Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal (M.P.)

Syllabus for Entrance Examination for Admission in Ph.D. Program

APPLIED PHYSICS

Mathematical Physics

Legendre, Bessel, Hermite, Laguerre and equations ; Physical applications, Generating function; Recurrence relation and orthogonal properties. Laplace and Fourier transforms and their applications. Solution of simultaneous linear equations, Gaussian elimination, pivoting, iterative method, matrix inversion. Numerical solution of ordinary differential equations, Euler's and Runge Kutta methods, predictor and corrector method. Elementary ideas of solutions of partial differential equations.BCC theory of Super-conductivity.

Electromagnetic Theory

Laplace and Poisson equations -- conductors and dielectrics -- boundary value problems -- Ampere's and Biot-Savart's laws -- Faraday's law -- Maxwell's equations -- scalar and vector potentials -- Coulomb and Lorentz gauges -- boundary conditions at interfaces -- electromagnetic waves -- interference, diffraction and polarization -- radiation from moving charges. Theory of Plasma state and application.

Quantum Mechanics

Application of Schodinger wave equation for particle in a box, linear harmonic oscillator and tunneling. Time independent perturbation method for non–degenerate and degenerate level and their applications , Normal Zeeman effect, first order Stark effect in Hydrogen atom, WKB method .

Solid state and semiconductor physics

Bloch theorem, Kronig-Penny model, origin of energy gap , Brillion zones, Number of possible wave functions per band, velocity of electrons according to periodic potential , Influence of electric field, effective mass, concept of hole.

Intrinsic and Extrinsic carrier concentration, Position of Fermi energy level , Carrier Drift, Variation of mobility with field strength-hot electron effect, Diffusion, carrier generation and recombination; Excess – carrier Lifetime, Continuity equation, Carrier density profile-diffusion length

Principle and working, characteristics and basic uses of following devices: FET, MOSFET, UJT, SCR, tunnel diode, Zener Diode, Solar cell, photo detector, LED and Quantum well structures. Magnetism and magnetic materials.

Nuclear and Particle Physics

Rutheford scattering -- basic properties of nuclei -- radioactive decay -- nuclear forces -- two nucleon problem -- nuclear reactions -- conservation laws -- fission and fusion -- nuclear models -- particle accelerators, detectors -- elementary particles -- photons, baryons, mesons and leptons -- Quark model.

Lasers and Fiber Optics

Laser rate equations: three- and four-level systems. Variation of laser power around threshold. Longitudinal and Transverse modes of laser cavity. Mode selection. Mode lasers. Single mode, multi mode, step index and graded index optical fibers, wave propagation through them. Pulse dispersion in optical fibers. Various losses in optical fibers. Fiber manufacturing processes: MCVD, PCVD, OVD and VAD and splicing of fibers, locking and Q switching. Ruby laser, Nd-YAG laser, Carbon di oxide laser, He-Ne laser, semiconductor Digital communication.

Electrodynamics

Maxwell's equations, boundary conditions for electric and magnetic fields, propagation of electromagnetic waves in air and ionized medium. Motion of charged particle in electromagnetic field: Uniform E and B fields, Nonuniform Fields, Diffusion across magnetic fields, time varying E and B fields.

Statistics & Research Aptitude

Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

National and international scenario of scientific research, literature reviewing, reference citation, scientific and research journals, impact valuation, research article and patent drafting, various scientific websites, abstracts.

CHEMISTRY

Physical Chemistry:
Structure of atom, Quantum Theory, Hydrogen atom, valence Bond and Molecular orbital theories, variation and perturbation-symmetry. Laws of Thermodynamics, enthalpy, entropy, free energy. Ideal & non ideal solutions. Phase component systems. Colligative properties. Electrochemical cells, electrolytic cells. Kinetic theory of gases. Rates of chemical reactions, collision and transition state theory, photochemical reactions, catalysis. Sloid state, Crystal system and lattices, miller planes, crystal defects, ionic crystals, metals. Nuclear chemistry. Colloidal state.VSEPR theory, uncertainty principle,Schrodinger's equation. Chemical Equilibrium : Free energy and entropy of mixing partial molar quantities, Gibbs-Duhem equation, equilibrium constant, temperature dependence of equilibrium constant.

Inorganic Chemistry:
Reactions of simple and industrially important compounds, boranes, carboranes, silicones, diamond and graphite. Hydrides and oxoacids of N,P,S and halogens. Boron nitride, borazines, phosphazenes. Xenon compounds. Haard soft acid base concept. Spinels.Characteristics of d and f block elements. Coordination chemistry. Theories of metal ligand bonding. Metal carbonyls. Chemistry of Lanthanides and Actinides : Spectral and magnetic properties; use of Lanthanide compounds as shift reagents.

Organic Chemistry:

Reactions, Synthesis and mechanism involving- Alkanes, Alkenes, Alkynes, Arenes, Alcohols, Phenols, Aldehydes, Carboxylic acids & their derivatives, Halides, Ketones, Nitro compounds, Amines. Stereochemical and conformational effects on reactivity and specificity. Heterocycles. Carbohydrates, Proteins, Nucleic acids. Bio molecules.
Aromaticity: Huckel rule and concept of aromaticity (n) annulenes and hetero annulenes, fullerenes (C_{60}).
Chemistry of natural products : Familiarity with methods of structure elucidation and biosynthesis of alkaloids, terpenoids, steroids, carbohydrates and proteins.

Analytical Chemistry:

Volumetric analysis, gravimetric analysis, TGA, Optical analytical methods, electro analytical methods, spectroscopic methods-UV, Vis, IR, NMR, ESR, Mass, X-ray diffraction techniques. Separation techniques. Chromatographic techniques. Electro analytical Techniques : Voltametry, polarography, amperometry, coulometry and conductometry.

Industrial Chemistry:

Industrial aspects of plastics, rubbers, ceramics, glass, inorganic acids HCl, H_2SO_4, H_3PO_4 etc.), corrosion, water, cement, fertilizers, alkalis and allied chemicals, pharmaceuticals, sugar, petrochemicals, pollution.

Statistics & Research Aptitude

Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

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APPLIED MATHEMATICS

Integral Transform:
Laplace Transform and Inverse Laplace Transform, Fourier Transform, Fourier Sine and Cosine Transform, Complex Fourier transform, Inversion formulae, linearity property, Change of scale property and shifting property, Fourier transform of derivatives, Parseval's identity. Application of Laplace and Fourier Transform, Definitions of Hankel transform, Mellin Transform, and their elementary properties.

