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Research Aptitude

- Definition of research
- Concepts and types of research
- Ethics in Research including Plagiarism
- Qualities of a competent Researcher
- Purpose and Scope of Research in Engineering Education (inter-disciplinary)
- Steps in conducting research
- Selection of Research problem
- Literature review
- Defining research Problem
- Hypothesis and its type
- Functions of Hypothesis
- Sampling techniques
- Measurement and Scaling techniques
- Data collection techniques and methods
- Analysis of Quantitative and Qualitative Data (including Basic Statistical parameters)
- Citation and Reference Styles
- Research report and thesis writing

Suggested Reading

2) Kumar, Ranjit (2014): Research methodology: A step by step guide for Beginners
4) Gregory, Ian (2003) Ethics in Research

School of Petroleum Management

Management
Management accounting, marketing, organizational behavior, human resource management, financial management, operations management, managerial economics, strategy, research methodology, information technology, quantitative methods and general management.
School of Petroleum Technology

Petroleum Engineering

Unit - I: Petroleum Exploration


Unit - II: Reservoir Engineering


Unit - III: Drilling Engineering


Unit - IV: Production Engineering

School of Liberal Studies

Economics
Developmental Economics, Microeconomics, Macroeconomics, Indian Economics, Basic Statistics, Basic Econometrics, Other allied areas.

Psychology

English
Indian English Literature and Contemporary Fiction in India, American Literature, Research Method, Comparative Literature, Trends in Contemporary Literature, 20th Century British Literature, Communication Theories and Applications, Other allied areas

Public Policy and Administration
Governance (Good Governance, E-Governance) and allied areas, Service Delivery, Public Private Partnerships, Public Health, Rural and Urban Development, Disaster Management, Police and Security Studies, Personnel Administration, Policy evaluation

International Relations

Mass Communication
Journalism, Development communication, Advertising, Public Relation, Corporate, Communication, Films (popular and documentary), Media literacy, Social Media, Media education and allied areas.

Business Administration
Banking, Insurance, Finance, Capital Market, Marketing, Other allied areas

Commerce
Commerce, Accounting, Taxation, Other allied areas

PH.D. admissions January 2020 Syllabus for Written Aptitude Test
School of Technology

Mechanical Engg.

**Fluid Mechanics:** Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli’s equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings.

**Heat-Transfer:** Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler’s charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan-Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

**Thermodynamics:** Thermodynamic systems and processes; properties of pure substances, behaviour of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.


**Engineering Materials and Metallurgy:** Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials, TTT diagrams, SEM, TEM, XRD.

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

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

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

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

**Engineering Mechanics:** Free body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion, including impulse and momentum (linear and angular) and energy formulations; impact.

**Strength of Materials:** Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; strain energy methods; thermal stresses.

**Theory of Machines:** Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of slider-crank mechanism; gear trains; flywheels.

**Vibrations:** Free and forced vibration of single degree of freedom systems; effect of damping; vibration isolation; resonance, critical speeds of shafts.

**Design:** Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints, shafts, spur gears, rolling and sliding contact bearings, brakes and clutches.

**Electrical Engg.**


**Civil Engg.**

Geotechnical and Foundation Engineering; Structural Engineering; Construction Management; Hydraulics and Environmental Engineering; Hydrology and Water Resources Engineering; Transportation Engineering; Surveying; Concrete Technology; Building materials; Construction Technology.
Computer Engg.

Unit – I : - Engineering Mathematics

Unit – II : Computer Architecture and Networks

Unit – III : System Software

Unit – IV : Algorithms and Artificial Intelligence
Information & Communication Technology

Unit – I : - Engineering Mathematics

Unit II: Communication and Signal Processing:

Unit III: RF Engineering:

Unit IV: Computing and Embedded Systems:

PH.D. admissions January 2020 Syllabus for Written Aptitude Test
Chemical Engg.

Engineering mathematics:
Linear algebra: matrix algebra, systems of linear equations, eigen values and eigenvectors.
Calculus: functions of single variable, limit, continuity and differentiability, taylor series, mean value Theorems, evaluation of definite and improper integrals, partial derivatives, total derivative, maxima And minima, gradient, divergence and curl, vector identities, directional derivatives, line, surface and Volume integrals, stokes, gauss and green’s theorems.
Differential equations: first order equations (linear and nonlinear), higher order linear differential Equations with constant coefficients, cauchy’s and euler’s equations, initial and boundary value Problems, laplace transforms, solutions of one dimensional heat and wave equations and laplace Equation.
Complex variables: complex number, polar form of complex number, triangle inequality.
probability and statistics: definitions of probability and sampling theorems, conditional probability, mean, median, mode and standard deviation, random variables, poisson, normal and binomial distributions, linear regression analysis.

