	0	0	3	3	4
	BME-882	Seminar-II	0	0	3	3	4
	BME-883	Grand Viva					4
Total of 8th Semester						**25**	**29**

* Elective-II 1. Computer in medicine, 2. Biological control system, 3. Bio-Informatics,
4. Tissue Engineering

Syllabus
3rd Semester

MATHEMATICS

Code: M 302
Contacts: 3L + 1T
Credits: 4

Fourier Series:

Introduction: Euler's formula; Problems on general Fourier Series; Conditions for Fourier Expansion; Fourier Expansions of Discontinuous Functions; Even and Odd functions; Change of interval; Half range series; Typical Waveforms (Square, Saw-toothed, Triangular, Half Wave rectifier, Full Wave rectifier); Parseval's Identity (statement only); Fourier Transform (FT) and its properties; Inverse Fourier Transform (statement only); Fourier transform of derivative (statement only); Convolution (statement only); Application of Fourier Transform in solving partial differential equations — Laplace's Equation (2D only), Heat Conduction Equation (1D only) and Wave Equation (1D only). *12L*

Calculus of Complex Variable:

Functions; Limits and Continuity; Analytic Functions; Cauchy Riemann Conditions; Analytic Continuation; Complex Integration and Cauchy's Theorem; Cauchy's Integral Formula; Taylor's and Laurent Series; Zeros of an Analytic Function; Poles; Essential Singularities; Residue Theorem (statement only) and it's application to evaluation of integral; Introduction to Conformal Mapping; Simple problems. *14L*

Probability and Statistics:

Mean, Median, Mode and Standard Deviation; Samples Space; Definition of Probability; Conditional Probability; General Multiplication Theorem; Independent Events; Bayes' Theorem; Random Variable; Discrete and Continuous Probability Distributions - Probability mass function; Probability density function; Distribution Function; Expectation; Variance; Probability Distribution—Binomial, Poisson and Normal. Correlation and Regression; Method of Least Squares; Linear Curve Fitting. *10L*

Graph Theory:

Graphs; Digraphs; Isomorphism; Walk; Path; Circuit; Shortest Path: Dijkstra's Algorithm; Tree; Properties of Tree; Binary Tree; Fundamental Circuit; Minimal Spanning Tree: Kruskal's Algorithm; Prim's Algorithm. Cut Set; Fundamental Cut Set and Cut Vertices; Matrix Representation of Graphs (Adjacency and Incidence Matrices); Network; Flow Augmenting Path; Ford-Fulkerson Algorithm for Maximum Flow; Max Flow – Min Cut Theorem (statement only). *12L*

Total ***48L***

Text Books:

1. Rathor, Choudhari,: Descrete Structure And Graph Theory.
2. Gupta S. C and Kapoor V K: Fundamentals of Mathematical Statistics - Sultan Chand & Sons.
3. Lipschutz S: Theory and Problems of Probability (Schaum's Outline Series) - McGraw Hill Book. Co.
4. Spiegel M R: Theory and Problems of Probability and Statistics (Schaum's Outline Series) - McGraw Hill Book Co.
5. Goon A.M., Gupta M K and Dasgupta B: Fundamental of Statistics - The World Press Pvt. Ltd.
6. Spiegel M R: Theory and Problems of Complex Variables (Schaum's Outline Series) - McGraw Hill Book Co.
7. Bronson R: Differential Equations (Schaum's Outline Series) - McGraw Hill Book Co.
8. Ross S L: Differential Equations - John Willey & Sons.
9. Sneddon I. N.: Elements of Partial Differential Equations - McGraw Hill Book Co.
10. West D.B.: Introduction to Graph Theory - Prentice Hall
11. Deo N: Graph Theory with Applications to Engineering and Computer Science - Prentice Hall.
12. Grewal B S: Higher Engineering Mathematics (thirtyfifth edn) - Khanna Pub.
13. Kreyzig E: Advanced Engineering Mathematics - John Wiley and Sons.
14. Jana- Undergradute Mathematics
15. Lakshminarayan- Engineering Math 1.2.3
16. Gupta- Mathematical Physics (Vikas)
17. Singh- Modern Algebra
18. Rao B: Differential Equations with Applications & Programs, Universities Press
19. Murray: Introductory Courses in Differential Equations, Universities Press
20. Delampady, M: Probability & Statistics, Universities Press
21. Prasad: Partial Differential Equations, New Age International
22. Chowdhury: Elements of Complex Analysis, New Age International
23. Bhat: Modern Probability Theory, New Age International
24. Dutta: A Textbook of Engineering Mathematics Vol.1 & 2, New Age International
25. Sarveswarao: Engineering Mathematics, Universities Press
26. Dhami: Differential Calculus, New Age International

ELECTRICAL AND ELECTRONIC MEASUREMENT

Code : EE 302
Contacts : 3L + 1T
Credits :4

General features – Construction and principle of operation of moving coil, moving iron, Dynamometer, Thermal and Rectifier type deflecting instruments. Deflecting, controlling and damping torques, extension of instrument ranges using shunts, multipliers and instrument transformers. Measurement of low, medium and high resistances, Kelvins double bridge, multimeters, megger, localization of cable faults.

D.C. and A.C. potentiometers, Measurement of high voltage, Electrostatic instruments, measurement of inductances, capacitance and frequency by A.C. Bridges.
Measurement of power in polyphase circuits, various wattmeter connections. A.C. and D.C. energy meters.

C.R.O. construction & principle measurement of voltage, current, frequency and phase by oscilloscope.
Electronic voltmeters – analog and digital. Digital multimeters, Audio oscillators, signal generators and frequency counter.

Text Books:
1. Electronic Instrumentation – H.S. Kalsi, ISTE/EXCEL BOOKS
2.Golding E.W. & Wides F.C. : Electrical Measuring Instruments & Measurements ; Wheeler
3.Kalsi:Electronic Instrumentation
4.Industrial Instrumentation & Control : SK Singh Tata McGraw Hill.New Delhi
5.Sawhney A K : A course in Electrical & Electronic Measurements & Instruments, Dhanpat Rai & Co.
6.Heltrick A.D. & Cooper W.D. : Modern Electronic Instrumentation & Measuring Instruments; Wheeler
7.Patranabis D: Sensors & Transducers, Wheeler 96

Electrical and Electronic Measurement Lab

Code: EE 392
Contact: 3P
Credit: 2

List of Experiments:

1. Instrument workshop- observe the construction of PMMC, Dynamometer, Electro thermal and Rectifier type instrument, Oscilloscope and digital multimeter
2. Calibrate moving iron and electrodynamometer type ammeter/volmeter by potentiometer

3. Calibrate dynamometer type Wattmeter by potentiometer
4. Calibrate A.C. energy meter
5. Measure the resistivity of material using Kelvin Double Bridge
6. Measurement of Power using Instrument transformer
7. Measurement of Power in Polyphase circuits
8. Measurement of Frequency by Wien Bridge using Oscilloscope
9. Measurement of Inductance by Anderson Bridge
10. Measurement of Capacitance by De Sauty Bridge

Circuit Theory & Networks
Code: EE 301
Contact: 3L + IT
Credit: 4

Different types of systems & networks: continuous & Discrete, Fixed and Time varying, Linear and Non-linear, Lumped and distributed, Passive & Active Networks & Systems
Laplace transform of impulse and sinusoidal steps waveforms for RL, RC, LC and RLC Circuits. Transient analysis of different electrical circuits with and without initial conditions, Fourier Series and Fourier Transform
Network theorems and their applications in circuit analysis, Formulation of network equations, Source transformations, Loop variable analysis and node variable analysis
Graph of network, concept of tree branch, tree link. Incidence matrix, Tie-set matrix and loop currents, Cut set matrix and node pair potentials
Two port networks, Open circuit Impedance and Short circuit Admittance parameters, Transmission parameters, hybrid parameters, and their inter-relations
Indefinite admittance matrix- their applications to the analysis of active network
Active filter analysis and synthesis using operational amplifier

SPICE: How SPICE works. Model statement, models for passive and active device, D.C. circuits analysis, small signal analysis, capacitors and inductors in D.C. Circuits, steady state and transient, plotting and printing, input and output Impedance, D.C. sensitivity analysis, harmonic decomposition (Fourier Series), Harmonic re-composition, voltage controlled components

Text books **:**

1. Sudhakar:Circuits & Networks:Analysis & Synthesis 2/e TMH New Delhi
2. Valkenburg M. E. Van, "Network Analysis", Prentice Hall.
3. Engineering circuit analysis with PSPICE and probe-Roger
4. Engg Circuit Analysis,: Hayt 6/e Tata Mcgraw-Hill
5. A. Chakravarty: Networks, Filters & Transmission Lines
6. D.Chattopadhyay and P.C.Rakshit: Electrical Circuits
7. A.V. Oppenheimer and A.S.Wilsky: Signals & Systems, PHI
8. R.V.Jalgaonkar.: Network Analysis & Synthasis.EPH.
9 . Sivandam- Electric Circuits and Analysis, Vikas
10. V.K. Chandna, A Text Book of Network Theory & Circuit Analysis, Cyber Tech

References **:**

1.Reza F. M. and Seely S., "Modern Network Analysis", Mc.Graw Hill Book Company
2.Roy Choudhury D., "Networks and Systems", New Age International Publishers.
3.Kuo F. F., "Network Analysis & Synthesis", John Wiley & Sons.