Fourier Series & Vector Calculus:
Fourier Series: Euler's Formulae, Dirichlet's Conditions, Fourier Series for Continuous and Discontinuous Functions, Half-Range Fourier Series.
Vector Calculus: Gradient, Divergence & Curl, Vector Differentiation, Vector Integration (Line, Surface & Volume), Gauss-Divergence, Stoke's & Green Theorem.

Differential Equations:
Ordinary Differential Equations: Differential Equation of First Order and First Degree , first order and Higher degree , Linear Higher order Differential Equation with Constant Coefficient, Homogeneous Linear Differential Equations, Simultaneous Differential Equations.
Partial Differential Equation: Linear Partial Differential Equation of First Order, Non-Linear Partial Differential Equation of First Order, Homogeneous Linear PDE with Constant Coefficients, Application of Partial Differential Equations.

Numerical Analysis:
Error and Approximations, Solution of Algebraic and Transcendental Equations, Interpolation for equal and unequal intervals, Inverse interpolation. Numerical Integration and Numerical Differentiation, Numerical Solution of Simultaneous linear equations, Solution of ordinary differential equation using Numerical Methods.

Operations Research:
Introduction to Linear Programming, Solution by Graphical and Simplex Method, Concept of Degeneracy and Duality, Optimal Solution of Transportation Problems, Assignment Problems, Job Sequencing Problems.

Functions of Complex Variable:

Complex Function, Continuity, Differentiability, Analytic Function, Complex Integration, Cauchy's Integral Theorem, Cauchy's Integral Formula, Zero's & Poles, Complex Sequence, Series and Power, Taylor's and Laurent Series. Residue (Definition), Residue Theorem, Evaluation of Real Integral, Conformal Mapping.

Probability & Statistics:
Probability, Distributions (Binomial, Poisson, Normal), Random variables, Distribution function, Probability density function, Expectation, Moments, Moment generating

function, Test of Hypotheses, Level of significance, Small and Large sampling, Chi-Square test.

Coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

Functional Analysis:
Normed spaces: Basic definitions & properties, Examples of normed spaces, Banach space, Factor space as Banach space, Convergence and absolute convergence, Necessary and sufficient condition for completeness of a normed linear space, Linear operator, properties of linear operators, Dual space.

Linear Algebra:
Group, Sub group, co-sets, normal Sub group, Semi group, Ring and Fields, Vector spaces, Vector subspaces, Linear dependence and independence, Bases & Dimension, Linear transformations, The Algebra of linear transformation, Rank of a Linear transformation, Characteristic roots, Relation between characteristic roots and characteristic vectors. Metric Space.

Graph Theory:
Definitions, Sub Graph, Finite and Infinite Graphs, Incidence and Degree, Isolated Vertex, Pendant Vertex, Null Graph, Isomorphism, Sub graphs, Walks, Path and Circuits, Connected & Disconnected Graph, Components, Euler Graph, Operation of Graphs, Hamiltonian Path and Circuit. Tree, Decision, Rooted, Binary, Spanning Trees, Properties of trees.

Research Aptitude
National and international scenario of scientific research, literature reviewing, reference citation, scientific and research journals, impact valuation, research article and patent drafting, various scientific websites, abstracting services.

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BIOTECHNOLOGY

Microbiology:
Prokaryotic and eukaryotic cell structure; Microbial nutrition, growth and control; Microbial metabolism (aerobic and anaerobic respiration, photosynthesis); Nitrogen fixation; Chemical basis of mutations and mutagens; Microbial genetics (plasmids, transformation, transduction, conjugation); Microbial diversity and characteristic features; Viruses.

Biochemistry:
Biomolecules and their conformation; Ramachandran map; Weak inter-molecular interactions in biomacromolecules; Chemical and functional nature of enzymes; Kinetics of single substrate and bi-substrate enzyme catalyzed reactions; Bioenergetics; Metabolism (Glycolysis, TCA and Oxidative phosphorylation); Membrane transport and pumps; Cell cycle and cell growth control; Cell signaling and signal transduction; Biochemical and biophysical techniques for macromolecular analysis.

Molecular Biology and Genetics:
Molecular structure of genes and chromosomes; DNA replication and control; Transcription and its control; Translational processes; Regulatory controls in prokaryotes and eukaryotes; Mendelian inheritance; Gene interaction; Complementation; Linkage, recombination and chromosome mapping; Extrachromosomal inheritance; Chromosomal variation; Population genetics; Transposable elements, Molecular basis of genetic diseases and applications.

Process Biotechnology:
Bioprocess technology for the production of cell biomass and primary/secondary metabolites, such as baker's yeast, ethanol, citric acid, amino acids, exo-polysacharides, antibiotics and pigments etc.; Microbial production, purification and bioprocess application(s) of industrial enzymes; Production and purification of recombinant proteins on a large scale; Chromatographic and membrane based bioseparation methods; Immobilization of enzymes and cells and their application for bioconversion processes. Aerobic and anaerobic biological processes for stabilization of solid / liquid wastes; Bioremediation.

Bioprocess Engineering:
Kinetics of microbial growth, substrate utilization and product formation; Simple structured models; Sterilization of air and media; Batch, fed-batch and continuous processes; Aeration and agitation; Mass transfer in bioreactors; Rheology of fermentation fluids; Scale-up concepts; Design of fermentation media; Various types of microbial and enzyme reactors; Instrumentation in bioreactors.

Plant and Animal Biotechnology:
Special features and organization of plant cells; Totipotency; Regeneration of plants; Plant products of industrial importance; Biochemistry of major metabolic pathways and products; Autotrophic and heterotrophic growth; Plant growth regulators and elicitors; Cell suspension culture development: methodology, kinetics of growth and production formation, nutrient optimization; Production of secondary metabolites by plant suspension cultures; Hairy root cultures and their cultivation. Techniques in raising transgencies.

Characteristics of animal cells:
Metabolism, regulation and nutritional requirements for mass cultivation of animal cell cultures; Kinetics of cell growth and product formation and effect of shear force; Product and substrate transport; Micro & macro-carrier culture; Hybridoma technology; Live stock improvement; Cloning in animals; Genetic engineering in animal cell culture; Animal cell preservation.

Immunology:
The origin of immunology; Inherent immunity; Humoral and cell mediated immunity; Primary and secondary lymphoid organ; Antigen; B and T cells and Macrophages; Major histocompatibility complex (MHC); Antigen processing and presentation; Synthesis of antibody and secretion; Molecular basis of antibody diversity; Polyclonal and monoclonal antibody; Complement; Antigen-antibody reaction; Regulation of immune response; Immune tolerance; Hyper sensitivity; Autoimmunity; Graft versus host reaction.

