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

APPLIED PHYSICS

Mathematical Physics

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

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


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:

Inorganic Chemistry:

Organic Chemistry:

Analytical Chemistry:
**Industrial Chemistry:**

Industrial aspects of plastics, rubbers, ceramics, glass, inorganic acids HCl, H2SO4, H3PO4 etc.), corrosion, water, cement, fertilizers, alkalis and allied chemicals, pharmaceuticals, sugar, petrochemicals, pollution.

**Statistics & Research Aptitude**

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APPLIED MATHEMATICS

Integral Transform:

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:

Numerical Analysis:

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:

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:**

**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 transencies.

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


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.

(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.


(C) Environmental Engineering


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


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.

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Syllabus for Ph.D Entrance Test, RGPV.

Common for CSE/IT/CA


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


**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.

**Specific to IT**


**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, Combinatorics, 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 |
| **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. |
ELECTRONICS AND COMMUNICATION ENGINEERING


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.

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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, PMLDC, Stepper Motor.

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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.


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.


**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**

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

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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-**

- **Energy Conservation, Management & Audit-**

- **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.
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..
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.


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; \(t\), \(z\), \(F\), \(\chi^2\) 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

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

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

MECHANICAL ENGINEERING

1. Thermodynamics Cycles and IC Engines

2. Heat Transfer and Refrigeration and Air-conditioning

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 turbulent 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 transmission

4. **Theory of Machines**


5. **Machine Design**


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**


8. **Production Engineering**


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 hermite 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.


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.
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, electroluminescence 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**

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.

NANOBIO TECHNOLOGY

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.

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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PHARMACY

1. Basic Pharmaceutics, Drug Delivery and Regulatory Affairs

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, antiasthmatic 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**

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.