CHEMISTRY

Inorganic Chemistry

1. Chemical periodicity
2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).
3. Concepts of acids and bases, Hard-Soft acid base concept, Non-aqueous solvents.
4. Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds.
5. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms.
6. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications.
7. Organometallic compounds: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis.
8. Cages and metal clusters.
9. Analytical chemistry- separation, spectroscopic, electro- and thermoanalytical methods.
10. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine.
11. Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.
12. Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

Physical Chemistry

1. Basic principles of quantum mechanics: Postulates; operator algebra; exactly-solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunneling.
2. Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.
3. Atomic structure and spectroscopy; term symbols; many-electron systems and antisymmetry principle.

4. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems.
5. Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules.
6. Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.
7. Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.
8. Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.
9. Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.
10. Chemical kinetics: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.
11. Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.
12. Solid state: Crystal structures; Bragg's law and applications; band structure of solids.
13. Polymer chemistry: Molar masses; kinetics of polymerization.
14. Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

Organic Chemistry

1. IUPAC nomenclature of organic molecules including regio- and stereoisomers.
2. Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.

3. Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.
4. Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.
5. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.
6. Common named reactions and rearrangements – applications in organic synthesis.
7. Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations.
8. Concepts in organic synthesis: Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.
9. Asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic.
10. Pericyclic reactions – electrocyclisation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.
11. Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).
12. Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.
13. Structure determination of organic compounds by IR, UV-Vis, 1H & 13C NMR and Mass spectroscopic techniques.

Interdisciplinary topics

1. Chemistry in nanoscience and technology
2. Catalysis and green chemistry
3. Medicinal chemistry
4. Supramolecular chemistry
5. Environmental chemistry

POLYMER SCIENCE

Chemistry of high polymers: Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness, polymerization methods: addition and condensation; their kinetics, metallocene polymers and other newer techniques of polymerization, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, azeotropic copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension, emulsion.

Polymer Characterization: Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques.

Synthesis and properties: Commodity and general purpose thermoplastics: PE, PP, PS, PVC, Polyesters, Acrylic, PU polymers. Engineering Plastics: Nylon, PC, PBT, PSU, PPO, ABS, Fluoropolymers Thermosetting polymers: PF, MF, UF, Epoxy, Unsaturated polyester, Alkyds. Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex, SBR, Nitrile, CR, CSM, EPDM, IIR, BR, Silicone, TPE.

Polymer blends and composites: Difference between blends and composites, their significance, choice of polymers for blending, blend miscibility-miscible and immiscible blends, thermodynamics, phase morphology, polymer alloys, polymer eutectics, plastic-plastic, rubberplastic and rubber-rubber blends, FRP, particulate, long and short fibre reinforced composites.

Polymer Technology: Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization, vulcanization kinetics.

Polymer rheology: Flow of Newtonian and non-Newtonian fluids, different flow equations, dependence of shear modulus on temperature, molecular/segmental deformations at different zones and transitions. Measurements of rheological parameters by capillary rotating, parallel plate, cone-plate rheometer. viscoelasticity-creep and stress relaxations, mechanical models, control of rheological characteristics through compounding, rubber curing in parallel plate viscometer, ODR and MDR.

Polymer processing: Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer.

Polymer testing: Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness. Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, ageing resistance, environmental stress cracking resistance.

BIOCHEMISTRY

Organization of life; Importance of water; Structure and function of biomolecules: Amino acids, Carbohydrates, Lipids, Proteins and Nucleic acids; Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, Ribonuclease A, Carboxypeptidase and Chymotrypsin.

Enzyme kinetics including its regulation and inhibition, Vitamins and Coenzymes ; Metabolism and bioenergetics; Generation and utilization of ATP; Metabolic pathways and their regulation: glycolysis, TCA cycle, pentose phosphate pathway, oxidative phosphorylation,gluconeogenesis, glycogen and fatty acid metabolism; Metabolism of Nitrogen containing compounds: nitrogen fixation, amino acids and nucleotides. Photosynthesis: Calvin cycle.

Biochemical separation techniques: ion exchange, size exclusion and affinity chromatography, Characterization of biomolecules by electrophoresis, UV-visible and fluorescence spectroscopy and Mass spectrometry.

Cell structure and organelles; Biological membranes; Transport across membranes; Signal transduction; Hormones and neurotransmitters.

