Ph.D. Examination pattern

1. The Entrance Test syllabus shall consist of 50% of research methodology, and 50% shallbe subject specific.
2. Total 100 multiple choice question to be asked (50 multiple choices from ResearchMethodology and 50 multiple choice questions from the concern subject).
3. Total marks will be 100.
4. Students who have secured 50 % marks in the entrance test are eligible to be called forthe interview

Syllabus for PhD (Part-Time)entrance exam for Academic Year 2022-23

Research Methodology

Meaning of Research Meaning, aims, nature and scope of research, Prerequisites of research Types of research. Research Problem Meaning of research problem Sources of research problemCharacteristics of a good research problem Hypothesis: Meaning and types of hypotheses. Research proposal or synopsis. Methods of Research Studies Qualitative and Quantitative research methods. Review of Related Literature Purpose of the review. Identification of the related literature. Organizing the related literature. Data Collection (Sampling) Population and sample, Characteristics of a good sample Techniques of sample Selection Types of data in research Tools of Data Collection Characteristics of good research, Types of data collection tools. Descriptive Statistics Tabulation, Organization, and Graphical Representation of Quantitative data Measures of Central Tendencies: Mean, Median, Mode Measures of Variability: Range, Quartile Deviation, Standard Deviation, Research Report Format of the research report Style of writing the report

Ph.D. in Metallurgical and Materials Engineering

Engineering Mathematics**:** Linear algebra: Matrix algebra, Eigen values and Eigen vectors. Calculus: Functions of single variable, limit, continuity, differentiability, integration, maxima and minima. Differential equations: first order equations, higher order equations. Vector calculus: Gradient, divergence and curl, line, surface and volume integrals, Stokes, Gauss and Green's theorem.

Thermodynamics and kinetics: First, second and third law of thermodynamics, basic thermodynamics functions, free energy, entropy, thermodynamic relations, applications of Maxwell relations, Activation energy.

Atomic structure and bonding: electrons in atoms, types of bonding-ionic bonding, covalent bonding, metallic bonding and secondary bonding.

Structure of crystalline solids: crystalline and non-crystalline materials, geometry of crystals, Miller indices, crystal structures in metal and ceramics, solid solutions.

Defects in solids: Point defects, line defects and dislocations, interfacial defects, volume defects, significance of defects in materials.

Diffusion: Diffusion: Fick's 1^{st} and 2^{nd} laws of diffusion, factors influencing diffusion.

Phase Diagram: Definitions and basic concepts, nucleation and growth, Hume-Rothery's rule, Gibbs phase rule, interpretation of binary phase diagram, Iron-Carbon phase diagram, types of phase transformation. Alloys:

Ferrous and nonferrous alloys.

Heat treatment of steel: Heat treatment process, annealing, tempering, transformations on heating and cooling, Hardening, factors in heat treatment

Mechanical properties of materials: Elastic deformation, plastic deformation, interpretation of stress-strain curve, engineering stress-strain curve, True stress-strain curve, factors affecting tensile properties, Fracture, factors affecting fatigue properties, typical creep curve, factors affecting creep behavior, slip system.

Electrical Properties of Materials: Electrical conduction, Semiconducting nature of materials, Dielectric behavior of materials, Ferroelectric and Piezoelectric behavior of materials.

Thermal Properties of materials: Heat capacity, Thermal expansion, Thermal conductivity, Thermal stresses

Magnetic Properties of materials: Basic concepts, Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Influence of temperature, Domains and Hysteresis.

Optical Properties of materials: Interaction of light with solids, Optical properties of metals and non-metals

Materials Characterization**:** X-ray diffraction, Electron microscopy: SEM, TEM, Scanning probe microscopy: STM and AFM. Spectroscopy technique: Raman spectrocopy, FTIR spectroscopy, UV spectroscopy, Photoluminesce, TGA, DTA and DSC.