Circuits & Networks Lab

Code: EE 391
Contact: 3P
Credit: 2

List of Experiments:

1. Transient response in R-L and R-C Network: Simulation/hardware
2. Transient response in R-L-C Series & Parallel circuits Network: Simulation/hardware
3. Determination of Impedance (Z) and Admittance(Y) parameters of two port network
4. Frequency response of LP and HP filters
5. Frequency response of BP and BR filters
6. Generation of Periodic, Exponential, Sinusoidal, Damped sinusoidal, Step, Impulse, Ramp signals using MATLAB in both discrete and analog form
7. Evaluation of convolution integral, Discrete Fourier transform for periodic & non-periodic signals and simulation of difference equations using MATLAB
8. Representation of poles and zeros in z-plane, determination of partial fraction expansion in z-domain and cascade connection of second order system using MATLAB
9. Determination of Laplace transform and inverse Laplace transformation using MATLAB
10. Spectrum analysis of different signals

Note: An Institution/College may opt for some other software or hardware simulation wherever possible in place of MATLAB

Biophysical signal and system simulation
Code: BME 301
Contact: 3L + 1T
Credit: 4

Continuous and Discrete time signal and system: Signal energy and power, Transformation of independent variable (Time shifting, scaling, inverting), Periodic, even & odd signals, Continuous time complex exponential and sinusoidal signals, Unit impulse and unit step function, RAMP Function. System Properties: Inter connection of system, Shift operator, Invertibility and inverse system, Causality- Stability- memory- Time invariance and Linearity of system.	**6L**
Fourier analysis for Continuous and Discrete time process: Linear combinations of harmonically related complex exponentials, Determination of the Fourier series representation of Continuous and Discrete time periodic signal, Properties of continuous and discrete time Fourier series. C.T.F.T and D.T.F.T. System transfer function and System Identification.	**6L**
Time frequency and Wavelet analysis: Stationary and Non stationary signals, Need for time frequency analysis for biomedical signal analysis, Introduction to tools for time frequency analysis- i) S.T.F.T (Short time Fourier Transform or Spectrogram) ii) Wavelet.	**4L**
Estimation of Noise in Signals: Sources and types of noise, A frequency domain representation of noise, Spectral component of noise, Power spectral density, Representation of noise using orthogonal coordinates, Mixing involving noise, Noise temperature, Noise band width, Noise factor, Equivalent noise resistance in cascade amplifier, Noise factor in an amplifier and cascade amplifier, Noise factor measurement.	**6L**
Feed Back System: Basic Feedback concept, Positive and Negative Feedback, Sensitivity analysis, Effect of Feedback on disturbance or Noise, Distortion analysis by Feed Back, Control system-Open loop Control System-Control system With Feed Back.	**4L**
Filtering Techniques: Types of filter (Active and Passive), General idea of L.P.F, H.P.F, B.P.F and N.F. First order Passive Filters (L.P, H.P, B.P & N.F), Basic idea about OPAMP, First order active filter (L.P, H.P, B.P & N.F), Use of filter for biomedical signal analysis.	**6L**
Modeling of Physiological System: Modeling of Nerve action potential: Hodgkin-Huxley model, Cable properties of nerve fibres. Modeling of Skeletal Muscle Contraction: Huxley Cross Bridge Model with mathematical expression. Modeling of Myoelectric activity. Modeling of cardiovascular system: Block diagram representation of cardio vascular system, Electrical circuit model of Blood Pressure, and Electrical circuit model of oxygenation. A model of immune response to disease (Block Diagram).	**8L**
Total	**40L**

References:

1. Oppenheim, Wilskey and Nawab- "Signal & System", Prentice Hall India.
2. Hayken & Van Veen- "Signal & System", Willey
3. Taub & Schilling-"Principles of Communication System", Tata McGraw Hill.
4. Kennedy & Devis-"Electronic Communication System", Tata McGraw Hill
5. Gayakward-"Opamps and Linear Integrated Circuits" , Prentice Hall India

6. A.K.Sawhney-"Electrical & Electronic Measurement & Instrumentation", Dhanpat Rai & Co. (P) Ltd.

Human Physiology-I
Code: BME-302
Credits: 4
Contacts: 3L + 1T

GENERAL PHYSIOLOGY

1.Basic Biological (Biophysical & Biochemical) Principles:

Diffusion, surface tension and viscosity – their characteristics, factors influencing and biological applications. Osmosis – osmometers, laws of osmosis, biological applications, relation with depression of freezing points. Acids, bases and pH. Colloids – classification, properties – optical and electrokinetic, biological importance of colloids. Dialysis and ultra-filtration. Chromatography: Principles & applications, Electrophoresis: Principles & applications, Gel electrophoresis. Ultracentrifugation: moving boundary and density gradient ultracentrifugation. Adsorption. Gibbs-Donnan equilibrium. Radioactivity – radioisotopes and their biological applications. Principles of radioimmunoassay (RIA), autoradiography. The resting membrane potential. The action potential. Electrotonic potentials. Propagation of nerve impulse in different types of nerve fibers. Compound action potentials.

2. Genetics:

Nucleic acid- 1. Structure of DNA- Physical & Chemical properties of DNA & RNA, Ultra structure & types of DNA & RNA(in details), Brief idea about super coiling of DNA Semiconservative mode of replication of DNA, Mechanism of replication of DNA, ,Genetic code. Genetically relation of color blindness and ocular albinism.
Chromosome aberration- Structural aberration- Deletion- Duplication- Inversion- translocation. Numerical aberration (Polyploidy & aneuploidy- Hyper & hypo). Gene mutation- classification-spontaneous & Induced- Chemical mutation- Practical Application of mutation.

3. Blood Vascular system

Composition and functions of blood. Plasma proteins – normal values, origin and functions. Brief idea on Bone marrow. Formed elements of blood – origin, formation, functions and fate. Hemoglobin – functions, compounds and derivatives. Abnormal hemoglobin-overview. Thalassemia-brief idea. Different types of anemia and their causes-overview. Erythrocyte sedimentation rate (ESR) and its significance. Hematocrit. PCV, MCV, MCH, MCHC. Blood volume – normal values, regulation. Blood coagulation – factors, process, anticoagulants, Prothrombin time. Clotting time. Bleeding time. Blood groups – ABO systems and Rh factors. Blood transfusion.
Ultra structure & functions of blood vessels (artery & vein). Structure type and function of capillaries. Differences between artery & vein.

4. Muscular Physiology:

Microscopic and electron microscopic structure of skeletal, smooth and cardiac muscles. Difference between skeletal, smooth and cardiac muscles. The sarcotubular system. Red and white striated muscle fibers. Single unit and multi unit smooth muscle. Motor point. Properties of muscle: excitability and contractility, all or none law, summation of stimuli, summation of contractions, effects of repeated stimuli, genesis of tetanus, onset of fatigue, refractory period, tonicity, conductivity, extensibility and elasticity. Electromyography. Muscle contraction – E C Coupling, Muscle fatigue, Rigor mortis, Sliding filament theory, Slow & fast muscle fibers, Isotonic & Isometric contraction.

5. Neuro Physiology

Electron microscopic structure of nerve cell or neurons. Neuroglia. Myelinated and unmyelinated nerve fibers. Conduction velocity of nerve impulse in relation to myelination and diameter of nerve fibers. Properties of nerve fibers – excitability, conductivity, all-or-none law, accommodation, adaptation, summation, refractory period, indefatiguability. Concept of chronaxie and rheobase. Synapses – types, structure, synaptic transmission of the impulse, synaptic potentials, neurotransmitters. Motor unit. Injury to peripheral nerves – degeneration and regeneration-brief idea.
Automatic nervous system – Introduction, Comparison of autonomic & somatic nervous system, Anatomy of autonomic motor pathways – Pre-ganglionic neurons, autonomic ganglia, sympathetic ganglia, autonomic plexus, post-ganglionic neurons structure of sympathetic and parasympathetic division. ANS- neurotransmitter and receptors- cholinergic neurons & receptors. Receptor agonist & antagonist. Physiological effect of ANS- sympathetic & parasympathetic response. Integration & control of autonomic function- autonomic Reflexes, autonomic control by higher centers.

Neural Transmission- Introduction, Autonomic Synaptic Transmission-Modes of transmission, sympathetic & parasympathetic response. CNS Synaptic transmission-Electrical synaptic transmission & chemical synaptic transmission.

Neuro muscular Junction – ***The neuromuscular junctions – structure, events in transmission, end-plate potential, post tetanic potential.***

6.*Cardio Vascular System –*

Structure & function of Heart & blood vessels (artery, vein and capillary) (Anatomical position, chambers of heart.) Blood circulation

through heart. Special junctional tissue of heart.(Myogenic and neurogenic heart-conducting system of heart. E.C.G. Cardiac cycle.

Heart Sound , Blood vessels – type, Structure & function, Systemic & pulmonary circulation. Blood – composition, Function, blood group, Blood clotting. Cardiac cycle and cardiac output. Blood Pressure-regulation & controlling factors.

7.Renal System- Function of kidney, Anatomy & Histology of Nephron & collecting duet. – Urine formation(Filtration, reabsorbtion and secretion)- Counter – current system of urine concentration, Anomalies in urine concentration.

Physiology Practical
Code: BME 392
Credits : 2

Identification of fixed histological slides – nerve tissues (cerebellum, cerebral cortex, neurons, spinal cord, nodes of Ranvier, corneal cell space), renal tissues. Blood vessels (artery & vein),skin, Tongue, Liver.

Hemoglobin estimation

Determination of blood pressure

Determination of BT, CT, ESR

Blood film making & identification of different blood corpuscle.

ECG wave identification

Measurement of TC of RBC & WBC & DC of WBC.

Determination of Blood Group (ABO; Rh).

4th Semester

Biomaterials

Code: BME 401
Contacts: 3L + 1T
Credits: 4

Introduction: Definition of biomaterials, requirements of biomaterials, classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.	6L
Metallic implant materials: Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with biometal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.	6L
Polymeric implant materials: Polyolefins, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetals. (Classification according to thermosets, thermoplastics and elastomers). Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives (processing aids), aging and environmental stress cracking. Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.	6L
Ceramic implant materials: Definition of bioceramics. Common types of bioceramics: Aluminium oxides, Glass ceramics, Carbons. Bioresorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).	
Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions.	4L
Biocompatibility & toxicological screening of biomaterials: Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situ implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.	4L

Sterilisation techniques: ETO, gamma radiation, autoclaving. Effects of sterilization on material properties. Testing of biomaterials/Implants: *In vitro* testing (Mechanical testing): tensile, compression, wears, fatigue, corrosion studies and fracture toughness. *In-vivo* testing (animals): biological performance of implants. *Ex-vivo* testing: *in vitro* testing simulating the *in vivo* conditions. Standards of implant materials.	5L 3L 6L
Total	**40L**

Test books

1. J B Park, *Biomaterials - Science and Engineering*, Plenum Press , 1984.
2. Sujata V. Bhat, *Biomaterials*, Narosa Publishing House, 2002.

References

1. Jonathan Black, *Biological Performance of materials*, Marcel Decker, 1981
2. C.P.Sharma & M.Szycher, *Blood compatible materials and devices*, Technomic Publishing Co. Ltd., 1991.
3. Piskin and A S Hoffmann, *Polymeric Biomaterials* (Eds), Martinus Nijhoff Publishers. (Dordrecht. 1986)
4. Eugene D. Goldbera , *Biomedical Ploymers*, Akio Nakajima.
5. A . Rembaum & M. Shen, *Biomedical Polymers*, Mercer Dekkar Inc. 1971
6. Lawrence Stark & GyanAgarwal , *Biomaterials*
7. L. Hench & E. C. Ethridge, *Biomaterials - An Interfacial approach*.