Process calculations and thermodynamics
Steady and unsteady state mass and energy balances including multiphase, multi-component, reacting and non-reacting systems. use of tie components; recycle, bypass and purge calculations; gibb’s phase rule and degree of freedom analysis.
first and second laws of thermodynamics. applications of first law to close and open systems.
second law and entropy. thermodynamic properties of pure substances: equation of state and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting vle of systems; chemical reaction equilibrium.

Fluid mechanics and mechanical operations
fluid statics, newtonian and non-newtonian fluids, shell-balances including differential form of bernoulli equation and energy balance, macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, turbulent flow: fluctuating velocity, universal velocity profile and pressure drop. particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.
Heat transfer
steady and unsteady heat conduction, convection and radiation, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations. design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.

Mass transfer
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.

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.

Instrumentation and process control
Measurement of process variables; sensors, transducers and their dynamics, process modeling and linearization, transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (p, pi, and pid); control valves; analysis of closed loop systems including stability, frequency response, controller tuning, cascade and feed forward control.

Plant design and economics
principles of process economics and cost estimation including depreciation and total annualized cost, cost indices, rate of return, payback period, discounted cash flow, optimization in process design and sizing of chemical engineering equipments such as compressors, heat exchangers, multistage contactors.

Chemistry

Inorganic Chemistry
1. Chemical periodicity
2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory ).
4. Main group elements and their compounds : Allotropy, synthesis, structure and bonding, industrial importance of the compounds.
5. Transition elements and coordination compounds : structure, bonding theories, spectral and
magnetic properties, reaction mechanisms.
6. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications.
8. Cages and metal clusters.
10. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine.
11. Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.
12. Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

**Physical Chemistry:**
1. Basic principles of quantum mechanics: Postulates; operator algebra; exactly-solvable systems: particle in a box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunneling.
2. Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.
3. Atomic structure and spectroscopy; term symbols; many-electron systems and antisymmetry principle.
4. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems.
5. Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules.
6. Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.
7. Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell’s relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.
10. Chemical kinetics: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.
11. Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.
12. Solid state: Crystal structures; Bragg’s law and applications; band structure of solids.
13. Polymer chemistry: Molar masses; kinetics of polymerization.
14. Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.
**Organic Chemistry**

1. IUPAC nomenclature of organic molecules including regio- and stereoisomers.
2. Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.
3. Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.
5. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.
7. Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations.
11. Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).
13. Structure determination of organic compounds by IR, UV-Vis, 1H & 13C NMR and Mass spectroscopic techniques.

**Interdisciplinary topics**

1. Chemistry in nanoscience and technology.
2. Catalysis and green chemistry.
3. Medicinal chemistry.
4. Supramolecular chemistry.
5. Environmental chemistry

**Physics**

**Mathematical Methods of Physics**

& Laurent series; poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.

Classical Mechanics


Electromagnetic Theory


Quantum Mechanics


Thermodynamic and Statistical Physics


Electronics and Experimental Methods

Semiconductor devices ( diodes, junctions, transistors, field effect devices, homo – and hetero – junction devices ), device structure, device characteristics, frequency dependence and applications. Opto – electronic devices ( solar cells, photo -detectors, LEDs ). Operational amplifiers and their applications. Digital techniques and applications ( registers, counters,
comparators and similar circuits). A / D and D / A converters. Microprocessor and microcontroller basics.

Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting.

Mathematical Methods of Physics


Classical Mechanics


Electromagnetic Theory

Dispersion relations in plasma. Lorentz invariance of Maxwell’s equation. Transmission lines and wave guides. Radiation – from moving charges and dipoles and retarded potentials.

Quantum Mechanics


Thermodynamic and Statistical Physics


Electronics and Experimental Methods

Atomic & Molecular Physics


Condensed Matter Physics


Nuclear and Particle Physics


Mathematics

UNIT – 1


**UNIT – 2**

**Complex Analysis:** Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy’s theorem, Cauchy’s integral formula, Liouville’s theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem. Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations.

**Algebra:** Permutations, combinations, pigeon-hole principle, inclusion-exclusion principle, derangements. Fundamental theorem of arithmetic, divisibility in $\mathbb{Z}$, congruences, Chinese Remainder Theorem, Euler’s $\phi$- function, primitive roots. Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley’s theorem, class equations, Sylow theorems. Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain. Polynomial rings and irreducibility criteria. Fields, finite fields, field extensions, Galois Theory.

**Topology:** basis, dense sets, subspace and product topology, separation axioms, connectedness and compactness.

**UNIT – 3**

**Ordinary Differential Equations (ODEs):** Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs. General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green’s function.

**Partial Differential Equations (PDEs):**

Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs.

Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations.

**Numerical Analysis :**

Differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

**Calculus of Variations:**


**Linear Integral Equations:**

Linear integral equation of the first and second kind of Fredholm and Volterra type, Solutions with separable kernels. Characteristic numbers and eigenfunctions, resolvent kernel.

**Classical Mechanics:**

Generalized coordinates, Lagrange’s equations, Hamilton’s canonical equations, Hamilton’s principle and principle of least action. Two-dimensional motion of rigid bodies, Euler’s dynamical equations for the motion of a rigid body about an axis, theory of small oscillations.