DNA replication, transcription and translation; Biochemical regulation of gene expression; Recombinant DNA technology and applications: PCR, site directed mutagenesis and DNA-microarray.

Immune system: Active and passive immunity; Complement system; Antibody structure, function and diversity; Cells of the immune system: T, B and macrophages; T and B cell activation; Major histocompatibilty complex; T cell receptor; Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

COMPUTER SCIENCE/ INFORMATION TECHNOLOGY

Digital Logic : Boolean algebra. Combinational and sequential circuits. Minimization. Number representations and computer arithmetic (fixed and floating point).

Computer Organization and Architecture : Machine instructions and addressing modes. ALU, data-path and control unit. Instruction pipelining. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).

Programming and Data Structures: Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

Algorithms : Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide-and-conquer. Graph search, minimum spanning trees, shortest paths.

Theory of Computation: Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and contex-free languages, pumping lemma. Turing machines and undecidability.

Compiler Design: Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation.

Operating System: Processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU scheduling. Memory management and virtual memory. File systems.

Databases :ER-model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.

Computer Networks: Concept of layering. LAN technologies (Ethernet). Flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state). TCP/UDP and sockets, congestion control. Application layer protocols (DNS, SMTP, POP, FTP, HTTP). Basics of Wi-Fi. Network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls.

ELECTRICAL ENGINEERING

Electrical Materials : Electrical Engineering Materials, crystal structures and defects, ceramic materials, insulating materials, magnetic materials – basics, properties and applications; ferrities, ferro-magnetic materials and components; basics of solid state physics, conductors; Photo-conductivity; Basics of Nano materials and Superconductors.

Electric Circuits and Fields: Circuit elements, network graph, KCL, KVL, Node and Mesh analysis, ideal current and voltage sources, Thevenin's, Norton's, Superposition and Maximum Power Transfer theorems, transient response of DC and AC networks, Sinusoidal steady state analysis, basic filter concepts, two-port networks, three phase circuits, Magnetically coupled circuits, Gauss Theorem, electric field and potential due to point, line, plane and spherical charge distributions, Ampere's and Biot Savart's laws; inductance, dielectrics, capacitance; Maxwell's equations.

Electrical and Electronic Measurements: Principles of measurement, accuracy, precision and standards; Bridges and potentiometers; moving coil, moving iron, dynamometer and induction type instruments, measurement of voltage, current, power, energy and power factor, instrument transformers, digital voltmeters and multi-meters, phase, time and frequency measurement, Q-meters, oscilloscopes, potentiometric recorders, error analysis, Basics of sensors, Transducers, basics of data acquisition systems

Computer Fundamentals: Number systems, Boolean algebra, arithmetic functions, Basic Architecture, Central Processing Unit, I/O and Memory Organisation; peripheral devices, data represenation and programming, basics of Operating system and networking, virtual memory, file systems; Elements of programming languages, typical examples.

Basic Electronics Engineering: Basics of Semiconductor diodes and transistors and characteristics, Junction and field effect transistors (BJT, FET and MOSFETS), different types of transistor amplifiers, equivalent circuits and frequency response; oscillators and other circuits, feedback amplifiers.

Analog and Digital Electronics: Operational amplifiers – characteristics and applications, combinational and sequential logic circuits, multiplexers, multi-vibrators, sample and hold circuits, A/D and D/A converters, basics of filter circuits and applications, simple active filters; Microprocessor basics- interfaces and applications, basics of linear integrated circuits; Analog communication basics, Modulation and demodulation, noise and bandwidth, transmitters and receivers, signal to noise ratio, digital communication basics, sampling,

quantizing, coding, frequency and time domain multiplexing, power line carrier communication systems.

Systems and Signal Processing: Representation of continuous and discrete-time signals, shifting and scaling operations, linear, time-invariant and causal systems, Fourier series representation of continuous periodic signals, sampling theorem, Fourier and Laplace transforms, Z transforms, Discrete Fourier transform, FFT, linear convolution, discrete cosine transform, FIR filter, IIR filter, bilinear transformation.