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Ph.D. in Geoinformatics

Electromagnetic Radiation (EMR): Wavelength regions and their applications Atmospheric windows, Interaction of EMR with atmosphere & Earth's Surface, Spectral response pattern, Geostationary & Sun Synchronous Satellites, Resolutions- Spectral, Spatial, Temporal and Radiometric, Earth Resource Satellite Sensors, Advances in remote sensing technologies: Thermal, RADAR, Microwave, Hyperspectral, Lidar etc.

Introduction to cartography, Map and Scale, Important Map Projections, Generalization- Elements, Control & Classification (Semantic & Geometric), Introduction to Global Positioning System, GPS Segments, GPS Positioning Types- Absolute, Differential, Geopositioning, GNSS: NAVSTAR, GLONASS, GALILEO etc

Basic concepts about spatial information, Spatial vs. non-spatial data, Components of GIS, Spatial data models – Raster and Vector, Data base design - editing and topology creation in GIS, Linkage between spatial and non-spatial data, Integration of Raster & Vector Data, Feature Based Topological functions, Interactive Data Exploration, Vector Data Query, Attribute Data Query.

Remote sensing systems, remote sensing sensors, Electromagnetic Radiation, Interaction of EMR with atmosphere & Earth's Surface, Spectral properties of major elements, Photographic System, Cameras, Filters & Films, Resolutions, Earth Resource Satellite, Satellite missions (Indian and Foreign), Major Remote Sensing Agencies, Fundamental of Digital Image Processing, Geographic Information System (GIS)& its components, Application of Geoinformatics. Remote Sensing (RS) Applications in Agriculture, Forestry, Land cover/ Land use, Water resources, cryosphere, disaster management- floods, landslide, cyclone, forest fire, drought & Environmental Impact Assessment (EIA)

Components of Earth System, Internal Structure of Earth, Lithosphere, Biosphere, Hydrosphere & Atmosphere, Plate Tectonics Theory and Its Relationship to Earthquakes and Volcanic Activity, rock types and structures, weathering and erosion, landforms of Fluvial, Eolian, Glacial and Marine origin. Water resources, Hydrological Cycle, Watershed and Watershed management, Groundwater, Aquifers, Agro-climatic regions, Forestry and ecology. Environment, Sustainable development, Global warming, Climate change, GHGs, Disaster Management, Recent disaster events, Major disaster management agencies.

Operating System, Databases, Internet and Web technologies, HTML, XML, Data formats, helper applications, Java, databases and the Web, Internet Map Servers, Web GIS Architectures, C++, JAVA, PYTHON applications.

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Ph.D. in Civil engineering (Area of research : Water resources engineering / Transportation engineering)

Water Resources Engineering: Fluid Mechanics-Continuity, Momentum and Energy equations- Potential flow- Laminar and Turbulent flow, Flow in Pipes -Boundary layer- Hydraulics -Energy depth relations - Specific Energy, Gradually varied flow, Unsteady free surface flow, Hydrologic Cycle-Precipitation, Evaporation, Watershed management, Flood routing, Surface run-off models-Well hydraulics-Hydrograph analysis-Irrigation Duty, Delta, Crop water requirements, Design of lined and un-lined canals, Groundwater occurrence; Darcy's Law, steady and unsteady flow in confined and unconfined aquifers, groundwater exploration techniques; overview of groundwater recharge estimation and artificial recharge techniques, Soil, water and wind erosion, Engineering Measures for Soil and Water Conservation, Biological and Engineering measures to control erosion.

Transportation Engineering: Urban transportation problems, travel demand estimation, Trip Generation & distribution models, mode split analysis, traffic assignment, corridor identification, stated preference methods, components of traffic system, traffic studies, microscopic & macroscopic traffic stream models, highway capacity, geometric design of traffic flow systems, design of at grade intersections, parking facilities, bicycle & pedestrian facilities-stresses in flexible & rigid pavements, design of flexible & rigid pavements, highway construction equipment, pavement construction, Evaluation of pavements, Pavement Maintenance.