Recombinant DNA Technology:
Restriction and modification enzymes; Vectors: plasmid, bacteriophage and other viral vectors, cosmids, Ti plasmid, yeast artificial chromosome; cDNA and genomic DNA library; Gene isolation; Gene cloning; Expression of cloned gene; Transposons and gene targeting; DNA labeling; DNA sequencing; Polymerase chain reactions; DNA fingerprinting; Southern and northern blotting; In-situ hybridization; RAPD; RFLP; Site-directed mutagenesis; Gene transfer technologies; Gene therapy.

Bioinformatics:
Major bioinformatics resources (NCBI, EBI, ExPASy); Sequence and structure databases; Sequence analysis (biomolecular sequence file formats, scoring matrices, sequence alignment, phylogeny); Genomics and Proteomics (Large scale genome sequencing strategies; Comparative genomics; Understanding DNA microarrays and protein arrays); Molecular modeling and simulations (basic concepts including concept of force fields).

Statistics & Research Aptitude
Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.
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CHEMICAL ENGINEERING

1. **Process Calculations and Thermodynamics:** Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis. First and Second laws of thermodynamics. First law application to close and open systems. Second law and Entropy Thermodynamic properties of pure substances: equation of state and departure function, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibria.

2. **Fluid Mechanics and Mechanical Operations:** Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

3. **Heat and Mass 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. Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage wise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption.

4. **Chemical Reaction Engineering:** Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time distribution, single parameter model; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

5. **Instrumentation and Process Control:** Measurement of process variables; sensors, transducers and their dynamics, transfer functions and dynamic responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves;

analysis of closed loop systems including stability, frequency response and controller tuning, cascade, feed forward control.

6. **Plant Design and Economics:** Process design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in design.

7. **Chemical Technology:** Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

8. **Statistics & Research Aptitude**

   Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

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CIVIL ENGINEERING

(A) Structural Engineering

Mechanics: Bending moment and shear force in statically determinate beams. Simple stress and strain relationship, Stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle. Simple bending theory, bending and shear stresses, combined and direct bending stresses, unsymmetrical bending, shear centre. Thin walled pressure vessels, torsion, torsional buckling, buckling of columns. Two dimensional problems in rectangular and polar coordinates

Structural Analysis: Analysis of statically determinate trusses, arches, beams, cables and frames, displacements in statically determinate structures and analysis of statically indeterminate structures by force or energy methods, and displacement methods (slope deflection and moment distribution methods), influence lines for determinate and indeterminate structures. Basic concepts of matrix methods of structural analysis. Compatibility equations. Finite element method, shape functions, isoparametric elements and its formulation numerical integration. Gaussian eliminations, Numerical Integration.

Structural Dynamics: Single Degree of freedom system, Multi degree of freedom system. Free and forced vibration, Response to harmonic excitation, Eigen value problem, Eigen vector.

Concrete Structures: properties of concrete, basics of mix design. Nondestructive testing of concrete, special concretes Concrete design- basic working stress and limit state design concepts, analysis of ultimate load capacity and design of members subjected to flexure, shear, compression and torsion by limit state methods. Water tanks, silos and bunkers. Basic elements of prestressed concrete, prestressing system and losses of prestressing.

Steel Structures: Basic limit state method, Analysis and design of tension and compression members, beams and beam- columns, column bases. Connections- simple and eccentric, beam column connections, plate girders and trusses. Plastic method of analysis of beams and frames.

(B) Geotechnical Engineering

Soil Mechanics: Origin of soils, soil classification, three-phase system, fundamental definitions, relationship and interrelationships, permeability & seepage, effective stress principle, consolidation, compaction, shear strength.

Foundation Engineering: Sub-surface investigations- scope, drilling bore holes, sampling, penetration tests, and plate load test. Earth pressure theories, effect of water table, layered soils. Stability of slopes-infinite slopes, finite slopes. Foundation types-foundation design requirements. Shallow foundations-bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands & clays. Deep foundations pile types, dynamic & static formulae, load capacity of piles in sands & clays, negative skin friction. Machine foundation

(C) Environmental Engineering

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

Air Pollution and Noise Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits. Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

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

(D) Water Resources Engineering

Fluid Mechanics and Hydraulics: Properties of fluids, principle of conservation of mass, momentum, energy and corresponding equations, potential flow, applications of momentum and Bernoulli's equation, laminar and turbulent flow, flow in pipes, pipe networks. Concept of boundary layer and its growth. Uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies, flow measurements in channels, tanks and pipes. Dimensional analysis and hydraulic modeling. Kinematics of flow, velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, unit hydrographs, flood estimation, reservoir capacity, reservoir and channel routing. Well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration. Crop water requirements. Design of: lined and unlined canals, waterways, head works, gravity dams and spillways. Design of weirs on permeable foundation. Types of irrigation system, irrigation methods. Water logging and drainage

(E) Transportation Engineering

Highway Planning: Geometric design of highways, testing and specifications of paving materials, design of flexible and rigid pavements.

Traffic Engineering: Traffic characteristics, theory of traffic flow, intersection design, traffic signs and signal design, highway capacity.

Surveying: Importance of surveying, principles and classifications, mapping concepts, coordinate system, map projections, measurements of distance and directions, leveling, theodolite traversing, plane table surveying, Electronic Distance measurement errors and adjustments, curves.

(F) Computer Applications

Basics of C and C++ programming, loops functions array, object oriented programming, 2D and 3-D Modeling software .

(G) Statistics & Research Aptitude

Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

National and international scenario of scientific research, literature reviewing, reference citation, scientific, engineering and research journals, impact valuation, research article and patent drafting, various scientific websites, abstracts.

Syllabus for Ph.D Entrance Test , RGPV.

Common for CSE/IT/CA

Algorithms: Algorithms and complexity; Combinatorics and graph theory; Geometric Algorithms, Parallel and Distributed Algorithms, Randomized Algorithms, Algorithms for Biometric Based Identification, Computational Biology, Bioinformatics and streaming data.

Computer Architecture : Embedded systems , Parallel and Distributed Computation, Embedded Computing Design ,Parallel Computing Structures , Parallel Algorithm for Array processors , Scheduling and load balancing in multiprocessor Systems , Multiprocessing control and algorithm, Real time and fault Tolerant Computing.

Computer Networks: Performance modeling, Routers and routing, analysis and design of wired and wireless networks, MAC sub layer, Wireless sensor networks: Implementation and verification of network security protocols, data management, communication and energy efficiency issues in Sensor Networks, Design of content distribution networks for data dissemination, Network algorithms, Quality of service protocols, Mobile Computing, Voice Routing, Voice over IP, RFID networks, Enterprise networks, Access and Broadband networks, Hyper media. Protocols, Network performance and analysis, IPv6, Internet Technologies, Cryptography, Biometrics ,Intrusion Detection System and Firewalls.

