

**SCHOOL OF BIOMEDICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
BANARAS HINDU UNIVERSITY**

**Course Structure for Five Year Dual Degree
(B. Tech. in Bioengineering and M. Tech. in Biomedical Technology)**

Part II

3rd Semester:

Subject	Contact Hr.	Credit	
BM 2101	Physiology-I	3	3
BM 2102	Biochemistry	3	3
EE 2114 A	Electrical Engineering	3	3
AM 2101	Mathematical Methods	3	3
MS 2101	Introduction to Material Science	3	3
AC 2101	Chemistry of Polymers	3	3
Practical:			
BM 2301	Biochemistry	3	2
BM 2302	Physiology-1	3	2
EE 2314 A	Electrical Engineering	3	2
Total for third Semester		27	24

4th Semester:

Subject	Contact Hr.	Credit	
BM 2201	Physiology-II	3	3
BM 2202	Electronic Devices and Circuits	4	4
BM 2203	Biopotentials	3	3
BM 2204	Network Analysis and Synthesis	4	4
AM 2201	Numerical Analysis	3	3
MS 2203	Metals and Alloys	3	3
Practical			
BM 2401:	Physiology-II	3	2
BM 2402:	Network Analysis and Electronic Circuits	3	2
AM 2401:	Computer Lab	3	2
Total for Fourth Semester		29	26

Part III

5th Semester:

Subject	Contact Hr.	Credit
BM 3101: Microprocessor and Microcontrollers	3	3
BM 3102: Electronic Circuits for Medical Instrumentation	4	4
BM 3103: Biomaterials	3	3
PH-2105: Pharmaceutical Microbiology	3	3
AC 3102: Analytical Techniques in Chemistry	3	3
MS 3106: Synthesis and preparation of Materials	3	3
Practical:		
BM 3301: Microprocessor and Microcontroller lab	3	2
PH : Microbiology Lab	3	2
BM 3302: Material Preparation lab	3	2
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Total for 5 th Semester	28	25

6th Semester:

Subject	Contact Hr.	Credit
Humanities*	3	3
BM 3201: Control System	3	3
BM 3202: Transducers and Instrumentation systems	4	4
MS 3210: Science of Ceramic Materials	3	3
AC 3201: Instrumental Methods for Chemical Analysis	3	3
ECE 3204/ BM 3203 Reliability Engineering	3	3
Practical:		
BM 3401: Polymer Material lab	3	2
BM 3402: Transducers and Instrumentation systems	3	2
BM 3403: Analytical Techniques in Chemistry	3	2
*Any one of the following open elective		
1. HU 321: History of Science and Technology		
2. HU 322: Industrial and Organizational Psychology		
3. HU 323: Intellectual Property Rights		
4. HU 324: Energy management		
5. HU 325: Industrial Sociology		
6. HU 326: Ethics, Philosophy and Values		
7. HU 327: Entrepreneurship Development		
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Total for 6 th Semester	28	25

Part IV**7th Semester:**

	Subject	Contact Hr.	Credit
(UG)	BM 4101: Biological Control System Analysis	3	3
(PG)	BM 4102: Biomechanics	3	3
(PG)	BM 4103: Biomedical Instrumentation	3	3
(UG)	BM 4104: Molecular Biology and Genetics	4	4
(UG)	ChE 4101: Transport Phenomena	4	4
Practical:			
(PG)	BM 4301: Biomedical instrumentation	3	2
(UG)	BM 4302: Control System	3	2
(UG)	BM 4303: Project	6	4
	BM 4304 Seminar	3	2
	BM 4305 Training/Tour/Viva-voce	-	2
Total for 7 th Semester		32	29

8th Semester:

	Subject	Contact Hr.	Credit
(UG)	BM 4201: Polymers in Medicine	4	4
(UG)	BM 4202: Radiation and Biomedical Applications	3	3
(PG)	BM 4203: Biomedical Signal and Image Processing	3	3
(PG)	BM 4204: Composite Materials	3	3
(UG)	EcE 4201: LSI/VLSI Design	3	3
Practical:			
(UG)	BM 4401: Hospital based diagnostic and therapeutic Instrumentation	3	2
(PG)	BM 4402: Biomechanics Lab	3	2
(PG)	BM 4403: Project / Dissertation	6	4
	BM4404 Viva-voce	-	2
Total for 8 th Semester		29	26

Part V

9th Semester:

Subject	Contact Hr.	Credit
BM 5101: Computer Application in Biomedical Engineering	3	3
*Select any three electives		
*BM 5102: Bioceramics	3	3
*BM 5103: Tissue engineering	3	3
*BM 5104: Advanced Biomechanics	3	3
*BM 5105: Rehabilitation Engg	3	3
*BM 5106: Bioinformatics	3	3
*BM 5107: Hospital system Management	3	3
*BM 5108: Mathematical methods in Biomedical Engg	3	3
*BM 5109: Biotransport Process	3	3
* PG Open Elective from other Department	3	3
Practical:		
(PG) BM 5301 Computer Application Lab	3	2
BM 5302 Seminar on Dissertation	-	5
BM 5303 Dissertation Evaluation-1	9	5
Total for 9 th Semester	27	27

10th Semester

Subject	Contact Hr.	Credit
BM 5401 PG Seminar	2	1
BM 5402 Dissertation Pre Submission seminar	-	5
BM 5403 Dissertation Evaluation-II	-	10
	2	16

Year wise credits

I Year 50

II Year 50

III Year 50

IV Year 55

V Year 43

Total credits 248

3rd – Semester

BM 2101: PHYSIOLOGY-I

Introduction to Human Physiology. Basic cell Structure, various cell organelles and their functions. Process of cell division. Tissues, their types, structure and functions. Organs and systems. Skin; basic structure and function

Hematology: Blood composition, properties and function. Structure and function of red blood cells, white blood cells and platelets. Blood transfusion. Hemostasis. Immune mechanisms.

Circulatory and Lymphatic System: Anatomy of the heart and the blood vessels. Heart-position and function. Origin of the heart beat and electrical activity of the heart. Arteries, capillaries and veins- structure and function. Cardiac and peripheral circulation. Blood pressure and its regulation. Blood flow and its regulation. Circulatory shock and its treatment. Lymph and dynamics of lymph flow.

Respiratory system: Anatomical parts of the system, position and function. Mechanics of respiration. Lung volumes and capacities. Gas transport between the Lungs and tissues. Regulation of respiration. Respiratory adjustments in health and diseases.

Digestive system: Different parts of the digestive system. Structure and function of these organs. Digestion of proteins, carbohydrates, fats. Basic mechanism of gastrointestinal absorption of nutrients.