Biomechanics
Code: BME 402
Contacts: 3L + 1T
Credits: 4

Introduction of mechanics: Review of the principles of mechanics, Vector mechanics- Resultant forces of Coplaner & Non-coplaner and Concurrent & non-concurrent forces, parallel force in space, Equilibrium of coplanar forces, Newton's laws of motion, Work and energy, Moment of inertia.	6L
Hard tissues: Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models – anisotropy, Electrical properties of bone, fracture mechanism and crack propagation in bones, fracture fixators, repairing of bones, mechanical properties of collagen rich tissues, teeth and its properties.	6L
Soft tissues: Structure and functions of cartilages, tendons, ligaments, stress-strain relationship, soft tissue mechanics, mechanical testing of soft tissues standard sample preparation, cross-section measurement, clamping of the specimen, strain measurement, environmental control), time dependent properties of testing.	6L
Biomechanics of joints: Skeletal joints, skeletal muscles, basic considerations, basic assumption and limitations, forces and stresses in human joints, mechanics of the elbow, mechanics of shoulder, mechanics of spinal column, mechanics of hip, mechanics of knee, mechanics of ankle.	8L
Locomotion: Human locomotion, gait analysis and goniometry, Ergonomics, Foot Pressure measurements – Pedobarograph, Force platform, mechanics of foot. Total Hip Prosthesis: requirements, different types of components, Stress analysis & instrumentation, Knee Prosthesis.	6L
Cardiovascular mechanics: Heart valves, artificial heart valves, biological and mechanical valves development, Heterogrils, Homograil, testing of valves.	4L
Fluid mechanics: introduction, viscosity and capillary viscometer, Rheological properties of blood, laminar flow, Couette flow and Hagen-poiseuille equation, turbulent flow.	4L
Total	**40L**

Text Books

1. Alexander R Mc Neill, Biomechanics, Chapman and Hall, 1975
2. D N Ghista, Biomechanics of Medical Devices, Macel Dekker, 1982

References

1. A Z Tohen and C T Thomas, Manual of Mechanical Orthopaedics
2. D N Ghista and Roaf, Orthopaedic Mechanics, Academic Press
3. VC Mow and W C Hayes, Basic Orthopedic Biomechanics, Lippincott, Raven publishers.

Biophysics
Code: BME 403
Contacts: 3L + 1T
Credits: 4

Body fluid: Properties of body fluid, determination of conduction of body fluid, measurement of EMF of cells, temperature and reaction rates: Arrhenius equation. Photochemical reaction, the law of photochemistry, fluorescence and phosphorescence, Principles of colorimeter, Beer-Lambert's law, biometrics.	6L
Biophysical activity of heart: electrical activity of the heart, monophonic and biphasic recordings, original and propagation of excitation & contraction, refractoriness, regular and ectopic pace makers, electrocardiography, waveform and measurement, ECG in diagnosis, arrhythmia's, flutter, fibrillation, vulnerable period, phonocardiography, ballistocardiography.	6L
Biophysical activity of brain and other organs: electrical activity of brain, waveforms & measurements, electrogastrography, electroneurography, nerve conduction studies, electroretinography, electroocculography, recording electrodes, interfaces, skin contact impedance, biological transducers, receptor potentials.	6L
Introduction to electrical simulation: impedance & current distribution, dielectric properties of biological materials, skin impedance, total body impedance, impedances at high frequencies, high voltage & transient properties, patient safety, electrical shocks and hazards, leakage currents, types & measurements, protection against shock, burn & explosion hazards.	6L
Radioactivity: Radio emission, radioisotopes, law of radioactive decay, half life period, production of radio isotopes for medical use, electromagnetic radiation, interaction of radiation with matter, exponential attenuation, half value thickness, photo electric, Compton and pair production process and their significance in radiology, radiation units, detection and measurements of radiation	6L
Introduction of ultrasonic wave: Ultrasonic wave motion, wave characteristics, intensity, and ultrasound properties in body (velocity, attenuation, reflection, refraction and absorption). Use of ultrasound in biological field.	6L
Introduction of magnetic field: Optical activity and magnetic rotation of substances, dipole moments, magnetic properties of substances. Useful and harmful effects of magnetic fields, radio waves, micro waves, ultra violet radiation and infrared radiation on human beings - Applications. Effect of hypothermia and hyperthermia. Production of ultra low and low temperature for medical use.	3L
Standards: BIS standards, ISO regulations, Electrical safety and regulation to keep the hospital environment safe, medical ethics.	5L
	2L
Total	**40L**

Text books

1. W.R.Hendee & E.R.Ritenour, Medical Imaging Physics (3rd eds), Mosbey Year-Book, Inc., 1992.
2. W.R.Hendee & E.R.Ritenour, Medical Physics.
3. Massey and Meredeth, Medical Physics.

References

1. Plummer, Bio Chemistry - The chemistry of Life, Mc Graw Hill.
2. Kuchel, Bio Chemistry, Schaum Series Mc Graw Hill.
3. Patrick Rcully, Electrical Simulation & Electropathology, Cambridge University press 4. Joseph Bronzino, Biomedical Instrumentation.
5. Khandpur R S, Handbook of Analytical Instrumentation, Tata Mc Graw Hill
6. Khandpur R S, Handbook of Medical Instrumentation, Tata Mc Graw Hill
7. David Cooney, Principles of Biomedical Engineering.
8. Snell et al, Bio Physical Principles of Structure and functions

9. Ruch and Patton, Bio Physics and Medical Physiology

Digital Electronics Circuit

Code : EC 405
Contact: 3L + 1T
Credit: 4

Number circuits: Logic gates, logic families and their characteristic–Bipolar logic, TTL logic, CMOS logic,CMOS-TTL interfacing.	10L
Combinational logic design: Switching algebra, combinational circuit analysis, combinational circuit synthesis, minimization methods-Karnaugh map,VEM, Quine McCluskey, timing issues, Hazards, Combinational design using MSI and LSI DECODERS, Multiplexers, Encoders, Comparators, Arithmetic Circuits, Tristate logic, combinational logicdesign using PLDs.	15L
Sequential logic design: Need for sequential circuits, binary cell, latches and flip-flops, clocked synchronous state machine analysis, clocked synchronous state machine design-ASM charts, state minimization, state assignment, synthesis using D-FF and JK-FF , asynchronous state machines, counters, shift registers, MSI devices as state machines, Practical issues in state machine design, sequential logic design with PLDs.	15L
Total	**40L**

References:

1. J.F.Wakerly, "Digital Design Principles and Practices" , PH, 1999
2. Fletcher, "Engineering approach to digital design", PHI, 1993
3. C.H.Roth, "Fundamentals of Logic Design", PWS, 1995
4. Zee Kohavi, "Switching and Finite Automata Theory".
5. N.N.Biswas, "Logic Design Theory", PHI, 1993.

Introduction to Programming

Code : CS 408
Contact : 3L+1T
Credits :4

Concepts of structural program development; concept of data types; precedence and associativity of operators; conditional transfer; deterministic and in-deterministic loops; recursions; functions and procedures - call by value, call by reference and their differences; programming for numerical methods; records.	12L
Data-type handling and various constructs (conditional, loop, functions etc); pointers: concept of pointers and passing parameters using pointers, non-numeric processing, concept of arrays of pointers and pointers to pointers; structures and unions – advantage of using structures, concept of information hiding, pointers to structures; files - basic concept of various types of file access methods: sequential, indexed sequential, random; various statements for file handling.	16L
Advanced Programming Languages like C++, ADA, LISP, PROLOG, and PASCAL. Comparison of various languages.	12L
Total	**40L**

Text Books:

1. Tennence W.Pratt, "Programming languages design and implementation", Prentice Hall of India.
2. Gottfried BS – Programming with C, TMH pub.
3. Allen B. Tucker, "Programming Languages", Mc Graw Hill.
4. Kanetkar, Yashvant – Understanding Pointers in C- 2nd Edn. BPB
5. Kanetkar, Yashvant - Let us C. - 3rd revised Edn. BPB

Biomedical Engineering Lab-I

Code: BME 491
Contacts: 3P
Credits: 2

List of Experiments:

1. Mechanical characterization of metallic biomaterials
2. Mechanical characterization of polymeric biomaterials

3. Hardness testing of biomaterials
4. Estimation of haemocompatibility of biomaterials by hemolysis studies
5. Measurement of torque required to tap and screwing in jaw bone.
6. Determination of moment of inertia of human limb using dynamometer.
7. Measurement of viscosity of body fluid.
8. Determination of moment of inertia of human bone using compound pendulum method.
9. Stress-strain analysis of hip prosthesis.
10. Surface roughness measurement of biomaterials.
11. Ultrasonic characterization of biomaterials.

Digital Electronics Circuits Lab

Code : EC 495
Contact: 3P
Credit: 2

List of Experiments:

1. Digital Circuit Design using TTL/CMOS gates.
2. Combinational Circuits using gates, MUX,decoders, arithmetic circuits.
3. Sequential Circuits-counters, shgift registers, sequence regenerators, signature detectors.

Programming Practice Lab

Code : CS 498
Contact: 3P
Credits: 2

List of Experiments:

1. Concepts of flow charts and decision tables, Examples and practice problems.
2. Introduction to Digital Computers and its components, Introduction to DOS and UNIX Operating System.
3. Development of Computer Program using C language- Roots of quadratic and Cubic equations; Summatio of N Natural numbers; Arranging numbers in ascending and descending orders; Separation of odd and even numbers, etc.

Text Books:

1. Kernighan, B.W. “The elements of programming style”, McGraw Hill
2. Yourdon, E., “Techniques of program structures and Design “, Prentice Hall
3. W.H., Teukolsky, S.A., Vetterling W.T. & Flannery, B.P., “Numerical Recipes in Fortran”, Cambridge University Press
4. Gotterfield, B.S. “Schaum’s outline of theory & programming with Basic”, McGraw Hill, New Delhi
5. Schied, F.S., “Theory and Problems of Computer & Programming”, McGraw Hill, New Delhi.

TECHNICAL REPORT WRITING & / LANGUAGE PRACTICE LABORATORY

Code: HU 481

credits: 2

Contacts: 3

Topics to be covered and number of hours required for it:
Introductory lecture is to be given to the students so that they get a clear idea of the syllabus and understand the need for having such a practice lab in the first place (3 hours)
Conversion practice is done on given situation topics. The students are also made to listen to pre-recorded cassettes produced by British Council and also by the Universities of Oxford and Cambridge (6 hours)
Group Discussions: The students are made to understand the difference between the language of conversion and group discussion. Strategies of such discussions are to teach to them. It is also helpful to use videocassettes produced by the U.G.C. on topics like group-discussion. After wards the class is divided into groups and the students have to discuss on given topics on current socio-economic-political-educational importance(12 hours)
Interview sessions-students are taught the do’s and don’ts of facing a successful interview. They then have to face rigorous practices of mock-interviews. There simulations of real life interview sessions where students have to face an interview panel (12 hours)
Presentations: The secrets of an effective presentation are taught to the students. Then each and every student has to make lab presentations with the help of the Overhead projector/ using power point presentation and other audio-visual aids in the laboratory. They also have to face the question answer sessions at the end of their presentation (12 hours)

Classes are also allotted to prepare the students for competitive examinations like the T.O.E.F.L. by making the students listen to specially produced C.D. cassettes of such examinations (3 hours)

The overall aim of this course is to inculcate a sense of confidence in the students and help them to become good communicators in their social as well as professional lives.

