Ph.D / M.Tech by Res. ENTRANCE EXAMINATION - 2019

QUESTION PAPER FORMAT

#	TYPE	MAXIMUM MARKS
I	**WRITTEN**	
a	PART A – Research Methodology	50 Marks (25 Questions of 2 Marks Each)
b	PART B – Technical Paper	50 Marks (25 Questions of 2 Marks Each)
II	**VIVA-VOCE**	
c	PART C – Technical Interview	50 Marks

Ph.D / M.Tech by Res. Syllabus

PART A

EPHM001: RESEARCH METHODOLOGY
(COMMON TO ALL PROGRAMS)

I. Research:

Meaning, Objectives and Characteristics of Research, Types of Research , Research Process, Problem Statement, Literature Survey, Importance, Sources, Identifying Gap Areas, Development Of Working Hypothesis.

II. Hypothesis:

Variables, Development of Working Hypothesis, Deriving Objectives of Research, Sampling, Material and Methods, Data Analysis, Results and Discussion: Discussion, Purpose and Function of Discussion

III. Research Design:

Basic Principles; Features of Good Design, Methods; Developing a Research Plan,

Determining Experimental and Sample Designs, Summary and Conclusions, Abstract-Key Words; References; Citation Styles

IV. Report And Article Writing:

Structure and Components; Types of Report; Technical Reports and Thesis; Significance; Preparation; Layout, Structure and Language of Typical Reports; Presentation; Effective Communication. **Scientific Article Writing:** Title Preparation; List of Authors and Addresses, Abstracts; Economy of Words

V. Research Proposal Fundamentals:

Grant Proposal, Proposal Parts; Research Ethics, Relationship in Research Groups; Hazards to Good Scientific Practice; Scientific Misconduct, Intellectual Property Rights, Patents, Copyrights, Trademarks

PART B: TECHNICAL PAPER

EPHM002: BIOTECHNOLOGY

I. **Cell and Microbiology:**

Cell Structure. Cell Organelles and their function. Structure of biological membranes, membrane transport. Specific cell types: Blood cells – RBC, WBC, platelets, their structure and functions, Nerve cell, Muscle cells, Stem cells, Cancer cell biology. Organization of Chromosomes. Cell cycle: Cell division, mitosis and meiosis. Cell signalling.

Prospects of Microbial world: Bacteria, Virus, Fungi, Algae & Protozoa. Microbial nutrition: Nutritional classification of bacteria, Growth factors -sources of nutrients, Metabolic regulators. Techniques in Microbiology: Staining, Sterilization, disinfection and preservation methods.

II. Genetics and Molecular Biology :

Inheritance of Characters: Gregor Mendel's work and laws of heredity, Test cross, pedigree analysis. Gene interaction. Sex determination. Linkage. Sex-linked inheritance. Extra-chromosomal inheritance. Human Genetic disorders. Population genetics: Hardy Weinberg law. Genome organization. DNA and RNA structure. DNA replication, transcription and translation in prokaryotes and eukaryotes. Post transcriptional and post translational modifications. Regulation of gene expression in prokaryotes and eukaryotes. DNA recombination and repair. Mutations; Oncogenes and Tumor suppressor genes. Gene therapy. Human genome project. Other sequenced genomes. High-throughput analysis of genome function. Single nucleotide polymorphisms.

III. **Biochemistry and Analytical Instrumentation :**

Structure, composition and functions of Carbohydrates, lipids, proteins and nucleic acids. Protein structure and conformation. Bioenergetics and Metabolism of carbohydrates, lipids, proteins and nucleic acids, Enzymes: kinetics, regulation, inhibition.

Centrifugation Techniques, Chromatographic Techniques- General principles, TLC, column chromatography, HPLC, Adsorption chromatography, Partition chromatography, Ion exchange chromatography, Exclusion chromatography, GLC, Affinity chromatography.

Electrophoretic Techniques: General principles, Native gels, SDS-PAGE, IEF, 2D gel electrophoresis, Agarose gel electrophoresis, Pulse field gel electrophoresis, Capillary electrophoresis.

Spectroscopic techniques: UV/visible, fluorescence, circular dichroism, NMR, ESR spectroscopy, X-ray diffraction, mass spectrometry.

Radiolabeling techniques: Detection and measurement of radioisotopes, molecular imaging of radioactive material, safety guidelines.

Microscopic techniques: Light microscopy, scanning and transmission electron microscopy, fluorescent and confocal microscopy.

IV. **Immunology and Immunotechnology :**

Innate and adaptive immune system**:**Passive and active immunity, Cells & Organs of the Immune System, Antigens, antigenicity and immunogenicity, Structure and function of Immunoglobulins, Organization and Expression of Immunoglobulin Genes.

B cell & T cell responses: B-Cell generation, activation and differentiation, antigen - antibody interactions, Hybridoma technology and applications, The Complement System, Major Histocompatibility Complex (MHC). Antigen processing and presentation ,T-Cell Receptors, T-Cell Maturation, activation and differentiation. Cytokines, Cell-Mediated Responses, Leukocyte migration and inflammation, Hypersensitivity.

Immune System In Health And Disease**:** Immune response to infections-Bacterial, Viral, F ungal and Parasitic diseases, Immunodeficiencies, Autoimmunity, Immunosuppression, Transplantation Immunology, Cancer and Immune system. Vaccines.

Immunotechniques**:** Antigen – Antibody Reactions, Affinity, Avidity, Cross-Reactivity, Precipitation Reactions, Agglutination Reactions, Radioimmunoassay, Enzyme-linked Immunosorbent Assay, Western Blot, Immunoprecipitations, Immunofluroscence, Flow Cytometry, Fluorescence, Immunoelectron Microscopy.

V. Genetic Engineering:

Tools of recombinant DNA technology. Isolation, purification and analysis of genomic and plasmid DNA. Molecular cloning. Construction of genomic and cDNA libraries. Polymerase chain reaction. DNA sequencing. Marker techniques: RAPD, RFLP. Blotting: Southern, Northern and Western Blotting. Transgenic organisms.

VI. Bioprocess Technology:

Process Calculations And Thermodynamics: Laws of conservation of mass and energy; recycle, bypass and purge calculations; degree of freedom analysis. Laws of Thermodynamics, Thermodynamic properties of pure substances, properties of mixtures: partial molar properties, fugacity, chemical reaction equilibria.

Fluid Mechanics And Mechanical Operations :Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, friction factors, energy balance, dimensional analysis, shell balances, flow meters, pumps and compressors, packed and fluidized beds, boundary layer theory, settling and sedimentation, filtration, mixing and agitation.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's laws, molecular diffusion in fluids and gases, Mass transfer resistance, oxygen transfer coefficients ,mass transfer coefficients, Theories of mass transfer; design and operation of equipment for distillation using Mccabe and Thiele methods, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering : Theories of reaction rates; kinetics of homogeneous and heterogenous reactions, interpretation of kinetic data, single and multiple reactions in ideal and non ideal reactors; residence time distribution.