Books:

1. Text book of Medical Physiology, Guyton A.C and J.E. Hall, Harcourt India Pvt. Ltd.
2. Ross and Wilson: Anatomy and Physiology, Churchill Livingstone.
3. Anatomy and Physiology, Gary A. Thibodeau and Kevin T. Patton Mosby.

BM 2102: BIOCHEMISTRY

Introduction: Scope of Biochemistry

Carbohydrates: Chemistry, Glycolysis and glycogenolysis, glycogenesis, gluconeogenesis, alcoholic fermentation, Krebs cycle, HMP Shunt, ATP Synthesis, regulation of carbohydrate metabolism.

Amino Acid: Chemistry properties and metabolism, Urea cycle.

Proteins: primary, Secondary, tertiary and quaternary structure, Types and Functions, Synthesis, Purification, Isoenzymes.

Lipids: Chemistry, Metabolism of fatty acids, Phospholipids, Cholesterol biosynthesis, regulation of metabolism.

Nucleic Acid: Chemistry of DNA and RNA, Functions and Genetic Code, Protein Synthesis

Enzymes: Classification, Assay, assay, kinetic formulation of Michaelis-Menten equation, mechanism of action, regulation (allosteric and feedback).

Vitamins: Structure and functions of vitamins, coenzymes.

Hormones: Molecular mechanism of actions (epinephrine or insulin and estradiol or testosterone,) Cyclic AMP and prostaglandins (elementary concepts).

Techniques: Centrifugation, chromatography, electrophoresis, tracer methods, spectrophotometer.

Balance Diet: Elementary concept

Books:

1. Biochemistry by Champe & Harvey
2. Wilson and Walker: Practical Biochemistry (3rd Ed.), Cambridge Univ. press, 2000
3. Biochemistry by Harper
4. Biochemistry by Stryer
5. Berg et al. Biochemistry (5th Ed.), Freeman, 2001

EE 2114 A: ELECTRICAL ENGINEERING

A.C. Circuits: Network element-Voltage and current sources, loop and nodal analysis, Superposition theorem, Thevenin's theorem. Transient and steady state response of R- L -C circuits for step and sinusoidal inputs, impedance concept. Phasor diagram. Single phase series and parallel circuits, resonance . Mutual inductance and coefficient of coupling . Three phase balanced circuits and power measurement.

Electromechanical Energy Converters: Construction, working principles and characteristics of D.C. generators and motors, transformer, three-phase and single-phase induction motors, synchronous generators and motors, universal motors. Starting and speed control of motors. Selection of motors.

Principles of power distribution: Introduction with the general layouts of 3 phase distribution systems. House and factory wirings Protection of equipment, Earthing.

Elements of power economics: Load and diversity factors. Tariff power factor improvement .

Measurements and Instruments: Construction and working principles of ammeter, voltmeter, wattmeter and energy meters, testing and calibration, instrument transformers.

Books:

1. Electric machine I.J. Nagrath and D.P.kothari , Tata Mc Graw Hill
2. Electrical Technology Edward Hugh LBS 8th edition

AM 2101: MATHEMATICAL METHODS

Solution in series, Bessel functions and Legendre function: Self – adjoint differential equations, Power series method of solving second order differential equation, Bessel's functions of first kind $J_n(x)$, and second kind $Y_n(x)$, Recurrence relations, Generating functions of $J_n(x)$, Orthogonal Property of Bessel Functions, Legendre's equation,

Legendre Polynomials $P_n(X)$, Rodrigues formula, Generating function of $P_n(X)$, Orthogonal Property of $P_n(X)$, Sturm-Liouville problem.

Integral Transform: Laplace transform and its properties, Inverse Laplace Transform. Use of partial fractions, Convolution theorem. Applications in solving differential equations. Fourier transform and its properties. Inverse Fourier Transform. Convolution theorem. Application of Fourier Transform in solving initial and boundary value problems. Laplace equation. Heat equation and wave equation.

Probability and Statistics: Probability: definitions, addition and multiplication laws, Baye's Theorem. Random variables Discrete and continuous probability distributions. Binomial, Poisson, normal and exponential distributions, mean variance moment Generating function, Characteristic function of a probability distribution. Joint probability distribution of two random variables. Linear regression and correlation analysis .

Books:

1. Advanced Engineering Mathematics by E. Kreyszig, John Wiley & Sons.
2. Advanced Engineering Mathematics by R. K. Jain, S.R.K. Iyenger, Narosa Publishing.
3. Probability and Statistics for engineers by Irwin Miller and John E. Freund, Prentice Hall of India.

MS 2101: INTRODUCTION TO MATERIALS SCIENCE

Classification of engineering materials and their applications: Metals and Alloys, Ceramics and Glasses, Polymers, Composites and Novel Materials. Price and availability of materials. Processing of engineering materials.

Chemical bonding and properties of materials: Mechanical, Electrical, Magnetic, Optical, Thermal; Oxidation and degradation behavior of engineering materials.

Levels of structure: Nuclear structure, Crystal structure, Nanostructure, Microstructure and Macrostructure. Processing, structure, property correlation.

Books

1. Materials Science & Engineering: An Introduction, W.D. Callister. Jr.
2. Engineering Materials: Properties & Selection, K.G Budinski, M.K. Budinski.
3. The Science and Engineering of Materials, D.R. Askeland.
4. Materials Science and Engineering, V. Raghavan.
5. Engineering Materials Part 1 & 2, Ashby and D.R.H. Jones
6. Understanding Solids, Richard Tilley
7. Properties of Materials, R. E. Newnham.

AC 2101: CHEMISTRY OF POLYMERS

Introduction – Definition, classification, mechanism of polymerization, addition polymerization, condensation polymerization, thermosetting, thermoplastic polymers.

Chemical geometrical structures T_g (glass transition temperature) crystallinity of polymers. Chemistry of selected organic polymers, Chemistry of selected inorganic polymers, polymer degradation mechanisms, polymer processing, molecular weight & size of polymer dissolution, thermodynamics of polymers, Florry Huggin theory, viscosity of polymer solution, size and shape of polymers.

Books:

1. Polymer Chemistry an Introduction, R.B. Seymour, C.E. Carraher, E. Charles, Marcel Dekker, New York.
2. Principle of Polymer Science, P. Bahadur & N.V. Shastry, Narosa Publishing House, New Delhi.
3. Polymer Science, V.R. Gowariker, N.V. Viswanathan and Jayadev Sreedhar, Halsted Press, John Wiley & Sons, New York.
4. Principles of Polymerization, George Odian, John Wiley & Sons. 4th Ed.
5. Polymer Chemistry, B. Vollmert, Springer-Verlag, Berlin.