Text:

1. Sharma—Business Correspondence & Report Writing, TMH
2. Prasad—Group Discussion & Interview (With Audio Cassette) , TMH

Reference:

1. Sashi Kumar—Spoken English (with Cassette) , TMH

Fifth Semester

Biosensors and Transducers
Code: BME 501
Contact: 3L + 1L **Credit: 4**

Different Transduction principles: Classification of transducers, selecting of transducers, circuit based on transduction. *Temperature transducers*: thermo-resistive transducers, thermoelectric, p-n junction, chemical thermometry. *Displacement transducers*: potentiometer, resistive strain gauges, inductive displacement, capacitive displacement transducer, force transducer. *Pressure transducer*: variable capacitance pressure transducers, LVDT transducers, strain gauge transducers, semiconductor transducers, catheter tip transducers. *Photoelectric transducers:* photo-emissive tubes, photovoltaic cell, photoconductive cell. *Flow transducers:* different types of flow sensors and detectors. Piezoelectric transducers and their applications.	**14L**
Study of biological sensors: Sensors / receptors in the human body, basic organization of nervous system-neural mechanism and circuit processing. Chemoreceptor: hot and cold receptors, barro receptors, sensors for smell, sound, vision, osmolality and taste. Sensor models in the time and frequency domains.	**4L**
Biochemical Transducers: Electrode theory: electrode-tissue interface, metal-electrolyte interface, electrode-skin interface, electrode impedance, electrical conductivity of electrode jellies and creams. Biopotential electrodes: microelectrodes, body surface electrodes, needle electrodes. Reference electrodes: hydrogen electrodes, silver-silver chloride electrodes, Calomel electrodes. Recording electrodes for ECG, EEG, and EMG. Transducers for the measurement of ions and dissolved gases, pH electrode, specific ion electrodes.	**12L**
Bio sensors: Ion exchange membrane electrodes, enzyme electrode, glucose sensors, immunosensors. Basic principles of MOSFET biosensors & BIOMEMS.	
Optical sensor- photo detectors, optical fiber sensors, and indicator mediated transducers, general principles of optical sensing, optical fiber temperature sensors. Pulse sensor: photoelectric pulse transducer, strain gauge pulse transducer.	**5L**
	5L
Total	**40L**

Text books:

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.
2. S.C. Cobbold, "Transducers for Biomedcial Instruments", Prentice Hall.
3. Brown & Gann, "Engineering Principles in Physiology Vol. I", Academic Press.
4. Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
5. Rao & Guha,"Principles of Medical Electronics & Biomedical Instrumentation", University Press, India.

References:

Iberall & Guyton , "Regulation & Control in Physiological System" , Instruments Society USA.
A.V.S. De Renck , "Touch Heat & Pain", Churchill Ltd. London.
Harry Thomas , "Handbook of Bio medical Instrumentation", Reston, Virginia.
D. L. Wise , "Applied Bio Sensors", Butterworth, London.

Biomedical Instrumentation
Code: BME 502
Contact: 3L + IT Credit: 4

Introduction to the biomedical instrumentation: Objectives for instrumentation system, component of man-instrument system, problems encountered in measuring a living system, biofeedback instrumentation.	**2L**

Measurement systems: Specifications of instruments, static & dynamic characteristics, classification of errors, statistical analysis. Introduction to reliability, accuracy, fidelity, speed of response, linearization of technique, data acquisition system.	**4L**
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 - resistance and capacitance type.	**6L**
Bioelectric amplifiers: Special features of bioelectric amplifiers, safety requirements, realization of bioelectric amplifiers, carrier amplifiers, chopper amplifiers, phase sensitive detector, isolation amplifiers, and instrumentation amplifiers.	
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 & EEG signals. Holter monitor and cardiac stress test.	**6L**
Patient monitoring system: Different component of patient monitoring system, sources of artifacts and their implication, organization and equipments used in ICCU & ITU. Computer assisted patient monitoring system (bedside monitors, central monitors, measurement of heart rate, blood pressure, respiratory rate, impedance pneumography, apnoea detectors, etc).	**8L**
Patient safety and electromedical equipment: physiological effects of electrical currents, macroshock and microshock, preventive measures to reduce shock hazards, Leakage current, isolation of patient circuits, safety of electrically susceptible patients, radiation hazards and safety, shielding, open ground problem and earthing methods.	**8L**
	6L
Total	**40L**

Text Books:

R. S. Khandpur "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill.
Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
Cromwell, Weibell & Pfeiffer, "Biomedical Instrumentation & Measurement", Prentice Hall, India

References:

Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg . , Boston.
J.Webster, "Bioinstrumentation", Wiley & Sons.
Joseph D.Bronzino, "The Biomedical Engineering handbook", CRC Press.

Analytic & Diagnostic equipments
Code: BME 503
Contact: 3L + IT Credit: 4

Analytical equipments: Colorimeter-principles of measurement and applications, Beer-Lambert's Law in spectrometry. UV, visible and infra-red spectrophotometers. Design of monochromators, detection systems. Basic applications in Biochemical analysis-Autoanalyser. Principles and applications- atomic absorption photometer, flame photometers, densitometers, gas and liquid chromatographs. Principles of scanning and transmission electron microscopy. Principles of simple, compound and phase contrast microscopes. Centrifuge-principles and applications. Different types of sterilization methods-autoclave.	**12L**
Blood Flow meters: Electromagnetic blood flow meter, ultrasonic blood flow meter, Doppler blood flow meter, NMR blood flow meter, cardiac output measurement – indicator dilution methods and impedance technique.	**6L**
Pulmonary function analyzers: Pulmonary function measurement-spirometry, respiratory gas analyzers, pneumotachography – different types of pneumotachometers, respiratory rate meter, impedance plethysmograph / pneumograph.	**6L**
Blood gas analyzers: Blood pH measurement, pCO_2 measurement, pO_2 measurement, a complete blood gas analyzer. Different types of oximetry systems, pulse oximeter.	**5L**
Blood pressure and heart sound measurement: Measurement of blood pressure using sphygmomanometer instrument based on Korotkoff sound, indirect measurement of blood pressure, automated indirect measurement, and specific direct measurement techniques. Heart sound measurement – stethoscope, phonocardiograph.	**4L**
Blood cell counters: Different methods for cell counting, Coulter Counters, automatic recognition and differential counting of cells.	
Endoscopy: Introduction, various types of endoscopes, cystoscopes, laproscopes, fiber optic endoscopes and endoscopes with integral TV cameras.	**3L**
	4L

Total	**40L**

Text Books:

R. S. Khandpur "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill.
Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
J.Webster, "Bioinstrumentation", Wiley & Sons

References:

Joseph Bronzino, " Biomedical Engineering and Instrumentation", PWS Engg . , Boston.
Willard Van Nostrand, ".Instrumental Methods of Analysis"-
Sharms, "Instrumental Methods", S Chand & Co.
Harry Bronzino E, "Handbook of Biomedical Engineering and Measurements", Reston, Virginia.
Jacobson & Websler, " Medicine & Clinical Engg"
Leslie Cromwell, " Biomedical Instrumentation and Measurements"
Hcinz Kressc, " Handbook of Electro medicine" , John Wiley.
Geddes & Baker , "Principles of Applied Biomedical Instrumentation" Wiley.

Medical Imaging-I
Code: BME 504
Contact: 3L + 1L Credit: 4

X-rays *:* Production X-rays, various components of radiographic systems, X-ray tube design, X-ray spectrum, rating charts of X-ray tubes. Electrical circuit for X-ray m/c, filament circuits and mA control, HT circuits, KV control, control of exposure timers, collimators, scatter and grids, absorbed dose, basics of tables & arms, properties of X -ray films &screens, dark room accessories, types of X-ray tubes for various medical applications (Low KV imaging, high KV imaging, mammography X-ray system).	**12L**
Photography and film image: Principle of photography and radiographic film image, film sensitometry, information content of an image, image quality factors (resolution, contrast, noise), MTF. Detectors: ionization chamber, proportional counter, Geiger-Muller counter, scintillation detectors, semiconductor radiation detector, efficiency and sensitivity of detectors. Image intensifier, automatic brightness control system, image distortion and artifacts.	**10L**
Fluoroscopy and angiography: Fluoroscopic imaging system, principle, specific system design. Digital fluoroscopy-c-arm system. Digital subtraction angiography (DSA), digital subtraction programming.	**6L**
Radiation therapy: Radiotherapy principles, dosage data for clinical applications (ISODOSE charts), radiation therapy planning, collimators and beam direction devices, dose measurement and treatment planning, tele isotope units. Safety protocols & protection.	**4L**
Infra red Imaging: Physics of thermography, Imaging systems, clinical themography, liquid crystal thermography. **Special imaging techniques:** Cineradiography, cinefluorography, stereoscopic radiography, magnification radiography, microradiography, tomography, neutron radiography.	**4L**
	4L
Total	**40L**

Text Books:

1. Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
2. R. S. Khandpur, "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill.
3. J.Webster, "Bioinstrumentation", Wiley & Sons

References:

1. Dowsett, Kenny & Johnston, "The Physics of Diagnostic Imaging", Chapman & Hall Medical, Madras/London.
2. Brown, Smallwood, Barber, Lawford & Hose, "Medical Physics and Biomedical Engineering", Institute of Physics Publishing, Bristol.
3. Massey & Meredith , "Fundamental Physics of Radiology", John Wright & Sons.
4. S. Webb, "The Physics of Medical Imaging", Ada m Hilger, Bristol.
5. Sybil M Stockley, "A Manual of Radiographic Equipments", Churchill Livingstones.
6. Chistrmis , "Physics of Diagnostic Radiology"

Communication circuits & systems
Code: BME 505
Contact: 3L + IT Credit: 4

Amplifiers: High frequency tuned amplifiers, single tuned and multiple tuned amplifiers. Power amplifiers: Class - A, Class - B, Class - AB & Class - C amplifiers, tuned power amplifier.	**8L**
Modulation & demodulation: Purpose of modulation, analog modulations: AM, SSB, DSB, FM, PM and corresponding demodulation.	**6L**
Pulse modulation: PAM, PDM, PPM, PCM, delta and delta sigma, analog to digital converter and digital to analog converter, high speed AD & DA converters.	**6L**

Digital modulation & demodulation: PSK, FSK, ASK and M-ARY system.	**6L**
Multiplexing techniques: FDM, TDM, introduction to CDM.	**4L**
Transmitter & Receiver: Introduction to analog transmitters and receivers (block diagram description), principle of superheterodying. Introduction to VCO and PLL.	**4L**
Telemetry system: Components of telemetry system, analog & digital telemetry, bio-signal telemetry and its special requirement, single and multi-channel biotelemetry, transmission of physiological signals over telephone line, application of telemetry in patient care (multi-patient telemetry & ambulatory patient monitoring) and sports.	**6L**
Total	**40L**

Text Books:

1. Taub & Schilling, "Principles of Communication Systems" 2nd. Ed., Tata MaGraw Hill.
2. Carlon, "Communication System, 4/e" Tata MaGraw Hill.
3. Kennedy & Davis, "Electronic Communication Systems" 4th ed. Tata MaGraw Hill.
4. B.P.Lathi,"Modern and Analog Communication System" 3rd ed. Oxford University Press.
5. R. S. Khandpur " Handbook of Bio-Medical Instrumentation", Tata McGraw Hill.

