ADITYA UNIVERSITY

Ph.D. Entrance Examination Syllabus

(Applicable for the batches admitted from the AY: 2024-25)

Civil Engineering

Part A: Research Methodology

1. Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process
2. Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance
3. Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. (10%)
4. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.
5. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.
6. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non-Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.
7. Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.
8. Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.
9. Use of Encyclopaedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.
10. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

Part:B

Engineering Mathematics

Linear Algebra:

Systems of Linear Equations, Matrix Algebra, Eigen Values and Eigen Vectors

Calculus:

Evaluation Of Definite And Indefinite Integrals, Application Of Definite Integral To Obtain Area And Volume, Limit, Continuity, And Differentiability, Gradient, Divergence and Curl,

Vector Identities, Taylor Series, Functions Of Single Variable, Mean Value Theorems, Local Maxima And Minima, Partial Derivatives, Total Derivative, Line, Surface And Volume Integrals, Directional Derivatives

Ordinary Differential Equation (ODE):

Initial and Boundary Value Problems, Euler-cauchy Equations, Higher Order Linear Equations With Constant Coefficients, First Order (Linear And Nonlinear) Equations

Partial Differential Equation (PDE):

First and Second Order One-dimensional Wave Equation and Two Dimensional Laplace Equation, Fourier Series, Separation of Variables, Solutions of one-Dimensional Diffusion Equation

Probability and Statistics:

Linear Regression, Sampling Theorems, Descriptive statistics – Mean, median, mode, and standard deviation Random Variables – Discrete and Continuous, Poisson and Normal Distribution, Conditional Probability

Numerical Methods:

Single And Multi-step Methods for First Order Differential Equations, Newton's And Lagrange Polynomials, Numerical Solutions of Linear and Non-linear Algebraic Equation, Error Analysis, Integration by Trapezoidal and Simpson's Rule, Numerical Differentiation

Structural Engineering

Engineering Mechanics:

Free Vibrations of undamped SDOF System, Internal Forces in Structures, System of forces, free-body diagrams, equilibrium equations, Centre of Mass, Frictions and Its Applications

Solid Mechanics:

Simple Bending Theory, Flexural And Shear Stresses, Shear Centre, Simple Stress and Strain Relationships, Buckling Of Column, Combined and Direct Bending Stresses, Uniform Torsion, Transformation Of Stress, Bending Moment And Shear Force In Statically Determinate Beams

Structural Analysis:

Method Of Superposition, Statically Determinate And Indeterminate Structures By Force/ Energy Methods, Analysis of trusses, arches, beams, cables and frames, Influence Lines, Displacement Methods: Slope Deflection and Moment Distribution Methods, Stiffness And Flexibility Methods Of Structural Analysis

Construction Materials and Management:

Construction Materials: Structural Steel – Composition, Material Properties and Behaviour, Construction Management: Types of construction projects, Concrete – Constituents, Mix Design, Short-Term and Long-Term Properties, Project Planning and Network Analysis – PERT and CPM, Cost Estimation

Concrete Structures:

Bond and Development Length, Working Stress and Limit State Design Concepts, Prestressed Concrete Beams, Design of Beams, Slabs, Columns

Steel Structures:

Connections – Simple And Eccentric, Beam-Column Connections, Plate Girders and Trusses, Design Of Tension and Compression Members, Beams and Beam- Columns, Column Bases,

Working Stress And Limit State Design Concepts, Concept of Plastic Analysis -Beams And Frames

Geotechnical Engineering

Soil Mechanics:

Principle Of Effective Stress And Quicksand Condition, Shear Strength, Mohr's Circle, Effective And Total Shear Strength Parameters, Stress-Strain Characteristics Of Clays And Sand, Unified and Indian Standard Soil Classification System, Three-Phase System And Phase Relationships, Index Properties, Compaction Of Soils, One- Dimensional Consolidation, Time Rate Of Consolidation, Permeability – One Dimensional Flow, Seepage Through Soils – Two – Dimensional Flow, Flow Nets, Uplift Pressure, Piping, Capillarity, Seepage Force, Stress Paths

Foundation Engineering:

Deep Foundations – Dynamic And Static Formulae, Axial Load Capacity Of Piles In Sands And Clays, Pile Load Test, Pile Under Lateral Loading, Pile Group Efficiency, Negative Skin Friction, Sub-Surface Investigations – Drilling Bore Holes, Sampling, Plate Load Test, Standard Penetration And Cone Penetration Tests, Combined Footing And Raft Foundation, Contact Pressure, Pressure Bulbs, Shallow Foundations – Terzaghi's And Meyerhoff's Bearing Capacity Theories, Effect Of Water Table, Stress Distribution In Soils Boussinesq's Theory, Earth Pressure Theories – Rankine And Coulomb; Stability Of Slopes – Finite And Infinite Slopes, Bishop's Method, Settlement Analysis In Sands And Clays

Water Resources Engineering

Fluid Mechanics:

Concept Of Boundary Layer and Its Growth, Continuity, Momentum And Energy Equations And Their Applications, Flow In Pipes, Pipe Networks, Properties Of Fluids, Fluid Statics, Potential Flow, Laminar And Turbulent Flow, Concept Of Lift And Drag

Hydraulics:

Dimensional analysis and hydraulic similitude, Forces on immersed bodies, Channel Hydraulics – Energy-depth relationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and water surface profiles, Flow measurement in channels and pipes

Hydrology:

Application of Darcy's Law, Hydrologic cycle, precipitation, evaporation, evapo transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, reservoir capacity, flood estimation and routing, surface runoff models, ground water hydrology – steady state well hydraulics and aquifers

Irrigation:

Cross Drainage Structures, Gravity Dams and Spillways, Types Of Irrigation Systems and Methods, Lined And Unlined Canals, Design Of Weirs On Permeable Foundation, Crop Water Requirements – Duty, Delta, Evapotranspiration

Environmental Engineering

Water and Waste Water Quality & Treatment:

Basics of water quality standards – Physical, chemical and biological parameters, Water Quality Index, Drinking Water Treatment, Sewerage System Design, Quantity Of Domestic Wastewater, Primary Treatment and Secondary Treatment, Unit Processes And Operations,

Water Requirement, Effluent Discharge Standards, Sludge Disposal, Reuse Of Treated Sewage For Different Applications, Water Distribution System

Air Pollution:

Types of Pollutants, Their Sources and Impacts, Air Quality Index and Limits, Air Quality Standards, Air Pollution Control

Municipal Solid Wastes:

Engineered Systems for Solid Waste Management (Reuse/ Recycle, Energy Recovery, Treatment and Disposal), Characteristics, Generation, Collection and Transportation Of Solid Wastes

Transportation Engineering

Transportation Infrastructure:

Geometric Design of Railway Track – Speed and Cant**,** Geometric Design Of Highways – Cross Sectional Elements, Sight Distances, Horizontal And Vertical Alignments**,** Taxiway and Exit Taxiway Design**,** Concept Of Airport Runway Length, Calculations and Corrections

Highway Pavements:

Design Factors For Flexible And Rigid Pavements, Desirable Properties Of Bituminous Paving Mixes, Highway Materials – Desirable Properties And Tests, Design Of Flexible And Rigid Pavement Using IRC Codes

Traffic Engineering:

Traffic Studies on Flow and Speed, Peak Hour Factor, Accident Study, Statistical Analysis of Traffic Data, Highway Capacity, Traffic Signs, Types of Intersections, Microscopic and Macroscopic Parameters of Traffic Flow, Fundamental Relationships, Signal Design by Webster's Method

Geomatics Engineering

Basics of Remote Sensing and GIS, Errors and Their Adjustment, Principles of Surveying, Traversing and Triangulation Survey, Total Station, Photogrammetry and Remote Sensing – Scale, Flying Height, Horizontal and Vertical Curves, Distance And Angle Measurement – Leveling And Trigonometric Leveling, Maps – Scale, Coordinate System

Electrical and Electronics Engineering

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9. Use of Encyclopaedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.
10. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

Part: B

Engineering Mathematics

Linear Algebra:

Eigenvectors, Systems of linear equations, Matrix Algebra, Eigenvalues

Calculus:

Theorems of Integral Calculus, Mean Value Theorems, Evaluation of Definite and Improper Integrals, Maxima and Minima, Partial Derivatives, Multiple Integrals, Vector Identities,

Fourier Series, Directional Derivatives, Surface Integral, Line Integral, Volume Integral, Stokes's Theorem, Divergence Theorem, Gauss's Theorem, Green's Theorem

Differential equations:

Cauchy's Equation, Higher-Order Linear Differential Equations with Constant Coefficients, First-Order Equations (Linear and Nonlinear), Method of Variation of Parameters, Partial Differential Equations, Initial And Boundary Value Problems, Euler's Equation, Method Of Separation Of Variables

Complex variables:

Solution Integrals, Cauchy's Integral Theorem, Analytic Functions, Cauchy's Integral Formula, Laurent Series, Taylor Series, Residue Theorem

Probability and Statistics:

Conditional Probability, Sampling Theorems, Mean, Mode, Median, Standard Deviation, Discrete and Continuous distributions, Random Variables, Poisson Distribution, Binomial Distribution, Normal Distribution, Correlation Analysis, Regression Analysis