4TH – SEMESTER

BM 2201: PHYSIOLOGY-II

Renal system: Parts of the renal system- kidney, ureter, urinary bladder and urethra. Structure and function of parts of the system. Formation and composition of urine. Regulation of acid-base balance. Micturition, diuretics and kidney disease.

Endocrine system and Reproductive system: Elementary knowledge of structure and function of endocrine glands. Functions of male reproductive organs, female reproductive organs & contraception.

Nervous Systems: Neuro-anatomy in brief. Receptor, neuron, synapse and reflexes. Neural circuits for processing information. Central nervous system, peripheral nervous system and autonomic nervous system. Neuro chemical environment of brain. Sensory and motor activity of the brain. States of brain activity. Behavioral and motivational activity of brain. Autonomic nervous system. Ventricles and cerebrospinal fluid. Methods to study neural structure and function.

Special Senses: Organs of vision, hearing, taste & smell. Mechanism of vision, color vision, mechanism of hearing, tests of hearing, Physiology of olfaction & smell.

Musculo-skeletal System: Different types of muscles and their characteristics. Structure of bone. Neuro-muscular transmission General description of types of joints, structure and movements. Disorder of joints.

Books:

1. Text book of Medical Physiology by Guyton A.C and J.E. Hall, Harcourt India Pvt. Ltd.
2. Ross and Wilson: Anatomy and Physiology, Ninth Eds. Churchill Livingstone.
3. The Physiological Basis of Medical Practice *Charles H. Best*
4. Anatomy and Physiology, Gary A. Thibodeau and Kevin T. Patton Mosby.

BM 2202 ELECTRONIC DEVICES AND CIRCUITS

Analog electronics:

Overview: Passive components, Introduction to Semiconductors. P Type and N type semiconductors, P-N junction, diode characteristics. Zener diode, tunnel diode, LED, photodiodes,

Diodes applications as Rectifiers: Half wave rectifiers, full wave rectifiers, their analysis filter and power supplies, voltage regulators(78XX, 79XX, 317 and 337), clippers, clampers, voltage multiplier.

Transistor:

Basic mechanism of transistor. Characteristics of CB, CC and CE configuration their analysis and frequency response biasing of transistor. Hybrid model power amplifiers push pull amplifiers in class A, class B, class AB; operation feedback in amplifier frequency response. Impedance matching. FET and MOSFET – Basic mechanism structure characteristics and parameters.

Digital Electronics:

Number system ,Boolean algebra and basic logic gates, combinational logic, Logic families ,encoders decoders and display devices, multiplexers, Demultiplexers , latches and flip flops, counters, shift registers, A/D and D/A converters.

Book list:

1. Digital Principles and applications by A. L Malvino & D. P. Leach. TMH
2. Electronics Principals by A.P. Malvino TMH 3rd ed.

BM 2203 BIOPOTENTIAL

Bio potentials, Resting potential, Action potential, Synaptic Potential-their generation, transmission and propagation.

Types and nature of bioelectric signals, interaction of signals to perform various functions of our body. Synaptic transmission and transduction in receptors. Electrical circuit model of the membrane

The laws of stimulation and conduction in a nerve impulse.

Electrophysiological Signals- ECG, EMG, EEG their generation, propagation, recording and diagnostic applications.

Books

1. Introduction to Neurobiophysics, Vasilescu, D. G. Margineanu, Abacus Press, Tunbridge Wells, Vent.
2. Review of Medical Physiology, W. F. Ganong.
3. Medical Physiology, Guyton.
4. Medical Physiology, Best and Taylor.

BM 2204: NETWORK ANALYSIS AND SYNTHESIS

Basics of network:

Standard input and test signals, voltage and current sources, network elements and types of network. Mesh and Node Analysis, Network theorems.

Graph theory:

Graph theoretic models of electrical network, incidence Matrix, loop Matrix cut-sets and cut-set matrices, relationship between the matrices, planar graphs and planarity testing algorithms, dual graphs and dual networks, Mesh and node analysis of graph.

Network functions:

Driving point and transfer function. Two Port Networks: short circuit admittances, open circuit impedances, hybrid parameters, chain parameters, Inverse Transmission parameters, Relationship between parameters, Interconnection of two port networks: Two Port Devices.

Analysis of Filters:

Classification of filters, constant-k type filters, m-derived filters, composite filters.

Network Synthesis:

Positive real function, physical realisability conditions, properties of one port immittance functions and their synthesis. Foster and Cauer forms, Two port network synthesis.

Books:

1. Network Analysis, M.E Van Valken Berg PHI 3rd edition.
2. Network Analysis and Synthesis, CL Wadhwa, New age 1st ed.

AM 2201: NUMERICAL ANALYSIS

Errors and their estimation.

Interpolation: Finite differences: Newton's forward and backward interpolation formula; Lagrange's formula; Central differences; Formula of Gauss, Bessel and Everett curve fitting: Method of least squares; Cubic splines.

Solution of algebraic and transcendental equations: Iterative methods, Newton-Raphson method, convergence and efficiency of method.

Matrices: Eigen value and eigen Vectors, Matrix Decomposition, Inverse of matrix, norm of Matrix.

Solution of System of Linear equations: Direct methods: Gauss elimination method, LU-Decomposition, Cholesky method, iteration methods: jacobi method, Gauss-Seidel Method; III conditioned systems.

Numerical Integration and Differentiation .

Numerical solution of ordinary differential equations; Euler method, Modified Euler method and Runge Kutta method .

Finite Difference method for solution of boundary value problems of ordinary and partial differential equations.

Books Suggested:

1. Numerical Analysis by S.S. Sastry, prentice Hall of India Pvt. Ltd., New Delhi.
2. Numerical Methods for Scientists and Engineers by M. K. Jain et. al , New Age International publishers, New Delhi.

MS 2203: METAL & ALLOYS

Brief overview of commercial metals and alloys and their crystal structure. General properties of metals and alloys.

Mechanical properties: Stress-Strain behavior, Elastic and plastic deformation, work hardening, other strengthening processes. Elementary ideas about creep, fatigue and fracture.

Recovery recrystallization and grain growth.

Processing: Casting, solidification, powder metallurgy, hot workability, sheet metal forming, welding, elementary ideas of rolling, forging and extrusion.

Typical applications and materials selection.

Carbon and alloy steel, tool steels, stainless steels, cast irons. Important non-ferrous alloys: Cu, Al, Ni, Zn, Ti, Mg based alloys.

Typical applications and materials selection.

Books:

1. Materials Science and Engineering, V. Raghavan.
2. Engineering Materials, properties and selection, K. G. Budinski and M.K. Budinski.
3. Introduction to Materials Science, W.D. Callister.
4. The Science and Engineering of Materials, D.R. Askeland.
5. Mechanical Metallurgy, G.E Dieter.
6. Metals Handbook vol. 1, 8th Edition.