Instrumentation And Process Control: Measurement of process variables; sensors, transducers and their dynamics, transfer functions and dynamic responses of simple systems, controller modes (P, PI, and PID); control valves; stability, frequency response and controller tuning.

VII. Upstream and Downstream processing Technology:

Sterilization and inoculums development. Fermentation processes. Microbial, Plant and animal cell culture techniques. Preservation and improvement of industrially important microorganisms. Bioreactors. Media preparation and optimization. Growth kinetics and fermentation.

Downstream processing of biologicals: – size, stability, properties; purification methodologies, Separation of cells, foam separation, flocculation, filtration, plate filters, rotary vacuum filter, centrifugation, Stokes law, basket centrifuge, bowl centrifuge, disintegration of microorganisms, mechanical and non-mechanical methods, membrane filtration, ultra filtration and reverse osmosis, chromatographic techniques, absorption, spray drier, drum dryers, freeze dryers. Product Resolution/Fractionation. Analysis of the final product. final product formulations, Final product fill, Freeze-drying.

Microbial products: Microbial production of vitamins, enzymes, organic acids, amino acids, antibiotics, ethanol.

VIII. Bioinformatics and Biostatistics:

Genome sequencing projects. Biological Databases. Sequence alignment, gene and promoter prediction, Phylogenetic Tree Construction Methods and Programs ,functional and comparative

genomics. Protein Structure Visualization, Comparison, and Classification. Homology modelling.

Types of statistical data, errors in data calculation. Statistical data analysis. Normal, binomial and Poisson distribution. Goodness of fit. Presentation of experimental data.

IX. Environmental and Agricultural Biotechnology :

Environmental Pollution, Sources and Control Biotechnology and environmental protection, Wastewater and solid waste treatment by physical, chemical and biological processes, Bioremediation: concepts, strategies and applications. Energy from waste. Application of Biotechnology in environmental management.

Microbes for sustainable agriculture: Biological nitrogen fixation, Biofertilizers, Biological control, Biopesticides.

Applications of plant transformation technology in agriculture**.** Transgenic plants for beneficial traits. Biosafety in plant genetic engineering. Antisense RNA technology.

EPHM003: COMPUTER SCIENCE AND ENGINEERING

I. Maths for CS:

Discrete Mathematics: Propositional and first order logic. Sets, relations, functions, partial orders and lattices. Groups. Graphs: connectivity, matching, coloring. Combinatorics: counting, recurrence relations, generating functions.

Linear Algebra: Matrices, determinants, system of linear equations, eigenvalues and eigenvectors, LU decomposition.

Calculus: Limits, continuity and differentiability. Maxima and minima. Mean value theorem. Integration.

Probability: Random variables. Uniform, normal, exponential, poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.

Graphs: Definition, walks, paths, trails, Connnected graphs, regular and bipartite. Cycles and circuits, Tree and rooted trees, Spanning trees, Eccentricity of a vertex, radius and diameters of graphs, Central graphs, Centre(s) of a tree, Hamiltonian and Eulerian graphs, Planar graphs

Groups: Finite fields and error correcting/detecting codes

II. Theory of Computation:

Computability: Models of computation – finite automata, Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and contex-free languages, pumping lemma. Turing machines and undecidability.

III. 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.

IV. Computer Organization and Architecture:

Propositional (Boolean) Logic, Predicate Logic, Well formed formulae, Satisfiability and Tautology

Logic Families: CMOS, Boolean Algebra, Minimization of Boolean functions, Flip-flops – types, race condition. Design of sequential and combinatorial circuits

Representation of Integers: Hex, Binary Decimal, 1s and 2s complement arithmetic, Floating Point representation

Machine Instructions, Addressing modes, ALU, data path and control unit, Instruction pipelining, memory hierarchy, caches, secondary storage, I/O – interrupts, DMA.

V. Programming:

Data structures – Arrays, Stacks, Heaps, Queues, Linked Lists, Trees, Graphs, Priority Queues

Procedural programming languages : Control structures, parameters passing, Recursion

Object oriented languages: class, object, inheritance, instantiation, polymorphism, overloading

VI. Database Design:

ER Diagrams and their transformation to relational design, Normalization, Tuple Calculus

Fields, Records and Files, Hashing, inverted lists, multi-lists, indexes, B and B+ trees.

Transactions and Concurrency control

VII. Computer Networks:

Network fundamentals – LAN, WAN, Wireless networks, Internetworks, Concept of Layering, Flow and error control techniques

Data Communication: Channel Capacity, transmission media

Internetworking: Switch/Hub, Bridge, Router, Gateways, Concatenated virtual circuits, Tunneling, Fragmentation, Firewalls

Routing: Virtual Circuits, Datagrams, Routing algorithms, Congestion Control

Network Security – Cryptography – Symmetric v/s asymmetric key. Authentication, Digital certificates, Firewalls

VIII. System Software and Compilers:

Loading, Linking, program relocatability, Linkage editing

Programming environments, Debuggers, Compilation and Interpretation, Phases of compilation, Context Free Grammars, Parsing and parse trees, Bottom up parsers, Top down parsers, Intermediate code generation, Code generation and optimization

IX. Operating Systems:

Memory managements: Virtual Memory, paging, fragmentation

Concurrency: synchronization, threads, critical sections, deadlocks

Scheduling: CPU and I/O scheduling,

Filesystems and I/O: Buffering, Filesystems metadata and data.

EPHM004: CIVIL ENGINEERING

I. Engineering Mathematics:

Matrix algebra, Systems of linear equations, Eigen values and Eigen vectors,

Definitions of probability, Conditional probability, Random variables; Descriptive statistics - Mean, median, mode and standard deviation, Numerical solutions of linear and non-linear algebraic equations, Newton's and Lagrange polynomials, Integration by trapezoidal and Simpson's rule.

II. Structural Engineering:

Bending moment and shear force in statically determinate beams, Simple stress and strain relationships, Theories of failures, Simple bending theory, flexural and shear stresses, Uniform torsion, buckling of column, combined and direct bending stresses; Statically determinate and indeterminate structures by force/ energy methods, Method of superposition, Analysis of trusses, beams, and frames, Displacement methods, Stiffness and flexibility methods of structural analysis.

Concrete - constituents, mix design, short-term and long-term properties; Rate analysis and standard specifications, Cost estimation, Project planning and network analysis - PERT and CPM; Working stress, Limit state design concepts, Design of RCC beams, slabs, columns & foundations.

Design of tension and compression members, Steel beams and beam- columns, column bases, Plastic analysis of beams and frames.