Environmental Engineering: Water and Wastewater-Water standards-Surface water treatment-Distribution of water- Sewage and Sewerage treatment-Primary, secondary and tertiary treatment of waste water-Effluent discharge standards- Air pollution-air quality standards- Noise pollution-control and measurement-Municipal solid waste- characteristics-collection and transportation-Engineered systems for solid waste management.

Geotechnical Engineering

Engineering properties of soils- Compaction and Consolidation-Foundation engineering- types of foundations – Shallow foundations -bearing capacity theories-Deep foundations; Earth pressure theories and earth retaining structures; Soil dynamics- free and forced vibrations; Rock mechanics-rock mass classification-laboratory and In-situ testing- foundations on rock-tunnelling. Soil exploration- sampling, drilling, in-situ tests-bore logs.

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Ph.D. in Environmental Sciences

Basic multi-disciplinary, knowledge on environmental studies, at the postgraduate level, is required. Information pertinent to environmental studies under the following areas is included:

- Introduction to Environmental Sciences
- Environmental Impact and Risk Assessment
- Pollution and Health
- Environmental Pollution
- Environmental Biology
- Urban Ecosystems
- Natural resources: Conservation and Management
- Atmosphere and Global Climate Change
- Natural & Managed Ecosystems
- Biodiversity and Conservation Biology
- Ecotoxicology and Environmental Health
- Environmental Chemistry
- Environmental and Mining Engineering
- Indian and International Environmental Law
- Environmental Policies and Politics
- Global & Contemporary Environmental Issues
- Energy & Environment
- Environmental Geosciences
- Environmental Management
- Mineral Resources and Environment
- Basic elements and tools of Statistical Analysis

Ph.D. in Physics

I. Mathematical Methods of Physics

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-HamiltonTheorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order,Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplacetransforms.Elementsofcomplexanalysis,analyticfunctions;Taylor&Laurentseries;poles,residuesandevaluationofintegrals.Elementaryprobabilitytheory,random variables,binomial,Poissonandnormal distributions. Central limittheorem.

II. Classical Mechanics

Newton's laws. Dynamical systems, Phase space dynamics, stability analysis. Central force motions.TwobodyCollisions-scatteringinlaboratoryand Centreofmassframes.Rigidbodydynamics-momentofinertiatensor.Non-inertialframesandpseudoforces.Variationalprinciple.Generalizedcoordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws andcyclic coordinates. Periodicmotion:smalloscillations, normalmodes. Specialtheory of relativity-Lorentztransformations,relativistickinematicsand mass–energyequivalence.

III. Electromagnetic Theory

Electrostatics:Gauss'slawanditsapplications,LaplaceandPoissonequations,boundaryvalueproblems.Magnetostatics:Biot-Savartlaw,Ampere'stheorem.Electromagneticinduction.Maxwell'sequations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalarand vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors.Reflectionandrefraction,polarization,Fresnel'slaw,interference,coherence,anddiffraction.Dynamicsof chargedparticlesinstaticand uniformelectromagneticfields.

IV. Quantum Mechanics

Wave-particleduality.Schrödingerequation(time-dependentandtime-independent).Eigenvalueproblems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function incoordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Diracnotation for state vectors. Motion in a central potential: orbital angular momentum, angular momentumalgebra,spin,additionofangularmomenta;Hydrogenatom.Stern-Gerlachexperiment.Time-independentperturbationtheoryandapplications.Variationalmethod.Timedependentperturbationtheory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statisticsconnection.

V. Thermodynamic and Statistical Physics

Lawsofthermodynamicsandtheirconsequences.Thermodynamicpotentials,Maxwellrelations,chemicalpotential,phaseequilibria.Phasespace,micro-andmacro-states.Micro-canonical,canonical andgrand-canonicalensemblesandpartitionfunctions.Freeenergyanditsconnectionwiththermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle ofdetailedbalance.BlackbodyradiationandPlanck'sdistributionlaw.