Control Systems: Principles of feedback, transfer function, block diagrams and signal flow graphs, steady-state errors, transforms and their

applications; Routh-hurwitz criterion, Nyquist techniques, Bode plots, root loci, lag, lead and lead-lag compensation, stability analysis, transient and frequency response analysis, state space model, state transition matrix, controllability and observability, linear state variable feedback, PID and industrial controllers.

Electrical Machines : Single phase transformers, three phase transformers - connections, parallel operation, auto-transformer, energy conversion

principles, DC machines - types, windings, generator characteristics, armature reaction and commutation, starting and speed control of motors, Induction motors - principles, types, performance characteristics, starting and speed control, Synchronous machines - performance, regulation, parallel operation of generators, motor starting, characteristics and applications, servo and stepper motors.

Power Systems : Basic power generation concepts, steam, gas and water turbines, transmission line models and performance, cable performance, insulation, corona and radio interference, power factor correction, symmetrical components, fault analysis, principles of protection systems, basics of solid state relays and digital protection; Circuit breakers, Radial and ring-main distribution systems, Matrix representation of power systems, load flow analysis, voltage control and economic operation, System stability concepts, Swing curves and equal area criterion. HVDC transmission and FACTS concepts, Concepts of power system dynamics, distributed generation, solar and wind power, smart grid concepts, environmental implications, fundamentals of power economics.

Power Electronics and Drives : Semiconductor power diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation, triggering

circuits, phase control rectifiers, bridge converters - fully controlled and half controlled, principles of choppers and inverters, basis concepts of adjustable speed DC and AC drives, DC-DC switched mode converters, DC-AC switched mode converters, resonant converters, high frequency inductors and transformers, power supplies.

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Basic Electronics Engineering: Basics of semiconductors; Diode/Transistor basics and characteristics; Diodes for different uses; Junction & Field Effect Transistors (BJTs, JFETs, MOSFETs); Transistor amplifiers of different types, oscillators and other circuits; Basics of Integrated Circuits (ICs); Bipolar, MOS and CMOS ICs; Basics of linear ICs, operational amplifiers and their applications-linear/non-linear; Optical sources/detectors; Basics of Opto electronics and its applications.

Basic Electrical Engineering: DC circuits-Ohm's & Kirchoff's laws, mesh and nodal analysis, circuit theorems; Electro-magnetism, Faraday's & Lenz's laws, induced EMF and its uses; Single-phase AC circuits; Transformers, efficiency; Basics-DC machines**,** induction machines, and synchronous machines; Electrical power sources- basics: hydroelectric, thermal, nuclear, wind, solar; Basics of batteries and their uses.

Materials Science: Electrical Engineering materials; Crystal structure & defects; Ceramic materials-structures, composites, processing and uses; Insulating laminates for electronics, structures, properties and uses; Magnetic materials, basics, classification, ferrites, ferro/paramagnetic materials and components; Nano materials-basics, preparation, purification, sintering, nano particles and uses; Nanooptical/magnetic/electronic materials and uses; Superconductivity, uses.

Electronic Measurements and Instrumentation: Principles of measurement, accuracy, precision and standards; Analog and Digital systems for measurement, measuring

instruments for different applications; Static/dynamic characteristics of measurement systems, errors, statistical analysis and curve fitting; Measurement systems for non-electrical quantities; Basics of telemetry; Different types of transducers and displays; Data acquisition system basics.

Network Theory: Network graphs & matrices; Wye-Delta transformation; Linear constant coefficient differential equations- time domain analysis of RLC circuits;Solution of network equations using Laplace transforms- frequency domain analysis of RLC circuits; 2-port network parametersdriving point & transfer functions; State equations for networks; Steady state sinusoidal analysis.

Analog and Digital Circuits: Small signal equivalent circuits of diodes, BJTS and FETs; Diode circuits for different uses; Biasing & stability of BJT & JFET amplifier circuits; Analysis/design of amplifier- single/multi-stage; Feedback& uses; Active filters, timers, multipliers, wave shaping, A/D-D/A converters; Boolean Algebra& uses; Logic gates, Digital IC families, Combinatorial/sequential circuits; Basics of multiplexers, counters/registers/ memories /microprocessors, design& applications.