III. Geotechnical Engineering:

Index properties, Permeability, Seepage, Principle of effective stress, compaction, consolidation, Mohr's circle, stress paths, effective and shear strength parameters.

Sub-surface investigations, Earth pressure theories, Stress distribution in soils, Shallow foundations, effect of water table, Combined footing and raft foundation, Contact pressure, Settlement analysis in sands and clays, Deep foundations.

IV. Water Resources Engineering:

Properties of fluids, Continuity, momentum, energy, Potential flow, Laminar and turbulent flow, Flow in pipes, pipe networks, Concept of boundary layer and its growth; Forces on immersed bodies, Flow measurement in channels and pipes, Dimensional analysis and hydraulic similitude, Kinematics of flow, velocity triangles, specific speed of pumps and turbines, Channel Hydraulics.

Hydrologic cycle, precipitation, evaporation, infiltration, reservoir capacity, reservoir and channel routing, surface run-off models; Duty, delta, estimation of evapo-transpiration, Crop water requirements, Design of lined and unlined canals, head works, Types of irrigation systems, irrigation methods.

V. Environmental Engineering:

Quality standards, basic unit processes and operations for water treatment, Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water, Sewage and sewerage treatment, quantity and characteristics of wastewater, Primary, secondary and tertiary treatment of wastewater, effluent discharge standards, sludge disposal.

Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle energy recovery, treatment and disposal).

VI. Transportation Engineering:

Highway alignment and engineering surveys, Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments, Geometric design of railway track, Highway materials - desirable properties and quality control tests, Design of bituminous paving mixes, Design factors for flexible and rigid pavements, Distresses in concrete pavements.

Traffic studies on flow, speed, travel time, PCU, peak hour factor, parking study, accident study and analysis, statistical analysis of traffic data, fundamental relationships, Control devices, Types of intersections and channelization, Highway capacity and level of service of rural highways and urban roads.

VII. Surveying:

Principles of surveying, Errors and their adjustment, Maps , Distance and angle measurement - Levelling and trigonometric levelling, Traversing and triangulation survey, Total station, Horizontal and vertical curves, Photogrammetry, Remote sensing.

EPHM005: ELECTRONICS AND COMMUNICATION ENGINEERING

I. Engineering Mathematics:

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and Eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and

improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform

II. Networks:

Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

III. Electronic Devices:

Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, and resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, Basics of LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

IV. Analog Circuits:

Small Signal Equivalent circuits of diodes, BJTs, MOSFETs and analog CMOS. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential and operational, feedback, and power. Frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits, 555 Timers. Power supplies.

V. Digital Circuits:

Boolean algebra, minimization of Boolean functions; logic GATEs; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinatorial circuits: arithmetic circuits, code converters, multiplexers, decoders, PROMs and PLAs. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

VI. Signals and Systems:

Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, DFT and FFT, z-transform. Sampling theorem. Linear Time-Invariant (LTI) Systems: definitions and properties; causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay. Signal transmission through LTI systems.

VII. Control Systems:

Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.

VIII. Communications:

Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density. Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Fundamentals of information theory and channel capacity theorem. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwidth consideration and probability of error calculations for these schemes. Basics of TDMA, FDMA and CDMA and GSM.

IX. Electromagnetics:

Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin

depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; S parameters, pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Basics of propagation in dielectric waveguide and optical fibers. Basics of Antennas: Dipole antennas; radiation pattern; antenna gain

EPHM006: ELECTRICAL AND ELECTRONICS ENGINEERING

I. **Electric Circuits and Networks**:

Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: Thevenin's, Norton's and Superposition and Maximum Power Transfer theorems, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks, three phase circuits.

II. **Electronic Devices**:

Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, and resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, Basics of LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

III. **Analog Circuits**:

Small Signal Equivalent circuits of diodes, BJTs, MOSFETs and analog CMOS. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential and operational, feedback, and power. Frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits, 555 Timers. Power supplies. 6. Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinatorial circuits: arithmetic circuits, code converters, multiplexers, decoders, PROMs and PLAs. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

IV. Signals and Systems:

Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, DFT and FFT, z-transform. Sampling theorem. Linear Time-Invariant (LTI) Systems: definitions and properties; causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay. Signal transmission through LTI systems.

V. Control Systems:

Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.

VI. Electromagnetics:

Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; S parameters, pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Basics of propagation in dielectric waveguide and optical fibers. Basics of Antennas: Dipole antennas; radiation pattern; antenna gain.

VII. Electrical Machines:

Single phase transformer -equivalent circuit, phasor diagram, tests, regulation and efficiency; 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; three phase induction motors - principles, types, performance characteristics, starting and speed control; single phase induction motors; synchronous -performance, regulation and parallel operation of generators, motor starting, characteristics and applications; servo and machines stepper motors.

VIII. Power Systems:

Basic power generation concepts; transmission line models and performance; cable performance, insulation; corona and radio interference; distribution systems; per-unit quantities; bus impedance and admittance matrices; load flow; voltage control; power factor correction; economic operation; symmetrical components; fault analysis; principles of over-current, differential and distance protection; solid state relays and digital protection; circuit breakers; system stability concepts, swing curves and equal area criterion; HVDC transmission and FACTS concepts.

IX. Electrical and Electronic Measurements:

Bridges and potentiometers; PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meters; oscilloscopes; potentiometric recorders; error analysis.

X. 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.

EPHM007: MECHANICAL ENGINEERING

I. Engineering Mathematics

Linear Algebra: Matrix algebra; linear system of equations- eigen values and eigen vectors

Calculus:- Functions of single variable-limit, continuity, and differentiability; mean value theorems; indeterminate forms; evaluation of definite and improper integrals; double and triple integrals; partial derivatives, total derivatives; Taylor's series in one and two variables; maxima and minima; Fourier series; gradient, divergence and curl of vevectors; directional derivatives; line, surface and volume integrals; applications of Gauss, Stokes and Green's theorems.

Differential equations: First and Second order linear and non-linear equations; higher order linear differential equations with constant coefficients; Euler-Cauchy equation; initial and boundary value problems; Laplace transforms; solutions of heat, wave and Laplace equations;

Complex variables: Analytic functions; Cauchy-Riemann equations; Cauchy's integral theorem; Taylor and Laurent series.

Probability and Statistics: Definitions of probability; sampling theorems; conditional probability; mean, median, mode and standard deviation; random variables; binomial, Poisson and normal distribution.

Numerical Methods: Numerical solutions of linear and non linear algebraic equations; integration by trapezoidal and Simpson's rules' single and multi step methods for differential equations.

II. Thermodynamics and Its Applications to Engineering Systems:

Basic Concepts:- Thermodynamic system and their classification; types of system boundaries; Thermodynamic state and thermodynamic equilibrium; Thermodynamic processes; Concept of Temperature and Zeroth law of thermodynamics; thermodynamic definition of work ;mechanical displacement work for different quasi static processes; definition of heat; characteristics of heat and work.