VI. Electronics and Experimental Methods

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junctiondevices), device structure, device characteristics, frequency dependence and applications. Opto-electronicdevices(solarcells,photo-detectors,LEDs).Operationalamplifiersandtheirapplications.Digitaltechniquesandapplications(registers,counters,comparatorsandsimilarcircuits).A/DandD/Aconverters.Microprocessor and microcontrollerbasics.

Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Leastsquaresfitting,

VII. Nuclear and Particle Physics

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empiricalmassformula,liquiddropmodel.Natureofthenuclearforce,formofnucleon-nucleonpotential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence ofshellstructure,single-particleshellmodel,itsvalidityandlimitations.Rotationalspectra.Elementaryideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions.

Classificationoffundamentalforces.Elementaryparticlesandtheirquantumnumbers(charge,spin,parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P,and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

VIII. Optics and Applied Optics

Interference, Anti-reflecting films, Color of thin films; Newton's rings, Michelson interferometer. Fabry Perot interferometer, Resolution and Free spectral range. Fraunhofer diffraction, diffraction by a single slit, double slit, circularaperture,resolving power of microscopes and telescopes, Diffraction grating, Resolving power and Dispersive power, Fresnel diffraction, Zone plate,diffraction due to straight edge. Polarization, linear, circular and elliptical polarizations, Brewster's law and Malus's law, Double refraction, half wave and quarter wave plates, Kerr effect, Pockel's effect, Faraday effect, Fermat's Principle, Ray equation and its solution

Optical Fibers: Structure of optical fibers, Single, multimode and W-profile fibers. Numerical aperture and acceptance angle. Multipath, Material dispersion, their combined effect, Attenuation in optical fibers, Photonic crystal fibers.Wave Propagation in Step-index Fibers, Wave Propagation in Graded-index Fibers, Optical Sources, Photo Detector and Sensors: Photo Detectors, Fiber Optics sensor, Optical fiber fabrication and cabling.

IX Atomic and Molecular Physics

Atomic structure: Rutherford model of atom and its drawbacks, Bohr atom model, Electron orbits, Energy levels and spectra, Effect of nuclear motion on atomic spectra, Spectra of hydrogen-like atoms, Bohr's correspondence principle, Ritzcombinationprinciple, Bohr-Sommerfeld Theory
Atoms in Electric and Magnetic Fields: Electron Angular Momentum. Space Quantization, Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment, Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. Atoms in External Electric and Magnetic Fields (qualitative discussion only):Normal and Anomalous Zeeman Effect, Panchen Back and Stark Effect; Classical theory of normal Zeeman effect.
Many electron atoms: Pauli's Exclusion Principle, Periodic table, Fine structure, Spin orbit coupling, Spectral Notations for Atomic States, Total Angular Momentum, Vector Model, L-S and J-J couplings, Hund's Rule, Term Symbols, Spectra of Alkali Atoms, Clebsch-Gordon coefficients
Molecular Spectra: Theory of the origin of pure rotational spectra of a diatomic molecule as a rigid rotator and as a non-rigid rotator, isotope effect, Raman Effect, Experimental study, Characteristics of Raman Lines, Classical and Quantum theory of Raman Effect

X. Solid State Physics
Crystal Structure:Amorphous and crystalline materials, crystal lattice, crystal planes and Miller indices, unit cells, typical crystal structure, coordination number, packing fraction, Diffraction of X-ray by crystal lattice, Brag's law, Laue's formulation of X-raydiffraction,reciprocal lattice, Brillouin zones, Laue spots, rotating crystalandDebyeScherrer methods, geometrical structure factor, atomic form factor, calculation for bcc,fcc and diamond structure, Metallic structure, close packed structure, quasicrystal.
Defects in solids: Lattice defects, vacancies, Schottky and Frenkel pairs, edge and screw dislocations, experimental methods to observed defects, neutron and electron diffraction methods.
Band Theory of solids: The Bloch theorem, Bloch functions, The Kroning-penney model, Number of wave functions in the band, Velocity and effective mass of the electron.
Bonding in solids: Lennard jones potential, concepts of cohesive energy, covalent bonding and its origin, ionic bonding, energy of bonding, transition between covalent and ionic bonding,metallic bonding, Vander Waalsbonding,hydrogen bond.
Lattice vibrations: Vibrational modes of continuous media, phonon, linear monoatomic and diatomic chains, acoustical and optical phonons, qualitative description of phonon spectra in solids.
Specific heat of solids: Einstein and Debye theories of specific heat of solids, density of states, T3 law, Normal and Umklapp process.

