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

QUESTION PAPER FORMAT

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<td>50 Marks (25 Questions of 2 Marks Each)</td>
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Ph.D / M.Tech by Res. Syllabus

PART A

EPHM001: RESEARCH METHODOLOGY
(COMMON TO ALL PROGRAMS)

I. Research:

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,
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:

II. Genetics and Molecular Biology:
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**:
Immune System In Health And Disease: Immune response to infections-Bacterial, Viral, Fungal and Parasitic diseases, Immunodeficiencies, Autoimmunity, Immunosuppression, Transplantation Immunology, Cancer and Immune system. Vaccines.

V. **Genetic Engineering**:
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:
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.
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.

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.

EPHM003: COMPUTER SCIENCE AND ENGINEERING

I. Maths for CS:
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.
Graphs: Definition, walks, paths, trails, Connected graphs, regular and bipartite. Cycles and circuits, Tree and rooted trees, Spanning trees, Eccentricity of a vertex, radius and diameters of graphs, Central graphs, Centres 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 context-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.


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

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II. **Networks**:


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III. **Electronic Devices**:


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IV. **Analog Circuits**:

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:**

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:**

II. **Electronic Devices:**

III. **Analog Circuits:**
IV. **Signals and 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 vectors; 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.

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 flow 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: Clausius 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-Differential 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 piipe- 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; tapered 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; comparators; 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-Wringer 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


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


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


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:


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:**

VI. **Landscape Design:**

VII. **Sustainability in Architecture:**

VIII. **Environmental Studies:**

IX. **Building Science & Technology:**

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:**
II. **Communication Design:**

III. **Interaction Design:**

IV. **Design History:**

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

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

VII. **Environmental Studies:**

VIII. **Design Management:**

IX. **Computing in Design:**
CAD. CAE

X. **Sustainability:**

**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**:


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.


**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.

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**EPHM011: MANAGEMENT STUDIES**

I. Finance & Economics:

**Managerial Economics:** Macro-economics, Demand/Supply analysis, Market structure;


II. HR:

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

III. Marketing:
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**:  

II. **Linear Algebra**:  
Partial Differential Equations: Lagrange and Charpit’s methods for solving first order PDE’s. Classification of second order PDE’s, general solution of higher order PDE’s with constant coefficients.

III. **Probability and Statistics:***


IV. **Complex Analysis:**

Analytic functions; Cauchy Reimann equations; 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:**


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, Lagrange and Newton’s interpolations, solution of polynomial and transcendental equations by Newton-Raphson method. Numerical integration by Trapezoidal rule, Simpson’s rule, Numerical solution of first order Ordinary differential equation by Euler’s method and Fourth order Runge-Kutta method.
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, Schrödinger 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**


**Chemical bonding**: Valence bond theory and LCAO-MO theory. Hybrid orbitals. Applications of LCAO-MOT to H2+, H2 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.


**Statistical thermodynamics**: microcanonical and canonical ensembles, Boltzmann distribution, partition functions and thermodynamic properties.


**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 and aliphatic). Addition reactions, Elimination reactions. Molecular rearrangements involving electron deficient atoms.

**Reactive intermediates** – Generation, stability and reactivity of carbocations, carbanions, carbenes, nitrilenes, arynes and free radicals.


**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, nitriles, sulfides – shapes and reactivity. Structure and bonding of boranes, carboranes, silicones, silicates, boron nitride, borazines and phosphazenes. Allotropes of carbon. Chemistry of noble gases, pseudohalogenes, and interhalogen compounds.


**Inner transition elements:** Periodic properties, spectra and magnetic properties. **Organometallic compounds:** 18-Electron rule; metal-alkyl, metal-carbonyl, metal-olefin and metalcarbene complexes and metalloccenes. 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.