First law of thermodynamics: First law for closed systems (control mass) undergoing cyclic and non cyclic processes; first law for steady state steady floe open systems(control volume); first law for unsteady flow open systems. Applications of first law for engineering systems.

Second Law of Thermodynamics: Limitations of first law; Direct and reversed heat engines; Thermal efficiency of a direct heat engine and Kelvin=Planck statement of second law; Coefficient of Performance of a reversed heat engine and Clasius statement of second law; Reversible (Carnot) heat engine; Absolute temperature scale and its importance.

Entropy: Clasius inequality and definition of entropy; entropy change for reversible and irreversible processes; principle of increase of entropy; entropy generation; Availability analysis for Power and refrigeration cycles.

III. Fluid Mechanics and Machinery:

Fluids and its Properties: Definition of a fluid; types of fluids; Fluid properties; absolute, gauge, atmospheric and vacuum pressures.

Fluid Statics: Pascal's law and pressure variation of fluid at rest; Total pressure and centre of pressure; Pressure on a an inclined plane submerged in a fluid; Buoyancy and floatation-equilibrium and stability; Manometry-Differentail manometers;

Kinematics of fluid flow: Methods of describing fluid flow; types of fluid flow; mass, momentum and energy equations for a control volume; local and convective acceleration of fluid motion; velocity potential and stream functions; types of fluid motion.

Fluid Dynamics: Euler's equation; Bernoulli's equation from Euler's equation; Bernoulli's equation for a real fluid; practical applications of Bernoulli's equation- Venturimeter, Orifice meter, Pitot tube; The momentum equation and its application; moment of momentum equation; flow through piupes; viscous flow of incompressible flows; laminar flow, critical velocity, Reynolda number; Relation between shear stress and pressure gradient; Stoke's law, Drag force; Hagen-Poiseuille equation; Boundary layer flow velocity boundary layer thickness, displacement thickness, momentum thickness; Turbulent flow through pipes-Darcy's friction factor; head loss in flows though a puipe- major head loss and minor head loss; other head losses; Velocity distribution in turbulent flow through a pipe; effects of surface roughness

Fluid Machinery : Definition and classification of turbomachines; Energy transfer in turbomachines- Euler turbine equation and its alternative form; Degree of reaction; effect of blade discharge angle and degree of reaction; efficiencies of a turbomachine; types of impellers for centrifugal compressor and effects of blade discharge angle; axial flow compressor velocity triangles for different degree of reaction; utilization factor and vane efficiency for a turbine-relation between utilization factor and degree of reaction; conditions for maximum utilization factor for impulse and 50 % axial flow turbines.

IV. Solid Mechanics

Basic Concepts: Characteristics of a force; System of forces; resultant of a system of forces; free body diagram; Equation of equilibrium – condition of equilibrium, equilibrium of a system of forces ;laws of equilibrium; principle of virtual work.

Kinetics of Particles: Rectilinear motion; motion under gravity; impulse and momentum equation; projectile motion;central force motion- Kepler's laws of planetary motion, Newton's law of gravitation.

Stress and Strain: Stress; strain; Poisson's ratio; Hooke's law; free body diagram; bar of varying cross section; elongation due to self weight; composite bars; stress-strain diagrams; mechanical properties of materials; elastic constant; volumetric strain; thermal stresses-composite section under thermal stress; temperature stress in compound bars; principal stress-stresses on a plane inclined to the direction of an applied force, stresses on an inclined plane subjected to two mutually perpendicular stresses, stresses on an inclined plane subjected to two mutually perpendicular normal stresses and shear stresses; Mohr's circle for plane stress and strain for biaxial stress; principal strains-Mohr's circle of strain; bending moment and shears force for beams; relationship between load intensity, shear force and bending moment, shear force and bending moment diagrams for beams; shear stresses in beams and thick circular tubes; shear stress distribution in beams of circular cross section; deflection of different types of beams ;Mohr's theorem beams; combined bending and torsion of beams-Principal stresses; shaft in series and parallel; taped circular shaft; energy method, unit load method; Euler's column theorem; vibration-types of vibration-free and forced vibrations; types of damping; single and multi degree of freedom systems; determination of natural frequency of using Rayleigh's energy method; torsional vibration; equivalent spring stiffness for springs in series and in parallel. analysis of viscous damped free vibrations of a single degree of freedom system; analysis of forced vibration of a single degree of freedom system subjected to a harmonic excitation; force transmitted to the foundation; theories of failure

V. Heat Transfer:

Introduction:- Different modes of heat transfer; Fourier's law of conduction and thermal conductivity of different materials; thermal diffusivity; Newton's law for convective heat transfer and convective heat transfer coefficient; free, forced and mixed convection heat transfer;

electro-magnetic radiation; Laws of Radiation - Stefan-Boltman law, Planck's law, Wien's displacement law;

Conduction: analysis of one dimensional steady state conduction in plane walls, one dimensional radial conduction in cylinders and spheres ; composite walls and concept of thermal resistance; one dimensional steady state conduction in fins of uniform cross section for very long fins and fins with insulated tip; efficiency and effectiveness of fins. Transient conduction in solids with negligible internal temperature gradients.

Convection: Basic concepts of convection – velocity and thermal boundary layers for flow over a flat plate; velocity and thermal boundary layer thicknesses for flow over a flat plate. Determination of local and average drag coefficients and total drag forces using the velocity profiles for flow over a flat plate; determination of the local and average heat transfer coefficients and the total heat transfer rate using the temperature profiles for flow over a flat plate; concepts for flow through surfaces- hydrodynamically developing and developed flow through a tube; relation between pressure drop and friction factor for laminar flow through a tube; thermally developing and thermally developed flow through a tube. Determination of heat transfer coefficient and rate of heat transfer from the thermally developed temperature profile for constant surface temperature and constant surface heat flux conditions. Free convection heat transfer from vertical and horizontal surfaces;

Condensation and Boiling Heat Transfer: Filmwise and drop wise condensation; film wise condensation on vertical and horizontal surfaces; condensation on horizontal tube banks; pool boiling regimes; critical heat flux in pool boiling.

Radiation: Radiation heat exchange between two parallel infinite black and gray surfaces; effect of thin radiation shields; radiation heat exchange between two finite surfaces- view factor; view factor algebra; radiation heat exchange in two and three zone enclosures.

VI. Material Science and Manufacturing:

Engineering Materials: Structure and properties of materials; Phase diagrams; heat treatment; stress-strain diagrams for engineering materials.

Casting, Forming and Joining Processes: Different types of castings; design of patterns, moulds and cores; solidification and cooling; riser and gating design; plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy, principles of welding, brazing, soldering and adhesive bonding.

