



Ph.D ENTRANCE TEST SYLLABUS 2023-24

**COER UNIVERSITY
ROORKEE, UTTARAKHAND**

Table of Contents

Sl. No.	Subject	Page Number
1.	Computer Science and Engineering/Computer Science	3-4
2.	Business Management	5-7
3.	Agronomy	8-9
4.	Mechanical Engineering	10-11
5.	Civil Engineering	12-15
6.	Electrical Engineering	16-17
7.	Energy Engineering	18-19
8.	Physics	20-21
9.	Chemistry	22-23
10.	Mathematics	24-25

Computer Science & Engineering/Computer Science:

Paper I: Research Methodology

Unit-I: Meaning of Research, Function of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Factors which Hinder Research, Significance of Research, Research and Scientific Methods, Research Process Criteria of good Research, Problems encountered by Researchers, Literature Review.

Unit-II: Identification of Research Problem, Selecting the Research Problem, Necessity of Defining the Problem, Goals and Criteria for Identifying Problems for Research, Perception of Research Problem, Techniques involved in Defining the Problem, Source of Problems, Personal Consideration.

Unit-III: Research Design, Formulation of Research Design, Need for Research Design, Features of a Good Design, Important Concepts related to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Computer and Internet in Designs.

Unit-IV: Interpretation and Report Writing, Meaning and Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different steps in Writing a Report, Layout of a Research Report, Types of report, Mechanics of writing a Research Report, Precautions for writing a Research Report, Conclusion.

Unit-V: Statistical Techniques and Tools, Introduction of Statistics, Functions, Limitations, Measures of Central Tendency, Arithmetic Mean, Median, Mode, Standard Deviation, Co-efficient of Variation (Discrete, Serious and Continuous Serious), Correlation, Regression, Multiple Regression, Sampling Distribution, Standard Error, Concept of Point and Interval Estimation, Level of Significance, Degree of Freedom, Analysis of Variance, One Way and Two Way Classified Data, 'F'-Test.

Paper II: Computer Science/ Computer Science & Engineering

Unit-I: Discrete Structures and Optimization (Mathematical Logic, Sets and Relations, Counting, Mathematical Induction, and Discrete Probability, Group Theory, Graph Theory, Boolean Algebra, Optimization), Computer System Architecture (Digital Logic Circuits and Components, Data Representation, Register Transfer and Micro Operations, Basic Computer Organization and Design, Programming the Basic Computer, Micro Programmed Control, Central Processing Unit, Pipeline, and Vector Processing, Input/ Output Organization, Memory Hierarchy, Multiprocessors).

Unit-II: Programming Languages and Computer Graphics (Language Design and Translation Issues, Elementary Data Types, Programming in C, Object-Oriented Programming, Programming in C++, Web Programming, Computer Graphics, 2-D and 3-D Geometrical Transforms and Viewing), Database Management Systems (Database System Concepts and Architecture, Data Modelling, SQL, Normalization for Relational Databases, Enhanced Data Models, Data Warehousing and Data Mining, Big Data Systems, NoSQL)

Unit-III: System Software and Operating System (System Software, Basics of Operating Systems, Process Management, Threads, CPU Scheduling, Deadlocks, Memory Management, Storage Management, File and Input/ Output Systems, Security, Virtual Machines, Linux Operating Systems, Windows Operating Systems, Distributed Systems), Software Engineering (Software Process Model, Software Requirements, Software Design, Software Quality, Estimation and Scheduling of Software Projects, Software Testing, Software Configuration Management)

Unit-IV: Data Structures and Algorithms (Data Structures, Performance Analysis of Algorithms and Recurrences, Design Techniques, Lower Bound Theory, Graph Algorithms, Complexity Theory, Selected Topics, Advanced Algorithms), Theory of Computation and Compilers (Theory of Computation, Regular Language Models, Context-Free Language, Turing Machines (TM), Unsolvable Problems and Computational Complexity, Syntax Analysis, Semantic Analysis, Run-Time System, Intermediate Code Generation, Code Generation, and Code Optimization)