Analog and Digital Communication Systems: Random signals, noise, probability theory, information theory; Analog versus digital communication & applications: Systems- AM, FM, transmitters/receivers, theory/practice/ standards, SNR comparison; Digital communication basics: Sampling, quantizing,coding, PCM, DPCM, multiplexing-audio/video; Digital modulation: ASK, FSK, PSK; Multiple access: TDMA, FDMA, CDMA; Optical communication: fibre optics, theory, practice/standards.

Control Systems: Classification of signals and systems; Application of signal and system theory; System realization; Transforms& their applications; Signal flow graphs, Routh-Hurwitz criteria, root loci, Nyquist/Bode plots; Feedback systems-open &close loop types, stability analysis, steady state, transient and frequency response analysis; Design of control systems, compensators, elements of lead/lag compensation, PID and industrial controllers.

Computer Organization and Architecture: Basic architecture, CPU, I/O organisation, memory organisation, peripheral devices, trends; Hardware /software issues; Data representation& Programming; Operating systems-basics, processes, characteristics, applications; Memory management, virtual memory, file systems, protection & security; Data bases, different types, characteristics and design; Transactions and concurrency control; Elements of programming languages, typical examples.

Electro Magnetics: Elements of vector calculus, Maxwell's equations-basic concepts; Gauss', Stokes' theorems; Wave propagation through different media; Transmission Lines-different types, basics, Smith's chart, impedance matching/transformation, S-parameters, pulse excitation, uses; Waveguides-basics, rectangular types, modes, cut-off frequency,

dispersion, dielectric types; Antennas-radiation pattern, monopoles/dipoles, gain, arrays-active/passive, theory, uses.

Advanced Electronics Topics: VLSI technology: Processing, lithography, interconnects, packaging, testing; VLSI design: Principles, MUX/ROM/PLA-based design, Moore & Mealy circuit design; Pipeline concepts & functions; Design for testability, examples; DSP: Discrete time signals/systems, uses; Digital filters: FIR/IIR types, design, speech/audio/radar signal processing uses; Microprocessors & microcontrollers, basics, interrupts, DMA, instruction sets, interfacing; Controllers & uses; Embedded systems.

Advanced Communication Topics: Communication networks: Principles /practices /technologies /uses /OSI model/security; Basic packet multiplexed streams/scheduling; Cellular networks, types, analysis, protocols (TCP/TCPIP); Microwave & satellite communication: Terrestrial/space type LOS systems, block schematics link calculations, system design; Communication satellites, orbits, characteristics, systems, uses; Fibre-optic communication systems, block schematics, link calculations, system design.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, Ellingham and phase stability diagrams, thermodynamics of surfaces, interfaces and defects, adsorption and segregation; basic kinetic laws, order of reactions, rate constants and rate limiting steps; principles of electro chemistry- single electrode potential, electro-chemical cells and polarizations, aqueous corrosion and protection of metals, oxidation and high temperature corrosion – characterization and control; heat transfer – conduction, convection and heat transfer coefficient relations, radiation, mass transfer – diffusion and Fick's laws, mass transfer coefficients; momentum transfer – concepts of viscosity, shell balances, Bernoulli's equation, friction factors.

Extractive Metallurgy: Minerals of economic importance, comminution techniques, size classification, Flotation, gravity and other methods of mineral processing; agglomeration, pyrohydro- and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals – aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making – principles, role structure and properties of slags, metallurgical coke, blast furnace, direct reduction

processes, primary and secondary steel making, ladle metallurgy operations including deoxidation, desulphurization, sulphide shape control, inert gas rinsing and vacuum reactors; secondary refining processes including AOD, VAD, VOD, VAR and ESR; ingot and continuous casting; stainless steel making, furnaces and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers, structure of surfaces and interfaces, nano-crystalline and amorphous structures; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, cast iron and aluminum alloys; surface treatments; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; industrial ceramics, polymers and composites; electronic basis of thermal, optical, electrical and magnetic properties of materials; electronic and opto-electronic materials.

Mechanical Metallurgy: Elasticity, yield criteria and plasticity; defects in crystals; elements of dislocation theory – types of dislocations, slip and twinning, source and multiplication of dislocations, stress fields around dislocations, partial dislocations, dislocation interactions and reactions; strengthening mechanisms; tensile, fatigue and creep behaviour; super-plasticity; fracture – Griffith theory, basic concepts of linear elastic and elasto-plastic fracture mechanics, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing – tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability.