BM 3101 MICROPROCESSORS AND MICROCONTROLLERS

INTRODUCTION TO MICROPROCESSORS

Microprocessors, Microprocessors Architecture and Microcomputer system, 8085 Microprocessor Architecture and Memory interfacing, 8085 Memory organization, Instruction set, Timing Diagrams, Memory mapping, Types of Data transfer schemes, Interrupts.

PERIPHERAL DEVICES AND INTERFACING

Peripheral interface devices 8155,8255, Programmable interval Timer 8253, Programmable interrupt controller 8259A, The keyboard / Display controller 8279, Programmable communication Interface 8251 USART, DMA controller 8257, Programmable DMA interface 8237.

Multi-microprocessor Systems, Interconnection Topologies, Design of PC based multiprocessor system.

MICROCONTROLLERS INTRODUCTION

Single chip microcontroller, Introduction to 8 bit microcontrollers, Architecture of 8051, Signal description of 8051, Register set of 8051, Instruction set of 8051, Memory and I/O interfacing by 8051, Interrupts of 8051, Application of 8051 microcontroller.

RECENT TRENDS IN MICROPROCESSOR & EMBEDDED DEVICES

The 16 bit and higher processor, salient feature, system architecture. Embedded devices their features and architecture.

Books:

1. Microprocessor Architecture, Programming and Applications with 8085, Gaonker Ramesh S., Third Edition, Pen ram International, 2000.
2. Intel Microprocessors Architecture, Programming and Interfacing, Roy A.K. and Bhurhandi K.M, McGraw Hill International Edition, 2001.
3. Microprocessors and Interfacing, Programming and hardware Second Edition, Douglas V.Hall, Tata McGraw Hill Edition, 1997.
4. Programming and Customizing the 8051 Microcontroller, Predko Myke, Tata McGraw Hill, New Delhi, Second Edition, 2001.

BM3102: ELECTRONIC CIRCUITS FOR MEDICAL INSTRUMENTATION

Operational amplifiers

Characteristics and type of OpAmps, dc and ac analysis, application of opamp as inverting & non inverting amplifier, adder, subtractor, integrator, differentiator, comparator, zero crossing detector, buffer differential and instrumentation amplifiers. opamp as precision

half wave full wave rectifiers, s/h circuit. Frequency to voltage & voltage to frequency converter,

Oscillator and Wave form generator

Phase shift and Wein Bridge, crystal oscillator. Sine wave, triangular wave, square wave and saw tooth wave generation, 555 IC its characteristics and its application

Active filters:

Types of filters, frequency transformation, realization of practical filters.

Power electronics devices:

Thyristor characteristics and its application as rectifier as inverter, chopper and cyclo-converters. Other power electronic devices power transistor and IGBT.

Books:

1. Operation amplifier and linear integrated circuits by robert f Coughlin and Frederick f dirstrolll PHI 4th edition.
2. Electronics principle by A.P. Malvino TMH 3rd edition.
3. The Design of Medical Electronic Devices (Reinaldo Perez)

BM 3103: BIOMATERIAL

Introduction to Biomaterials classification of Biomaterials strength and strengthening mechanism of metals and alloys application of metals and alloys as Biomaterials. Polymerization, Condensation and addition Polymerization. Molecular weight of polymer Structure, property relation ship of polymers. Hard and soft tissue application of polymers.

Cells, Tissues, Organs- Structure and Properties. Epithelial tissue, Corrective tissue, cartilage, bone, skin, teeth. Dermal Prosthesis, Facial Prosthesis, Soft tissue replacement, hard tissue replacement, Biocompatibility.

Books:

1. "Biological Performance of materials", Black Jonathan Marcel Decker, 1981.
2. "Biomaterial Science and Engineering", Park J.B., Plenum Press, 1984.
- 3 "Biomaterial: an interfacial approach",. Hench L.L. & E.C.Ethridge, Academic Press, 1982.

PH-2105: Pharmaceutical Microbiology

General techniques of microbiology, morphology, life history, habit, variation, reproduction, mode of nutrition and cultivation of bacteria, yeasts, moulds and common protozoa.

Principles of isolation and identification of pure culture, different staining methods, preparation of staining solutions and culture media.

Principles of sterilization, efficiency of various methods of sterilization with special reference to thermo labile medicaments, cleaning and sterilization of glasswares, medicaments, surgical dressings.

Ligatures and sutures, manufacturing units and their manufacture and standardization.

Effects of physical and chemical agents on bacteria, disinfectants and antiseptics, mode of action and standardization of disinfectants.

Aseptic methods, mode of contamination and determination of degree of contamination.

Aseptic handling of sterile materials and medicaments and test for sterility of medicaments, culture media, ligatures and sutures.

Reaction of micro-organism to disease, common infections and communicable diseases, their causative organism, mode and route of infection. Methods of control and diagnostic test of organisms of special interest to India .

Books:

1. "Industrial Microbiology", Prescott and Dunn, McGraw Hill Book Company Inc.
2. "Fundamental Principles of Bacteriology A.J.Salle,".
3. "Disinfection and Sterilization" G.Sykes.

AC 3102: ANALYTICAL TECHNIQUES IN CHEMISTRY

Basic Concept of Analytical Chemistry and its application in chemical analysis.

Statistical Methods of data analysis. Industrial chemical analysis. Signal Processing: analog and digital. Sensitivity, detection limit, resolution, dynamic range, selectivity in analysis.

Electroanalytical Chemistry: charge transfer at the electrode-solution interface, polarizable and non-Polarizable electrodes, Introduction to voltammetry, Diffusion current, cyclic voltammetry, potential programs used in Electro analysis, Surface Modified electrodes, Bioelectrochemistry. Use of dropping mercury electrode in metal ion analysis, ion selective electrodes and their applications.

Books:

1. Analytical Chemistry: an Introduction 7th Ed, Skoog, West, and Harris, Saunders, College Publishing, 1999 (ISBN: 0-03-097285-X).
2. Principles of Instrumental Analysis, Fifth Edition, Skoog, Holler and Nieman. Brooks/Cole-Thompson Learning Publishers.
3. Vogel's Quantitative Chemical Analysis, 6th Edition.
4. Contemporary Instrumental Analysis , Kenneth A. Rubinson, Culinary and Hospitality Industry Publications Services.
5. Electrochemical Methods: Fundamentals and Applications, 2nd Edition by Allen J. Bard, Larry R. Faulkner.

MS 3106: SYNTHESIS AND PREPARATION OF MATERIALS

Ceramic Powder synthesis methods: Solid State reaction method, Chemical routes: Co precipitation, Spray drying, freeze drying, sol-gel method, hydrothermal and combustion. Microwave Synthesis.