Unit-V: Data Communication and Computer Networks (Data Communication, Computer Networks, Network Models, Functions of OSI and TCP/IP Layers, World Wide Web (WWW), Network Security, Mobile Technology, Cloud Computing, and IOT), Artificial Intelligence (Approaches to AI, Knowledge Representation, Planning, Natural Language Processing, Multi-Agent Systems, Fuzzy Sets, Genetic Algorithms (GA), Artificial Neural Networks).

2. Business Management:

Paper I: Research Methodology

Unit-I: Meaning of Research, Function of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Factors which Hinder Research, Significance of Research, Research and Scientific Methods, Research Process Criteria of good Research, Problems encountered by Researchers, Literature Review.

Unit-II: Identification of Research Problem, Selecting the Research Problem, Necessity of Defining the Problem, Goals and Criteria for Identifying Problems for Research, Perception of Research Problem, Techniques involved in Defining the Problem, Source of Problems, Personal Consideration.

Unit-III: Research Design, Formulation of Research Design, Need for Research Design, Features of a Good Design, Important Concepts related to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Computer and Internet in Designs.

Unit-IV: Interpretation and Report Writing, Meaning and Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different steps in Writing a Report, Layout of a Research Report, Types of report, Mechanics of writing a Research Report, Precautions for writing a Research Report, Conclusion.

Unit-V: Statistical Techniques and Tools, Introduction of Statistics, Functions, Limitations, Measures of Central Tendency, Arithmetic Mean, Median, Mode, Standard Deviation, Co-efficient of Variation (Discrete Series and Continuous Series), Correlation, Regression, Multiple Regression, Sampling Distribution, Standard Error, Concept of Point and Interval Estimation, Level of Significance, Degree of Freedom, Analysis of Variance, One Way and Two Way Classified Data, 'F'-Test.

Paper II: Business Management

Unit-I:

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, Organization Structure and Design – Types, Authority, Responsibility, Centralization, Decentralization 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 Organization, Organizational Behavior – Significance & Theories Individual Behavior – Personality, Perception, Values, Attitude, Learning and Motivation Group Behavior – Team Building, Leadership, Group Dynamics Interpersonal Behavior & Transactional Analysis Organizational Culture & Climate Work Force Diversity & Cross Culture Organizational Behavior Emotions and Stress Management Organizational 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.

Unit-II: 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, Labor Welfare and Social Security, Trade Union & Collective Bargaining, International Human Resource Management – HR Challenge of International Business, Green HRM, 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.

Unit-III: 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 Uncertainty 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 – 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.

Unit-IV: Consumer and Industrial Buying Behavior: Theories and Models of Consumer Behavior, 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, SupplyChain 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 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.

Unit-V: International Business – Managing Business in 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 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.

3. Agronomy

Paper I : Research Methodology

Unit-I: Meaning of Research, Function of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Factors which Hinder Research, Significance of Research, Research and Scientific Methods, Research Process Criteria of good Research, Problems encountered by Researchers, Literature Review.

Unit-II: Identification of Research Problem, Selecting the Research Problem, Necessity of Defining the Problem, Goals and Criteria for Identifying Problems for Research, Perception of Research Problem, Techniques involved in Defining the Problem, Source of Problems, Personal Consideration.

Unit-III: Research Design Formulation of Research Design, Need for Research Design, Features of a Good Design, Important Concepts related to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Computer and Internet in Designs.

Unit IV : Interpretation and Report Writing, Meaning and Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different steps in Writing a Report, Layout of a Research Report, Types of report, Mechanics of writing a Research Report, Precautions for writing a Research Report, Conclusion.