Software Engineering : Object oriented software development; Component architectures. Reengineering of software; systems analysis and design; MIS systems; Project management; Decision Support System , Quality assurance , Software Testing , Metrics and Models for Software Architecture, Software Fault Tolerance ,Quantitative approaches to project-and process management, Design Methodologies, Formal Specification .

Database Management Systems : Object oriented, temporal and parallel databases; Query optimization and transaction management; Real time databases systems, indexing multidimensional data, distributed database systems; data dissemination systems; data warehousing and mining . Integrated mining with relational DBMS, Temporal mining, Integrating mining with OLAP.

Specific to CSE

Artificial Intelligence & Soft Computing : Natural language processing , Machine Learning and Neural Networks, Fuzzy Systems, Pattern Recognition and Text Processing, Intelligent systems and their applications , Intelligent interfaces. Swarm Intelligence ,Genetic Algorithm . Robotics and Kinematics .

System Programming and Principles of Programming languages : Functional and logic programming languages, Theory of programming languages , Programming Environments, Translators for Declarative and Functional Languages, Analysis and implementation of functional and logic programming languages, Automatic Generation of Compilers, Compilers for Non conventional Architectures, Code Optimization, Theory of code optimization; Optimizing and parallelizing compilers , Complexity Theory, Logic in Computer Science, Algorithmic information theory, Computational number theory, Applications of grid Computing

Computer Graphics : Computer Vision and Image Understanding ,Computer aided graphics design, High Performance computing, Visualization; Rendering, Image and video retrieval; motion capture; point based methods ,Virtual Reality

Operating Systems: Processes, Interprocess communication, Memory management, Concurrent processing, synchronization, Scheduling, File systems, Protection and Security, Distributed Operating System. Real time operating System, Network Operating System .

Simulation & Modelling: Statistical independence, Bernoulli Process, Renewal Process, Random Incidence, Markov Modulated Bernoulli Process, Irreducible Finite Chains with Aperiodic States, Discrete-Time Birth-Death Processes, Markov property, Finite Markov Chains, Continuous time Markov chain, Hidden Markov Model. Characteristics of queuing system, poisson's formula, breadth-death system, equilibrium of queuing system, analysis of M/M/1 queues, FSM, Petri-net Model.

Web Engineering :Web Engineering Models, Web Servers , Architecture of browser and search engines, Web Security issues , security audit of websites , web effort estimation , productivity ,Measurement , Quality usability and reliability ,Semantic web, Ontology .XML , HTML , DHTML, SGML .

Specific to IT

Web technology & E Commerce: Electronic Commerce and physical Commerce, Different type of e-commerce, e-commerce scenarios, advantages of e-commerce. Business models: Feature of B2B e-commerce, Business models, Integration. E-Services: category of e-services, Web- enabled services, Matchmaking services, information-selling on the web. Internet payment system , SET Protocol for credit card payment , E-Governance ,WAP Architecture.

Information Theory Coding : Information Measures, Review probability theory, Random variables, Processes, Mutual Information, Entropy, Uncertainty, Shannon's theorem, redundancy, Huffman Coding, Discrete random Variable. Gaussian random variables, Bounds ,Linear block codes , cyclic codes ,BCH codes , Reed-Solomon codes, space time codes, concatenated codes, turbo coding and LDPC codes .

Mobile & Pervasive Computing: Mobile computing , Adaptability , Mobility Management ,Context –Aware Computing and its applications , Introduction to Ad Hoc and Sensor Networks , Approaches to Security

Data Mining: Data integration models and algorithms, Graphical models, Information extraction and retrieval, Forecasting and smart e-business, Sensor and Bioinformatics data mining, Text and Web data mining.

Multimedia and Animation : High Performance computing; Visualization; Rendering; Animation; Image and video retrieval; motion capture; point based methods.

Middleware Technologies: Exposure to Markup languages, HTML,DHTML, VRML, SGML, XML etc. CGI, Applets & Servlets , Distributed objects, object request brokers, component technology ,CORBA .

Specific to Computer Application:

Discrete Mathematics	:	Set, Posets, Relations, Recurrence relations, Functions, Combinatories, Lattices, Boolean Algebra
Numerical Methods	:	Numerical solution of linear and non-linear equations, Interpolation, Numerical Differentiation & Integration, Numerical solution of ordinary and partial differential equations
Statistical Methods	:	Theory of Probability, Binomial, Poisson & Normal Distributions, Correlation and Regression, Tests of Hypothesis.
Optimization	:	Linear programming and its solution, Project Management: CPM & PERT, Queuing models, Inventory models, Assignments & Transportation Problems, Dynamic Programming
Web technology & E Commerce	:	Electronic Commerce and physical Commerce, Different type of e-commerce, e-commerce scenarios, advantages of e-commerce. Business models: Feature of B2B e-commerce, Business models, Integration. E-Services: category of e-services, Web- enabled services, Matchmaking services, information-selling on the web. Internet payment system , SET Protocol for credit card payment , E-Governance ,WAP Architecture.
Data Mining	:	Data integration models and algorithms, Graphical models, Information extraction and retrieval, Forecasting and smart e-business, , Text and Web data mining.
Middleware Technologies	:	Exposure to Markup languages, HTML,DHTML, VRML, SGML, XML etc. CGI, Applets & Servlets ,Distributed objects, object request brokers, component technology ,CORBA .

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ELECTRONICS AND COMMUNICATION ENGINEERING

1. **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.

2. **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 twintub CMOS process.

3. **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 waveshaping circuits, 555 Timers, Power supplies.

4. **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.

5. **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.

6. **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.

7. **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.

8. **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.

9. **Statistics & Research Aptitude**
   Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

   National and international scenario of scientific research, literature reviewing, reference citation, scientific and research journals, impact valuation, research article and patent drafting, various scientific websites, abstracts.

Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal (M.P.)

Syllabus for Entrance Examination for Admission in Ph.D. Program

ELECTRICAL ENGINEERING

1. **Electric Circuits and Fields:** Network graph, KCL, KVL, node and mesh analysis, transient response of dc and ac networks; sinusoidal steady-state analysis, resonance, basic filter concepts; ideal current and voltage sources, Thevenin's, Norton's and Superposition and Maximum Power Transfer theorems, two-port networks, three phase circuits; Gauss Theorem, electric field and potential due to point, line, plane and spherical charge distributions; Ampere's and Biot-Savart's laws; inductance; dielectrics; capacitance.