Characterization of powders: Size and surface area.

Green Body Forming: Dry pressing, slip and tape casting, extrusion, injection molding, and sol-gel. Sintering, Hot pressing, Microwave sintering. Powder coating, flame and plasma spraying. electrodeposition.

Polymer Synthesis: Type of synthesis: free radical, addition, condensation suspension polymerization, Emulsion, ionic polymerization, copolymerization, block copolymer, grafting.

Thin Film Preparations: Epitaxial, Grain Oriented and Polycrystalline Thin Films, Fundamentals of vacuum instruments. Thermal and electron beam evaporation. Sputtering methods: DC, RF and Magnetron. Laser ablation. Chemical vapour deposition. MOCVD. Electro-deposition. Molecular Beam epitaxy. Spin coating.

Crystal growth techniques: Bridgman, Stockbarger and Czochralski techniques. Aqueous solution growth. Hydrothermal growth. Molten salt growth. Vapour phase growth.

Books:

1. Principles of Polymerization , G. Odian
2. Hand book of thin films , Maisel
3. Thin Film , A. Goswami
4. Modern Ceramic Engineering ,David W. Richerson
5. Ceramic Processing and Sintering by M. N. Rahman.
6. Principles of Ceramic Processing, James S. Reed.
7. Art and Science of Growing Growing Crystals, J.J. Gilman.
8. The Growth of Single Crystals, R. A. Laudise

6th – Semester

BM 3201: CONTROL SYSTEM

Introduction: The control system, classification of control system, open loop and closed loop systems, representation, mathematical modeling of physical systems, transfer function, block diagram, signal flow graphs, state variable representation, feedback principles and characteristics of control system, control system components.

Time domain and frequency domain analysis, specifications in time and frequency domain, type 0, 1, 2, systems, error coefficients.

Stability analysis: Routh Hurwitz criteria, Nyquist criterion, Bode plot, root locus method, Nichols chart, relative stability analysis.

Introduction to design, compensation of feedback control systems, basic control actions, proportional, integral, derivative, PL, PD, PID and their comparison.

Introduction to non-linear and adaptive control systems.

Books:

1. Control system engineering, I J. Nagrath and M. Gopal New Age International publishers
2. Modern control system engineering, K. Ogata, Prentice Hall.
3. Modern control system, R. C. Dorf and R. H. Bishop, Addison Wesley.
4. Automatic control system. B. C. Kuo, Prentice Hall

BM 3202 Transducers and Instrumentation systems

Basic concepts of measurements systems, characteristics and performance of measuring devices.

Transducers: Classification of transducers, transducers for displacements, strain, pressure, flow and temperature.

Indicating and recording instruments: Introduction, digital voltmeters (DVM's), CRO's, galvanometric recorders, servo type potentiometric recorders, thermal, inkjet, laser recorders, magnetic tape recorders, digital recorder of memory type, data acquisition system, data display and storage LED and LCD display devices.

Telemetry: Data transmission: cable transmission of analog voltage and current signals, cable transmission of digital data, fiber optic data transmission, radio telemetry, pneumatic transmission, synchro position repeater system, slip rings and rotatory transformers, data storage and rotatory playbacks, an alternative to data transmission.

Books:

1. Measurement systems and application and design by Ernest O. Doebelin, Mc Graw Hill 4th edition
2. Instrumentation measurement analysis by BC Nakra, KK Chaudhary, TMH 1st edition
3. Instrumentation devices and system by CS Rasger, GR Sharma and VSV Mani TMH 1st edition.

MS 3210: SCIENCE OF CERAMIC MATERIALS

Bonding and crystal structure of ceramics. Effect of bonding, crystal structure and microstructure on physical properties of ceramics. Point defects in ionic compounds. Effect

of partial pressure of oxygen and temperature on defect concentration. Nonstoichiometry. Effect of alliovalent impurities on concentration of defects. Electronic properties of ceramic materials.

Synthesis of ceramic powder and nanoparticles and their consolidation. Sintering and grain growth mechanisms.

Theoretical fracture strength, Griffith's theory of brittle fracture, toughness and fracture toughness, factors influencing the strength of ceramic materials. Toughening mechanisms, transformation toughening, r-curve behaviour and designing with ceramics.

Weibull modulus. Creep and fatigue in ceramics materials.

Thermal expansion, thermal conductivity, thermal stresses and thermal shock resistance.

Spontaneous microcracking. Thermal tempering.

Books:

1. Fundamentals of Ceramics, M.W. Barsoum.
2. Modern Ceramic Engineering, D. W. Richerson.
3. Introduction to Ceramics, W.D. Kingery, H.K. Bowen and D.R. Uhlmann.
4. Ceramic fabrication process, W.D. Kingery.
5. Modern Glass Practice, S.R. Sholze.
6. Properties of Ceramic Raw Materials, W. Rayon

AC 3201 INSTRUMENTAL METHODS FOR CHEMICAL ANALYSIS

Basic theory, instrumentation, laboratory techniques and analytical application of the following: Absorption Spectrophotometer: UV-visible. FTIR, NMR, ESR, Mass Spectrometry and AAS. Emission Spectrophotometry: ICP-AES (XPS). Chromatography: Adsorption, ion-ex change and HPLC.

Books:

1. Analytical Chemistry: an Introduction (7th Ed), Skoog, West, and Harris Saunders, College Publishing.
2. Principles of Instrumental Analysis, Fifth Edition, Skoog, Holler and Nieman. Brooks/ Cole-Thompson Learning Publishers.
3. Vogel's Quantitative Chemical Analysis, **6th Edition.**
4. Contemporary Instrumental Analysis by Kenneth A. Rubinson, Culinary and Hospitality Industry Publications Services.
5. Electrochemical Methods: Fundamentals and Applications, 2nd Edition by Allen J. Bard, Larry R. Faulkner ISBN: 0-471-04372-9, December 2000.

ECE 3204 RELIABILITY ENGINEERING

Quality and reliability. Importance of reliability, Reliability parameters. Methods of achieving reliability. Measure of control tendency and dispersion. Systems reliability with constant and variable failure rates. Series and parallel reliability, Maintainability and

availability. Failure mechanism. Reliability data and analysis. Reliability improvement methods and quality control.

7th – Semester

BM 4101: BIOLOGICAL CONTROL SYSTEM ANALYSIS

Introduction to Physiological control systems, Illustration, Example of a physiological control system, Difference between engineering and physiological control system, Art of modeling Physiological systems, Linear models of physiological systems, Distributed parameters versus lumped parameter models, Principle of superposition.