Unit-V : Statistical Techniques and Tools, Introduction of Statistics, Functions, Limitations, Measures of Central Tendency, Arithmetic Mean, Median, Mode, Standard Deviation, Co-efficient of Variation (Discrete Series and Continuous Series), Correlation, Regression, Multiple Regression, Sampling Distribution, Standard Error, Concept of Point and Interval Estimation, Level of Significance, Degree of Freedom, Analysis of Variance, One Way and Two Way Classified Data, 'F'-Test.

Paper II: Agronomy

Unit-I: Crop Ecology and Geography Principles of Crop Ecology, Ecosystem-Concept and Determinants of Crop Productivity, Physiological Limits of Crop Yield and Variability in Relation to Ecological Optima, Crop Adaptation, Climate Shift and its Ecological Implication, Greenhouse Effect, Agro-Ecological and Agro Climatic Regions of India, Geographical Distribution of Cereals, legumes, Oilseeds, Vegetables, Fodders and Forages, Commercial Crops, Condiments and Spices, Medicinal and Aromatic Plants, Adverse Climatic Factors and Crop Productivity, Photosynthesis, Respiration, net Assimilation, Solar Energy conversion Efficiency and Relative Water Content, Light Intensity, Water and CO₂ in relation to Photosynthetic Rates and Efficiency.

Unit-II: Weed Management Scope and Principles of Weed Management, Weed Classification, Biology, Ecology and Allelopathy, Weed Seed Dormancy, Crop Weed Competition, Weed Threshold, Herbicides Classification, Formulations, Mode of Action, Selectivity and Resistance, Persistence of Herbicides in Soils and Plants, Application

Methods and Equipment, Cultural, Physical, Chemical and Biological Weed Control, Bio-Herbicides: Integrated Weed Management, Special Weeds, Parasitic and Aquatic Weeds and their Management in Cropped and Non-Cropped Lands, Weed Control Schedules in Field Crops, Vegetables and Plantation Crops, Role of Genetically Modified (GM) Crops in Weed Management.

Unit-III: Dryland Agronomy Concept of Dryland Farming, Dryland Farming Vs Rainfed Farming, History, Development, Significance and Constraints of Dryland Agriculture in India, Climatic Classification and Delineation of Dryland Tracts, Characterization of Agro-Climatic Environments of Drylands, Rainfall Analysis and Length of Growing Season, Types of Drought, Effect on Plant Growth, Drought Resistance, Drought Avoidance, Drought Management, Crop Planning including Contingency, Crop Diversification, Varieties, Cropping Systems and Mid-Season Corrections for Aberrant Weather Conditions, Techniques of Moisture Conservation In-situ to Reduce Evapotranspiration, Runoff and to Increase Infiltration, Rain Water Harvesting and Recycling Concept, Techniques and Practices, Summer Ploughing, Seed Hardening, Pre-Monsoon Sowing, Weed and Nutrient Management, Concept and Importance of Watershed Management in Dryland Areas.

Unit-IV: Crop Production & Agricultural Statistics Crop Production Techniques for Cereals, Millets, Pulses /Grain Legumes, Oilseeds, Fiber Crops, Sugarcane, Tobacco, Fodder and Pasture Crops including Origin, History, Distribution, Adaptation, Climate, Soil, Season, Modern Varieties, Seed Rate, Fertilizer Requirements, Crop Geometry, Intercultural Operations, Water Requirement, Weed Control, Harvest, Quality Components, Industrial Use, Economics and Post-Harvest Technology. Package of Practices in the Respective Locations. Frequency Distribution, Standard Error and Deviation, Correlation and Regression Analyses, Coefficient of Variation, Tests of Significance t Test, F Test and Chi-Square (χ^2), Data Transformation and Missing Plot Techniques, Design of Experiments and their Basic Principles, Completely Randomized, Randomized Block, Split Plot, Strip-Plot, Factorial and Simple Confounding Designs, Efficiency of Designs, Methods of Statistical Analysis for Cropping Systems including Intercropping, Pooled Analysis.