Machining and machine Tool Operations: Mechanics of machining; basic machine tools; single and multi point cutting tools; tool geometry and tool materials; tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, design of jigs and fixtures;

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comporators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools.

VII. Measurement Science:

Introduction to Measurements: Fundamental methods, errors in measurement, uncertainty analysis; Standards of Length, Slip gauges-Wringing phenomena, Indian Standards (M-87, M-112); Transducers; Intermediate modifying devices; Terminating Devices

Methods of strain measurement: Force measurement, Proving ring, Torque measurement; Pressure Measurement and Temperature Measurement

Fundamentals of Geometrical Dimensioning and Tolerancing systems: Principle of inter changeability and selective assembly limits of size, Indian standards, geometrical dimensioning (ASME), Taylor principle of limit gauges, Wear allowance on gauges.

Comparators: Mechanical comparators, Optical Comparators, Electric and Electronic Comparators, Pneumatic Comparator

Form measurements: Angular measurements, Interferometer, Screw thread and Gear measurements, Tool makers microscope, Profile projector, Gear terminology.

Temperature Measurements: Temperature Standards and Definition, Thermometry Based on Thermal Expansion, Electrical Resistance Thermometry, Thermoelectric Temperature Measurement, Radiative Temperature Measurements, Physical Errors in Temperature Measurement

Pressure and Velocity Measurements: Pressure Concepts, Pressure Reference Instruments, Pressure Transducers, Pressure Transducer Calibration, Pressure Measurements in Moving Fluids, Modeling Pressure and Fluid Systems, Design and Installation: Transmission Effects, Fluid Velocity Measuring Systems

F**low Measurements:** Historical Background, Flow Rate Concepts, Volume Flow Rate through Velocity Determination, Pressure Differential Meters, Insertion Volume Flow Meters, Mass Flow Meters, Flow Meter Calibration and Standards, Estimating Standard Flow Rate.

VIII. Industrial Engineering & OR

Production Planning and Control, Inventory control: Forecasting models, aggregate production planning, scheduling, materials requirement planning. Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling; MRP and MRP-II; order control and flow control; routing, scheduling and priority dispatching; push and pull production systems, concept of JIT manufacturing system; logistics, distribution, and supply chain management; Inventory – functions, costs, classifications, deterministic and probabilistic inventory models, quantity discount; perpetual and periodic inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

Quality &Reliability Management: Quality – concept and costs, quality circles, quality assurance; statistical quality control, acceptance sampling, zero defects, six sigma; total quality management Reliability, availability and maintainability; distribution of failure and repair times; determination of MTBF and MTTR, reliability models; system reliability determination; preventive maintenance and replacement, total productive maintenance – concept and applications.

Statistical Process Control: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits)

Control Charts for Variables: Control Charts for X-Bar and R- Charts

Process Capability: The foundation of process capability, Natural Tolerance limits, cp – process capability index, cpk, pp – process performance index, summary of process measures.

Control Charts for Attributes: Binomial distribution, Poisson distribution (from the point of view of Quality control) Control Chart for Fraction Nonconforming, Control Chart for number Nonconforming, Control Charts for Nonconformities or Defects, Control Chart for Number of non-conformities per unit.

EPHM008: ARCHITECTURE

I. History of Architecture:

Pre-Historic styles, Ancient Civilizations -Egyptian, Mesopotamian, Greek and Roman Architecture in Europe – Early Christian, Byzantine, Romanesque, Gothic, Renaissance periods Indian Architecture- Vedic, Buddhist, Temple Architecture – Dravidian & Indo Aryan styles Islamic Architecture – Slave , Khilji, Tughlaq, Sayyid & Lodhi, Provincial, Mughal dynasty Colonial Architecture in India. Neo classical Architecture. Industrial Revolution, Bauhaus, Modern movement, Chicago school, Arts & Crafts Movement

II. Contemporary Architecture:

Works and influences of famous Architects- Le Corbusier, F. L. Wright, Mies van der Rohe, Walter Gropius, etc. Post modernism. Deconstructivism. Theories in Architecture. Architectural Criticism.

III. Elements And Principles Of Design:

Organizing principles, Principles of Visual composition, Generation of Forms, Character & Style in Architecture, Ornamentation.

IV. Planning:

Evolution of Town planning, Planning principles, Methods of Survey, Urbanization, Land use Development Plans, Urban & Regional Planning, Remote sensing techniques

V. **Housing:**

Housing Concepts. Timeline of Housing developments in India. Demographic, Socio-cultural, Economic growth factors. Affordability and Finance Institutions in India. Housing management for diverse sectors

VI. **Landscape Design:**

Theory of Landscape design. Landscape elements and Principles. Materials. Plant selection for varied uses.

VII. **Sustainability in Architecture:**

Sustainability concepts & terms. Climate Responsive Built forms. Waste Management. Intelligent buildings. Passive design strategies

VIII. **Environmental Studies:**

Types of Ecosystems. Hydrological cycle. Ecological Balance and Environmental quality. Environment Behaviour studies. Environmental Impact Assessment. Disaster Management. Energy systems & management.

IX. **Building Science & Technology:**

Advanced Building Materials & Techniques. Structural systems. Building Services -HVAC, MEP, IBMS. Fire & Safety. Energy efficient buildings

X. **Project Management:**

Network Techniques. PERT, CPM; Planning, Controlling & Scheduling of Projects. Supply Chain Management.

XI. **Professional Practice:**

Ethics & Code of Conduct; Architects Act; COA regulations; Building bye laws – NBC, Local and municipal bodies.

XII. **Computers In Architecture:**

Introduction to CAD; Application of MS OFFICE suite; Sketch up, PHOTOSHOP, 3DS Max

EPHM009: DESIGN

I. **Product Design:**

Product Semantics. Design for Delight. Product Service Systems. Design for Safety. Ergonomics

II. **Communication Design:**

Typography. Character Design. Principles of Animation. Basics of Photography and Videography..Information Design

III. **Interaction Design:**

UX/UI Principles. Implementation. Models & Mental Models. Modeling Users. Design Patterns.

IV. **Design History:**

Art & Craft Tradition. Industrial Revolution. Bauhaus. Design Theory.

V. **Element of Design & Principles of Design:**

Design Elements: Point, Line, Plane, Volume. Design Principles. Gestalt laws.

VI. **Design Thinking & Innovation (Creativity):**

Design Thinking Methods. Techniques for Creativity and Innovation. DPE Framework - Design, Play, Experience.

VII. **Environmental Studies:**

Types of Ecosystems. Hydrological Cycle. Ecological Balance and Environmental Quality. Environmental Behavioral Studies. Environmental Impact Assessment. Energy Systems and Management.