2. **Signals and Systems:** Representation of continuous and discrete-time signals; shifting and scaling operations; linear, time-invariant and causal systems; Fourier series representation of continuous periodic signals; sampling theorem; Fourier, Laplace and Z transforms.

3. **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 machines - performance, regulation and parallel operation of generators, motor starting, characteristics and applications; servo and stepper motors.

4. **Power Systems:** Basic power generation concepts; transmission line models and performance; cable performance, insulation; 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; Voltage Stability, HVDC transmission and FACTS concepts, Power system Security, GSDF, LODF.

5. **Control Systems:** Principles of feedback; transfer function; block diagrams; steady-state errors; Routh and Niquist techniques; Bode plots; root loci; lag, lead and lead-

lag compensation; state space model; state transition matrix, controllability and observability.

6. **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.

7. **Analog and Digital Electronics:** Characteristics of diodes, BJT, FET; amplifiers - biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers - characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits; multiplexer; Schmitt trigger; multi-vibrators; sample and hold circuits; A/D and D/A converters; 8-bit microprocessor basics, architecture, programming and interfacing.

8. **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, STATCOM, SRM, PMBLDC, Stepper Motor.

9. **Statistics & Research Aptitude**

Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

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Syllabus for Entrance Examination for Admission in Ph.D. Program

ELECTRONICS AND INSTRUMENTATION ENGINEERING

Basics of Circuits and Measurement Systems: Kirchof's laws, mesh and nodal Analysis Circuit theorems, One-port and two-port Network Functions, Static and dynamic characteristics of Measurement Systems, Error and uncertainty analysis, Statistical analysis of data and curve fitting.

Transducers, Mechanical Measurement and Industrial Instrumentation: Resistive, Capacitive, Inductive and piezoelectric transducers and their signal conditioning, Measurement of displacement, velocity and acceleration (translational and rotational), force, torque, vibration and shock, Measurement of pressure, flow, temperature and liquid level, Measurement of pH, conductivity, viscosity and humidity.

Analog Electronics: Characteristics of diode, BJT, JFET and MOSFET, Diode circuits, Transistors at low and high frequencies, Amplifiers, single and multi-stage, Feedback amplifiers, Operational amplifiers, characteristics and circuit configurations, Instrumentation amplifier, Precision rectifier. V-to-I and I-to-V converter, Op-Amp based active filters. Oscillators and signal generators.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions, IC families, TTL, MOS and CMOS. Arithmetic circuits, Comparators, Schmitt trigger, timers and mono-stable multi-vibrator. Sequential circuits, flip-flops, counters, shift registers, Multiplexer, S/H circuit, Analog-to-Digital and Digital-to-Analog converters, Basics of number system, Microprocessor applications, memory and input-output interfacing, Microcontrollers.

Signals, Systems and Communications: Periodic and a periodic signals, Impulse response, transfer function and frequency response of first- and second order systems, Convolution, correlation and characteristics of linear time invariant systems, Discrete time system, impulse and frequency response. Pulse transfer function. IIR and FIR filters, Amplitude and frequency modulation and demodulation, Sampling theorem, pulse code modulation, Frequency and time

division multiplexing. Amplitude shift keying, frequency shift keying and pulse shift keying for digital modulation.

Electrical and Electronic Measurements: Bridges and potentiometers, measurement of R,L and C. Measurements of voltage, current, power, power factor and energy, A.C & D.C current probes. Extension of instrument ranges, Q-meter and waveform analyzer, Digital voltmeter and multi-meter. Time, phase and frequency measurements, Cathode ray oscilloscope, Serial and parallel communication, Shielding and grounding.

Control Systems and Process Control: Feedback principles. Signal flow graphs. Transient Response, steady-state-errors, Routh and Nyquist criteria, Bode plot, root loci, Time delay systems, Phase and gain margin, State space representation of systems, Mechanical, hydraulic and pneumatic system components, Synchro pair, servo and step motors. On-off, cascade, P, P-I, P-I-D, feed forward and derivative controller, Fuzzy controllers.

Analytical, Optical and Biomedical Instrumentation: Mass spectrometry, UV, visible and IR spectrometry, X-ray and nuclear radiation measurements, Optical sources and detectors, LED, laser, Photo-diode, photo-resistor and their characteristics, Interferometers, applications in metrology, Basics of fiber optics, biomedical instruments, EEG, ECG and EMG, Clinical measurements, Ultrasonic transducers and Ultra sonography, Principles of Computer Assisted Tomography.

Statistics & Research Aptitude

Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

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Syllabus for Entrance Examination for Admission in Ph.D. Program

ENERGY TECHNOLOGY

- **Renewable & Non-Renewable Energy Sources-**

  Principles of energy conversion and energy systems such as Solar, Wind, Biomass, Hydroelectric, Nuclear, Geothermal, Ocean Thermal, Tidal, Hybrid Systems and recent innovative technologies in the field of energy sector, Mathematical simulation and optimization of energy systems, Energy security and policy, energy financing and sustainable economy, Design and system integration issues in renewable energy power plants, Fossil fuels, coal, petroleum and natural gas etc., nuclear power generation, bio-energy and bio-fuels, energy use pattern in different parts of the world

- **Power Generation, Transmission & Distribution of renewable & Non-renewable-**
  Electrical Energy Generation, concepts, various types of generating stations and their locations. Smart grids and micro grids based on renewable power sources.

- **Energy Sources, Policy & Planning -**
  Review of world & Indian energy situation in respect of demand, supply & resources in the historic context. Review of power development in India. Primary & secondary energy resources and their inter convertibility.

- **Clean Coal & Green Power Technology-**
  Coal Technologies, Zero Emission Technology, Green Productivity, Advanced Energy Systems-Fluidized Bed Combustion, Atmospheric Fluidized Bed Combustion (AFBC), Pressurized Fluidized Bed Combustion (PFBC) and Circulating Fluidized Bed Combustion (CFBC),Clean Coal Technologies-Supercritical Cycles, Integrated Gasification Combined Cycle (IGCC)Power Plants, Cold and Hot Gas Clean-Up system, Hydrogen generation, Fuel Cell, MHD-generator.

- **Energy Conservation, Management & Audit-**
  Energy Audit, Need, Types of Energy Audit, Energy Management Audit, Maximizing System Efficiencies, Optimizing the Input Energy Requirements, Energy Audit Instruments. Investment Need, Financial Analysis Techniques-Financing Options, Energy Performance Contracts and Role of ESCOs

- **Clean Development Mechanism-**
  Major objective of CDM, Projects for benefit from CDM finance, CDM methodology, CDM opportunities & priorities in India, flow of fund in Kyoto protocol.