Cardiovascular system_ Modeling and simulation, Theoretical basis, Model development, Heart model, circulatory model,

Pulmonary mechanics modeling and simulation, Theoretical basis, Model development, Lung tissue visco-elastance, chest wall, airways, Full model of respiratory mechanics, Interaction of Pulmonary and Cardiovascular models.

Eye movement system and its mathematical model, oculomotor muscle model, linear muscle model .

Simple models of muscle stretch reflex action, Ventilator control action, Lung mechanics and their SIMULINK implementation, Study of steady state analysis of muscle stretch reflex action, ventilatory control action by MATLAB tools, Study of transient response analysis of neuromuscular reflex model action by MATLAB tools, Study of frequency domain analysis of linearized model of lungs mechanics, Circulatory control model and glucose insulin regulation model by MATLAB tools.

Applications of Control theory to physiological systems. Time-domain, frequency domain, stability analysis. Biological performance criteria and adaptive control systems.

Books:

1. “Physiological control systems: Analysis, Simulation and Estimation”, Khoo Michael C.K., Prentice Hall of India Pvt, Ltd, New Delhi
- 2 “Virtual Bioinstrumentation Biomedical, Clinical and Healthcare applications”, .Olsen Jon B. and Eric Rosow, Prentice Hall PTR, Upper Saddle River, Nj.
3. “Biological Control System analysis”, Milsum John H., McGraw Hill, 1966.

BM 4102: BIOMECHANICS

Scalar and vector quantities. Different operations on vector. Forces and moments, system of forces, resultant of system of forces in 3D and 2D. Equilibrium equations. Applications with example on human body.

Work-energy equations: Applications to Biomedical system. Stress-strain diagram.

Stress concentration. Mechanical properties of human bone. Mechanical properties of cortical bone, properties of cancellous bone, viscoelasticity, elastic model of bone. Mechanical testing of soft tissues.

Books

1. "Fundamentals of Biomechanics", Ozkaya Nihat, Margrate Nordin, Springer publication.
2. "A primer of Biomechanics", Lucas G. L., F. W. Cooke, Springer publication.
3. "The principles of exercise therapy", Gardiner M. Dena, CBS Publisher.

BM 4103: BIOMEDICAL INSTRUMENTATION

Basic concept of biomedical instrumentation. Electrodes, transducers, biosensors and their characteristics. Biopotential amplifiers. Biotelemetry. Recording of ECG, EEG, EMG, ERG, evoked potentials etc.

Cardiovascular measurements. Measurement of the respiratory system.

Analytical instruments in Biomedical Engineering; oximeter, spectrophotometer, colorimeter, blood gas analyzer, blood cell counter.

Therapeutic & assist devices for cardiovascular system and respiratory system. Physiotherapy devices. Electrosurgical units. Safety aspects of biomedical equipment.

Books:

1. Handbook of Biomedical Instrumentation", Khandpur R.S Tata McGraw, New Delhi, 2004
2. Principle of Applied Bio medical Instrumentation, Geddes L.A. and L.E.Baker, 3rd edition Wiley Interscience Publication, 1989.
3. Medical instrumentation, Webster John, John Wiley and sons, New York. 2003.
4. Bio medical Instrumentation and Measurements, Cromwell Leslie, Fred J. Weibell, Erich A. Pfeiffer, PHI, 2nd edition, 2004.
5. n, Principles of Applied Biomedical Instrumentation, Geddes L.A. and L.E.BakeJohWiley & Sons, 1989.
- 6Principles of Biomedical Instrumentation and Measurement, . Richard Aston Merrill, Publishing Company, 1990.

BM 4104: MOLECULAR BIOLOGY AND GENETICS

Gene Its concept and inheritance
DNA Structure, forms and replication, Mutation
RNA types and function, transcription
Ribosome and translation
Regulation of transcription and translation
Chromosomal theory of heredity
Chromosomes and gene organization in eukaryotes
Chromatin structure, cell division and cell cycle
Recombination in bacteria, conjugation, transduction and transformation, mapping of bacteria gene
Genome mapping in eukaryotes
RNA tumor Viruses –replication and function
Gene cloning

Books:

1. Molecular Biology of the Gene (2nd Ed.), Watson , Benjamin/Cummings, 1976.
2. Principals of gene manipulation (6th Ed.), Primrose , Blackwell Scientific, 2001.
3. molecular Biology of the cell , Alberts ,Garland, 2002
4. Analysis and Principles, Brooker Genetics ,Addison-Wesley1999
5. Principles of Genetics, Snustad & Simmons: (John Wiley, 2003)
6. Boyer: Modern Experimental Biochemistry and Molecular Biology (2nd ed.), Benjamin / Cummings, 1993

CH 4101: TRANSPORT PHENOMENON

Molecular transport of momentum, energy, and mass and concept of viscosity, thermal conductivity, and diffusivity.

Shell momentum, energy, and mass balance and distribution of velocity, temperature, and concentration in one dimension.

Equations of changes for isothermal, non-isothermal, and multi component mixtures. Velocity, temperature, and concentration distributions with more than one independent variable, Boundary layer theory.

Turbulent transport: Laminar-turbulent transition, Basic characteristic features of turbulent flow, Time smoothed equation of changes, Eddy viscosity, thermal conductivity and diffusivity, Distribution of velocity, temperature, and concentration in turbulent flows.

Interphase transport: Friction factor, Heat transfer coefficient, mass transfer coefficient.

Macroscopic balances and its applications in analysis and solution of process engineering problems.

Transport phenomena in non-Newtonian fluids. Momentum, heat and mass transport analogies.

Books:

1. Transport Phenomena, R.B. Bird, W.E. Stewart and E. W. Lighfoot, John Wiley & Sons.
2. Transport Phenomena, Brodkey, R.S. and Hershey, H. C, McGraw-Hill
3. Fundamentals of Momentum heat and Mass Transfer, Welty, J.R., Wicks, C.W., Wilson, R.E. And Rorrer, G John Wiley & Sons.

8th - Semester

BM 4201: POLYMER IN MEDICINE

Polymerization, Hard tissue application of polymer – polyolefin's, Acrylic Polymers Fluorocarbon polymers, Rubbers, soft tissue replacement- sutures- surgical tapes, Tissue adhesive , eye implant blood interfacing implant, skin implant, polymeric Drug delivery system and Polymeric drug – Polylactide and Polyglycolide as carrier for drugs and micelles for drug delivery system .

Books:

1. Biomaterial Science and Engineering, J. B. Park. Plenum press
2. Polymers in medicine edited, C Migliaresi, L. Nicolais, P Giusti, E Chiellini.
3. Properties of Biomaterials in the Physiological Environment, S. D. Bruck.