References:

1. Millman & Halkias, "Integrated Electronics" Tata MaGraw Hill.
2. Lapatine, "Electronic communication".
3. Kennedy, "Electronic Communication System".
4. Roody and Cooien, "Electronic Communication".

Data Structure and Algorithm
Code: CS 502
Contact: 3L + IT **Credit: 4**

Overview of C language, Time and Space analysis of Algorithms - Order Notations.	**6L**
Linear Data Structures: Sequential representations - Arrays and Link Lists, Stacks, Queues and Dequeues, Strings, Application. Linear Data Structures, Link Representation - Linear linked lists, Circularly linked lists. Doubly linked lists, application.	**8L**
Recursion: Design of recursive algorithms, Tail Recursion, When not to use recursion, Removal of recursion.	**4L**
Non-linear Data Structure: Trees - Binary Trees, Traversals and Threads, Binary Search Trees, Insertion and Deletion algorithms, Height-balanced and weight-balanced trees, B-trees, B+ -trees, Application of trees; Graphs - Representations, Breadth-first and Depth-first Search.	**8L**
Hashing: Hashing Functions, collision Resolution Techniques.	**4L**
Sorting and Searching Algorithms- Bubble sort, Selection Sort, Insertion Sort, Quicksort, Merge Sort, Heapsort and Radix Sort.	**4L**
File Structures: Sequential and Direct Access. Relative Files, Indexed Files - B+ tree as index. Multi-indexed Files, Inverted Files, Hashed Files.	**6L**
Total	**40L**

Text books:

Data Structure Through C-Bandyopadhyay & De,Pearson Education
Data Structure Using C-Berman,OUP
Ajay Agarwal- Data Structure Through C, Cyber Tech
Data Structures and Algorithms – O.G. Kakde and U.A. Deshpande, ISTE/EXCEL BOOKS.
Aho Alfred V., Hopperoft John E., UIlman Jeffrey D., "Data Structures and Algorithms", Addison Wesley.
Drozdek A –Data Structures and Algorithms.
Pujari A.K. – Data Mining & Techniques, Universities Press.

References:

1. Heileman: Data structures, algorithms & OOP- Tata McGraw Hill
2. Data Structures Using C – M.Radhakrishnan and V.Srinivasan, ISTE/EXCEL BOOKS
3. Weiss Mark Allen, Algorithms, Data Structures, and Problem Solving with C++, Addison Wesley.
4. Horowitz Ellis & Sartaj Sahni, Fundamentals of Data Structures, Galgotia Pub.
5. Tanenbaum A. S., Data Structures using 'C'

Biomedical Engg. Lab-II
Code: BME 591

Contacts: 3 P **Credits: 2**

List of experiments:

Characterization of biopotential amplifier for ECG & EMG signals.
Isolation of bio-signal (EMG / ECG) using analog circuits.
Measurement of galvanic skin resistance.
Measurement of heart sound using electronic stethoscope.
Determination pulmonary function using spirometer (using mechanical system).
Measurement of respiration rate using thermister /other electrodes.
Measurement of pulse rate using photoelectric transducer & pulse counting for known period.
Detection of QRS component from ECG signals using analog circuits.
Measurement of heart rate using F-V converter.
Measurement of blood pH.

Communication circuits & systems
Code: BME 592
Contact: 3P **Credit: 2**

List of experiments:

1. Study on current (V-I) and voltage (I-V) mode signal transmission using OP-amp. (trans impedance and trans conductance amplification using OP-amp.)
2. Study of PCM coder and decoder (A-D & D-A converter).
3. Study of amplitude modulation technique.
4. Study of amplitude demodulation technique.
5. Study of frequency modulation technique.
6. Study of frequency demodulation technique.
7. Study of Voltage Controlled Oscillator (VCO)
8. Study of phase locked Loop (PLL).
9. Study of Time Division Multiplexing (TDM) and Demultiplexing.

Data structure Lab
Code: CS 592
Contacts: 3 P **Credits: 2**

List of experiments:

Experiments should include but are not limited to:

1. Implementation of array operations.
2. *Implementation of linked lists:* inserting, deleting, and inverting a linked list.
3. *Stacks and Queues:* adding, deleting elements of Circular Queue: Adding & deleting elements.
4. *Merging Problem:* evaluation of expressions/operations on multiple stacks & queues.
5. Implementation of stacks & queues using linked lists.
6. Polynomial addition, Polynomial multiplication.
7. *Sparse Matrices*: Multiplication, addition.
8. Recursive and Non-recursive traversal of Trees
9. Threaded binary tree traversal. AVL tree implementation.
10. Application of Trees, Application of sorting and searching algorithms.
11. *Hash tables implementation*: searching, inserting and deleting, searching & sorting techniques.

Sixth Semester

Therapeutic Equipments
Code: BME 601
Contact: 3L + IT
Credit: 4

Cardiac Pacemakers & Defibrillators: Effects of electric field on cardiac muscles and laws of stimulation. External, internal, and Programmable pacemakers. Pulse generator: sensing, output and timing circuits. Power sources, electrodes and leads system, pacing system analyzers. Defibrillators- basic principle and comparison of output wave forms of different DC defibrillator, energy requirements, synchronous operation, implantable defibrillators, defibrillator safety and analyzers, RF ablation treatment for arrhythmia.	**10L**
Ventilators & Anaesthetic system: Basic principles of ventilators, different generators, inspiratory phase and expiratory phase, different ventillatory adjuncts, neonatal ventilators, p based ventilator, ventilator testing. Anaesthesia: Need of anaesthesia, gas used and their sources, gas blending and vaporizers, anaesthesia delivery system, breathing circuits.	**8L**

Physical therapy: Physical therapy principles • **Electrical stimulators:** Strength-duration curve, types of stimulators, an electrodiagnostic / therapeutic stimulator. Nerve-muscle stimulator: peripheral nerve stimulator, Ultrasonic stimulators, stimulators for pain and relief. • **Diathermy:** IR diathermy, UV diathermy, short wave diathermy, microwave diathermy, ultrasonic diathermy.	**8L**
Surgical Diathermy & LASER: Principles and applications of surgical diathermy, Physics and engineering of ultrasonic lithotripter, basic principle of extracorporeal shock wave lithotripter. Principle operation of LASER, various application of CO_2, argon, He -Ne, Nd – YAG & pulsed ruby LASER, Application of LASER in surgery.	**7L**
Electro-surgery & Neonatal care unit: Electrosurgery machine, electrosurgery circuits, solid state electrosurgery generator circuits, electrosurgery safety, testing electrosurgery units, cautery, light sources, suction apparatus, and sterilizers. Baby incubator, radient warmer and phototherapy unit.	**7L**
Total	**40L**

Text Books:

R. S. Khandpur "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill.
Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
J.Webster, "Bioinstrumentation", Wiley & Sons

References:

Joseph Bronzino, " Biomedical Engineering and Instrumentation", PWS Engg . , Boston.
Willard Van Nostrand, ".Instrumental Methods of Analysis"-
Sharms, "Instrumental Methods", S Chand & Co.
Harry Bronzino E, "Handbook of Biomedical Engineering and Measurements", Reston, Virginia.
Jacobson & Websler, " Medicine & Clinical Engg"
Leslie Cromwell, " Biomedical Instrumentation and Measurements"
Hcinz Kressc, " Handbook of Electro medicine" , John Wiley.
Geddes & Baker , "Principles of Applied Biomedical Instrumentation" Wiley.

Biomedical Signal Processing
Code: BME 602
Contact: 3L + IT
Credit: 4

Introduction to signals & systems: Sampling theorem, continuous and discrete LTI system, properties of LTI system.	**6L**
Introduction to Z Transform: The Z transform, properties of Z transform, inverse Z transform, transfer function in Z domain, location of poles and zeroes of Z-domain.	**6L**
Discrete Fourier Series and Transform: Discrete Fourier series (DFS) and its properties, Discrete Fourier Transform (DFT) and its properties. Fast Fourier Transform (FFT): Radix-2, decimation in time and frequency algorithms.	**10L**
Digital Filters Realizations: Characteristics of FIR filters, frequency response, design of FIR filters using Windowing Techniques. Analog filter approximations - Butterworth and Chebychev. Design of IIR filters from analog filters: bilinear transformation method, step and impulse invariance techniques, spectral transformations. Comparison of FIR and IIR filters, simple filter design using MATLAB. Analysis of ECG signals using digital filters and MATLAB (tutorial).	**16L**
Introduction to time-frequency analysis: Stationary and non-stationary signals, application of time frequency analysis for biomedical signals. Brief idea about - Short Time Fourier Transform (STFT) and Wavelet.	**2L**
Total	**40L**

Text Books:

1. L.R.Rabiner & B.Gold, "Theory and application of Digital Signal Processing".
2. S.K.Mitra, "Digital Signal Processing : A computer based approach", TMH.
3. J.G.Prokis & D.G.Manolakis, "Digital Signal Processing: Principles, Algorithm and Applications", PHI/Pearson Education.
4. S.Salivahanan et al, "Digital Signal Processing", TMH.
5. Wills J. Tompkins, " Biomedical digital signal processing", Prentice Hall of India Pvt. Ltd.
6. D.C.Reddy, " Biomedical signal processing – Principles and Technique", Tata McGraw-Hill.

Reference:

1. Oppenheim & Ronald W Schafer," Digital Signal Processing", Prentice Hall India.
2. Andreas Antonion , "Digital Filters Analysis & Design", Prentice Hall India.
3. R Rabiner & B. Gold , "Theory & Application of Digital Signal processing", PHI.

4. Andreas Antoniou , "Digital Signal Processing", Prentice Hall India.
5. Oppenheim & Ronald W Schafer," Discrete Time Signal Processing", Prentice Hall India.
6. Iefeachor, "Digital Signal Processing", Pearson Education.