Unit-V: Sustainable Land Use Systems & Organic Farming Cropping system Tillage - Concept, Types, Tillage, Tools and Implements, Modern Concepts of Tillage and Conservation Agriculture, Land Capability Classification, Alternate Land Use and Agro Forestry Systems, Types, Extent and Causes of Wasteland, Shifting Cultivation, Concept of Sustainability, Sustainability Parameters and Indicators, Agricultural and Agro-Industrial Residues and its Recycling. Definition, Principles, Classification, Cropping System for different Ecosystem, Interaction and Indices, Non-Monetary Inputs and Low Cost Technologies. LEIA, HEIA and LEISA, Farming Systems – type – Natural, Bio-Dynamic, Bio-Intensive, Response, Precision, Biological and Organic Farming, Organic and Bio Inputs, Soil Health and Organic Matter and Integrated Organic Farming Systems, IFS – Concepts, Models for different Ecosystem, Resource Recycling and Evaluation.

4. Mechanical Engineering

Paper I: Research Methodology

Unit-I: Meaning of Research, Function of Research, Characteristics of Research, Steps involved, Inter Disciplinary Research, Factors which Hinder Research, Significance of Research, Research Process Criteria of good Research, Problems encountered by Researchers, Literature Review.

Unit-II: Identification of Research Problem, Selecting the Research Problem, Necessity of Defining the Problem, Goals and Criteria for Identifying Problems for Research, Perception of Research Problem, Techniques involved in Defining the Problem, Source of Problems, Personal Consideration.

Unit-III: Research Design Formulation of Research Design, Need for Research Design, Features of a Good Design, Important Concepts related to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Computer and Internet in Designs.

Unit-IV: Interpretation and Report Writing, Meaning and Technique of Interpretation, , Significance of Report Writing, Different steps in Writing a Report, Layout of a Research Report, Types of report, Mechanics of writing a Research Report, Precautions for writing a Research Report, Conclusion.

Unit-V: Statistical Techniques and Tools, Introduction of Statistics, Functions, Limitations, Measures of Central Tendency, Arithmetic Mean, Median, Mode, Standard Deviation, Co-efficient of Variation (Discrete Serious and Continuous Serious), Correlation, Regression, Multiple Regression, Sampling Distribution, Standard Error, Concept of Point and Interval Estimation, Analysis of Variance, One Way and Two Way Classified Data, 'F'-Test.

Paper II: Mechanical Engineering.

Unit-I:

Engineering Mechanics: Free body diagrams and equilibrium, kinematics and dynamics of particles and of rigid bodies in plane motion impact, Theory of Machines: Kinematics and dynamics of plane mechanisms, dynamic analysis of slider-crank mechanism, gear trains, flywheels, bearings, governors, static & dynamic balancing of rotors.

Mechanisms: Kinematic and dynamic analysis & synthesis of planar and spatial mechanisms, numerical methods in kinematics & dynamics, Vibrations: Free, damped and forced vibrations of single degree, multi degree and continuous mechanical systems, vibration measuring instruments, vibration isolation, numerical methods, transient and non-linear vibrations.

UNIT II:

Thermodynamics: Thermodynamic systems and processes, properties of pure substances, behavior 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.

Power Engineering: Air and gas compressors, vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles, properties of moist air, psychrometric chart, basic psychrometric processes.

UNIT III :

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

Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines. 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

UNIT IV :

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.

Unit-V:

Production Engineering: Unconventional Machining Processes, Computer controlled machines, CAD/CAM, CNC, Mechanics of Metal Cutting, Tool wear and Machinability, Economics of Metal cutting, Metal Forming, Casting Processes, Powder Metallurgy, Joining Processes, Finishing operations and super finishing processes, Measurement.

Maintenance: Preventive maintenance, shut down maintenance, predictive maintenance, bath tub curve, failure analysis, Automobile- Torque of an engine, performance of an engine, braking, steering, cooling, lubrication, ignition, fuel supply systems, maintenance of vehicles, evs, hybrid vehicles, batteries used in evs.