BM 4202: RADIATION AND BIOMEDICAL APPLICATIONS

Basic concepts, types, sources, generation and characteristics of electromagnetic radiations and its influence on living beings with particular emphasis on human beings. Biological effects and Biomedical applications of X- Rays, Gamma-rays, Microwaves, Ultrasound etc. Introduction to Radioisotopes and its Biomedical Applications.

Properties of laser, classification, basic concept, types, interaction with tissues, photocoagulation, photo thermal ablation, photochemical ablation, photo disruption, Photo medicine and photo biology lasers used for medical applications, CO₂, Ruby, Nd, YAG, Ar, Kr, He, Ne .

Applications of lasers in general surgery, Lithotripter, dermatology, ophthalmology, cardiovascular and chest surgery, gynecology laser neurosurgery, tumor surgery, urology, otolaryngology and neck and head surgery. Application of laser in diagnosis, holography .

Safety with biomedical lasers.

Books:

- 1 “Optical fiber communication”, . Senior, PHI.
2. “Therapeutic laser, theory and practice”, Churchill, Baxter G.David, Livingstone.
3. “Optoelectronics, An introduction”, Tripathi K. N B.S. Publications.
4. “Medical Applications of lasers”. Vij and K. Mahesh,

BM 4203: BIOMEDICAL SIGNAL AND IMAGE PROCESSING

Fundamentals of digital signal and image processing. Storage and display operation properties of digital image. Image preprocessing by statistical and probabilistic methods.

Image enhancement and restoration. Segmentation of images by applying threshold, Edge based and Region based techniques. Image feature extraction, analysis of medical images.

Medical imaging systems; X-ray system, C.T. Scan, Ultrasound (A, B and M scans). MRI and Positron Emission Tomography.

Books:

1. “Biomedical digital signal processing”, Tompkins Wills J, Prentice Hall of India Pvt.Ltd. New Delhi.
2. “Digital signal processing”, Mitra S.K., Tata McGraw Hill Limited.
3. “Digital signal processing”, Oppenheim & Schafer, prentice hall of India.
4. “Biomedical Signal Processing-Principles & Techniques”, Reddy D.C., Tata McGraw Hill, 2005.

BM 4204: COMPOSITE MATERIALS

Introduction: Types of composites and their advantages.

Reinforcement: Glass, boron, carbon, organic and ceramic fibers, their structure, properties and processing.

Matrix materials: Polymers, metal and ceramic matrices, their structure, properties and processing. Wettability and interface bonding.

Polymer matrix composites: Lamina, laminate composites. Primary and Secondary manufacturing; Lay-up, Filament winding, pultrusion, compression molding. Machining, drilling and routing, applications.

Metal matrix composites: processing techniques and applications. Ceramic Matrix composites; processing techniques and applications.

Introduction to Nano-composites and applications

Micromechanics: Mechanical properties, thermal properties and load transfer.

Macro mechanics: Elastic behavior, fracture behavior, fatigue behavior, creep behavior of composites. Tribological and electrical behavior of composites.

Degradation of composites due to various environmental conditions. Corrosion resistance of composite. Designing with composites

Biological application of composites

Books:

1. Composite materials by Krishna K. Chawla Springer verlag , New york , 1998
2. Composites Engineering hand book by P.K. Mallick Marcel dekker, Inc. New York, 1997

ECE 4201: LSI/VLSI DESIGN

Evolution of circuit Integration.

MOS Transistors_ fabrication and characteristics. MOSFET scaling and short-channel effects. Layer representation and layout rules.

Analysis and design of inverters and inverter based circuits. Circuit and interconnection delays. Driving large loads Super buffers

Combinational and sequential logic circuits Dynamic logic circuits. Memories.

VLSI design strategies- Full custom, Standard Cell and Gate Array design. FPGAs. Subsystem design. Testing and testabilities. CAD for VLSI.

9th – Semester

BM 5101 COMPUTER APPLICATION IN BIOMEDICAL ENGINEERING

Use of computers in physiological data acquisition and analysis. Programming, storage and display of data with reference to bioelectric potentials. Applications of Microprocessor and Microcontroller in medicine.

Digital filters; FIR and IIR type and their application to biomedical signal filtering. Data reduction techniques. Spectrum analysis.

Intelligent computing systems in medicine; Introduction to Intelligence and Artificial Intelligence. Heuristic Search method, knowledge Based system, ANN architecture and learning algorithms.

LIST OF ELECTIVES:

BM 5102 BIOCERAMICS

Definition and scope of Bio-materials. Structure-property relationship of biological materials, structure of proteins, polysaccharides, structure-property relationship of hard tissues cell, bone, teeth and connective tissues.

Structure, properties and functional behaviour of bio-materials. Tissues response to implants (bio-compatibility, wound healing process), body response to implants, blood compatability.

Classification of bio-ceramic materials for medical applications. Alumina and zirconia in surgical implants, bioactive glasses and their clinical applications, A.W. machinable and phosphate glass ceramics. Dense and porous hydroxyl apatite calcium phosphate ceramics, coatings and resorbable ceramics. Carbon as an implant. CMC and PMC composites. Characterization of bio-ceramics.

Regulation of medical devices.

Books:

1. The Bioceramics Volume 10 by (L. Sedel)
2. Introduction to Ceramics, W.D. Kingery, H.K. Bowen and D.R. Uhlmann.

BM 5103: TISSUE ENGINEERING

Introduction to tissue engineering. Specific tissue types. Biochemical influence on cell function. Interaction between cells and their environment. Wound healing. Cells micro mechanisms for regeneration and repair. Stem cells. Biomaterials in tissue engineering. Tissue culture. Bioreactors and biomolecular production. Immunity and surface reaction.

Skin tissue engineering. Bone and cartilage tissue engineering. Cardiac tissue engineering. Valve tissue engineering. Vascular tissue engineering. Neural tissue engineering. Visceral tissue engineering. Organ and tissue transplantation. Scaffold design and fabrication. Ethics.

Books:

1. The molecular and cellular biology of wound repair. Clark, Plenum Press
2. Biomaterials Science. Ratner, Hoffman, Schoen, Academic Press.
3. Frontiers of tissue engineering. Patricks, Mikos, McIntire, Pergamon Press.
4. Principles of Tissue engineering. Lenza, Langer, vacanti, Academic Press.
5. Tissue engineering Methods and protocols. Morgan and Yarmush, Humana Press
6. Molecular biology of cell. Alberts, Bray, Lewis, Garland Press

BM 5104: ADVANCED BIOMECHANICS

Principle of continuum mechanics. Tensor treatment to explain elastic, Viscoelastic, electric and electromechanical properties of bones, teeth and connective tissues. Wave propagation in extended and partly bound media and its application in analyzing the structural microtextural symmetry in calcified tissues. Theoretical models for bone as a hierarchical composite.