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Syllabus for Entrance Examination for Admission in Ph.D. Program

ENGLISH

1. Chaucer to Shakespeare
2. Jacobean to Restoration Periods
3. Augustan Age : 18th Century Literature
4. Romantic Period
5. Victorian Period
6. Modern Period
7. Contemporary Period
8. American and other non-British Literatures
9. Literary Theory and Criticism
10. Rhetoric and Prosody

Research Aptitude

National and international scenario of research, literature reviewing, reference citation, research journals, impact valuation, research article and patent drafting, various websites for research, abstracting services..

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Syllabus for Entrance Examination for Admission in Ph.D. Program

MANAGEMENT

Managerial Economics-Demand Analysis , Production function ,Cost-output relations, Market structures, Pricing theories, Advertising, Macro-economics, National Income concepts, Infrastructure-Management and policy , Business Environment, Capital Budgeting

The concept and significance of organizational behaviour – Skills and roles in an organization – Classical , Neo-classical and modern theories of organizational structure – Organizational design- Understanding and Managing individual behaviour personality-Perception-Values-Attitudes-Learning-Motivation.
Understanding and managing group behaviour, Processes – Inter-personal and group dynamics – Communication – Leadership – Managing change – managing conflicts. Organizational development.

Concepts and perspectives in HRM; HRM in changing environment
Human resource planning – Objectives, Process and Techniques
Job analysis – Job description, Selecting human resources
Induction, Training and Development , Exit policy and implications
Performance appraisal and evaluation, Potential assessment
Job evaluation, Wage determination, Industrial Relations and Trade Unions
Dispute resolution and Grievance management, Labour Welfare and Social security measures

Financial management- nature and scope, Valuation concepts and valuation of securities, Capital budgeting decisions-Risk analysis, Capital structure and cost of capital, Dividend policy- Determinants, Long term and short term financing instruments, Mergers and acquisitions

Marketing environment and Environment scanning; Marketing Information system and Marketing research; Understanding consumer and industrial market; Demand Measurement and Forecasting; Market Segmentation-Targeting and Positioning; Product decision; Product Mix; Product Life Cycle; New Product Development; Branding and Packaging; Pricing methods and strategies.
Promotion Decisions-Promotion mix; Advertising; Personal selling; Channel management; Vertical marketing systems; Evaluation and control of marketing effort; Marketing of services; Customer relation management;

Uses of internet as a marketing medium-other related issues like branding, market development, advertising and retailing on the net.
New issues in Marketing.

Role and scope of production management ; Facility location; Layout planning and analysis; Production planning and control- production process analysis; Demand forecasting for operations; Determinations of product mix; Production scheduling; Work measurement; Time and motion study; Statistical Quality control.
Role and scope of Operations Research; Linear Programming; Sensitivity analysis; Duality; Transportation model; Inventory control; Queuing theory; Decision theory; Markov analysis; PERT/CPM.

Probability theory; Probability distributions- Binomial, Poisson, Normal and Exponential; Correlation and Regression analysis; Sampling theory; Sampling distributions; Tests of Hypothesis; Large and small samples; *t, z ,F, Chi*-square tests.
Use of Computers in Managerial Applications; Technology issues and Data processing in organizations; Information systems; MIS and Decision making; System Analysis and design; Trends in Information Technology; Internet and Internet-based applications.

Concept of corporate strategy; Components of strategy formulation; Ansoff's growth vector; BCG Model; Porter's generic strategies; Competitor analysis; Strategic dimensions and group mapping; Industry analysis; Strategies in industry evolution, fragmentation, maturity, and decline; Competitive strategy and corporate strategy; Transnationalization of world economy; managing cultural diversity; Global Entry strategies; Globalisation of financial system and services; Managing international business; Competitive advantage of nations; RTP and WTO.

Concepts–Types, Characteristics; Motivation; Competencies and its development; Innovation and Entrepreneurship; Small business-Concepts Government policy for promotion of small and tiny enterprises; Process of business opportunity identification; Detailed business plan preparation; Managing small enterprises; Planning for growth; Sickness in Small Enterprises; Rehabilitation of sick enterprises; Intrapreneurship (organizational entrepreneurship).

Ethics and Management system; Ethical issues and analysis in management; Value based organizations; Personal framework for ethical choices; Ethical pressure on individual in organizations; Gender issues; Ecological consciousness; Environmental ethics; Social responsibilities of business; Corporate governance and ethics.

Research Aptitude

National and international scenario of scientific research, literature reviewing, reference citation, scientific and research journals, impact valuation, research article and patent drafting, various scientific websites, abstracts.

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Syllabus for Entrance Examination for Admission in Ph.D. Program

MECHANICAL ENGINEERING

1. **Thermodynamics Cycles and IC Engines**

   Basic concepts, Open and Closed systems. Heat and work. Zeroth, First and Second Law, Application to non-Flow and Flow processes. Entropy, Availability, Irreversibility and Tds relations. Claperyron and real gas equations, Properties of ideal gases and vapours. Standard vapour, Gas power and Refrigeration cycles. Two stage compressor. C-I and S.I. Engines. Pre-ignition, Detonation and Diesel-knock, Fuel injection and Carburation, Supercharging. Turbo-prop and Rocket engines, Engine Cooling, Emission & Control, Flue gas analysis, Measurement of Calorific values. Conventional and Nuclear fuels, Elements of Nuclear power production.

2. **Heat Transfer and Refrigeration and Air-conditioning**

   Modes of heat transfer. One dimensional steady and unsteady conduction. Composite slab and Equivalent Resistance. Heat dissipation from extended surfaces, Heat exchangers, Overall heat transfer coefficient, Empirical correlations for heat transfer in laminar and turbulent flows and for free and forced Convection, Thermal boundary layer over a flat plate. Fundamentals of diffusive and connective mass transfer, Black body and basic concepts in Radiation, Enclosure theory, Shape factor, Net work analysis. Heat pump and Refrigeration cycles and systems, Refrigerants. Condensers, Evaporates and Expansion devices, Psychrometry, Charts and application to air conditioning, Sensible heating and cooling, Effective temperature, comfort indices, Load calculations, Solar refrigeration, controls, Duct design.

3. **Fluid Mechanics and Machines**

   Properties and classification of fluids, Manometry, forces on immersed surfaces, Center of pressure, Buoyancy, Elements of stability of floating bodies. Kinematics and Dynamics. Irrotational and incompressible. Inviscid flow. Velocity potential, Pressure field and Forces on immersed bodies. Bernoulli's equation, Fully developed flow through pipes, Pressure drop calculations, Measurement of flow rate and Pressure drop. Elements of boundary layer theory, Integral approach, Laminar and tubulent flows, Separations. Flow over weirs and notches. Open channel flow, Hydraulic jump. Dimensionless numbers, Dimensional analysis, Similitude and

modelling. One-dimensional isentropic flow, Normal shock wave, Flow through convergent - divergent ducts, Oblique shock-wave, Rayleigh and Fanno lines.