**UNIT – 4**


Simple random sampling, stratified sampling and systematic sampling. Probability proportional to size sampling. Ratio and regression methods. Completely randomized designs, randomized block designs and Latin-square designs. Connectedness and orthogonality of block designs, BIBD. 2^K factorial experiments: confounding and construction. Hazard function and failure rates, censoring and life testing, series and parallel systems. Linear programming problem, simplex methods, duality. Elementary queuing and inventory models. Steady-state solutions of Markovian queuing models: M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space, M/G/1.
Environmental Engg.

Mathematics


Environmental Chemistry and Micro-biology

Soil and Air and Industrial Microbiology, Introduction to algae for treatment of wastewater, Microbiology of bioremediation and solid waste treatment.

**Air Pollution**

Air pollutants, classification of air pollutants, properties of gaseous and particulate matter, effects of Air pollution on plants, animals, human health, Sources of Air pollution and emission inventory, Sampling and Analysis: Ambient air sampling, stack sampling, Air quality standards. Air pollution meteorology: Atmospheric energy balance, environmental lapse rates and atmospheric stability, winds, wind profiles, plume behaviour, convective current, turbulence, Dispersion of Air pollutants, Prediction of effective stack height - physics of plume rise, Holland's equation, Briggs equation, modifications of Gaussian dispersion models. Air quality monitoring, instrument, sampling frequency, sampling network design, Introduction to various air quality models – steady state, dynamic, continuous, discrete and empirical. Air pollution control devices, Air sampling and analysis, theory and equipment ambient and Stack sampling, monitoring of quality emission standards and Indoor air pollution, Control of Particulate matter: Dusts, fumes, smoke, samples, settling chambers, cyclones, spray towers, electrostatic precipitators, etc

**Atmospheric Processes**

Elements of Atmosphere and Physical Meteorology: Vertical temperature and pressure profile of atmosphere, atmospheric composition, scale height, solar and terrestrial radiation, transport of matter, energy and momentum in nature, wind, type of clouds and rain formation process. Conventional observational techniques, conventional measurement of pressure, temperature, humidity, wind, precipitation, visibility, Modern Observational Techniques: LIDARS, SODARS, RADARS, CTD, ARGO, Introduction of remote sensing from space. General Meteorology: Thermodynamics of dry and moist air: atmospheric stability and dry adiabatic lapse rate, saturated adiabatic lapse rate, pseudo adiabatic processes and equivalent potential temperature Clausius-Clapeyron (C-C) equation. Micrometeorology: Atmospheric fluid mechanics, turbulence, surface roughness and convective boundary layer. Satellite Meteorology: Introduction to satellite meteorology, weather satellite and orbits, satellite images, satellite winds, Data acquisition, data processing and applications, monitoring the global environment, Climate Change: Elements of weather and climate modeling, Basic equation and dynamics of atmosphere, Climate variability and climate change, Global warming and climate change, Elementary idea of Global climate models, Comparison of various IPCC reports, important findings of IPCC AR5, Impacts of climate change – Global and India.

**Solid And Hazardous Waste Management**

Types and Sources of solid wastes: Need for solid, hazardous and bio-medical waste management, Legislations on management and handling of municipal solid wastes, hazardous wastes and biomedical wastes. Waste generation rates, Composition, Hazardous Characteristics, TCLP tests, Waste sampling, Source reduction of wastes, Recycling and reuse. Handling and

**Industrial Wastewater Management**


**Environmental Modelling:**

Introduction: Mathematical modelling and simulation, Defining systems and its components, Types of models and their applications. Models for Fate and Transport of Contaminants: Modelling of volatilization, chemical transformations, sorption/desorption, photochemical transformations, biological transformations. Brief review of mass, momentum and energy

**Water Treatment**

Water cycle, quantity of water, Sources of water, water quality standards for potable and non-potable use, impact of water quality on human health, water usage rate, Design period and population forecast, Conventional Water Treatment, Specific Water Treatment like Water Softening, Ion Exchange, Electrodialysis, Membrane Technology: ultra filtration, nano filtration, Reverse Osmosis, Desalination, Defluoridation, Demineralization, Removal of colour, odour and heavy metals.

**Solar Energy**

Modes of solar energy conversion: Photovoltaic and thermal; Energy efficiency; Electromagnetic radiations and light; Characteristic of solar radiation; Solar collectors; Photon and its energy; Black body radiation; Fundamentals of thermodynamics; Entropy; Heat transfer; Specific heat; Kinetic theory of gases; Thin films and its methods of deposition; Plasma and its application in materials processing; Semiconductor and its fundamental properties; PN junction diodes and its energy diagram; Physical characterization techniques: XRD, SEM, IR-spectroscopy, AFM, XPS, Raman spectroscopy; Energy storage – SLA and Li ion battery technologies.