Ph.D in Commerce

General Economic Environment
Business Environment Meaning and Elements of Business Environment Economic environment, Economic Policies, Economic Planning, Legal environment of Business in India. Competition policy, Consumer protection, Environment protection. Policy Environment: Liberalization, Privatization and globalisation. Second generation reforms, Industrial policy and implementation. Industrial growth and structural changes.

Financial & Management Accounting
Basic Accounting concepts, Capital and Revenue, Financial statements Partnership Accounts : Admission, Retirement, Death, Dissolution and Cash Distribution Advanced Company Accounts : Issue, forfeiture, Purchase of Business Liquidation, Valuation of shares, Amalgamation, Absorption Reconstruction, Holding Company Accounts Cost and Management Accounting : Ratio Analysis, Funds Analysis, Cash Flow Analysis, Marginal costing and Break-even analysis, Standard costing Budgetary control, Costing for decision-making Responsibility accounting.

Business Economics
Nature and uses of Business Economics, Concept of Profit and Wealth maximization. Demand Analysis and Elasticity of Demand, Curve Analysis Law. Utility Analysis and Indifference of Returns and Law of variable proportion Cost, Revenue, Price determination in different market situation: Perfect competition, Monopolistic competition, Monopoly, Price discrimination and Oligopoly, Pricing Strategies.

Financial Management
Capital Structure, Financial and Operating leverage Cost of capital, Capital budgeting Working capital management Dividend Policy.

Banking and Financial Institution
Importance of Banking to Business, Types of Banks and Their Functions, Reserve Bank of India, NABARD and Rural Banking, Banking Sector Reforms in India, NPA, Capital adequacy norms E-banking Development Banking : IDBI, IFCI, SFCs, UTI, SIDBI Unit - X : International Business Theoretical foundations of international business, Balance of payments International liquidity, International Economic Institutions - IMF, World Bank, IFC, IDA, ADB World Trade Organisation-its functions and policies Structure of India's foreign trade : Composition and direction. EXIM Bank EXIM Policy of India, Regulation and Promotion of Foreign Trade. Insurance types and principal and IRDA.

Business Statistics & Data Processing
Data types, Data collection and analysis, sampling, need, errors and methods of sampling, Normal distribution, Hypothesis testing, Analysis and Interpretation of Data Correlation and Regression, small sample T-test, F-test and chi-square test Data processing - Elements. Data entry, Data processing and Computer applications Computer Application to Functional Areas Accounting.

PhD in Computer Science Engineering

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

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

Computer Organization and Architecture: Machine instructions and addressing modes. ALU, data-path and control unit, Instruction pipelining, pipeline hazards. Memory hierarchy: cache, main memory and secondary storage:, 1/0 interface (interrupt and DMA mode).

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

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

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

Operating System: System calls, processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU and I/O scheduling. Memory management and virtual memory. File systems.

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

Computer Networks Concept of layering: OSI. and TCP/1P Protocol Stacks; Basics of packet; Data link layer: framing, error detection; Routing protocols: Fragmentation and IP addressing, IPvs4. CIDR notation, Transport layer: flow control, UDP, TCP, sockets; Application layer protocols.

Ph.D in Management

Please refer UGC-NET syllabus for Ph.D. Entrance test