Electric circuits

Network elements:

Dependent Sources, R, L, C, M Elements, Ideal Voltage And Current Sources, Network solution methods: KVL, KCL, Node And Mesh Analysis, Network Theorems: Thevenin's, Norton's, Superposition and Maximum Power Transfer Theorem, Resonance, Transient Response of dc & ac networks, Sinusoidal Steady-State Analysis, Balanced Three-Phase Circuits, Two-Port Networks, Complex Power And Power Factor in ac circuits, Star-Delta Transformation

Electromagnetic Fields

Electric Field Intensity, Coulomb's Law, Electric Flux Density, Divergence, Gauss's Law, Electric field and potential due to point, line, plane and spherical charge distributions, Effect Of Dielectric Medium, Biot-Savart's Law, Capacitance Of Simple Configurations, Ampere's Law, Curl, Self And Mutual Inductance Of Simple Configurations, Lorentz Force, Inductance, Faraday's Law, Magnetomotive Force, Magnetic Circuits, Reluctance

Signals and Systems

Average Value Calculation for any General Periodic Waveform, Shifting and Scaling Properties, Representation of Continuous and Discrete-Time Signals, Linear Time-Invariant and Causal Systems, Laplace Transform and Z Transform, R.M.S. Value, Sampling Theorem, Fourier Series Representation of Continuous and Discrete-Time Periodic Signals, Applications of Fourier Transform for Continuous and Discrete-Time Signals

Electrical Machines

Single-phase transformer: Equivalent Circuit, Open Circuit And Short Circuit Tests, Phasor Diagram, Regulation And Efficiency, Three-phase transformers: connections, vector groups, parallel operation, Electromechanical Energy Conversion Principles, Auto-Transformer, DC machines: separately excited, series and shunt, motoring and generating, mode of operation and their characteristics, speed control of dc motors, Three-phase induction machines: principle of operation, types, performance, torque-speed characteristics, no-load and blocked-rotor tests, equivalent circuit, starting and speed control, Synchronous machines: cylindrical and salient pole machines, performance and characteristics, regulation and parallel operation

of generators, starting of synchronous motors, Types of Losses And Efficiency Calculations Of Electric Machines

Power Systems

Models And Performance Of Transmission Lines And Cables, Basic Concepts Of Electrical Power Generation, Ac And Dc Transmission Concepts, Economic Load Dispatch (With And Without Considering Transmission Losses), Electric Field Distribution And Insulators, Series And Shunt Compensation, Distribution Systems, Bus Admittance Matrix, Per-Unit Quantities, Gauss- Seidel And Newton-Raphson Load Flow Methods, Power Factor Correction, Voltage And Frequency Control, Symmetrical Components, Principles of Over-Current, Differential, Directional And Distance Protection, Symmetrical and Unsymmetrical Fault Analysis, Circuit Breakers, System stability concepts, Equal Area Criterion

Control Systems

Feedback Principle, Mathematical Modelling and Representation Of Systems, Transfer Function, Transient And Steady-State Analysis Of Linear Time-Invariant Systems, Block Diagrams And Signal Flow Graphs, Stability Analysis Using Routh-Hurwitz And Nyquist Criteria, Root Loci, Bode Plots, Lag, Lead And Lead-Lag Compensators, Solution Of State Equations Of LTI Systems, P, PI And PID Controllers, State-Space Model

Electrical and Electronic Measurements

Measurement Of Voltage, Current, Power, Energy And Power Factor, Bridges And Potentiometers, Instrument Transformers, Oscilloscopes, Error Analysis, Phase, Time and Frequency measurement, Digital Voltmeters And Multimeters, Time And Frequency Measurement

Analog and Digital Electronics

Simple diode circuits: Clamping, Clipping, Rectifiers, Amplifiers: Biasing, Equivalent Circuit and Frequency Response, Oscillators And Feedback Amplifiers, Operational amplifiers: characteristics and applications; single stage active filters, Active Filters: Sallen Key, Butterwoth, VCOs and timers, combinatorial and sequential logic circuits, multiplexers, demultiplexers, Schmitt triggers, sample and hold circuits, A/D and D/A converters.

Power Electronics

Static V-I characteristics and firing/gating circuits for Thyristor, MOSFET, IGBT; DC to DC conversion, Buck, Boost And Buck-Boost Converters, Single and Three-Phase Configuration Of Uncontrolled Rectifiers, Bidirectional ac to dc Voltage Source Converters, Voltage And Current Commutated Thyristor Based Converters, Magnitude And Phase Of Line Current Harmonics For Uncontrolled and Thyristor-Based Converters, Single-Phase And Three-Phase Voltage And Current Source Inverters, Power Factor And Distortion Factor Of ac to dc Converters, Sinusoidal Pulse Width Modulation

Mechanical Engineering

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Part: B

Engineering Mathematics

Linear Algebra:

Systems of Linear Equations, Matrix Algebra, Eigenvalues and Eigenvectors

Calculus:

Limit, Functions Of A Single Variable, Continuity and Differentiability, Indeterminate Forms, Mean Value Theorems, Evaluation Of Definite And Improper Integrals, Taylor Series

(In One And Two Variables), Partial Derivatives, Double And Triple Integrals, Total Derivative, Fourier Series, Maxima and Minima, Gradient, Divergence and Curl, Directional Derivatives, Vector Identities, Line, Surface and Volume Integrals, Applications Of Gauss Theorem, Stokes, and Green's Theorems

Differential equations:

Initial and Boundary Value Problems, Higher-Order Linear Differential Equations With Constant Coefficients, First-Order Equations (Linear And Nonlinear), Euler-Cauchy Equation, Laplace Transforms, Solutions of heat, wave and Laplace's equations

Complex variables:

Taylor and Laurent Series, Cauchy-Riemann Equations, Analytic Functions, Cauchy's Integral Theorem and Integral Formula

Probability and Statistics:

Definitions of Probability, Sampling Theorems, Conditional Probability, Median, Mean, Mode, and Random Variables, Binomial, Poisson and Normal Distributions

Numerical Methods:

Integration by Trapezoidal and Simpson's Rules, Numerical Solutions of Linear and Non-Linear Algebraic Equations, Single and Multi-Step Methods for Differential Equations

Applied Mechanics and Design

Engineering Mechanics:

Friction And Its Applications Including Rolling Friction, Free-Body Diagrams and Equilibrium, Screw Jack, Brakes, Belt-Pulley, Clutches, Vehicles, Wedge, Trusses and Frames, Virtual Work, Impulse And Momentum (Linear and Angular) and Energy Formulations, Kinematics And Dynamics Of Rigid Bodies in Plane Motion, Lagrange's Equation

Mechanics of Materials:

Thin Cylinders, Elastic Constants, Stress and Strain, Poisson's Ratio, Mohr's Circle For Plane Stress And Plane Strain, Bending and Shear Stresses, Shear Force And Bending Moment Diagrams, Deflection Of Beams, Concept Of Shear Centre, Euler's Theory Of Columns, Torsion Of Circular Shafts, Thermal Stresses, Energy Methods, Testing Of Materials With Universal Testing Machine, Strain Gauges and Rosettes, Testing Of Hardness and Impact Strength

Theory of Machines:

Velocity and Acceleration Analysis of Plane Mechanisms, Dynamic Analysis of Linkages, Displacement, Cams, Gears and Gear Trains, Flywheels and Governors, Gyroscope, Balancing of Reciprocating and Rotating Masses

Vibrations:

Resonance, Effect of Damping, Free and Forced Vibration of Single Degree of Freedom Systems, Vibration Isolation, Critical Speeds of Shafts

Machine Design:

Failure Theories, Design For Static and Dynamic Loading, Principles Of The Design of Machine Elements Such As Bolted, Riveted And Welded Joints, Fatigue Strength and the S-N Diagram, Gears, Shafts, Brakes and Clutches, Rolling and Sliding Contact Bearings, Springs

Fluid Mechanics and Thermal Sciences

Fluid Mechanics:

Fluid Statics, Fluid Properties, Stability Of Floating Bodies, Forces On Submerged Bodies, Control-Volume Analysis of Mass, Momentum And Energy, Differential Equations of Continuity and Momentum, Fluid Acceleration, Dimensional Analysis, Bernoulli's Equation, Boundary-Layer, Viscous Flow of Incompressible Fluids, Flow through Pipes, Elementary Turbulent Flow, Head Losses in Pipes, Bends and Fittings, Basics of Compressible Fluid Flow

Heat-Transfer:

One Dimensional Heat Conduction, Modes of Heat Transfer, Heat Transfer Through Fins, Resistance Concept and Electrical Analogy, Lumped Parameter System, Unsteady Heat Conduction, Thermal Boundary Layer, Heisler's Charts, Heat Transfer Correlations For Flow Over Flat Plates and through Pipes, Dimensionless Parameters In Free and Forced Convective Heat Transfer, Heat Exchanger Performance, Effect of Turbulence, Radiative Heat Transfer, LMTD and NTU methods, Wien's Displacement Law, Stefan- Boltzmann Law, View Factors, Black and Grey Surfaces, Radiation Network Analysis

Thermodynamics:

Properties Of Pure Substances, Behaviour of Ideal And Real Gases, Zeroth and First Laws Of Thermodynamics, Second Law of Thermodynamics, Availability and Irreversibility, Thermodynamic Systems and Processes, Thermodynamic Property Charts and Tables, Calculation of Work And Heat in Various Processes, Thermodynamic Relations

Applications:

Power Engineering: Vapour And Gas Power Cycles, Air and Gas Compressors, Concepts of Regeneration and Reheat, I.C. Engines: Diesel and dual cycles, Air-standard Otto, Refrigeration and air-conditioning: Basic Psychrometric Processes, Properties of Moist Air, Vapour and Gas Refrigeration and Heat Pump Cycles, Psychrometric Chart, Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines; steam and gas turbines

Materials, Manufacturing, and Industrial Engineering &Engineering Materials:

Stress-Strain Diagrams for Engineering Materials, Phase Diagrams, Structure and Properties of Engineering Materials, Heat Treatment

Casting, Forming and Joining Processes:

Solidification And Cooling, Riser And Gating Design, Design of Patterns, Molds and Cores, Different Types of Castings, Fundamentals of Hot and Cold Working Processes, Plastic Deformation and Yield Criteria, Principles of Powder Metallurgy, Load Estimation For Bulk (Forging, Extrusion, Rolling, Drawing) and Sheet (Shearing, Deep Drawing, Bending) Metal Forming Processes, Principles of Welding, Soldering, Brazing, and Adhesive Bonding

Machining and Machine Tool Operations:

Basic Machine Tools, Mechanics of Machining, Single and Multi-Point Cutting Tools, Tool Life And Wear, Tool Geometry and Materials, Economics of Machining, Principles of Work Holding, Jigs and Fixtures, Principles of Non-Traditional Machining Processes, Abrasive Machining Processes, NC/CNC machines and CNC programming

Metrology and Inspection:

Interferometry, Linear and Angular Measurements, Limits, Fits and Tolerances, Comparators, Alignment and Testing Methods, Form and Finish Measurement, Concepts of Coordinate-Measuring Machine (CMM), Tolerance Analysis in Manufacturing and Assembly

Computer Integrated Manufacturing:

Additive Manufacturing, Basic concepts of CAD/CAM and their Integration Tools

Production Planning and Control:

Materials Requirement Planning, Aggre Production Planning, Forecasting Models, Scheduling, Lean Manufacturing

Inventory Control:

Safety Stock Inventory Control Systems, Deterministic Models

Operations Research:

Simplex Method, Linear Programming, Transportation, Assignment, Simple Queuing Models, Network Flow Models, PERT and CPM

Electronics & Communication Engineering

Part A: Research Methodology

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Part: B

Engineering Mathematics

Linear Algebra:

Basis, Vector Space, Matrix Algebra, Linear Dependence and Independence Rank, Eigenvalues and Eigenvectors, Solution of Linear Equations- Existence and Uniqueness

Calculus:

Partial Derivatives, Theorems Of Integral Calculus, Mean Value Theorems, Evaluation Of Definite And Improper Integrals, Line, Surface And Volume Integrals, Maxima And Minima, Multiple Integrals, Taylor Series

Differential Equations:

Higher-Order Linear Differential Equations, First-Order Equations (Linear and Nonlinear) Cauchy's And Euler's Equations, Variable Separable Method, Complementary Function and Particular Integral, Methods of Solution Using Variation of Parameters, Partial Differential Equations, Initial and Boundary Value Problems

Vector Analysis:

Divergence and Curl, Vector Operations, Vectors in Plane and Space, Gradient, Green's and Stokes' Theorems, Gauss's Theorem

Complex Analysis:

Series, Cauchy's Integral Theorem, Analytic Functions, Cauchy's Integral Formula Sequences, Taylor and Laurent Series, Convergence Tests, Residue Theorem

Probability and Statistics:

Median, Mean, Mode, Standard Deviation, Probability Distributions, Combinatorial Probability, Poisson Distribution, Binomial Distribution, Normal Distribution, Exponential Distribution, Joint and Conditional Probability

Networks, Signals and Systems Circuit Analysis

Thevenin's Theorem, Node and Mesh Analysis, Circuit Analysis, Superposition, Reciprocity, Norton's Theorem, Sinusoidal steady-state analysis: Complex Power, Maximum Power Transfer, Time and frequency domain analysis of linear circuits: RL, RC And RLC Circuits, Solution Of Network Equations Using Laplace Transform, Linear 2-port network parameters, wye-delta transformation.

Continuous-time signals:

Sampling Theorem and Applications, Fourier series and Fourier Transform

Discrete-time signals:

DTFT, DFT, z-transform, discrete-time processing of continuous-time signals, LTI systems: Definition and Properties, Stability, Causality, Impulse Response, Convolution, Poles and Zeroes, Group Delay, Frequency Response, Phase Delay

Electronic Devices

Equilibrium Carrier Concentration, Energy Bands in Intrinsic and Extrinsic Semiconductors, Direct and Indirect Band-Gap Semiconductors

Carrier transport:

Drift Current, Diffusion Current, Mobility and Resistivity, Zener Diode, Poisson and Continuity Equations, Generation And Recombination of Carriers, P-N Junction, Photo Diode and Solar Cell, BJT, MOS Capacitor, LED, MOSFET

Analog Circuits

Diode circuits:

Clamping, Clipping, and Rectifiers

BJT and MOSFET amplifiers:
AC Coupling, Biasing, Small-Signal Analysis, Current Mirrors and Differential Amplifiers, Frequency Response
Op-amp circuits:
Integrators, summers, Amplifiers, Differentiators, Schmitt Triggers and Oscillators, Active Filters

Digital Circuits

Number representations:
Binary, integer and floating-point- numbers, Combinatorial circuits: Arithmetic Circuits, Minimization of Functions Using Boolean Identities and Karnaugh Map, Boolean Algebra, Logic Gates and Their Static CMOS Implementations, Multiplexers, Code Converters, Decoders
Sequential circuits:
Finite State Machines, Counters, Latches and Flip-Flops, Shift-Registers, Setup and Hold Time, Propagation Delay, Critical Path Delay
Data converters:
Sample and Hold Circuits, ADCs & DACs
Semiconductor memories:
SRAM, ROM, DRAM
Computer organization:
Machine Instructions and Addressing Modes, Data-Path and Control Unit, ALU, Instruction Pipelining
Control Systems
Feedback Principle, Basic Control System Components, Transfer Function, Signal Flow Graph, Block Diagram Representation, Transient and Steady-State Analysis of LTI Systems, State Variable Model and Solution Of State Equation Of LTI Systems, Routh-Hurwitz And Nyquist Stability Criteria, Frequency Response, Bode and Root-Locus Plots, Lag, Lead And Lag Lead Compensation

Communications

Random processes:
Properties of White Noise, Autocorrelation and Power Spectral Density, Filtering of Random Signals through LTI Systems
Analog communications:
Superheterodyne Receivers, Angle Modulation and Demodulation, Amplitude Modulation and Demodulation, Spectra of AM and FM
Information theory:
Mutual Information and Channel Capacity Theorem, Entropy
Digital communications:
DPCM, PCM, Digital Modulation Schemes (ASK, PSK, FSK, QAM), Inter-Symbol Interference, Bandwidth, MAP, Matched Filter Receiver, ML Detection, Hamming Codes, Fundamentals Of Error Correction, SNR and BER, CRC

Electromagnetics

Maxwell's equations:

Poynting Vector, Boundary Conditions, Differential and Integral Forms and Their Interpretation, Wave Equation

Plane waves and properties:

Propagation through Various Media, Polarization, Reflection and Refraction, Phase an, Group Velocity, Skin Depth

Transmission lines:

Characteristic Impedance, Equations, Impedance Matching, S-Parameters, Impedance Transformation, Smith Chart, Linear Antenna Arrays, Light Propagation in Optical Fibers, Rectangular and Circular Waveguides, Dipole and Monopole Antennas

Computer Science and Engineering

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Part: B

Engineering Mathematics

Discrete Mathematics:

Graphs: connectivity, matching, coloring, Combinatorics: counting, recurrence relations, generating functions, Propositional and First Order Logic, Monoids, Groups, Sets, Relations, Functions, Partial Orders and Lattices