Manufacturing Processes: Metal casting – patterns and moulds including mould design involving feeding, gating and risering, melting, casting practices in sand casting, permanent mould casting, investment casting and shell moulding, casting defects and repair; hot, warm and cold working of metals, Metal forming – fundamentals of metal forming processes of rolling, forging, extrusion, wire drawing and sheet metal forming, defects in forming; Metal joining – soldering, brazing and welding, common welding processes of shielded metal arc welding, gas metal arc welding, gas tungsten arc welding and submerged arc welding;

welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welded joints; powder metallurgy; NDT using dye-penetrant, ultrasonic, radiography, eddy current, acoustic emission and magnetic particle methods.

BIO-MEDICAL ENGINEERING

Basics of Human Physiology : Organization of Human Body, Muscle Physiology, Cardiovascular System, ECG, Einthoven's Triangle, Twelve Lead System and ECG Waveforms, Respiratory System,Blood,Alimentary System, Urinary System, Nervous System, Special Senses, Eyes ,Ear ,Reproductive System ,Endocrine System

Electrical Network Analysis and Synthesis : Review of D.C. & A.C. circuits, DC Circuits, Mesh & Node Analysis, Network Theorems (D.C. & A.C. circuits), Circuit Analysis, Time and Frequency Response of Circuits, Two-Port Networks, Fundamentals of Network Synthesis

Electronic circuit analysis and design: Diodes Circuits, Bipolar Junction Transistor, A.C. Equivalent Model, Junction Field Effect Transistor: Working and basic terminology related to JFET, MOSFET, and Multistage Amplifiers.

Biomaterials , Prosthetics and Orthotics: Introduction of Biomaterials, Classification of Biomaterials, General Applications, Techniques for characterization of Surface properties of Biomaterials, Properties and Applications of Polymeric and degradable Biomaterials, Composite Biomaterials, Properties and Applications of Metallic Biomaterials and its Biocompatibility, Properties and Applications of Ceramic Biomaterials, Biological Testing of Biomaterials, Movement biomechanics Overview of joints and movements, anatomical levers, gait cycle (stance and swing phase with stick diagram), gait parameters. Prosthetics and Orthotics Principles of three point pressure, Lower limb prostheses, partial weight bearing-PTB socket, total contact- quadrilateral socket. Upper limb prosthesis (terminal devices) Spinal orthoses.

Biomedical Transducers and Measuring Instruments : Generalized Instrumentation System, General Properties of Input Transducer. Static Characteristics: Accuracy, Precision, Resolution, Reproducibility, Sensitivity, Drift, Hysteresis, Linearity, Input Impedance and Output Impedance. Dynamic Characteristics: First Order and Second Order Characteristics, Time Delay, Error Free Instrument, Transfer Functions. Design Criteria, Generalized Instrument Specifications, Medical Instruments,Oscilloscopes,Displacement, motion and Pressure Measurement, Temperature Measurement, Bio potential Electrodes, Chemical Sensors,Fiber Optic Sensors, Biosensor: Classifications and types with examples.

Linear Integrated Circuits : Differential Amplifiers, Differential amplifiers with Swamping Resistor Constant current source, current mirror circuits, Introduction to operational Amplifier, Applications of operational Amplifier , Oscillators using Operational Amplifier,Negative Feedback, Negative feedback characteristics, Feedback Topologies, Series-Shunt, Shunt-Series, Series-Series, Shunt-Shunt Configurations Negative feedback amplifiers, Power Amplifiers.

Digital Electronics: Introduction to Number system, Binary, Octal, Hexadecimal and other. Conversion from One system to another, Binary, BCD and Hexadecimal. Binary Arithmetic (addition, subtraction, multiplication, division) Hexadecimal and octal arithmetic, first and second complement methods, Binary Codes, Boolean Algebra Logic Gates, Combinational Circuits, Combinational Logic Circuit Design, Use of Multiplexers in Logic Design, Sequential Logic Circuits,Registers