Medical Imaging-II
Code: BME 603
Contact: 3L + IT
Credit: 4

Introduction to digital image: Signal input, image matrix, digital image quality, digital image processing, picture archiving and communication system (PACS).	**4L**
X-Ray computed tomography: Principles of sectional imaging, scanner configuration, detectors, data acquisition system, image formation principles, conversion of x-ray data in to scan image. 2D image reconstruction techniques: back projection, iterative and analytical methods. Viewing system, image quality and artifacts.	**10L**
Ultra Sound In Medicine: Introduction, production of ultrasound, acoustic impedance, ultrasonic transducers and types, transmitter and detector principles, probe design, principles of image formation. Display system: principles of A-mode, B-mode and M-mode display. Principles of scan conversion (real time imaging), image processing, Doppler Ultra sound and Colour flow mapping. Application of diagnostic ultra sound.	**10L**
Magnetic Resonance Imaging: Introduction, principles of MRI, MRI instrumentation, magnets, gradient system, RF coils-receiver system. Relaxation processes, pulse sequence, image acquisition and reconstruction techniques, Functional MRI - Application of MRI.	**8L**
Radio isotope imaging / Nuclear medicine: Radio nuclides for imaging, radionuclide production: cyclotron production, reactor production, generator production. Rectilinear scanners, Linear scanners, SPECT, PET, Gamma Camera, Comparison of other tomographic techniques.	**8L**
Total	**40L**

Text Books:

4. Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
5. R. S. Khandpur, "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill.
6. J.Webster, "Bioinstrumentation", Wiley & Sons

References:

7. Dowsett, Kenny & Johnston, "The Physics of Diagnostic Imaging", Chapman & Hall Medical, Madras/London.
8. Brown, Smallwood, Barber, Lawford & Hose, "Medical Physics and Biomedical Engineering", Institute of Physics Publishing, Bristol.
9. Massey & Meredith , "Fundamental Physics of Radiology", John Wright & Sons.
10. S. Webb, "The Physics of Medical Imaging", Ada m Hilger, Bristol.
11. Sybil M Stockley, "A Manual of Radiographic Equipments", Churchill Livingstones.
12. Chistrmis , "Physics of Diagnostic Radiology"

Hospital Engineering & Information System
Code: BME 604
Contact: 3L + IT
Credit: 4

Classification of hospital & architecture: General hospital, specialized hospital, primary health care – their role and functions. Aspects of hospital services – inpatient, outpatient and emergency. Location and environment of hospital, Hierarchy of medical and paramedical staff & their functions and responsibilities. Modern Hospital Architecture- space in a hospital building, design of ward, intensive care units, air conditioning, plumbing & sanitation, gas supply, waste disposal, cleaning, dietry, sterilizing, laundry, storage and operation theatre systems, Radiology, Central labs, Blood banks, OPD, Casuality, etc.	**8L**
Electrical power systems in hospitals: Safety of electrical systems, Protective systems - interference of patient's protection grounding. Design of sub stations, breakers, Surge protectors, EMI filters, voltage stabilizers, generator sets and UPS. Uninterrupted power supply for ICU and computerized monitoring units. Specification & estimation for hospital wiring - small case study.	**8L**
Air conditioning & gas supply systems: Air conditioning and refrigeration systems for small and large areas. Air changes, filtering and sterility. Deodourization, disinfection, dehumidification and cryogenic systems. Centralized supply of air, oxygen, nitrous oxide & vacuum - Principle of production of liquid oxygen. Management lifts fire fighting equipments.	**6L**

Hospital engineering & Management: Definition of biomedical Engineering, clinical engineering & hospital engineering. Importance of BME department – servicing and maintenance, testing, acceptance & maintenance protocols, Computerized preventive maintenance planning, MROs. Training of men for medical equipments preventive and periodical maintenance procedures. Preparation of estimates, specifications, tender details etc. Importance of ISO 9000 Certificates - Obtaining ISO certificates in hospitals. Proposed protocols.	**10L**
Hospital Information system: Role of database in HIS. Need of Networking in HIS. Overview of Networking, topologies and its configuration. Structuring medical records to carry out functions like admissions, discharges, treatment history etc. Computerization in pharmacy & billing. Automated clinical laboratory systems & radiology information system.	**8L**
Total	**40L**

Books :

Harold E. Smalley, "Hospital Management Engineering – A guide to the improvement of hospital management system", PHI.
C. A. Caceras ,"Clinical Engineering"
L. C. Redstone ,"Hospital and Health Care Facilities"
Ward ,"Aneasthetic Equipments".
BIS, "ISO Certification details"
Bhaumick and Bhattachary," EHV Substation equipments"
Alexander Kusko," Emergency and Standby Power Systems"
Balagune Swamy ,"Reliability Engineering"
Anantha Narayanan ,"Basic Refrigeration and Air Conditioning"

MICROPROCESSOR AND APPLICATIONS

Code : EI 601
Contacts : 3L +1T
Credits : 4

Introduction to computer architecture and organisation; Architecture of 8-bit microprocessors; Bus configuration; The CPU Module; Binary and Hexadecimal number representations; Introduction of assembly language and machine language programming; Introduction set of typical (8085) 8-bit processor; Subroutines and stacks; programming exercises; Timing diagram; Memory technology; ROM and RAM families; Memory interfacing; Interfacing of input- output ports; programmable peripheral interface chips, serial and parallel data transfer schemes, programmed and interrupt driven data transfer; Direct memory access; Programmable interval timer; Microprocessor development and trouble shooting tools, interfacing of ADC and DAC chips, 8-bit micro-controllers – Architecture and programming of 8031/8051, typical application, IEEE 488 Bus. Introduction to 8086 – 16 bit microprocessor.

BOOKS:

1. Gaonkar R.S. - Microprocessor Architecture, Programming and Applications, Wiley Eastern.
2. Malvino A.P. - Digital Computer Applications, An introduction to Microprocessor, Tata Mc-Graw Hill, New Delhi, India.
3. Hall D.V. -Microprocessors and Digital System, Mc-Graw Hill.
4. Borole, 8085 Microprocessor, Jaico
5. Leventhal L.A. -8080A/8085 Assembly Language Programming , Tata Mc-Graw Hill.
6. Short, Microprocessors & Programmed logic, Pearson Education
7. Mathivanam, Microprocessor, PHI
8. Bose S.K. -Gates to Microprocessors, Wiley Eastern, 1986.
9. Ahsom S. -Microprocessors with Application in Process Control, TMH, ND, 1986.
10. Chowdhury & Chowdhury – Microprocessors, Scitech
11. Ajit Pal – Microprocessor, Principles & Applications - TMH

Medical Instruments Lab-1
Code: BME 691
Contact: 3P

Credit: 2

1. Power isolation: isolation transformer and DC-DC converters.
2. Timer circuits: ON delay and OFF delay study.
3. Pacemaker Circuits.
4. Lead selection circuits.
5. Study of ultrasonic devices – transmitter and detector.
6. Measurement of blood flow velocity – ultrasonic method.
7. Study & characterization of Biotransducers – Pressure, Temparature, Humidity
8. Study & characterization of Bioelectrodes – ECG, EMG, EEG.
9. EMG processing and fatigue: preamplifier, precision rectifier, and averager.
10. Study of X-ray radiography systems.

Biomedical Signal Processing Lab
Code: BME 692
Contact: 3P
Credit: 2

1. Sine wave generation using C.
2. Designing an FIR filter using MATLAB and DSP Kit.
3. Designing an IIR filter using MATLAB and DSP Kit.
4. Fourier analysis of periodic signal.
5. Time frequency domain properties of different windows using MATLAB.
6. Implementation of the Double-Precision Complex FFT for ECG signal.
7. Design of Notch filter for elimination of 50Hz from ECG signal.
8. EMG processing using MATLAB –Rectification and Signal Averaging.

MICROPROCESSOR AND APPLICATIONS LAB
Code : EI 681
Contacts : 3P
Credits : 2

1. Familiarization with 8085 register level architecture and trainer kit components, including the memory map. Familiarization with the process of storing and viewing the contents of memory as well as registers.
   i) Study of prewritten programs on trainer kit using the basic instruction set (date transfer, load/store, Arithmetic, Logical), ii) Assignments based on above.
2. Familiarization with 8085 simulator on PC.
   i) Study of prewritten programs using basic instruction set (data transfer, load/Store, Arithmetic, Logical) on the simulator, ii) Assignments based on above.
3. Programming using kit/simulator for
   i) table look up, ii) copying a block of memory, iii) shifting a block of memory, iv) packing and unpacking of BCD numbers, v) addition of BCD numbers, vi) binary to ASCII conversion, vii) string matching
4. Program using subroutine calls and IN/OUT instructions using 8255 PPI on the trainer kit eg. subroutine for delay, reading switch state and glowing LEDs accordingly, finding out the frequency of a pulse train etc.
5. Interfacing any 8-bit latch (eg 74LS373) with trainer kit as a peripheral mapped output port with absolute address decoding.
6. Interfacing with I/O modules :
   i) ADC, ii) Speed control of mini DC motor using DAC, iii) Keyboard , iv) Multi-digit Display with multiplexing, v) Stepper motor
7. Study of 8031/8051 Micro Controller kit and writing programms for the following tasks using the kit.
8. i) Table look up, ii) Basic arithmetic and logical operations, iii) c) Interfacing of keyboard and stepper motor

7th Semester

Biosignal processing
Code: BME 701
Contact: 3L + IT
Credit: 4

Introduction: Frequency domain representation, properties, spectral analysis, linear filtering, cepstral analysis, AR model, MA model, ARMA model, adaptive filters-general structure, LMS adaptive filter, noise cancellation, feature extraction and pattern recognition, data acquisition system.	**8L**
Cardiological and Electromuscular signal processing: Basic Electrocardiography, ECG Data Acquisition (Preprocessing),	**10L**

QRS detection, rhythm analysis. Arrhythmia detection algorithms. Automated ECG analysis. ECG pattern recognition. Basic electromyography, EMG data acquisition and rectification, averaging. **Neurological signal processing:** The EEG Signals and its Characteristics, EEG Analysis: time frequency domain method, linear prediction theory, autoregressive (A.R.) method. Detection of spikes and spindles. Detection of alpha, beta and gamma waves. Least squares and polynomial modeling: the Markov Model and Markov Chain, Dynamics of Sleep-Wake Transition, Hypnogram Model Parameters. **Prony's method:** Original Prony's method. Prony's method based on the least squares estimate. Analysis of evoked potential using Prony's method. **Data compression techniques:** ECG acquisition and transmission. Data reduction algorithms. Turning point. AZTEC, CORTES and the KL transform.	**10L** **4L** **4L**
Total	**36L**

Text / Reference Books:

1. D.C.Reddy, "Biomedical Signal Processing – Principles and Techniques", TMH.
2. Wills J. Tompkins, " Biomedical digital signal processing", Prentice Hall of India Pvt. Ltd.
3. Digital biosignal processing. Weitkunat R, Elsevier.
4. Biomedical signal processing. Akay M. Academic Press.
5. Computer technique in medicine. Macfarlane P.W. Butter Worth
6. Biomedical signal processing. Vol-I, Time frequency analysis. Cohen A. CRC press.