Linear Algebra:
Matrices, System of Linear Equations, Determinants, LU Decomposition, Eigenvalues and Eigenvectors
Calculus:
Maxima and Minima, Integration, Mean Value Theorem, Limits, Continuity and Differentiability
Probability and Statistics:
Mean, Median, Mode and Standard Deviation, Conditional Probability and Bayes Theorem, Uniform, Normal, Exponential, Poisson and Binomial Distributions, Random Variables
Digital Logic:
Boolean algebra, Number Representations and Computer Arithmetic (Fixed and Floating Point), Minimization, Combinational and Sequential Circuits
Computer Organization and Architecture:
I/O Interface (Interrupt and DMA Mode), ALU, Data-Path and Control Unit, Memory Hierarchy: Cache, Main Memory and Secondary Storage, Machine Instructions and Addressing Modes, Instruction Pipelining, Pipeline Hazards
Programming and Data Structures:
Recursion, Programming in C, Arrays, Stacks, Queues, Linked Lists, Trees, Binary Search Trees, Binary Heaps, Graphs
Algorithms:
Algorithm Design Techniques: Greedy, Dynamic Programming And Divide-And-Conquer, Graph Traversals, Minimum Spanning Trees, Shortest Paths, Searching, Sorting, Hashing, Asymptotic Worst Case Time And Space Complexity
Theory of Computation:
Turing Machines and Undecidability, Regular Expressions and Finite Automata, Regular and Context-free Languages, Pumping Lemma, Context-free Grammars and Push-down Automata
Compiler Design:
Runtime Environments, Lexical Analysis, Parsing, Syntax-Directed Translation, Local Optimisation, Data Flow Analyses: Constant Propagation, Liveness Analysis, Common Subexpression Elimination, Intermediate Code Generation
Section 8: Operating System:
File Systems, System Calls, Processes, Threads, Inter-Process Communication, Concurrency and Synchronization, Deadlock, Memory Management and Virtual Memory, CPU and I/O Scheduling
Databases:
Integrity Constraints, Normal Forms, ER-Model, Transactions and Concurrency Control, File Organization, Indexing (E.g., B and B+ Trees), Relational Model: Relational Algebra, Tuple Calculus, SQL
Computer Networks:
Fragmentation and IP Addressing, IPv4, CIDR Notation, Basics Of IP Support Protocols (ARP, DHCP, ICMP), Network Address Translation (NAT), Basics Of Packet, Circuit And Virtual Circuit-Switching, Transport Layer: Flow Control And Congestion Control, UDP, TCP, Sockets, Routing Protocols: Shortest Path, Flooding, Distance Vector And Link State

Routing, Concept Of Layering: OSI And TCP/IP Protocol Stacks, Application Layer Protocols: DNS, SMTP, HTTP, FTP, Email, Data Link Layer: Framing, Error Detection, Medium Access Control, Ethernet Bridging

Mining Engineering

Part A: Research Methodology

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Part:B

Engineering Mathematics

Linear Algebra:

Matrices and Determinants, Systems of linear equations, Inverse and Rank of matrix, Cayley-Hamilton Theorem, Eigenvalues and Eigenvectors

Calculus:

Sequences and series, Taylor's theorem, Limit, continuity and differentiability, Fourier series, Partial Derivatives, Indeterminate forms and L' Hospital's rule, Mean value theorems, Maxima and minima, Test for convergence

Vector Calculus:

Gradient, Line, Divergence and Curl, Stokes, Gauss and Green's theorems, Surface and volume integrals

Differential Equations:

Linear and non-linear first order ODEs, Cauchy's and Euler's equations, Higher order linear ODEs with constant coefficients

Probability and Statistics:

Measures of central tendency and dispersion, Correlation and regression analysis, Hypothesis testing, Binomial, Poisson, exponential and normal distributions

Numerical Methods:

Solutions of linear algebraic equations, Integration of trapezoidal and Simpson's rule, Interpolation, Single and multi-step methods for differential equations

Mining Geology, Mine Development and Surveying

Mining Geology:

Minerals, Rocks and their Origin, Classification, Structural Geology, Ore Genesis

Mine Development:

Methods of access to deposits, Drilling method and machines, Underground drivages, Rock-Tool Interaction applicable to mechanical cutting systems and their selection, Explosives and energetics, blasting devices, blast design practices

Mine Surveying:

Levels and levelling, theodolite, tacheometry, triangulation, Errors and adjustments, Contouring, Underground surveying, Photogrammetry, EDM, Total Station, GPS, Basics of GIS and remote sensing, Correlation, Curves

Geomechanics and Ground Control

Engineering Mechanics:

Equivalent force systems, two dimensional frames and trusses, Equations of equilibrium, Friction forces, Particle kinematics and dynamics, free body diagrams, Beam analysis

Geomechanics:

Geo-technical properties of rocks, Instrumentation and in-situ stress measurement techniques, Rock mass classification, Ground vibrations, Stress distribution around mine openings, Slope stability, Theories of rock failure, Subsidence

Ground Control:

Design of pillars, Mine filling, Roof supporting systems, Strata Control and Monitoring Plan

Mining Methods and Machinery

Mining Methods:

Surface mining: layout, development, loading, transportation and mechanization, continuous surface mining systems; highwall mining; Underground coal mining: bord and pillar systems, room and pillar mining, longwall mining, thick seam mining methods,

Underground metal mining: open, supported and caved stoping methods, stope mechanization, ore handling systems.

Mining Machinery:

Generation and transmission of mechanical, hydraulic and pneumatic power; Materials handling: wire ropes, haulages, conveyors, face and development machinery, hoisting systems, pumps; comminution methods and machinery.

Surface Environment, Mine Ventilation and Underground Hazards

Surface Environment:

Air, water and soil pollution: Standards of quality, causes and dispersion of contamination and control; Noise pollution and control; Land reclamation; EIA

Mine Ventilation:

Underground atmosphere; Heat load sources and thermal environment, air cooling; Mechanics of airflow, distribution, natural and mechanical ventilation; Mine fans and usage; Auxiliary ventilation; Ventilation survey and planning; Ventilation networks.

Underground Hazards:

Mine Gases, Methane drainage, Rescue apparatus and practices, Underground hazards from fires, explosions, dust and inundation, Accident data analysis, Assessment, Mine legislation, Occupational health and safety, Safety management plan, Mine lighting

Mineral Economics, Mine Planning, Systems Engineering

Mineral Economics:

Mineral resource classification, Mine valuation, discounted cash flow analysis, Mineral taxation

Mine Planning:

Sampling methods, practices and interpretation; Reserve estimation techniques: Basics of geostatistics and quality control; Optimization of facility location; Mine planning and its components, Determination of mine size and mine life; Ultimate pit configuration and its determination, Optimum mill cut-off grade and its determination, Stope planning, Design of haul road, Selection of mining system vis-à-vis equipment system.

Systems Engineering:

Concepts of reliability; Reliability of simple systems; Maintainability and availability; Linear programming, transportation and assignment problems; Network analysis; Inventory models; Queuing theory; Decision trees.

Petroleum Engineering

Part A: Research Methodology

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Part:B

Linear Algebra:

Matrix Algebra, Eigen Values and Eigenvectors, Systems of Linear Equations

Calculus:

Functions Of Single Variable, Total Derivative, Taylor Series, Mean Value Theorems, Limit, Continuity And Differentiability , Partial Derivatives, Directional Derivatives, Maxima And Minima, Vector Identities, Line, Surface And Volume Integrals, Gradient,

Divergence And Curl, Evaluation Of Definite And Improper Integrals, Stokes, Gauss And Green's Theorems

Differential equations:

First Order Equations (Linear and Nonlinear), Initial and Boundary Value Problems, Higher Order Linear Differential Equations with Constant Coefficients, Cauchy's And Euler's Equations, Solutions of One Dimensional Heat and Wave Equations and Laplace Equation, Laplace Transforms

Complex variables:

Polar Form of Complex Number, Complex Number, Triangle Inequality

Probability and Statistics:

Normal and Binomial Distributions, Definitions of Probability and Sampling Theorems Poisson, Random Variables, Mean, Median, Mode and Standard Deviation, Conditional Probability, Linear Regression Analysis

Numerical Methods:

Integration by Trapezoidal and Simpson's Rule, Numerical Solutions of Linear and Non-Linear Algebraic Equations, Single and Multi-Step Methods for Numerical Solution of Differential Equations

Petroleum Exploration:

Origin, Migration and Accumulation of Petroleum, Classification and Description of Some Common Rocks with Special Reference to Clastic and Non Clastic Reservoir Rocks, Petroleum Exploration Methods

Oil and Gas Well Drilling Technology:

Drill String & Casing String Function, Operations, Selection & Design, Drilling Method , Application Of Horizontal, Multilateral, Extended Reach, Slim Wells, Drilling Fluids Function And Properties, Drilling Fluid Maintenance Equipment, Directional Drilling Tools , Drill Bit Types And Their Applications, Well Planning, Drilling Rigs Rig Operating Systems, Drilling Problems, Their Control & Remedies, Directional Survey, Oil & Gas Well Cementing Operations

Reservoir Engineering:

Reservoir Drives, Drive Mechanics and Recovery Factors, Coring and Core Analysis, Water And Gas Coning, Reserve Estimation & Techniques, Flow of Fluids Through Porous Media, Phase behavior of Hydrocarbon System, Reservoir Pressure Measurements, Reservoir Fluid Properties, petrophysical Properties Of Reservoir Rocks

Petroleum Production Operations:

Well Equipment, Pressure Vessels, Storage Tanks, Shell And Tube Heat Exchangers, Pumps And Compressors, LNG Value Chain, Well Completion Techniques, Artificial lift techniques, Formation Damage, Metering And Measurements Of Oil & Gas, Workover & Completion Fluids, Well Servicing & Workover Operations, Multiphase Flow In Tubing And Flow-Lines, Well Production Problems And Mitigation, Field Processing Of Oil & Gas, Storage and, Transportation Of Petroleum And Petroleum Products, Production Testing, Production System Analysis & Optimization, Multiphase Flow In Tubing And Flow-Lines, Nodal System Analysis & Well Stimulation Techniques