VIII. **Design Management:**

Managing ambiguity in design. Forming and Managing Design Teams. Design Project Management. Intellectual Property

IX. **Computing in Design:**

CAD. CAE

X. **Sustainability:**

Sustainability concepts. Design for Development. Design for Social Innovation. Design and the Capability Approach. Passive design strategies.

EPHM010: COMPUTER APPLICATIONS

I. **Mathematical Foundations in Computer Science:**

Discrete structures: Sets, relations, functions, pigeon hole principle, equivalence and partial orderings.

Graphs: connectivity, matching, colouring.

Probability: Random variables. Uniform, normal, exponential, Poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.

II. **Data Structures and Algorithms**:

Data Structures: Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

Algorithms: Asymptotic notations, searching, sorting, hashing. Algorithm design techniques: divide-and-conquer, greedy and dynamic programming. Graph search, minimum spanning trees, shortest paths.

III. **Computer Organization and Architecture:**

Representation of Integer: Octal, Hex, Decimal and Binary, 2's Complement and 1's complement arithmetic, Floating point representation. Boolean Logic, Predicate Logic, Well-formed formula (WFF), Satisfactory and tautology. Machine instructions and addressing modes. Memory hierarchy, I/O interface.

IV. **Operating Systems:**

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

V. **Database Systems:**

RDBMS: Relational model, E-R Diagram and their transformation to relation design, normalization -INF, 2NF and BCNF.

SQL: Data definition language(DDL) Data manipulation language (DML), Data control language (DCL), views, indexes, sequences, synonyms, data dictionary.

VI. **Software Engineering:**

Software Process, Modelling Languages, Requirement and feasibility analysis, Process Models, Planning and managing the project, Personal Software Process, Domain specific modelling, Software architecture and design patterns, Software reliability and testing techniques, Aspect oriented programming

VII. **Computer Networks**:

Network Basics: LAN technologies, Application layer protocols (DNS, SMTP, POP, FTP, HTTP), Flow and error control techniques, IPv4/IPv6, routers and routing algorithms (distance vector, link state), congestion control.

Network security: Authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls.

VIII. Current Trends and Technologies:

Parallel and Distributed Computing: Distributed system models, parallel virtual machine and message passing interface, clusters, computational grids and applications, internet cloud computing platforms.

Mobile Computing: Mobile Computing, Mobile Computing vs. wireless Networking, Mobile Computing Applications, Characteristics of Mobile computing, Structure of Mobile Computing Application, Basics of Wi-Fi.

Data Mining: Extraction models, Mining business data and large data sets, summarization, classification, regression, clustering.

Web Programming: HTML, Scripting basics, Client side and server-side scripting, Java Script-Object, names, literals, operators and expressions, events, windows, documents, frames, data types, built-in functions, Browser object model.

EPHM011: MANAGEMENT STUDIES

I. Finance & Economics:

Managerial Economics: Macro-economics, Demand/Supply analysis, Market structure; **Capital Budgeting Decision**: Capital Budgeting Decision, NCF estimation, DCF Techniques, Capital Rationing, Risk Analysis of Project Portfolios, capital Structures Decision, leverage decision, calculation specific cost of capital, WACC; **Security analysis and Portfolio Management**: Analysis and Valuation of Debt and Equity , Analysis of different securities, Fundamental and Technical Analysis, Efficient Market Hypothesis - Portfolio Management – CAPM, **Derivatives:** Mechanics , operation , delivery, margin, leverage and liquidity, Forwards, Price determinants, Options ,Black Scholes model, Binomial model, Execution and delivery process, SWAPS, Hedging; **International Financial Management**: International flow of Funds, BoP, International Monetary System, Markets for Foreign Exchange, Spot and Forward market, Market for currency futures and currency options, Hedging , International Investment decision, FDI, International Capital Budgeting , Channels of funds , Multilateral Development banks ,Instruments; **Mergers and Acquisitions:** M & A Theories ,valuation method, Evaluation of pre merger and post merger performance of merged or acquired entities, International M&A, Regulatory issues in Cross-border M&A. **Behavioural Finance**: Capital Markets Landscape: The size-Internationalization and Integration-Market Volatility, FIIs, Perfect Capital Markets, Irrelevance of Efficient Market Theory , Imperfect Substitutes, Noise Trading, Informational Imperfections, The Anatomy of Bubble, Behavioural Dynamics of Market- Beliefs -Biases , Styles of Investing-Socially Responsible Investing.

II. HR:

Introduction to HRM – Functions Of HRM- Recruitment, selection -Job Analysis - Meaning,

definition and purpose. Methods of job analysis: job analysis interviews, job analysis questionnaire, Hiring Process & Hiring decision -Nature of hiring: regular, temporary, full time, part time, apprentice, contractual, and outsourcing, Existing post or new post to be created, Need analysis, cost analysis and job analysis. Types of Hiring – internal and external Hiring; **Learning & Development**-Learning Theories, The Learning Process, Mental and Physical Processes. Training Needs Analysis: Meaning and significance of training needs, types and components of needs, Training implementation & Methods, Training Evaluation; **Human Capital & Knowledge Management** - From Physical Assets to Knowledge Assets, Organizational Perspectives on Knowledge Management, Multidisciplinary nature of KM, Drivers of KM, The Two Major Types of Knowledge, Why Is KM Important Today? KM for Individuals, Communities and Organizations, Future Challenges for KM; **Talent Management-** Talent Management System- Components and benefits of Talent Management System; creating TMS, challenges of TMS. Developing and Retaining Talent - Potential identification and development, integrating coaching, training and development with talent management, employee retention ; **Performance Management** - Methods ; **International HRM** - Models of IHRM Strategies for International Growth: Exploiting global integration-The logic of global integration; **Compensation & Benefits**-The Pay Model, Strategic Pay Policies, Strategic Perspectives of Pay, Strategic Pay Decisions, Best Practices vs. Best fit options; **Industrial relations** - approaches to industrial relations in India, collective bargaining, negotiations-types of negotiations - problem solving attitude, techniques of negotiation, negotiation process, essential skills for negotiation; **Conflict Management** - Understanding conflict, components, perspectives of conflict, types of conflict, models of conflict – Process and Structural Models, functional & dysfunctional conflict, relationship between conflict and performance in team, levels of conflict – intrapersonal, interpersonal, group & organizational conflicts, sources of conflict - intra-personal, interpersonal, group & organizational sources. Various approaches to handling conflict.