Performance, Operation and control of hydraulic Pump and impulse and reaction Turbines, Specific speed, Classification. Energy transfer, Coupling, Power transmissio**n**

4. Theory of Machines

Kinematic and dynamic analysis of planer mechanisms. Cams. Gears and gear trains. Flywheels. Governors. Balancing of rigid rotors and field balancing. Balancing of single and multicylinder engines, Linear vibration analysis of mechanical systems. Critical speeds and whirling of shafts Automatic controls.

5. Machine Design

Design of Joints : cotters, keys, splines, welded joints, threaded fasteners, joints formed by interference fits. Design of friction drives : couplings and clutches, belt and chain drives, power screws.
Design of Power transmission systems : gears and gear drives shaft and axle, wire ropes. *Design of bearings :* hydrodynamics bearings and rolling element bearings.

6. Strength of Materials

Stress and strain in two dimensions, Principal stresses and strains, Mohr's construction, linear elastic materials, isotropy and anisotropy, stress-strain relations, uniaxial loading, thermal stresses. Beams : Bending moment and shear force diagram, bending stresses and deflection of beams. Shear stress distribution. Torsion of shafts, helical springs. Combined stresses, thick-and thin-walled pressure vessels. Struts and columns. Strain energy concepts and theories of failure.

7. Engineering Materials

Basic concepts on structure of solids. Crystalline maferials. Detects in crystalline materials. Alloys and binary phase diagrams. Structure and properties of common engineering materials. Heat treatment of steels. Plastics, Ceramics and composite materials. Common applications of various materials.

8. Production Engineering

Metal Forming: Basic Principles of forging, drawing and extrusion; High energy rate forming; Powder metallurgy. *Metal Casting:* Die casting, investment casting, Shall Moulding, Centrifugal Casting, Gating & Riser design; melting furnaces. *Fabrication Processes:* Principles of Gas, Arc, Shielded arc Welding; Advanced Welding Processes, Weldability: Metallurgy of Welding.

Metal Cutting: Turning, Methods of Screw Production, Drilling, Boring, Milling, Gear Manufacturing, Production of flat surfaces, Grinding & Finishing Processes. Computer Controlled Manufacturing Systems-CNC, DNC, FMS, Automation and Robotics.

Cutting Tools Materials, Tool Geometry, Mechanism of Tool Wear, Tool Life & Machinability; Measurement of cutting forces. Economics of Machining. Unconventional Machining Processes. Jigs and Fixtures. Fits and tolerances, Measurement of surface texture, Comparators Alignment tests and reconditioning of Machine Tools.

CAD TOOLS: Definition of CAD Tools, Types of system, CAD/CAM system evaluation criteria, brief treatment of input and output devices. Graphics standard, functional areas of CAD, Modeling and viewing, software documentation, efficient use of CAD software. GEOMETRIC MODELLING**:** Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves her mite cubic splines Bezier curves Bsplines rational curves.

9. **Industrial Engineering:**

Production Planning and Control : Forecasting - Moving average, exponential smoothing, Operations, scheduling; assembly line balancing, Product development, Break-even analysis, Capacity planning, PERT and CPM.
Control Operations: Inventory control ABC analysis, EOQ model, Materials requirement planning. Job design, Job standards, Work measurement, Quality Management - Quality analysis and control.

Operations Research: Linear Programming - Graphical and Simplex methods, Transportation and assignment models. Single server queueing model.
Value Engineering : Value analysis for cost/value.

10. Statistics & Research Aptitude

Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

National and international scenario of scientific research, literature reviewing, reference citation, scientific and research journals, impact valuation, research article and patent drafting, various scientific websites, abstracts.

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Syllabus for Entrance Examination for Admission in Ph.D. Program

NANOTECHNOLOGY

NANO SCALE MECHANICS

Wave-particle duality; Wave functions in coordinate and momentum representations; Commutators and Heisenberg's uncertainty principle; Matrix representation; Dirac's bra and ket notation; Schroedinger equation (time-dependent and time-independent); Eigen value problems such as particle-in-a-1D , 2D and 3D box,.; Tunneling through a barrier.

MATERIAL SCIENCE

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;

SYNTHESIS OF NANOMATERIALS

Top-down techniques : Nanostructures by mechanical milling (ball milling) and mechanical attrition, Lithography -immersion lithography, Electron and ultraviolet (EUV) ,photolithography, X- ray lithography, Electron beam lithography, focused ion beams. Nanosphere lithography – Molecular self-assembly, soft lithography, molecular manipulation by STM and AFM

Bottom-up techniques: Chemical vapor deposition (CVD), Physical vapour deposition (PVD) thermal and e beam evaporation, Pulsed laser ablation, pulse laser deposition. Chemical Routes: chemical precipitation and co-precipitation, chemical bath deposition (CBD), Sol-gel synthesis, and spray pyrolysis

CHARACTERIZATION OF NANOMATERIALS (I)

Spectroscopic techniques : Spectrophotometers, UV-Vis spectrophotometers, IR spectrophotometers, Fourier Transform Infrared radiation (FTIR), photoluminescence, electroluminesce and thermoluminescence spectroscopy, Nearfield scanning optical microscopy (NSOM)

Diffraction techniques : X-ray Diffraction (XRD), powder and single crystal Diffraction, X-ray fluorescence (XRF), X ray photoelectron spectroscopy (XPS), Energy Dispersive X-ray analysis (EDAX), Extended X ray absorption fine structures (EXAFS), Dispersive high pressure XRD

CHARACTERIZATION OF NANOMATERIALS (II)

Surface analysis: Scanning tunneling microscopy (STM), Contact and non contact atomic force microscopy (AFM), Conductive AFM, Magnetic force microscopy (MFM)

Elemental analysis: Nuclear magnetic resonance (NMR) and Raman spectroscopy: description and analysis. Surface analysis methods: Secondary ion mass spectroscopy (SIMS), Auger electron spectroscopy, Electron spectroscopy for chemical analysis.

Electron microscopic techniques: Scanning Electron Microscopy (SEM), Transmission electron microscopy (TEM), High resolution TEM Field emission SEM, Electron energy loss spectroscopy (EELS)

PROPERTIES OF NANOSTRUCTURES

Electrical transport properties in semiconductor nanostructures: Density of states: Quantum wells, Q wires and Q dots. quantization of conductance, coulomb blockade, Kondo effect, ballistic transport.