Offshore Drilling and Production Practices:

Use Of Conductors And Risers, Deep Water Applications Of Subsea Technology, Offshore Drilling From Fixed Platform, Jack-Up, Ships And Semi Submersibles, Offshore Well Completion, Offshore Fixed Platforms, Offshore Mobile Units, Station Keeping Methods Like Mooring Dynamic Positioning System, Offshore Oil And Gas Operations & Ocean Environment, Offshore production: Oil processing platforms, water injection platforms, storage, SPM and SBM transportation and utilities, Deep water drilling rig, Deep water production system, Emerging deep water technologies

Petroleum Formation Evaluation:

Standard Log Interpretation Methods, Evaluation Of CBL/VDL, USIT, SFT, RFT, Cross-Plotting Methods, Special Type Of Logging Tools, Evaluation Of Petrophysical Of Sub-Surface Formations: Principles Applications, Advantages And Disadvantages Of SP, Resistivity, Radioactive, Acoustic Logs And Types Of Tools Used, Casing Inspection Tools (Principles, Applications And Limitations), Formations Micro Scanner (FMS), NMR Logging Principles, Production Logging Tools, Principles, Limitations And Applications

Oil and Gas Well Testing:

Injection Well Testing, Interference Testing, Pulse Testing, Well-Test Analysis By Use Of Type Curves, Radius Of Investigation, Principle Of Superposition, Gas Well Testing Multilayer Reservoirs, Drill Stem Testing, Pressure Transient Tests: Drawdown And Build Up-Test Analysis, Diffusivity Equation, Derivation & Solutions, Wellbore Effects, Multiple Well Testing Horner's Approximation

Health Safety and Environment in Petroleum Industry:

Offshore Oil Spill and Oil Spill Control, Health Hazards in Petroleum Industry: Toxicity, Physiological, Asphyxiation, Respiratory and Skin Effect of Petroleum Hydrocarbons, Sour Gasses, Safety System: Manual & Automatic Shutdown System, Blow down Systems. Fire Detection and Suppression Systems, Personal Protection System & Measures, Waste Treatment Methods, Environment: Environment Concepts, Impact on Ecosystem, Air, Water and Soil, Disaster & Crisis Management in Petroleum Industry, Gas Detection System, Offshore Environmental Studies, the Impact of Drilling & Production Operations On The Environment, Environmental Transport Of Petroleum Wastes, HSE Policies

Enhanced Oil Recovery Techniques:

Macroscopic and Microscopic Displacement Efficiency, Basic Principles and Mechanism of EOR, Screening Of EOR Process, EOR Methods: Chemical Flooding, Miscible Flooding, Thermal Recoveries (Steam Stimulation, Hot Water & Steam Flooding, In-Situ Combustion), Microbial EOR, Concept of Pattern Flooding, Recovery Efficiency, Permeability Heterogeneity

Latest trends in Petroleum Engineering:

Coal Bed Methane, Shale Gas, Oil Shale, Gas Hydrate, and Heavy Oil

Agricultural Engineering

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Part:B

Engineering Mathematics

Linear Algebra:

Eigenvalues and Eigenvectors, Matrices and Determinants, Linear and Orthogonal Transformations, caley Hamilton Theorem, Solutions of Linear Equations

Calculus:

Partial derivatives, Limit, continuity and differentiability, Maxima and minima of function with several independent variables, Taylor and MacLaurin series, Sequences and Series – infinite series, tests for convergence, Homogeneous function – Total differentiation, Euler's theorem on homogeneous functions, Fourier

Vector Calculus:

Scalar and vector point functions, Vector differentiation, Stokes, Gauss and Green's theorems, Vector differential operators – del, gradient, Divergence and curl, Physical interpretations-line, surface and volume integrals

Differential Equations:

Homogeneous differential equations, Linear and non-linear first order Ordinary Differential Equations (ODE), Laplace transforms and their inverse, Partial Differential Equations – Laplace, heat and wave equations, Higher order linear ODEs with constant coefficients

Probability and Statistics:

Random variables, Mean, median, mode and standard deviation, Correlation and regression analysis, Poisson, normal and binomial distributions

Numerical Methods:

Numerical integration – trapezoidal and Simpson's rule, Solutions of linear and non-linear algebraic equations, Numerical solutions of ODEs

Farm Machinery

Machine Design:

Overload safety devices used in farm machinery, Design and selection of machine elements – gears, pulleys, chains and sprockets and belts, Measurement of force, stress, torque, speed, displacement and acceleration on machine elements – shafts, couplings, keys, bearings and knuckle joints

Farm Machinery:

Soil tillage, Hitch systems and hitching of tillage implements, Forces acting on a tillage tool, Functional requirements, principles of working, construction and operation of manual, Animal and power operated equipment for tillage, sowing, planting, fertilizer application, intercultivation, spraying, mowing, chaff cutting, harvesting and threshing calculation of performance parameters – field capacity, efficiency, application rate and losses, Cost analysis of implements and tractors

Farm Power-Sources of Power

Bio-fuels, Sources of power on the farm – human, animal, mechanical, electrical, wind, solar and biomass

Farm Power:

Thermodynamic principles of I.C. engines, Engine components, I.C. engine cycles, Lubricants and their properties, I.C. engine systems – fuel, cooling, lubrication, ignition, electrical, intake and exhaust, Power efficiencies and measurement, Selection, operation, maintenance and repair of I.C. engines, Performance index, cost analysis of implements and tractors, Fuels and combustion, Calculation of power, torque, fuel consumption, heat load and power losses

Tractors and Power tillers:

Type, selection, maintenance, and repair of tractors and power tillers, Power transmission systems – gear trains, differential, final drives and power take-off, Tractor clutches and brakes, Tractor tests and performance, Human engineering and safety considerations in design of tractor and agricultural implements, Traction theory, Steering and hydraulic control systems used in tractors, Three point hitches – free link and restrained link operations, Mechanics of tractor chassis

Soil and Water Conservation Engineering

Fluid Mechanics:

Ideal and real fluids, properties of fluids, Continuity equation, kinematics and dynamics of flow, Hydrostatic pressure and its measurement, Laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram, Flow in open channels, dimensional analysis – concepts of geometric dimensionless numbers, Bernoulli's theorem, Flow through orifices, weirs and notches

Soil Mechanics:

Engineering properties of soils, Index properties of soils, Fundamental definitions and relationships, Shear strength, Mohr's circle of stress, active and passive earth pressures, Permeability and seepage analysis, Stability of slopes, Terzaghi's one dimensional soil consolidation theory

Hydrology:

Hydrological cycle and measurement of its components, Analysis of precipitation data, Meteorological parameters and their measurement, Hydrograph analysis, unit hydrograph theory and application, Flood routing, hydrological reservoir and channel routing, Infiltration – indices and equations, drought and its classification, Runoff estimation, Streamflow measurement

Surveying and Leveling:

Measurement of distance and area, Chain surveying, methods of traversing, Theodolite traversing, Total station, introduction to GPS survey, computation of areas and volume, Types of levelling, Instruments for surveying and levelling, Measurement of angles and bearings, plane table surveying, Contouring

Soil and Water Erosion:

Mechanics of soil erosion – wind and water erosion, Soil loss estimation, Soil erosion types, factors affecting erosion, Terraces and bunds, Gully control structures, drop, drop inlet and chute spillways, Earthen dams, Vegetative waterways, Biological and engineering measures to control erosion

Watershed Management:

Water budgeting in watershed, rainwater harvesting, check dams and farm ponds, Watershed characterization and land use capability classification

Irrigation and Drainage Engineering

Soil-Water-Plant Relationship:

Water requirement of crops, Measurement of infiltration, soil moisture and irrigation water infiltration, Consumptive use and evapotranspiration

Irrigation Water Conveyance and Application Methods:

Design of irrigation channels and underground pipelines, Surface, sprinkler and micro irrigation methods, design and evaluation of irrigation methods, Irrigation scheduling, Irrigation efficiencies

Agricultural Drainage:

Planning, design, and layout of surface and sub-surface drainage systems, Drainage coefficient, Non-conventional drainage system, Irrigation and drainage water quality and reuse, Leaching requirement and salinity control

Groundwater Hydrology:

Darcy's Law, steady and unsteady flow in confined and unconfined aquifers, groundwater exploration techniques, Groundwater occurrence, Overview of groundwater recharge estimation and artificial recharge techniques

Wells and Pumps:

Types of wells, steady flow through wells, Classification of pumps, Pump characteristics, Design and construction of water wells, Pump selection and installation

Agricultural Process Engineering

Engineering properties of agriculture produce:

Physical, thermal, frictional, rheological and electrical properties

Evaporation and Drying:

Hydrothermal treatments**,** Concentration and drying of liquid foods – evaporators, tray, drum and spray dryers**,** Psychrometry – properties of air-water vapor mixture**,** Drying kinetics**,** Drying and milling of cereals, pulses and oilseeds

Size Reduction and Material Handling:

Mechanics and energy requirement in size reduction of agriculture produce, Size separation by screening, Particle size analysis for comminuted solids, Cleaning and grading, Centrifugal separation of solids, liquids and gases, Effectiveness of separation, Filtration and membrane separation, Fluidization of granular solids-pneumatic, bucket, screw and belt conveying, Homogenization

Processing of Agriculture Produce:

Value addition of agriculture produce, Processing of seeds, spices, fruits and vegetables

Storage Systems:

Perishable food storage, godowns, bins and grain silos, packaging material and machines, Controlled and modified atmosphere storage

Dairy and Food Engineering

Heat and Mass Transfer:

Steady state heat transfer in conduction, convection and radiation, Working principles of heat exchangers, Transient heat transfer in simple geometry, Simultaneous heat and mass transfer in agricultural processing operations, Material and energy balances in food processing systems, Water activity, sorption and desorption isotherms Diffusive and convective mass transfer

Preservation of Food:

Kinetics of microbial death – pasteurization and sterilization of milk and other liquid foods, Refrigeration and cold storage basics and applications, Preservation of food by cooling and freezing

Management

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Part:B

Principles of Management

Management – Concept, Process, Theories and Approaches, Management Roles and Skills, Functions – Planning, Organizing, Staffing, Coordinating and Controlling. Communication – Types, Process and Barriers. Decision Making – Concept, Process, Techniques and Tools, Organisation Structure and Design – Types, Authority, Responsibility,

Centralisation, Decentralisation and Span of Control, Managerial Economics – Concept & Importance, Demand analysis – Utility Analysis, Indifference Curve, Elasticity & Forecasting Market Structures – Market Classification & Price Determination, National Income – Concept, Types and Measurement Inflation – Concept, Types and Measurement Business Ethics & CSR, Ethical Issues & Dilemma Corporate Governance Value-Based Organisation

Organisational Behaviour

Organisational Behaviour – Significance & Theories, Individual Behaviour – Personality, Perception, Values, Attitude, Learning and Motivation, Group Behaviour – Team Building, Leadership, Group Dynamics Interpersonal Behaviour & Transactional Analysis, Organizational Culture & Climate, Work Force Diversity & Cross Culture Organisational Behaviour Emotions and Stress Management, Organisational Justice and Whistle Blowing Human Resource Management – Concept, Perspectives, Influences and Recent Trends, Human Resource Planning, Recruitment and Selection, Induction, Training and Development, Job Analysis, Job Evaluation and Compensation Management

Human Resource Management

Strategic Role of Human Resource Management Competency Mapping & Balanced Scoreboard Career Planning and Development, Performance Management and Appraisal, Organization Development, Change & OD Interventions Talent Management & Skill Development, Employee Engagement & Work-Life Balance, Industrial Relations: Disputes & Grievance Management, Labour Welfare and Social Security, Trade Union & Collective Bargaining, International Human Resource Management – HR Challenge of International Business, Green HRM

Financial Management

Accounting Principles and Standards, Preparation of Financial Statements**,** Financial Statement Analysis – Ratio Analysis, Funds Flow and Cash Flow Analysis, DuPont Analysis**,** Preparation of Cost Sheet, Marginal Costing, Cost Volume Profit Analysis Standard Costing & Variance Analysis**,** Financial Management, Concept & Functions**,** Capital Structure – Theories, Cost of Capital, Sources and Finance Budgeting and Budgetary Control, Types and Process, Zero base Budgeting**,** Leverages – Operating, Financial and Combined Leverages, EBIT–EPS Analysis, Financial Breakeven Point & Indifference Level.

Investment Analysis

Value & Returns – Time Preference for Money, Valuation of Bonds and Shares, Risk and Returns**,** Capital Budgeting – Nature of Investment, Evaluation, Comparison of Methods; Risk and Uncertainly Analysis**,** Dividend – Theories and Determination**,** Mergers and Acquisition – Corporate Restructuring, Value Creation, Merger Negotiations, Leveraged Buyouts, Takeover**,** Portfolio Management – CAPM, APT**,** Derivatives – Options, Option Payoffs, Option Pricing, Forward Contracts & Future Contracts**,** Working Capital Management – Determinants, Cash, Inventory, Receivables and Payables Management, Factoring**,** International Financial Management, Foreign exchange market

Strategic Management

Strategic Management – Concept, Process, Decision & Types, Strategic Analysis – External Analysis, PEST, Porter's Approach to industry analysis, Internal Analysis – Resource Based Approach, Value Chain Analysis, Strategy Formulation – SWOT Analysis, Corporate Strategy – Growth, Stability, Retrenchment, Integration and Diversification, Business Portfolio Analysis – BCG, GE Business Model, Ansoff's Product Market Growth Matrix, Strategy Implementation – Challenges of Change, Developing Programs Mckinsey 7s Framework, Marketing – Concept, Orientation, Trends and Tasks, Customer Value and Satisfaction, Market Segmentation, Positioning and Targeting, Product and Pricing Decision – Product Mix, Product Life Cycle, New Product development, Pricing – Types and Strategies, Place and promotion decision – Marketing channels and value networks, VMS, IMC, Advertising and Sales promotion

Brand Management

Consumer and Industrial Buying Behaviour: Theories and Models of Consumer Behaviour, Brand Management – Role of Brands, Brand Equity, Equity Models, Developing a Branding Strategy; Brand Name Decisions, Brand Extensions and Loyalty, Logistics and Supply Chain Management, Drivers, Value creation, Supply Chain Design, Designing and Managing Sales Force, Personal Selling, Service Marketing – Managing Service Quality and Brands, Marketing Strategies of Service Firms, Customer Relationship Marketing – Relationship Building, Strategies, Values and Process, Retail Marketing – Recent Trends in India, Types of Retail Outlets., Emerging Trends in Marketing – Concept of e-Marketing, Direct Marketing, Digital Marketing and Green Marketing, International Marketing – Entry Mode Decisions, Planning Marketing Mix for International Markets

Statistics

Statistics for Management: Concept, Measures Of Central Tendency and Dispersion, Probability Distribution – Binominal, Poison, Normal and Exponential, Data Collection & Questionnaire Design Sampling – Concept, Process and Techniques, Hypothesis Testing – Procedure; T, Z, F, Chi-square tests Correlation and Regression Analysis, Operations Management – Role and Scope, Facility Location and Layout – Site Selection and Analysis, Layout – Design and Process, Enterprise Resource Planning – ERP Modules, ERP implementation Scheduling; Loading, Sequencing and Monitoring, Quality Management and Statistical Quality Control, Quality Circles, Total Quality Management – KAIZEN, Benchmarking, Six Sigma; ISO 9000 Series Standards, Operation Research – Transportation, Queuing Decision Theory, PERT / CPM

International Business

International Business – Managing Business in the Globalization Era; Theories of International Trade; Balance of Payment, Foreign Direct Investment – Benefits and Costs, Multilateral regulation of Trade and Investment under WTO International Trade Procedures and Documentation; EXIM Policies Role of International Financial Institutions – IMF and World Bank, Information Technology – Use of Computers in Management Applications;

MIS, DSS, Artificial Intelligence and Big Data, Data Warehousing, Data Mining and Knowledge Management – Concepts Managing Technological Change

Entrepreneurship

Entrepreneurship Development–Concept, Types, Theories and Process, Developing Entrepreneurial Competencies, Entrepreneurship – Concept and Process, Women Entrepreneurship and Rural Entrepreneurship, Innovations in Business – Types of Innovations, Creating and Identifying Opportunities, Screening of Business Ideas, Business Plan and Feasibility Analysis – Concept and Process of Technical, Market and Financial Analysis, Micro and Small Scale Industries in India; Role of Government in Promoting SSI Sickness in Small Industries – Reasons and Rehabilitation, Institutional Finance to Small Industries – Financial Institutions, Commercial Banks, Cooperative Banks, Micro Finance.

Mathematics

Part A: Research Methodology

1. Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process
2. Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance
3. Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. (10%)
4. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.
5. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.
6. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non-Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.
7. Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.
8. Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.
9. Use of Encyclopaedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.
10. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

Part:B

Analysis:

Elementary set theory, finite, countable, and uncountable sets, Real number system, Archimedean property, supremum, infimum. Sequence and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Heine Borel theorem, Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral, Improper Integrals.

Linear Algebra:

Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformation, Algebra of matrices, rank, and determinant of matrices, linear equations., Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis. Quadratic forms, reduction, and classification of quadratic forms

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 Z, congruences, Chinese Remainder Theorem, Euler's Ø- function, primitive roots. Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, and Sylow theorems. Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain. Topology: basis, dense sets, subspace and product topology, separation axioms, connectedness, and compactness.

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, and the system of first-order ODEs. A 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:

Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, Finite differences, Lagrange, Hermite, and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

Calculus of Variations:

Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema. Variational methods for boundary value problems in ordinary and partial differential equations.

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 the 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.

Descriptive Statistics, Exploratory Data Analysis:
Markov chains with finite and countable state space, classification of states, limiting behavior of n-step transition probabilities, stationary distribution, Poisson, and birth-and-death processes. Standard discrete and continuous univariate distributions. sampling distributions, standard errors and asymptotic distributions, distribution of order statistics, and range. Methods of estimation, properties of estimators, confidence intervals. Tests of hypotheses: most powerful and uniformly most powerful tests, likelihood ratio tests. Analysis of discrete data and chi-square test of goodness of fit. Large sample tests. Simple nonparametric tests for one and two sample problems, rank correlation, and test for independence, Elementary Bayesian inference. Simple random sampling, stratified sampling, and systematic sampling. Probability is proportional to size sampling. Ratio and regression methods. Hazard function and failure rates, censoring and life testing, series and parallel systems.