Artificial Organs & Rehabilitation Engineering
Code: BME 701
Contact: 3L + IT
Credit: 4

Introduction to artificial organs: Biomaterials used in artificial organs and prostheses, inflammation, rejection, correction. Rheological properties of blood, blood viscosity variation: effect of shear rate, hematocrit, temperature and protein contents. Casson equation, flow properties of blood through the blood vessels, problems associated with extracorporeal blood flow. **Artificial kidney:** Brief of kidney filtration, basic methods of artificial waste removal, hemodialysis, equation for artificial kidney and middle molecule hypothesis. Hemodialysers: flat plate type, coil type and hollow fiber. Analysis of mass transfer in dialyers (cross current & cocurrent flow), regeneration of dialysate, membrane configuration, wearable artificial kidney machine, separation of antigens from blood in ESRD patients. **Artificial heart-lung machine:** Brief of lungs gaseous exchange / transport, artificial heart-lung devices. Oxygenators: bubble, film oxygenators and membrane oxygenators. Gas flow rate and area for membrane oxygenators. Liver support system, artificial pancreas, blood and skin. **Audiometry:** air conduction, bone conduction, masking, functional diagram of an audiometer. Hearing aids: different types, receiver amplifiers. Opthalmoscope, retinoscope, I.A.B.P principle and application. **Rehabilitation Engineering:** Impairments, disabilities and handicaps, Measurement and assessment. Characterizing engineering concepts in sensory and motor rehabilitation. Engineering concept in communication disorders. Rehabs for locomotion, visual, speech & hearing. Artificial limb and hands, prosthetic heart valves. Externally powered and controlled orthotics and prosthetics. Myoelectric hand and arm prostheses. The marcus intelligent hand prostheses, gait study, spinal rehabilitation	**6L** **10L** **6L** **4L** **10L**
Total	**36L**

Text / Reference Books:

Hand book of biomedical engineering. Bronzino. Joseph
Hand book of biomedical instrumentation. R.S.Khandpur
Artificial Organs. Erie.D.Blom, Howard.B.Rotham.
Biomedical Engineering Principles (Volume – II). David O. Cooney., Marcel Dekker Inc.
Robbinson C.J., Rehabilitation Engineering. CRC press 1995
Ballabio E.etal, Rehabilitation Engineering. IOS press 1993.

Power and Control System
Code: BME 703
Contact: 3L + IT
Credit: 4

Thyristor: Introduction, Thyristor family, Principles of operations of SCR, Two transistor model of SCR, Gate	**10L**

characteristics, Turn on & off methods of Thyristor, Firing of Thyristor, Gate trigger circuits. Brief of modern power semiconductor devices: DIAC, TRIAC, GTO, RCT, SIT, LASCR, IGBT, MOSFET, UJT.	
Phase Control Rectifiers and Inverters: Introduction, Phase angle control, 1-Phase half & full wave control rectifier, 3-Phase half & full controlled bridge converter, Thyristor Inverter classification: Series Inverters, Parallel Inverters, 1-Phase & 3-Phase bridge inverters.	**8L**
Choppers and AC Regulators: Principle of operation, Step up/down chopper, Chopper Configuration, AC Chopper, 1-Phase & 3- phase AC Regulator.	**6L**
Feedback Characteristics: Open and closed loop, Mathematical models of physical systems, Transfer function, Block diagram algebra, Signal flow graphs, Feed back & non feed back systems, Regenerative feedback.	**4L**
Control system components: Error sensing devices, potentiometer, tachometer, servomotors, stepper motor, Hydraulic system, Pneumatic System, P, PI and PID controller.	**6L**
Time Domain and Frequency Domain Analysis: Introduction, Time response to 1st order & 2nd order systems, Effect of adding pole zeros to TF, R-H criteria, Root Locus method, Frequency response plot: Polar Plots, Bode Plots, Nyquist Criteria.	**6L**
Total	**40L**

Text/ Reference books:

1. Power Electronics – MD Singh & KB Khanchandani, Tata Mackgrow Hill
2. Power Electronics – Mohan, Undeland & Robbins – John Willey & Sons
3. Power Electronics – Vedam Subhramanyam – New Age International
4. Modern Power Electronics – B.K. Bose – Jacio Publishing House
5. Modern Power Electronics – P.C. Sen – Wheeler Publishing
6. Power Electronics – B.R. Gupta – S.K. Kataria & Sons.
7. Modern Control Engineering – K. Ogata – P H I
8. Automatic Control Systems – Kuo – P H I
9. Control Systems Engineering – I.J. Nagnath & Gopal – New Age

Industrial Management
Code: HU 702
Contact: 3L
Credits: 3

Human Resource Management: Recruitment and selection, Performance appraisal, Industrial Relations, Trade Union, Collective Bargaining	**6L**
Organizational Behaviour: Different Schools of Management Thought: Scientific Management, Administrative Theory, Theory of Bureaucracy, Human Relations Theory (Elton Mayo). Motivation: Concept, Different Theories (Maslow, ERG, Herzberg). Communication: Purpose, process, Barriers to effective communication, Guidelines to make communication effective. Perception: Process, Importance, Factors influencing perception, Shortcuts for judging people- Halo effect, Stereotyping, Projection.	**8L**
Quality Management: Concept, Dimensions for goods and services, Cost of Quality, Statistical Quality Control, Control Charts, Acceptance Sampling (single).Total Quality Management: Concept, benefits, Criticism. New Quality Tools: Kaizen, Six Sigma, Quality Circles.	**6L**
***Productions Management**: Concept, Difference from Operations Management, Types of Production (Mass, Batch, Project), Functions of Production Management. Productivity: Concept, Different Inputs and Productivity Measures, Effeciency and Effectiveness, Measures to increase Productivity.*	**5L**
Marketing Management: Basic Concepts of Marketing, Difference between Selling and Marketing, Elements of Marketing Mix- the 4 P's. Marketing Environment: Mega Environment, Micro Environment, Internal Environment, Relevant Environment. Simple Marketing Strategies: SWOT Analysis, BCG Matrix, Industry Matrix.	**6L**
Materials Management: Concept, Functions, EOQ Models- Wilson model, model with shortage, model with quantity discount, model without shortage , Selective Inventory Control—ABC, VED, FSN analysis.	**5L**
Total	**36L**

Books:

1. Industrial Management, Vol.1 L.C. Jhamb, EPH
2. Industrial Relations, Trade Unions & Labour Legislation - Sinha, Pearson Education Asia
3. Organizational Behaviour, S.P. Robbins, Prentice Hall
4. Productions and Operations Management, S. N. Chary, TMH

5. Marketing Management, Phillip Kotler, Prentice Hall/Pearson Education.
6. Productions and Operations Management, Joseph Monks,TMH

Biosignal processing Lab
Code: BME 791
Contact: 3L
Credit: 2

1. Computation of convolution and correlation sequences
2. Analog and digital signal conditioning
3. Signal averaging improvement in the SNR using coherent averaging
4. Signal averaging improvement in the SNR using incoherent averaging
5. Exponential averaging
6. Data polishing: mean and trend removal
7. PSD estimation
8. Data compression techniques: AZTEC, TP
9. Data compression techniques: CORTES
10. Data compression techniques: K.L.Transform

Biomedical Instruments Lab-II
Code: BME 792
Contact: 3L Credit: 2

1. Calculation of nerve conduction velocity using EMG machine
2. EEG processing and analysis
3. PCG processing and analysis
4. Electronic BP measurement and calibration
5. Spectral analysis of biopotential
6. Study on simulated DC defibrillator
7. Study on digital body/skin temperature monitoring system
8. Study on hearing aid and audiometer: air and bone conduction
9. Study on muscle stimulator
10. Study on mechanical pulse sensor / strain gauge sensor.

Elective – I

LASERS and Fiber Optics in medicine
Code: BME 701A
Contact: 3L
Credit: 3

Laser characteristics: Single frequency operation, coherence of laser, spatial distribution, intensity of laser emission, polarization of laser emission, measurement of pulsed laser energy. Principles of laser applications in medicine and biology.

Laser in biology: Optical properties of tissue, Pathology of laser reaction in skin, thermal effects, laser irradiation, Non thermal reactions of laser energy in tissue, effect of adjuvant.

Lasers in surgery: Surgical instrumentation of CO_2, Ruby, Nd-YAG, He-Ne, Argon ion, Q-switched operations, continuous wave, Quasi – continuous, surgical applications of these lasers.

Laser applications: Lasers in dermatology, lasers in ophthalmology, laser photocoagulations, laser in dentistry, Laser flow cytometry, Laser transillumination & diaphanography - Speckle intereferometry, holography - Application Safety with biomedical Lasers.

Fiber optics in diagnosis: Transmission of signals, light, and construction details of optical fiber, application of fiber optics in medical field.

Test Books:
1. Leon Goldman, " The Biomedical laser Technology and Clinical Applications " Springer-Verlar
2. Leon Goldman, " Lasers in Medicine", Springer-Verlac
3. Pratesi E.D.R, and Sacchi, "Lasers in photomedicine and photo biology", Springer-Verlay
4. Basht M.L.Wel, "Laser applications in medicine and biology", Vol I,II,III, Plenum Press (1971 & 1974).
5. Nandini K. Jog, "Electronics in medicine and biomedical instrumentation", PHI

Medical informatics & expert systems
Code: BME 701B

Contact: 3L
Credit: 3

Introduction to data structures: Elements, arrays, records, sets, tables etc. Singly and doubly linked data, stacks, queues, trees etc. Introduction to database, data models, Relational, distributed and other types of databases, data indexing and structuring techniques: data independence, data definition language and data manipulation language. E -R diagram with examples. Relational model, structure of Relational databases, Query language, views, Examples.

Relational database design: Normalisation - 1NF, 2NF and 3NF. Indexing and Hashing. Security of databases. Design example on a popular RDBMS package. Miniaturized data storage and retrieval system like CD-ROM, Magneto Optical Discs, optical juke boxes, write many read many devices and miniature magnetic tape devices. Interfacing and retrieval details.

Introduction to AI & Expert system: Knowledge components, knowledge representation schemes, production systems. Expert system tools, Languages, shells, Lisp Machines and PC based expert system tools.

Study of MYCIN project and context of MYCIN experiments, knowledge representation and searching. Study of EMYCIN, ONCOSIN, ONCOLGY Protocol management. Basics of DENDRAL project – Artificial Intelligence for Organic Chemistry.

Text / Reference Books

1. H Dominic Covvey et al , "Computer in the practice of, medicine", Addison Wesley
2. Date C J, " An introduction to Database Systems", Addison Wesley Publication
3. M F Collen, " Hospital Computer Systems"-
4. Lee, " Computers in Medicine", Mc Graw Hill
5. Szolovits P (ed), "Artificial Intelligence in Medicine", Westview Press
6. G Buchanan & Shortliffe , "Rule based Expert systems - The MYCIN Experiments of the stanfold Heuristic Programming Project", Addison Wesley
7. Clancey & Shortliffe , "Readings in Medical Artificial Intelligence " , Addison Wesley
8. Earl B Hunt, " Artificial Intelligence ", Academic Press
9. Elaine Rich , "Artificial Intelligence "
10. Earl B Hunt, " Artificial Intelligence ", Academic Press

Transportation in living system
Code: BME 701C
Contact: 3L
Credit: 3

I**ntroduction**: Organization of the human body, cells, tissues, different organs, natural membrane system.

Heat transport: Body temperature regulation based on thermostate principle and its operation, transportation in tissues, muscle, skin and other organs in different environmental temperature.