5. Civil Engineering

Paper I: Research Methodology

Unit-I: Meaning of Research, Function of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Factors which Hinder Research, Significance of Research, Research and Scientific Methods, Research Process Criteria of good Research, Problems encountered by Researchers, Literature Review.

Unit-II: Identification of Research Problem, Selecting the Research Problem, Necessity of Defining the Problem, Goals and Criteria for Identifying Problems for Research, Perception of Research Problem, Techniques involved in Defining the Problem, Source of Problems, Personal Consideration.

Unit-III: Research Design, Formulation of Research Design, Need for Research Design, Features of a Good Design, Important Concepts related to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Computer and Internet in Designs.

Unit-IV: Interpretation and Report Writing, Meaning and Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different steps in Writing a Report, Layout of a Research Report, Types of report, Mechanics of writing a Research Report, Precautions for writing a Research Report, Conclusion.

Unit-V: Statistical Techniques and Tools, Introduction of Statistics, Functions, Limitations, Measures of Central Tendency, Arithmetic Mean, Median, Mode, Standard Deviation, Co-efficient of Variation (Discrete Series and Continuous Series), Correlation, Regression, Multiple Regression, Sampling Distribution, Standard Error, Concept of Point and Interval Estimation, Level of Significance, Degree of Freedom, Analysis of Variance, One Way and Two Way Classified Data, 'F'-Test.

Paper II: Civil Engineering

UNIT-I

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations, Internal forces in structures, Frictions and its applications, Centre of mass.

Solid Mechanics: Bending moment and shear force in statically determinate beams, Simple stress and strain relationships, simple bending theory, flexural and shear stresses, shear center.

Structural Analysis: Statically determinate and indeterminate structures by force/energy methods, Method of superposition, Analysis of trusses, arches, beams, cables and frames, Displacement methods: Slope deflection and moment distribution methods, Influence lines, Stiffness and flexibility methods of structural analysis.

Construction Materials and Management: Construction Materials: Structural Steel –

Composition, material properties and behavior, Concrete - Constituents, mix design, short- term and long-term properties. Construction Management: Types of construction projects, Project planning and network analysis - PERT and CPM, Cost estimation.

Concrete Structures: Working stress and Limit state design concepts, Design of beams, slabs, columns, Bond and development length, Prestressed concrete beams.

Steel Structures: Working stress and Limit state design concepts, Design of tension and compression members, beams and beam- columns, column bases, Connections - simple and eccentric, beam-column connections, plate girders and trusses, Concept of plastic analysis - beams and frames.

UNIT-II

Soil Mechanics: Three-phase system and phase relationships, index properties, Unified and Indian standard soil classification system, Permeability - one dimensional flow, Seepage through soils – two - dimensional flow, flow nets, uplift pressure, piping, capillarity, seepage force, Principle of effective stress and quicksand condition, Compaction of soils, One- dimensional consolidation, time rate of consolidation, Shear Strength, Mohr's circle, effective and total shear strength parameters, Stress-Strain characteristics of clays and sand, Stress paths.

Foundation Engineering: Sub-surface investigations - Drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests, Earth pressure theories - Rankine and Coulomb, Stability of slopes – Finite and infinite slopes, Bishop's method, Stress distribution in soils, Pressure bulbs, Shallow foundations- bearing capacity theories, effect of water table, Combined footing and raft foundation, Contact pressure, Settlement analysis in sands and clays, 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.

UNIT-III

Fluid Mechanics: Properties of fluids, fluid statics, Continuity, momentum and energy equations and their applications, Potential flow, Laminar and turbulent flow, Flow in pipes, pipe networks, Concept of boundary layer and its growth, Concept of lift and drag.