III. Marketing:

Marketing Management: Creating Customer Satisfaction and Loyalty, Identifying Market Segments and Targets, Consumer Markets, Dealing with Competition, Positioning; **Marketing Strategy:** Corporate, Business & Functional, strategy, opportunity Analysis, formulating Marketing Strategy for New Markets, Growth Markets, Mature and Declining Markets, New Economy; **Retail Marketing:** Choosing a Store Location, Merchandise Management and Pricing, Store management, Retailing Strategy; **Digital Marketing:** Marketing in digital era, Various Elements in Digital Landscape: SMM, SEO, SEM, Developing & Implementing Digital Strategies ;**Electronic commerce**: e-commerce business models, e-commerce advertising, retailing and services; **Web personalization**: Creating Web Personalization Strategy, Integrating Cross Channel Marketing into Web Personalization Strategy, Testing and Optimization; **Social media marketing** : Rules of Engagement of target audiences, Content marketing and micro blogging, Social Media Marketing Planning, Video Marketing & Social

Networks; **Brand management**: Brands and Brand Management, Identifying and Establishing Brand Positioning & Values Planning and Implementing Brand Marketing Programs Measuring and Interpreting Brand Performance Growing and Sustaining Brand Equity; **Consumer Behaviour**: tools for understanding Consumer Behavior Consumer research, Perception and Attention, Memory, Affect Decision Making, Judgment and Reasoning, Consistency & Dissonance, Social and Cultural Influences, Consumer Behavior and product, promotion, and price, Segmentation, Product Positioning, and Consumer Behavior, Branding, Diffusion and Experimentation, Promotion, Pricing, Green Marketing and social marketing, ethical issue in CB; **Sales & Distribution**: Types, Trends, Selling Process, Management of Sales Territory, Training and Evaluation of Sales force, Distribution Channel Management, **Services marketing**: Focus on the Customer ,Understanding Customer requirements, Aligning Service Design and standards ,Delivering and Performing a Service, Managing Service Promise, Service and the bottom line; **Supply chain management**: Frameworks, Designing the Supply Chain Network, Designing and Planning Transportation Networks, Sourcing and Pricing, Information Technology in the Supply Chain, Coordination in a supply chain

IV. **General Management:**

Strategic Management: Organizational Internal Analysis, Building Competitive Advantage Through Business Level Strategy, Corporate Level Strategy, Corporate Governance and Ethics;

Leadership: Theories of leadership; **IP**: Different kinds of IP, IP as a value creator; **Digital economy**: Components of Digital economy, Data inversion.

EPHM012: MATHEMATICS

I. **Analysis**:

Finite, Countable and Uncountable sets. Archimedian Property, Supremum and Infimum. Sequences and Series, Convergence, limsup, liminf, Bolzano-Weirstrass theorem, Continuity, Uniform Continuity, Differentiability, Mean-Value Theorem, L'Hospital 's Rule, Taylor's theorem, Maxima and Minima. Improper Integrals and their convergence, Partial derivatives, Maxima and Minima, Lagrange's Multipliers.

II. **Linear Algebra**:

Finite dimensional Vector Spaces, Linear transformations and their matrix representations, rank, systems of linear equations, Eigen values and Eigen vectors, Cayley-hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and Unitary matrices, Finite dimensional inner product spaces, Gram-schmidt orthonormalization process, Self-adjoint operators.

Linear and Partial Differential Equations: Introduction to differential equations, linear equations with variable coefficients, Euler's method. The Existence and uniqueness theorem, Homogeneous equations solutions, linear independence, Wronskian, Non-homogeneous equations: Method of undetermined coefficient and variation of Parameters. Power series solution: Legendre polynomial, Bessel mathematical mathematical function of the first kind and their properties.

Partial Differential Equations: Lagrange and Charpit's methods for soling first order PDE's. Classification of second order PDE's, general solution of higher order PDE's with constant coefficients.

III. **Probability and Statistics**:

Conditional Probability, Baye's theorem, Random Variable, Probability and Cumulative Density functions (PDF & CDF). Probability and Cumulative mean function (PMF &CMF), Moment generating function, theoritical distribution (Binomail, Poisson, Normal, Uniform and Hyper Geometric).

IV. **Complex Analysis**:

Analytic functions; Cauchy Reimann eqtions; Line integral, Cauchy's integral theorem and Integral formula; Taylor's series and Laurent Series; Residue theorem and its applications, Conformal mapping and applications, bi linear transformation.

V. **Graph-Theory**:

Graphs, Types of Graphs, Properties and applications of graphs, Matrix representation of graphs. Euler and Hamiltonian graphs, Isomorphic graphs. Trees, Properties of Trees, Pendent Vertices, Spanning Tree, Fundamental Circuits, Spanning tree in Weighted graph, Vertex Colouring, Chromatic number, Chromatic Polynomial, R- Critical graphs.

VI. **Finite Element Methods**:

Introduction to finite element methods, one and two dimensional bases functions-Lagrange and Hermite Polynomials elements, triangular and rectangular elements, Finite element method for one dimensional problem: Model boundary value problems, discretization of the domain, derivation of elemental equations and their connectivity, composition of boundary conditions and solutions of the algebraic equations.

VII. **Numerical Methods**: Solution of systems of linear equations using LU decomposition, Gauss elimination and Gauss-Siedel methods, Lagrane and Newton's interpolations, solution of polynomial and transcendental equations by Newton-Raphson method. Numerical integration by Trapezoidal rule, Simpson's rule, Numerical solutio of first order Ordinary differential equation by Euler's method and Fourth order Runge-Kutta method.

EPHM013: PHYSICS

Mathematical Physics: Linear vector space and matrices ; Vector calculus. Linear differential equations including partial differential equations; Complex analysis. Laplace transforms . Fourier analysis and transforms. basic ideas of tensors. Special functions

Classical Mechanics: Conservation laws; central forces, Centre of mass concept with application to systems of particles . Rigid body dynamics; moment of inertia tensor; Noninertial frames and pseudo forces; Variational principle; Lagrange's and Hamilton's formalisms; equation of motion, Cyclic coordinates. Poisson bracket. periodic motion, small oscillations, normal modes. Special theory of relativity – Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Solution of electrostatic and magnetostatic problems including boundary value problems. Dielectrics and conductors; Biot-Savart's and Ampere's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges;Electromagnetic waves and their reflection, refraction, interference, diffraction and polarization. Poynting vector, Poynting theorem, energy and momentum of electromagnetic waves; radiation from a moving charge.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle, Observables, operators and expectation values, Schrodinger equation and application to one, two and three dimensional potential problems - particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; time independent and dependent perturbation theory.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates and microstates; phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics – Maxwell – Boltzmann, Fermi-Dirac and Bose Einstein; Application to specific heat capacity of solids, black body radiation, Bose Einstein condensate and Fermi gas; first and second order phase transitions, critical point.