Signals and Control System: Introduction to Signals, Introduction to Systems, Fourier Analysis of Continuous time Signals Orthogonal functions, Representation of signals in terms of weighted orthogonal basis functions, Coefficient calculation on the basis of minimum square error. Fourier series: Representation of Fourier series in terms of sine, cosine, exponential functions. The complex Fourier spectrum, Properties of Fourier series, convergence of Fourier series, Gibbs phenomenon. Fourier transform and its properties. Fourier transform of singular functions. Energy density spectrum Laplace Transform,Introduction to Control Systems, Time domain and Frequency domain behaviour of Systems Time domain analysis of first order and second order systems. Condition of BIBO stability in time domain. Frequency response of linear systems. Stability and Routh array, Bode plots, Root Locus

Biomedical Instrumentation-I: Basic principle, technical specification, working and applications of Laboratory Instruments:Spectrophotometer,Colorimeter Electrolyte Analyser Blood cell counter Auto-analyser Blood gas analyser Basic principle, technical specification, working and applications of Laboratory Instruments, Blood Flow Measurement, Pulmonary Function Analyser and Ventilator, Heart Lung machine and types of artificial oxygenator, Audiometers, Introduction to Microprocessor, Architecture of Intel 8086 Microprocessor, Instruction set and Programming of 8086, 8086 Addressing modes,8086 Instruction encoding formats and instruction set, Assembler directives, 8086 programming and debugging of assembly language program, Memory Interfacing with 8086, Peripherals interfacing with 8086, 8087 Math coprocessor

Analog and Digital Circuits Design : Waveform Generation IC's,Special Function IC's, Active Filters, KRC filter, Capacitor filter, switched capacitor filter, Generalized Impedance Convertor (GIC), Power Devices and Circuits,SCR's: Basic structure, characteristics, Two transistor and Operations. series and parallel connections of SCRs.,DIAC and TRIAC: Basic Structure and characteristics, applications, UJT, Voltage Controllers and Regulators ,Analog switches, Relays ,Types of voltage regulators, Motors And Drivers

Biomedical Digital Signal Processing :Basic Elements of DSP concepts of frequency in analog and digital signals –sampling theorems –Discrete time signals and systems-Properties –Z-transform- linear & circular convolution- Correlation –DTFT,Introduction to DFT-Properties of DFT,Introduction DIT and DIF FFT algorithms. Use of FFT in linear filtering, Discrete Cosine transforms,Review of Design of analog Butterworth and Chebyshev Filters, Frequency transformation in analog domain, Design of IIR Digital Filters using Impulse invariance method-Design of digital Filters using Bilinear transformation, Structure of FIR filters-Linear phase filters –Filter design using window technique- Frequency sampling techniques –Finite Word length effects in digital filters. Realisation of FIR &IIR filters Direct ,cascade and parallel forms Introduction to Digital signal Processors–Architecture –Features-addressing formats –functional mode-introduction to commercial Processors. Application of DSP in Biomedical Applications

Principles of Communication Engineering: Introduction to communication system, Elements of communication system, types of communication system, Noise, Signal to Noise ratio, Noise factor, Noise figure, Noise Temperature. Amplitude Modulation, AM Receiver, AM detectors, FM Modulation, FM demodulation, Analog Pulse Modulation Techniques, Digital Pulse Modulation and Transmission Techniques, Multiplexing techniques, Generation of Bioelectric Potentials, Biofeedback Technique: EEG, EMG, Patient Monitoring System, Biotelemetry, Telemedicine concepts and its application

Biostatistics : Physiological Modelling, Model of Neurons, Neuromuscular System, Eye Movement Model, Thermo regulatory systems, modelling of other physiological systems, Modelling the Immune response, Modelling of Drug delivery systems, Modelling of Insulin Glucose feedback system and Pulsatile Insulin secretion

Microcontrollers and Embedded Systems : Embedded Systems, MCS-51 Microcontroller,8051programming,Microcontroller design and interfacing case studies, Interfacing with PC using RS232, Serial Communication Protocols, Real time operating

system

Medical Imaging-I: Ultrasound in Medicine,Display System ,Real time Ultrasound ,X- ray Imaging,Flouroscopic Imaging and x ray Image Intensifier Digital subtraction Angiography, Computed Radiography and Digital Radiography ,Mammography, Medical Thermography,Endoscopy.

Digital Image Processing : Basics of Image Processing, Image Enhancement, Image Segmentation, Image Transforms, Image Compression, Morphology, Representation and Description: Dilation, Erosion, Open, Close, Hit- or-miss, Boundary extraction, Region filling, Thinning and thickening Chain Codes, Polygonal approximations, Signatures, Fourier descriptors, Moments.