Dental forces, implant-tissue biomechanics, Crack propagation in bones, dynamic models.

Wolf's law and introduction to orthopedic biomechanics. Human body dynamics and locomotion analysis. Pressure sore biomechanics. Interaction between tissues and support surface. Mechanics of spinal distraction rods. Biomechanics of human motion and control interfaces with application to limb orthotics and prosthetics. Design of hip prosthesis. Automated driver's training programme. Sports biomechanics.

Books

1. "Fundamentals of Biomechanics", Ozkaya Nihat, Margrate Nordin, Springer publication.
2. "A primer of Biomechanics", Lucas G. L., F. W. Cooke, Springer publication.
3. "The principles of exercise therapy", .Gardiner M. Dena , CBS Publisher.

BM 5105 REHABILITATION ENGINEERING

Introduction Types of physical impairments, Principles of Rehabilitation, Motor, Sensor and Communication disorders.

Intelligent prosthetic knee & arm. Advanced automatic prosthetics and orthotics.

Prevention and cure of visual impairment, Electronics travel appliances, path sounder, laser cane, ultrasonic torch and guide, light probes, obstacle sensors, electro cortical prosthesis, classification.

Subjective and objective measurement methods. Characterizing human systems, sub, systems and assertive devices.

Biomaterials outlook for organ transplant, design considerations evaluation process.

Engineering design of artificial heart and circulatory assist devices, Implementation and implantation aspects.

Computer application in rehabilitation engineering; Interfaces in compensation for visual perception and improvement of orientation and mobility, rehabilitation aids for mentally impaired.

Books

1. Rehabilitation Technology, Ballabio, E, IOS Press.
2. Biomedical Engg., Handbook, Bronzino J. D., CRC press (New York), 1995.
3. Rehabilitation Engineering Robinson C. J CRC Press.

BM 5106 BIO INFORMATICS

Introduction: objectives of Bioinformatics, Data integration, Data Analysis, Bioinformatics databases and tools, Molecular approach versus Bioinformatics approach, Overview of Bioinformatics application.

Basic chemistry of nucleic acids, Structure of DNA, Genes, The functional elements in DNA, DNA sequencing and Polymeric chain reaction, Cloning methodology, Amino acids, Protein structure Protein folding, Protein function.

The basics of Linux system, Text processing, Writing Shell programs, Introduction to Perl, Programming with Perl, Perl applications for Bioinformatics, Bio-Perl.

Introduction to Sequence Analysis, Models for sequence analysis and their Biological motivation, Methods of alignment, Usage of gap penalties and Scoring matrices, Tools for sequence alignment, Tools for multiple sequence alignment, Applications of Multiple alignment.

Applications of Gene mapping, DNA sequencing, DNA micro arrays, Algorithms for gene alignment, Gene prediction tools, Tools for DNA/RNA structure and function analysis.

Protein structure visualization, Protein structure prediction, Methods of protein structure for known folds, Methods of protein structure for unknown folds, Methods for structure prediction, Protein analysis, Tools for protein analysis.

Books:

1. Bioinformatics Concepts, Skills and Applications, Rastogi S.C., Namita Mendiratta, Parag Rastogi CBS publication.
2. Bioinformatics: A practical guide to the Analysis of Genes and Proteins, A.D, Francis Ouellette Baxevanis, Wiley Interscience, New York.
3. Bioinformatics Sequence and Genome Analysis, Mount David Cold Spring Harbor Laboratory Press.
4. Bioinformatics Basics Applications in Biological Science and Medicine, Hooman Rashidi, and Lukas K.Buehler, CRC Press.
5. Beginning Perl for Bioinformatics, Tisdall James, O'Reilly publications.

BM 5107 HOSPITAL SYSTEM MANAGEMENT

Classification of hospital systems, general hospital, specialists hospital, teaching research, primary health center, their role, functions, role of biomedical engineering, aspects of hospital services, out patient, in patients, supportive emergencies, and drug and medical supply, nursing services, dietary services, transport services.

Hospital planning, location, orientation, budgeting, communication within the hospital and outside the hospital, electric power supply for various theatres and rooms, diesel generators, standby power supply.

Air conditioning of important theatres and equipments, housings, water supply, requirements and managements, lifts, fire fighting and equipments, sanitation with in the hospitals, laundry services.

Computer and information management in hospitals, computer added hospital managements: application, administration /discharge records of patients – patients billing, – maintenance of patients' record, their history, and maintenance of inventory of medicines and drugs purchase.

Electrical factors in hospital design: voltage stabilizers, uninterrupted power supply for intensive care UNITS and computerized monitoring UNITS, safety precautions, interference of systems, protection, grounding of ECG, EEG, EMG and therapeutic equipments.

Biomedical equipments services, their purchase, servicing and maintenance, condemned equipment disposal, training of men for medical equipments, preventive and periodical maintenance procedures.

Hospital waste management.

Books:

1. Hospital administration and management D Goel S. I. & R. Kumar, Deep, Publication – New Delhi.
- 2 Source book of Modern technology for hospital and health care, . Sahn Ashok ISHA, BANGLORE 1992.

BM-5108: MATHEMATICAL METHODS IN BIOMEDICAL ENGINEERING

Mathematical modeling and solution of biomedical problems namely respiratory rate, blood flow, cardiac output and impedance diffusion, ultra filtration etc.

Operational research applied to the description of physiological systems and signals processing by interfacing instrumentation, biomedical variability and probabilistic solution to medical decision making, population dynamics perturbation technique in dealing with the problems of thermodynamics. Stochastic process . Finite- Difference method .

BM 5109: BIOTRANSPORT PROCESS

Introduction to fluid flow, heat transfer and mass transfer. Unified approach of momentum; Heat and Mass transfer; flow behaviors of Newtonian and non-Newtonian fluids; application of momentum; heat and mass transfer principles of biological system with particular emphasis on human beings; fluid mechanics of time dependent flows in pulmonary and urinary systems; Engineering models and their utilization in describing in-vivo observations. Modeling of the body as compartment; Source and stream; heat exchange between human body and its environment; mass transfer in membrane; heamodialysis as related to artificial kidney; extra corporal oxygenators.

Books

1. “Biomedical Engineering Principles, An Introduction to fluid , heat and mass transfer process”, Cooney D. O., Marcel Dekker Inc, (1976).
2. “Transport Phenomena in living systems- Biomedical Aspects of Momentum and Mass Transport”, Lightfoot E. N., John Wiley (1974).
- 3 “Basic transport phenomena in biomedical engineering”, Fournier, Ronald L., Taylor & Francis, 1998.