Vibrational and thermal properties of low-dimensional materials,: phonons, quantization of phonon modes, 0D, 1D, 2D, and 3D phonons, heat capacity and thermal transport at nanoscale

Nano fluid mechanics: flow of nanofluid, electrophoresis dielectrophoresis: Size selective separation of dielectric nano particles, nano and micro fluid channels, low reynold number fluid dynamics, optical tweezer.

Linear and nonlinear optical properties: Size Quantization effect, Optical blue shift phenomenon, , interactions between Nanoparticles, coupled dipoleapproximation, Light detection in nano-structures; scanning near-field microscopy, single-molecule detection.

Metamaterials: Negative refractive index metamaterials, super resolving metamaterials, negative refractive index lenses. Plasmonic nanowire metamaterials.

CARBON NANOTUBES

Structure and properties of C_{60}, Graphene, Carbon nanotubes and its types, Synthesis techniques for CNT preparation, purification techniques. Properties of Carbon Nanotubes and Graphene: Optical, Electrical and electronic properties, Mechanical, Thermal and vibrational properties.

Applications of Carbon Nanotubes :Fuel cells, CNT FETs, Light emitting displays and flat panel displays, hydrogen storage, solar panels.

NANOELECTRONICS

Nanoscale devices: Resonant tunneling diodes, single electron transistor, modulation-doped field effect transistor MODFETs, and Heterojunction Bipolar Transistors (HBTs) **Nanostructure magnetism:** Giant magneto resistance effect (GMR), Anisotropic magneto resistance (AMR) and Colossal magneto resistance (CMR), Magnetic multilayered thin films and nanowires, super paramagnetism and ferromagnetism in semiconducting quantum dots.

NANOBIOTECHNOLOGY

Physics of Biological sytems Interaction of biomolecules with surfaces, basic concepts of cell and molecular biology, Dendrimers, micelles, liposomes, block coplymers, Bionanomaterials: Biomimtric Systems, bioceremics & nanotherapeutics, microorganisms for synthesis of nanomaterials, biomembranes. Bio-functionalization of gold, magnetic and polymer nanoparticles and CNTs, Nano dental materials, metal nanoparticles and drug delivery vechicles– Nanoshells–Tectodentrimers.

STATISTICS AND RESEARCH APTITUDE

Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

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Syllabus for Entrance Examination for Admission in Ph.D. Program

PHARMACY

1. **Basic Pharmaceutics, Drug Delivery and Regulatory Affairs**
   Micromeretics and powder rheology, surface tension and interfacial phenomena, viscosity and rheology. Identification techniques of microbes, cultivation, isolation of microbes, principles of sterilization. Basic principles of evaporation, distillation, drying, size reduction, mixing, crystallization, filtration and centrifugation. Classification, designing, manufacturing, packaging and evaluation of various dosage forms. Approved conventional and novel formulation excipients. Controlled and novel drug delivery systems, drug targeting. Techniques for in-vitro and in-vivo testing. Invitro-Invivo correlation. Pre-formulation studies. Physical, chemical and therapeutic incompatibilities. General considerations & concepts of chemical kinetics and drug stability. Biopharmaceutical aspects of dosage form design, principles of pharmacokinetics. Bioavailability and bioequivalence studies, dosage regimens, repetitive dosing and dose adjustments in renal and hepatic failure, individualization of dosage regimen. BCS Classification of drugs, ICH guidelines. Concept of pharmaceutical quality management, requirements of GMP, GLP, GCP, regulatory requirements of drugs and pharmaceuticals.

2. **Pharmaceutical and Medicinal Chemistry**
   Basic organic chemistry regarding synthesis and reactions of the main organic functional groups, organic stereochemistry, substitution (free radical, nucleophilic, electrophilic); elimination reactions; addition reactions; rearrangement reactions, General pathways of drug metabolism, Basic concepts and application of prodrug design, Biochemical mechanism of drugs, categories of drug with special reference to SAR, Mode of action, Classification and synthesis of anticancer, NSAIDs, anti-infective, antihistaminic, anxiolytics, sedatives, hypnotics, anticonvulsants, adrenergic antagonists and general anesthetics. Radiolabelling, Drug designing and screening, concepts of QSAR and CADD.

3. **Pharmacology and Drug Therapeutics**
   Types of receptors, drug-receptor interaction including signal transduction, mechanism, drug action, side effects, and contraindications of drugs acting on central nervous system, autonomous nervous system, anticancer agents, NSAIDs, anti-infective, antidiabetic, antihypertensive, antiasthmetic and antihistaminic. Pharmacological screening, general principles, various screening models, screening methodologies (in-vitro and in-vivo tests). Bioassay methods, principles of toxicology, Chemotherapy and pathophysiology.

4. **Pharmacognosy and Biotechnology**

General methods of extraction, isolation, purification and characterization of natural products. Various separation techniques used for isolation of natural products. Biosynthetic pathways of various metabolites (e.g. Alkaloids, glycosides, tannins, lignans, saponins, lipids, flavonoids, coumarins, anthocyanidines etc.). Quality control of crude drugs, phytochemical screening methods, plant tissue culture.

Recombinant DNA technique, Fermentation, Immunology and vaccines. Enzyme immobilization, Genetics and gene therapy, Fundamentals of cell and molecular biology.

5. **Pharmaceutical Analysis**

Fundamental principles, basic instrumentation, and pharmaceutical applications of UV-Visible spectroscopy, Infrared spectroscopy, PMR, C13 NMR spectroscopy, mass spectroscopy of gas-liquid chromatography, HPLC, HPTLC, Gel chromatography, Electrophoresis and ion-pair chromatography. Introductory principle, instrumentation and application of GC-Mass, HPLC-Mass for complex mixtures.

Theory, methods and applications of enzyme and radioimmunoassay techniques, Thermogravimetric analysis (TGA), Differential scanning calorimetry (DSC), Differential Thermal Analysis (DTA), X-ray diffractometry (XRD), Electron microscopy. Stability indicating assay procedures, analytical method development and validation. Impurity profiling, drug estimation in biological samples. Analytical instrument validation.

6. **Statistics & Research Aptitude**

Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

National and international scenario of pharmaceutical research, literature reviewing, reference citation, scientific and research journals, impact valuation, research article and patent drafting, various scientific websites, abstracts, pharmacopoeial drug monographs and official standards, national and international research institutions of repute.

Verbal reasoning

Analogy, Classification, Series Completion and Logical Deduction.

Non-verbal reasoning

Pattern perception, Figure matrix, Rule detection.