Physics

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Part:B

Part 'A' Core

Mathematical Methods of Physics:

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic

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

Classical Mechanics:

Newton's laws. Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics moment of inertia tensor. Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes. Special theory of relativity Lorentz transformations, relativistic kinematics and mass–energy equivalence.

Electromagnetic Theory:

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields.

Quantum Mechanics:

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli Exclusion Principle, spin-statistics connection.

Thermodynamic and Statistical Physics:

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law.

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,

Part 'B' Advanced

Mathematical Methods of Physics:

Green's function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using RungeKutta method. Finite difference methods. Tensors. Introductory group theory: SU(2), O(3).

Classical Mechanics:

Dynamical systems, Phase space dynamics, stability analysis. Poisson brackets and canonical transformations. Symmetry, invariance and Noether's theorem. Hamilton-Jacobi theory.

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:

Spin-orbit coupling, fine structure. WKB approximation. Elementary theory of scattering: phase shifts, partial waves, Born approximation. Relativistic quantum mechanics: Klein-Gordon and Dirac equations. Semi-classical theory of radiation.

Thermodynamic and Statistical Physics:

First- and second-order phase transitions. Diamagnetism, paramagnetism, and ferromagnetism. Ising model. Bose-Einstein condensation. Diffusion equation. Random walk and Brownian motion. Introduction to nonequilibrium processes.

Electronics and Experimental Methods:

Linear and nonlinear curve fitting, chi-square test. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding. Fourier transforms, lock-in detector, box-car integrator, modulation techniques. High frequency devices (including generators and detectors).

Atomic & Molecular Physics:

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A&B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

Condensed Matter Physics:

Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific

heat. Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals.

Nuclear and Particle Physics:

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semiempirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions. Classification of fundamental forces. Elementary particles and their quantum numbers (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.

Chemistry

Part A: Research Methodology

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Part: B

Physical Chemistry

Structure:

Postulates of quantum mechanics. Operators. Time dependent and time independent Schrödinger equations. Born interpretation. Dirac bra-ket notation. Particle in a box: infinite and finite square wells; concept of tunnelling; particle in 1D, 2D and 3D-box; applications. Harmonic oscillator: harmonic and anharmonic potentials; hermite polynomials. Rotational

motion: Angular momentum operators, Rigid rotor. Hydrogen and hydrogen-like atoms : atomic orbitals; radial distribution function. Multi-electron atoms: orbital approximation; electron spin; Pauli exclusion principle; slater determinants. Approximation Methods: Variation method and secular determinants; first order perturbation techniques. Atomic units. Molecular structure and Chemical bonding: BornOppenheimer approximation; Valence bond theory and linear combination of atomic orbitals – molecular orbital (LCAO-MO) theory. Hybrid orbitals. Applications of LCAO-MO theory to H2 +, H2; orbital theory (MOT) of homo- and heteronuclear diatomic molecules. Hückel approximation and its application to annular π-electron systems.

Group Theory:

Symmetry elements and operations; Point groups and character tables; Internal coordinates and vibrational modes; symmetry adapted linear combination of atomic orbitals (LCAOMO); construction of hybrid orbitals using symmetry aspects.

Spectroscopy:

Atomic spectroscopy; Russell-Saunders coupling; Term symbols and spectral details; origin of selection rules. Rotational, vibrational, electronic and Raman spectroscopy of diatomic and polyatomic molecules. Line broadening. Einstein's coefficients. Relationship of transition moment integral with molar extinction coefficient and oscillator strength. Basic principles of nuclear magnetic resonance: gyromagnetic ratio; chemical shift, nuclear coupling.

Equilibrium:

Laws of thermodynamics. Standard states. Thermochemistry. Thermodynamic functions and their relationships: Gibbs-Helmholtz and Maxwell relations, Gibbs-Duhem equation, van't Hoff equation. Criteria of spontaneity and equilibrium. Absolute entropy. Partial molar quantities. Thermodynamics of mixing. Chemical potential. Fugacity, activity and activity coefficients. Ideal and Non-ideal solutions, Raoult's Law and Henry's Law, Chemical equilibria. Dependence of equilibrium constant on temperature and pressure. Ionic mobility and conductivity. Debye-Hückel limiting law. Debye-Hückel-Onsager equation. Standard electrode potentials and electrochemical cells. Nernst Equation and its application, relationship between Electrode potential and thermodynamic quantities, Potentiometric and conductometric titrations. Phase rule. ClausiusClapeyron equation. Phase diagram of one component systems: CO2, H2O, S; two component systems: liquid- vapour, liquid-liquid and solid-liquid systems. Fractional distillation. Azeotropes and eutectics. Statistical thermodynamics: microcanonical, canonical and grand canonical ensembles, Boltzmann distribution, partition functions and thermodynamic properties.

Kinetics:

Elementary, parallel, opposing and consecutive reactions. Steady-state approximation. Mechanisms of complex reactions. Unimolecular reactions. Potential energy surfaces and classical trajectories, Concept of Saddle points, Transition state theory: Eyring equation, thermodynamic aspects. Kinetics of polymerization. Catalysis concepts and enzyme catalysis. Kinetic isotope effects. Fast reaction kinetics: relaxation and flow methods. Diffusion controlled reactions. Kinetics of photochemical and photophysical processes.

Surfaces and Interfaces:
Physisorption and chemisorption. Langmuir, Freundlich and Brunauer– Emmett–Teller (BET) isotherms. Surface catalysis: Langmuir-Hinshelwood mechanism. Surface tension, viscosity. Self-assembly. Physical chemistry of colloids, micelles and macromolecules.

Inorganic Chemistry
Main Group Elements:
Hydrides, halides, oxides, oxoacids, nitrides, sulfides – shapes and reactivity. Structure and bonding of boranes, carboranes, silicones, silicates, boron nitride, borazines and phosphazenes. Allotropes of carbon, phosphorous and sulphur. Industrial synthesis of compounds of main group elements. Chemistry of noble gases, pseudohalogens, and interhalogen compounds. Acid-base concepts and principles (Lewis, Brønsted, HSAB and acid-base catalysis).
Transition Elements:
Coordination chemistry – structure and isomerism, theories of bonding (VBT, CFT, and MOT). Energy level diagrams in various crystal fields, CFSE, applications of CFT, JahnTeller distortion. Electronic spectra of transition metal complexes: spectroscopic term symbols, selection rules, Orgel and Tanabe-Sugano diagrams, nephelauxetic effect and Racah parameter, charge-transfer spectra. Magnetic properties of transition metal complexes. Ray-Dutt and Bailar twists, Reaction mechanisms: kinetic and thermodynamic stability, substitution and redox reactions. Metal-metal multiple bond.
Lanthanides and Actinides:
Recovery. Periodic properties, spectra and magnetic properties.
Organometallics:
18-Electron rule; metal-alkyl, metal-carbonyl, metal-olefin and metal-carbene complexes and metallocenes. Fluxionality in organometallic complexes. Types of organometallic reactions. Homogeneous catalysis – Hydrogenation, hydroformylation, acetic acid synthesis, metathesis and olefin oxidation. Heterogeneous catalysis – Fischer- Tropsch reaction, Ziegler-Natta polymerization.
Radioactivity:
Detection of radioactivity, Decay processes, half-life of radioactive elements, fission and fusion processes.

Bioinorganic Chemistry:
Ion (Na+ and K+) transport, oxygen binding, transport and utilization, electron transfer reactions, nitrogen fixation, metalloenzymes containing magnesium, molybdenum, iron, cobalt, copper and zinc.
Solids:
Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg's law, ionic crystals, structures of AX, AX2, ABX3 type compounds, spinels, band theory, metals and semiconductors.
Instrumental Methods of Analysis:
UV-visible, fluorescence and FTIR spectrophotometry, NMR and ESR spectroscopy, mass spectrometry, atomic absorption spectroscopy, Mössbauer spectroscopy (Fe and Sn) and X-

ray crystallography. Chromatography including GC and HPLC. Electroanalytical methods-polarography, cyclic voltammetry, ion-selective electrodes. Thermoanalytical methods.

Organic Chemistry

Stereochemistry:

Chirality and symmetry of organic molecules with or without chiral centres and determination of their absolute configurations. Relative stereochemistry in compounds having more than one stereogenic centre. Homotopic, enantiotopic and diastereotopic atoms, groups and faces. Stereoselective and stereospecific synthesis. Conformational analysis of acyclic and cyclic compounds. Geometrical isomerism and optical isomerism. Configurational and conformational effects, atropisomerism, and neighbouring group participation on reactivity and selectivity/specificity.