Transportation of fluids: Blood transport trough internal organs, urogenitary system, cardio pulmonary system, central nervous system, gastro intestine system, diffusion, osmosis, electroosmosis, ultrafiltration, reverse osmosis through natural membrane systems, reverse osmosis through artificial synthetic membranes.

Transportation of lymph: Transportation of lymph through internal organs, urogenitary system, cardio pulmonary system, central nervous system, gastro intestine system, problems on lymph transfer in human body.

Mass transfer: Constituents of blood, urine, mass transfer in kidney, skeletal, nervous, gastro intestine system, cardio pulmonary system, comparision with artificial organs.

Text / Reference Books:

1. David O.Cooney, An introduction to fluid, heat & mass transport process- Principles, Vol.1, Marcel Dekker Inc., Newyork.
2. Gang, Medical Physiology
3. Best and Taylor, Physiology.

Neural Network and Fuzzy Logic Control
BME 70
Contracts: 3L
Credits: 3

Introduction: Artificial neuron, MLP, back propagation, Hopfield networks, Kohenen self organizing maps, adaptive resonance.

Neural network for control: Schemes of neuro-control, identification and control of dynamical system, case study.

Introduction to Fuzzy logic: Fuzzy sets, Fuzzy relations, Fuzzy conditional statements, Fuzzy rules, Fuzzy algorithm, functional diagram.

Fuzzy logic control systems: Fuzzy logic controller, Fuzzification interface, knowledge base, decision making logic, defuzzification interface, design of Fuzzy logic controller, case study.

Neuro-Fuzzy logic control: Adaptive fuzzy systems, optimization of membership function and rule base of fuzzy logic controller using neural networks, fuzzy neuron, case study.

Reference Books:

1. Klir G.J. and Folger T.A, Fuzzy sets, Uncertainty and Information, PHI
2. Simon Hayking, Neural network, ISA, Research Triangle Parke, 1995.
3. Kosco B., Neural networks and fuzzy systems: A dynamic approach to machine Intelligence, Prentice Hall USA, 1992.
4. Hertz J., Korgh A. and Palmer R.G., Introduction to the theory of neural computation. Addition-Wesley publishing co,, California, 1991.
5. Nie and Linkers: Fuzzy neural control: principles, alogorithms, and applications, PHI, 1998.

Eighth Semester

Medical Image processing
Code: BME 801
Contact: 3L + IT
Credit: 4

Digital image fundamentals: Image digitization, sampling and quantization, neighbour of pixels, connectivity, relations, equivalence and transitive closure, distance measures, arithmetic / logic operations, discrete transform, fast Fourier transform, 2-D Fourier transform, inverse Fourier transform.	**8L**
Image enhancement fundamentals: Spatial domain method, frequency domain method, contrast enhancement, histogram processing, image smoothing, image averaging, masking, image sharpening, removing of blur caused by uniform linear motion, enhancement in the frequency domain – low pass, high pass, mean and band-pass filtering.	**10L**
Image restoration fundamentals: Degradation model, discrete formulation, algebraic approach to restoration – unconstrained & constrained.	**4L**
Image compression and segmentation fundamentals: Fidelity criteria, image compression models, lossy and lossless compression technique. Image segmentation: point detection, line detection, edge detection, edge linking and boundary detection.	**10L**
Algorithms used in medical image processing: Brief of reconstruction techniques – algebraic, simultaneous iterative and simultaneous algebraic. Reconstruction algorithm for parallel projections, fan beam projection and back projection. Introduction to various approaches of pattern recognition.	**8L**
Total	**40L**

Text books:

1. Digital image processing by Gonzalez and Woods, 2nd ed., Pearson
2. Digital image processing and analysis by Chanda & Majumdar, PHI
3. Fundamental of digital image processing by Jain, PHI
4. Pattern recognition by Tou and Gonzalez

Modeling of physiological system
BME 802
Contracts: 3L
Credits: 4

Approaches to modeling: The technique of mathematical modeling, classification of models, characteristics of models. Purpose of physiological modeling and signal analysis, linearization of nonlinear models. Time invariant and time varying systems for physiological modeling.	**8L**

Equivalent circuit model: Electromotive, resistive and capacitive properties of cell membrane, change in membrane potential with distance, voltage clamp experiment and Hodgkin and Huxley's model of action potential, the voltage dependent membrane constant and simulation of the model, model for strength-duration curve, model of the whole neuron. Huxley model of isotonic muscle contraction, modeling of EMG, motor unit firing: amplitude measurement, motor unit & frequency analysis.	**12L**
Physiological modeling: Electrical analog of blood vessels, model of systematic blood flow, model of coronary circulation, transfer of solutes between physiological compartments by fluid flow, counter current model of urine formation, model of Henle's loop, *and Linearized model of the immune response:* Germ, Plasma cell, Antibody, system equation and stability criteria.	**10L**
Total	**30L**

Text/ Reference books:

1. Endarle, Blanchard & Bronzino, Introduction to Biomedical Engg. , Academic press.
2. Suresh.R.Devasahayam, Signals & Systems in Biomedical Engineering, Kluwer Academic/ Plenum Publishers.
3. V.Z. Marmarelis, Advanced methods of physiological modeling, Plenum Press.
4. J. Candy, Signal Processing: The Model Based approach, Mc. Graw Hill.
5. L.Stark, Neurological Control System, Plenum Press.
6. R.B. Stein, Nerve and Muscle, Plenum Press.

VALUES & ETHICS IN PROFESSION
HU-801
Contracts: 3L
Credits- 3

Science, Technology and Engineering as knowledge and as Social and Professional Activities **Effects of Technological Growth:** Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: sustainable development. Energy Crisis: Renewable Energy Resources. Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics. Appropriate Technology Movement of Schumacher; later developments. Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis. Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of assembly line and automation. Human centered Technology. **Ethics of Profession:** Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies. **Profession and Human Values:** Values Crisis in contemporary society. Nature of values: Value Spectrum of a good life. Psychological values: Integrated personality; mental health. Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution. Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity. Moral and ethical values: Nature of moral judgements; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.	
Total	**30L**

Books:

1. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994 (2nd Ed)
2. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.
3. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.

Medical Image Processing Lab
BME-891
Contact: 3L
Credit: 2
[Students are required to perform at least SIX experiments]

Maximum distance algorithm
Image enhancement – Histogram
Image smoothing
Image sharpening
Algorithm for low pass filter, high pass filter, median filter
Point detection
Line detection
Edge detection
Masks

Image data compression

Medical Instruments and system Lab
Code: BME 892
Contact: 3L
Credit: 2
[Students are required to perform any EIGHT experiments]

1. Study on ECG heart rate monitor with alarm system
2. Study on peripheral pulse rate monitor with alarm system
3. Study on apnea monitor
4. Study on short wave / ultrasound diathermy unit
5. Study on EMG biofeedback system
6. Study on ECG simulator and servicing of ECG machine
7. Study on bio-telemetry - double FM system
8. Study on colorimeter
9. Study on flame photometer
10. Study on anthropometry or skin fold caliper / pacemaker simulator /

Elective - II

Computers in Medicine
BME 803A
Contracts: 3L
Credits: 3

Introduction: Computer hardware and software, Computer programming languages, Computers and their use in medical field: need of computing hospitals, cost effectiveness.

Patient data base management: Computerized medical records, security. Computer in clinical laboratory, Database approach, automated clinical laboratory and analysis, computerized semen analysis, analysis of ECG, EEG and EMG. Chromosome analysis by computer, computerized cytology & histogram, automated scanning for cervical cancer.

Basics of computer assisted medical imaging, basics of computer assisted medical decision making, general model algorithms, fuzzy set theory, cognitive set theory, cognitive models, QMR, KES and TIA.

Computer in intensive care units, metabolic balance upkeeping, pulmonary function evaluation, Cardio vascular evaluation. Computer assisted therapy, computer for case of renal disorders.

Computer aids for the handicapped, basic discussion with examples, introduction to computer assisted instruction in medicine, ISDN in medicine.

Text Books:
1. Computer in medicine – R.D. Lele (Chapter 3-13).

Biological control systems
BME 803B
Contracts: 3L
Credits: 3

Introduction: Technological control system, transfer function, mathematical approaches, system stability, introduction to biological control system, Modeling and block diagram, closed loop dynamics of first order and second order control system, similarities between biological and engineering control system, biological receptors and receptor characteristics.

Process regulation: Acid-base balance, extra-cellular water and electrolyte, interstitial fluid volume, blood pressure, blood glucose, CO_2, thermal regulatory system.

Biological control: Cardiac rate, blood pressure, respiratory rate, mass balancing of lungs, oxygen uptake by RBC and pulmonary capillaries, oxygen and carbon dioxide transport in blood and tissues, urine formation and control, Pupil control systems, skeletal muscle servomechanism, and semicircular canal. Free swinging limbs, Endocrine control system.

Text / Reference Books:

1. Mondern control engineering. Ogata Katsuhika. 2nd edition, Prentice Hall of India.
2. Regulation and control in physiological system, Ibrell and Guyton
3. Biological control systems analysis, Milsum John H. Tata McGraw-Hill.
4. Application of control theory to physiological systems, Milhorn T.H. Saunder.

Bio-Informatics
BME 803C
Contracts: 3L
Credits: 3

Introduction to genomics: Information flow in biology, DNA sequence data, experimental approach to genome sequence data, genome information resources.

Functional proteomics: Protein sequence and structural data, protein information resources and secondary data bases.

Computation genomics: Internet basics, biological data analysis and application, sequence and data bases, NCBI model, file format, Perl programming, bioperl, introduction and overview of human genomic project.

Sequence alignment and data base search: Protein primary sequence analysis, DNA sequence analysis, pair wise sequence alingnment, FASTA algorithm, BLAST, multiple sequence alignment, DATA base searching using BLAST and FASTA.

Structural data bases: Small molecules data bases, protein information resources, protein data bank, genebank, swissport, enterz..

Text / reference books:

1. Introduction to bioinformatics, Atwood, Pearson education.
2. Introduction to bioinformatics, Arther M.Lesk-OUP
3. Bioinformatics sequences and genome analysis, David W.Mount, 2nd. Edn. CBS publishers.
4. Introduction to bioinformatics computer skills, Cynthia Gibas and Per Jambeck, 2001 SPD.

Tissue Engineering
BME 803D
Contracts: 3L
Credits: 3

Introduction: Basic definition, 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.

Molecular biology aspects: 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.

Scaffold and transplant: Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells: introduction, hepatopoiesis.

Case study and regulatory issues: Case study of multiple approaches: cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering.

Text / reference books:

1. Principles of tissue engineering, Robert. P.Lanza, Robert Langer & William L. Chick, Academic press.
2. The Biomedical Engineering –Handbook, Joseph D. Bronzino, CRC press.
3. Introduction to Biomedical Engg. , Endarle, Blanchard & Bronzino, Academic press.
4. Tissue Engineering, B. Palsson, J.A. Hubbell, R.Plonsey & J.D. Bronzino, CRC- Taylor & Francis