Biomedical Instrumentation=II: Physiotherapy, Electrotherapy Equipments: Basic principle, working and technical specifications of Shortwave Diathermy, Ultrasonic therapy unit, Infrared and UV lamps, Nerve and Muscle Stimulator.Surgical Instruments,Cardiac Pacemakers,Cardiac Defibrillators, Hemodialysis Machine, Laser Applications in Biomedical Engineering .

Medical Imaging-II:Principle of Computed tomography :Scanner configurations/generations, CT system: Scanning unit(gantry), detectors, data acquisition system, spiral CT, scanner parameters, CT Number Reconstruction ,techniques, Radon Transform, Filtered Back projection, Fourier Reconstruction, Technique, Iterative reconstruction Technique, Image quality and artifacts, Clinical applications of CT, Advancements in CT, Nuclear Magnetic Resonance, Magnetic Resonance Imaging, Magnetic Resonance Spectroscopy (MRS).

Biomechanics Prosthesis and Orthosis : BIOMECHANICS: Force system, Tissue Biomechanics, Movement Biomechanics, Joint analysis: Instrumentation for gait analysis: Measurement devices. PROSTHETICS AND ORTHOTICS : Principles in designing orthoses and prostheses, Principles of three point pressure, total contact, partial weight bearing, Classification in prosthetics and orthotics: Lower Extremity orthoses andprostheses, Upper Extremity orthoses and prostheses. Spinal orthoses.

Very Large Scale Integrated Circuits : Introduction to VHDL hardware description language, core features of VHDL, data types, concurrent and sequential statements, data flow, behavioral, structural architecture. Architecture of Xilinx XC4000 FPGA family, Combinational and Sequential Logic design using VHDL ,Very Large Scale Integration

(VLSI) Technology , MOS Transistors, Design rules and Layout NMOS and CMOS design rules and layout, Design of NMOS and CMOS inverters, NAND and NOR gates. Interlayer contacts, butting and buried contacts, stick diagrams, layout of inverter, NAND and NOR gates. Design of basic VLSI circuits Design of circuits like multiplexer, decoder, priority encoder, Flip flops, shift registers using MOS circuits

Networking and Information System in Medicine :LAN, MAN, WAN, Performance of network/device parameters ,Ethernet Technology: Ethernet types, Types of cables and connectors, Crossover and straight through cables, Colour coding of cables : OSI Model, TCP/IP, Addressing types (IP, MAC & Port), IP V4 addressing, Basic Security Concepts, PACS Components, Generic workflow, PACS architectures, Introduction to RIS and HIS, HIS/RIS/PACS integration, PIR, Storage Area Network, Network Attached storage, RAID, PACS Server & Archive and operating systems,Introduction to Healthcare informatics standard HL7 and DICOM, IHE, IHE Domains, Legal issues in PACS, HIPAA.

Nuclear Medicine : Basics of Nuclear Physics, Radiopharmaceuticals, Radiation Safety, Detectors in Nuclear Medicine & Counting and Measuring System, In Vitro techniques(Brief Description): Introduction, Single and Double Isotope method, Radioimmunoassay, RIA Counting System, Liquid scintillation Counting system, RIA, Applications.: In Vivo Techniques, Emission Tomography ,Introduction to Hybrid Modalities, Radionuclide Therapy

Biomedical Microsystems : Basics of miniaturization & materials, mems fabrication processes, polymers coating techniques: spinning, spraying and electrode position, photolithography, etching processes , soft lithography, surface characterization techniques, micro total analysis systems (μtas) ,micro/ nano biosensors, drug delivery devices ,microsystem packaging .

Hospital Management : Process of management, organization of the hospital & Hospital Planning, Planning for Clinical and Supportive Services ,Planning for Engineering and Auxiliary Services, Auxiliary Services ,Management Marketing Department, Material Management & Inventory Control Classification of Materials, Purchase Management, Store Management, Inventory Control.

Mains Examination (Part II) – English

This test is a qualifying test and is to be designed to assess the working English knowledge, efficiency and expression of English and Report Writing abilities. Accordingly, the Question paper, suggestively, may have Essay, Précis-writing, comprehension, case analysis & Report writing.

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