Reaction Mechanisms:

Basic mechanistic concepts – kinetic versus thermodynamic control, Hammond's postulate and Curtin-Hammett principle. Methods of determining reaction mechanisms through kinetics, identification of products, intermediates and isotopic labelling. Linear free-energy relationship – Hammett and Taft equations. Nucleophilic and electrophilic substitution reactions (both aromatic and aliphatic). Addition reactions to carbon-carbon and carbon-heteroatom (N and O) multiple bonds. Elimination reactions. Reactive intermediates – carbocations, carbanions, carbenes, nitrenes, arynes and free radicals. Molecular rearrangements.

Organic Synthesis:

Synthesis, reactions, mechanisms and selectivity involving the following classes of compounds – alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, nitriles, halides, nitro compounds, amines and amides. Uses of Mg, Li, Cu, B, Zn, P, S, Sn and Si based reagents in organic synthesis. Carbon-carbon bond formation through coupling reactions – Heck, Suzuki, Stille, Sonogoshira, Negishi, Kumada, Hiyama, Tsuji-Trost, olefin metathesis and McMurry. Concepts of multistep synthesis – retrosynthetic analysis, strategic disconnections, synthons and synthetic equivalents. Atom economy and Green Chemistry, Umpolung reactivity – formyl and acyl anion equivalents. Selectivity in organic synthesis – chemo-, regio- and stereoselectivity. Protection and deprotection of functional groups. Concepts of asymmetric synthesis – resolution (including enzymatic), desymmetrization and use of chiral auxiliaries, organocatalysis. Carbon-carbon and carbon-heteroatom bond forming reactions through enolates (including boron enolates), enamines and silyl enol ethers. Stereoselective addition to C=O groups (Cram, Prelog and Felkin-Anh models).

Pericyclic Reactions and Photochemistry:

Electrocyclic, cycloaddition and sigmatropic reactions. Orbital correlations – FMO and PMO treatments, Woodward-Hoffmann rule. Photochemistry of alkenes, arenes and carbonyl compounds. Photooxidation and photoreduction. Di-π-methane rearrangement, Barton-McCombie reaction, Norrish type-I and II cleavage reaction.

Heterocyclic Compounds:

Structure, preparation, properties and reactions of furan, pyrrole, thiophene, pyridine, indole, quinoline and isoquinoline.

Biomolecules:

Structure, properties and reactions of mono- and di-saccharides, physicochemical properties of amino acids, chemical synthesis of peptides, chemical structure determination of peptides and proteins, structural features of proteins, nucleic acids, lipids, steroids, terpenoids, carotenoids, and alkaloids.

Experimental Techniques in Organic Chemistry:

Optical rotation (polarimetry). Applications of various chromatographic techniques such as thin-layer, column, HPLC and GC. Applications of UV-visible, IR, NMR and Mass spectrometry in the structural determination of organic molecules.

English

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Part: B

Drama
Poetry
Fiction, short story
Non-Fictional Prose

NOTE: The first four units must also be tested through comprehension passages to assess critical reading, critical thinking and writing skills. These four units will cover

all literatures in English.

Language: Basic concepts, theories and pedagogy. English in Use.
English in India: history, evolution and futures
Cultural Studies
Literary Criticism
Literary Theory post World War II

Research Methods and Materials in English

Pharmaceutical Sciences

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7. Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.
8. Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Pharmaceutical Sciences, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.
9. Use of Encyclopaedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.
10. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

Part: B

Pharmaceutics:

Introduction to Physical Pharmacy: Micromeritics and Powder Rheology, Surface and Interfacial Phenomenon, Viscosity and Rheology, Dispersion Systems, Complexation, Kinetics and Drug Stability

Unit Operations in Manufacturing: Fluid Flow, Heat Transfer, Evaporation, Distillation, Drying, Size Reduction, Mixing, Filtration and Centrifugation, Crystallization,

Dehumidification and Humidity Control, Refrigeration and Air Conditioning, Materials of Construction, Material Handling Systems

Dosage Forms, Designing & Evaluation: Liquid Dosage Forms, Semisolid Dosage Forms, Suppositories, Extraction and Galenical Products, Blood Products and Plasma Substitutes, Pharmaceutical Aerosols, Ophthalmic Preparations, Cosmetology and Cosmetic Preparations, Capsules, Microencapsulation, Tablets, Coating of Tablets, Parenteral Products, Packaging of Pharmaceutical Products, Dispensing and Community Pharmacy

Designing of Dosage Forms: Preformulation studies, Chemical properties, Prodrugs in solving problems related to stability, bioavailability and elegance, ICH guidelines for stability testing of formulations

Biopharmaceutics: Introduction to Biopharmaceutics, Pharmacokinetics, Clinical Pharmacokinetics, Bioavailability and Bioequivalence

Advanced Drug delivery systems: oral controlled release drug delivery systems, parenteral products, implantable systems, transdermal patches, ocular, intravaginal, intrauterine system, cardiovascular drug delivery system coated balloon catheters and coated stents.

Pharmaceutical Ethics, Pharmacy Act 1948, Drugs and Cosmetics Act 1940 and Rules 1945

Pharmaceutical Microbiology and Biotechnology:

Importance of Microbiology in Pharmacy: Identification of Microbes, Control of microbes by physical and chemical methods, Sterilization, Immunology and Immunological Preparations, Antibiotics, Recombinant DNA technology, Enzyme immobilization, PCR.

Pharmaceutical Chemistry: Inorganic Pharmaceutical & Medicinal Chemistry: Importance of inorganic compounds in pharmacy and medicine, Gastrointestinal agents, Major intra- and extra-cellular electrolytes,

Organic Chemistry and its Importance in Pharmacy: Stereochemistry, Stereoselective and stereospecific reactions, Structure nomenclature preparation and reactions, Nucleophilic and electrophilic aromatic substitution reactions, Elimination reactions, Conservation of orbital symmetry and rules, Neighbouring group effects, Catalysis by transition metal complexes, Heterocyclic compounds, named reactions

Biochemistry: Enzymes, Coenzymes, Citric acid cycle, Lipid metabolism, biological oxidation

Medicinal Chemistry: Autacoids, Steroidal drugs, Drugs acting on the central nervous system, Diuretics, Cardiovascular drugs, Thyroid and antithyroid drugs, Insulin and oral hypoglycemic agents, Microbial transformations, Enzyme immobilization, Principle of drug design

Pharmaceutical Analysis:

Fundamentals of volumetric analysis: Acid–base titrations, Oxidation–reduction titrations, Precipitation titrations, Gravimetric analysis, non-aqueous titrations, Complexometric titrations, Extraction procedures including separation of drugs from excipients, Potentiometry, Conductometry, Colorimetry, Polarography, Amperometry,

Chromatography: HPLC, Paper chromatography, TLC, HPTLC, GC, Column chromatography, UPLC

Ultraviolet and visible spectrophotometry, Fluorimetry, Infrared spectrophotometry, Nuclear Magnetic Resonance spectroscopy (proton technique only), Mass spectrometry (EI & CI only), Flame photometry, atomic absorption spectroscopy, X-ray diffraction analysis, Radioimmunoassay

Quality Assurance: GLP, ISO 9000, TQM, Quality review and documentation, Regulatory control, Regulatory drug analysis

Pharmacology:

Fundamentals of general pharmacology, Systemic Pharmacology: Pharmacology of peripheral nervous system, central nervous system, cardiovascular system, hemopoietic system, urinary system, Autacoids, respiratory system, gastrointestinal tract, endocrine system.

General principles of chemotherapy, Antibiotics (penicillins, cephalosporins, aminoglycosides, chloramphenicol, macrolides, tetracyclines, quinolones, fluoroquinolones, miscellaneous antibiotics), Chemotherapy of tuberculosis, leprosy, fungal diseases, viral diseases, HIV and AIDS, UTIs and STDs, Malaria, Amoebiasis and other protozoal infections, Anthelmintics, Chemotherapy of malignancy, Immunosuppressive agents.

Basic concepts of pharmacotherapy, Clinical pharmacokinetics and individualization of drug therapy, Drugs used during infancy and in elderly persons (pediatrics and geriatrics), Drugs used during pregnancy, Drug-induced diseases, Basics of drug interactions, Common clinical laboratory tests and their interpretation

Toxicology and Pharmacotherapy: General principles of clinical toxicology

Pharmacognosy:

Sources of drugs, Classification of drugs, Study of medicinally important plants belonging to the families Apocynaceae, Solanaceae, Rutaceae, Umbelliferae, Leguminosae, Rubiaceae, Liliaceae, Graminae, Labiatae, Cruciferae, Papaveraceae. Cultivation, Collection, Processing and Storage of crude drugs, Quality control of crude drugs, Introduction to active constituents of drugs.

Systematic Pharmacognostic Study: Carbohydrates and derived products, Lipids, Resins, Tannins, Volatile oils, Fibers

Glycoside-Containing Drugs: Saponins, Cardioactive glycosides, Anthraquinone cathartics.

Alkaloid-Containing Drugs: Pyridine-piperidine, Tropane, Quinoline and Isoquinoline, Indole, Imidazole, Steroidal, Alkaloidal amine, Glycoalkaloid, Purines. Holistic concept of drug administration in traditional systems of medicine, Introduction to Ayurvedic preparations (Arishtas, Asavas, Gutikas, Tailas, Churnas, Lehyas, Bhasmas)