Atomic and Molecular Physics: Spectra of one- and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X- ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Semiconductor Physics: Intrinsic and Extrinsic semiconductors; pn junction – electric field and capacitance, rectification properties – mathematical treatment; Bipolar Junction Transistors, Field Effect Transistors , amplifier and oscillators

EPHM014: Ph.D ENTRANCE SYLLABUS - Chemistry

Physical Chemistry

Quantum mechanics : Postulates , Time dependent and time independent Schrödinger equations, Born interpretation, Particle in a box, Harmonic oscillator, Rigid rotor. Hydrogen atom: atomic orbitals. Multi-electron atoms: orbital approximation. Variation and first order perturbation techniques.
Chemical bonding: Valence bond theory and LCAO-MO theory. Hybrid orbitals. Applications of LCAO-MOT to H_2+, H_2 and other homonuclear diatomic molecules, heteronuclear diatomic molecules like HF, CO,NO, and to simple delocalized π– electron systems. Hückel approximation and its application to annular π – electron systems.
Group Theory: Point groups and character tables.
Spectroscopy :Origin of selection rules for rotational, vibrational, electronic and Raman spectroscopy of diatomic and polyatomic molecules. Einstein coefficients.
Relationship of transition moment integral with molar extinction coefficient and oscillator strength. Basic principles of nuclear magnetic resonance: nuclear *g* factor, chemical shift, nuclear coupling.
Chemical Thermodynamics: Laws of thermodynamics, Standard states. Thermochemistry. Thermodynamic functions and their relationships: Gibbs-Helmholtz and Maxwell relations, van't Hoff equation. Criteria of spontaneity and equilibrium. Absolute entropy. Partial molar quantities. Thermodynamics of mixing. Chemical potential. Fugacity, activity and activity coefficients. Chemical equilibria. Dependence of equilibrium constant on temperature and pressure. Non-ideal solutions.
Electrochemistry:Ionic mobility and conductivity. Debye-Hückel limiting law. Debye-Hückel-Onsager equation. Standard electrode potentials and electrochemical cells. Potentiometric and conductometric titrations.
Phase equilibria: Clausius-Clapeyron equation. Phase diagram of one component systems: CO_2, H_2O, S; two component systems: liquid-vapour, liquid-liquid and solid-liquid systems. Fractional distillation. Azeotropes and eutectics.
Statistical thermodynamics: microcanonical and canonical ensembles, Boltzmann distribution, partition functions and thermodynamic properties.
Chemical Kinetics: Transition state theory: Eyring equation, thermodynamic aspects. Potential energy surfaces and classical trajectories. Elementary, parallel, opposing and consecutive reactions. Steady state approximation. Mechanisms of complex reactions. Unimolecular reactions. Kinetics of polymerization and enzyme catalysis. Fast reaction kinetics: relaxation and flow methods. Kinetics of photochemical and photophysical processes.
Surface Chemistry: Physisorption and chemisorption. Langmuir, Freundlich and BET isotherms. Surface catalysis: Langmuir-Hinshelwood mechanism. Surface tension, viscosity. Self-assembly. Physical chemistry of colloids, micelles and macromolecules.
Macromolecules : Molar masses , kinetics of polymerization

Organic chemistry

Principles of Stereochemistry: Chirality and determination of absolute configurations of organic molecules with or without chiral centres. Homotopic, enantiotopic and diastereotopic atoms, groups and faces. Stereoselective and stereospecific synthesis. Conformational analysis of acyclic and cyclic

compounds. Geometrical isomerism. Configurational and conformational effects, and neighbouring group participation on reactivity and selectivity/specificity.
Reaction Mechanisms: Basic mechanistic concepts – kinetic *versus* thermodynamic control,. Nucleophilic and electrophilic substitution reactions (both aromatic andaliphatic). Addition reactions , Elimination reactions. Molecular rearrangements involving electron deficient atoms.
Reactive intermediates – Generation, stability and reactivity of carbocations, carbanions, carbenes, nitrenes, arynes and free radicals.
Organic Synthesis: Common named reactions and rearrangements**,** Synthesis, reactions, mechanisms and selectivity involving the following classes of compounds – alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, nitriles, halides, nitro compounds, amines and amides. Carbon-carbon bond formation through coupling reactions - Concepts of multistep synthesis - retrosynthetic analysis, strategic disconnections, synthons and synthetic equivalents. Umpolung reactivity , protection and deprotection of
functional groups. Selectivity in organic synthesis – chemo-, regio- and stereoselectivity. Concepts of asymmetric synthesis – resolution (including enzymatic),desymmetrization and use of chiral auxilliaries.
Pericyclic Reactions: Electrocyclic, cycloaddition and sigmatropic reactions. **Heterocyclic Compounds**: Structure, preparation, properties and reactions of furan,pyrrole, thiophene, pyridine, indole, quinoline and isoquinoline.
Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physicochemical properties of amino acids, chemical synthesis of peptides, structural features of proteins, nucleic acids, steroids, terpenoids, carotenoids, and alkaloids.
Organic Spectroscopy: Applications of UV-visible, IR, NMR and Mass spectrometry in the structural determination of organic molecules.
Principles of Green Chemistry: The twelve principles of Green Chemistry and their applications.

Inorganic Chemistry

Periodicity and concepts of acids and bases: Hard-Soft acid base concept, Non-aqueous solvents.
Main Group Elements: Hydrides, halides, oxides, oxoacids, nitrides, sulfides – shapes and reactivity. Structure and bonding of boranes, carboranes, silicones, silicates, boron nitride, borazines and phosphazenes. Allotropes of carbon. Chemistry of noble gases, pseudohalogens, and interhalogen compounds.
Transition Elements: Coordination chemistry – structure and isomerism, theories of bonding (VBT, CFT, and MOT). Jahn-Teller distortion. Electronic spectra of transition metal complexes: spectroscopic term symbols, selection rules, Orgel diagrams, charge-transfer spectra. Magnetic properties of transition metal complexes. Reaction mechanisms: kinetic and thermodynamic stability, substitution and redox reactions.
Inner transition elements: Periodic properties, spectra and magnetic properties. **Organometallic compounds**: 18-Electron rule; metal-alkyl, metal-carbonyl, metal-olefin and metalcarbene complexes and metallocenes. Types of organometallic reactions. Homogeneous and Heterogeneous catalysis .
Radioactivity: Decay processes, half-life of radioactive elements, fission and fusion processes.
Bioinorganic Chemistry: Ion (Na+ and K+) transport, oxygen binding, transport and utilization, electron transfer reactions, nitrogen fixation, metalloenzymes .
Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg's law, ionic crystals, structures of AX, AX2, ABX3 type compounds, spinels, band theory, metals and semiconductors.
Instrumental Methods of Analysis: UV-visible spectrophotometry, NMR and ESR spectroscopy, mass spectrometry. Chromatography including GC and HPLC. Electroanalytical methods- polarography, cyclic voltammetry, ion-selective electrodes. Thermoanalytical methods.
Nanomaterials : Classification, synthesis and properties.