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

Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, reservoir capacity, flood estimation and routing, surface run-

off models, ground water hydrology - steady state well hydraulics and aquifers,

Application of Darcy's Law.

Irrigation: Types of irrigation systems and methods, Crop water requirements - Duty, delta, evapotranspiration, Gravity Dams and Spillways, Lined and unlined canals, Design of weirs on permeable foundation, cross drainage structures.

Water and Waste Water Quality and Treatment: Basics of water quality standards – Physical, chemical and biological parameters, Water quality index, Unit processes and operations, Water requirement, Water distribution system, Drinking water treatment.

Sewerage system design, quantity of domestic wastewater, primary and secondary treatment. Effluent discharge standards, Sludge disposal, Reuse of treated sewage for different applications.

UNIT-IV

Transportation Infrastructure: Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments. Geometric design of railway Track – Speed and Cant. Concept of airport runway length, calculations and corrections, taxiway and exit taxiway design.

Highway Pavements: Highway materials - desirable properties and tests, Desirable properties of bituminous paving mixes, Design factors for flexible and rigid pavements, 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, Microscopic and macroscopic parameters of traffic flow, fundamental relationships, Traffic signs, Signal design by Webster's method, Types of intersections, Highway capacity.

Geomatics Engineering: Principles of surveying, Errors and their adjustment, Maps - scale, coordinate system, Distance and angle measurement - Levelling and trigonometric levelling, Traversing and triangulation survey, Total station, Horizontal and vertical curves. Photogrammetry and Remote Sensing - Scale, flying height, Basics of remote sensing and GIS.

UNIT-V:

Engineering Seismology : Engineering Seismology, Seismology and Seismic Exploration (Definitions). Introduction to Seismic Hazard and Earthquake Phenomenon. Global seismicity - Analysis of earthquake focal mechanisms. Seismotectonics and Seismic Zoning of India. Microzonation. Mechanism of Faulting. Earthquake Prediction. Site Response to Earthquakes: Local geology and soil conditions. Site investigations and soil tests. Dynamic design criteria for a given site. Earthquake Monitoring and Seismic Instrumentation. The Seismograph – Principles of Seismometer. Location of the epicenter of an earthquake. Earthquake size and intensity. Energy released in an earthquake. Earthquake: Risk and Preparedness. Earthquake: Social Consequences, Codes and Public Policy.

Structural Dynamics: Free and Forced Vibration of Single, Two and Multi Degree of

Freedom Systems, Normal modes of vibration of Two Degree of Freedom Systems, Orthogonality of modes, Mode superposition techniques, Dynamic response of Single, Two and Multi degree freedom systems, Mode superposition techniques, Dynamic response of continuous systems, Free and forced vibration of continuous systems, Rayleigh-Ritz method, Formulation using conservation of energy , virtual work, Direct integration methods for dynamic response,

Nonlinear MDOF systems, Numerical Integration Algorithms, Substructure technique. Earthquake Ground motion, Engineering Seismology, Characteristics of earthquakes, Estimation of earthquake parameters - Effects of earthquake on structures, Response spectra, Evaluation of earthquake forces,

Earthquake resistant design of masonry and RC structures, Capacity based design and detailing, Structural systems, Shear walls, Rigid Frames, Principles and guidelines for earthquake resistant design, Design guidelines for earthquake resistant masonry buildings, Vibration control techniques, Tuned Mass Dampers, Seismic base isolation.

6. Electrical Engineering:

Paper I : Research Methodology

Unit-I: Meaning of Research, Function of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Factors which Hinder Research, Significance of Research, Research and Scientific Methods, Research Process Criteria of good Research, Problems encountered by Researchers, Literature Review.

Unit-II : Identification of Research Problem, Selecting the Research Problem, Necessity of Defining the Problem, Goals and Criteria for Identifying Problems for Research, Perception of Research Problem, Techniques involved in Defining the Problem, Source of Problems, Personal Consideration.

Unit-III : Research Design, Formulation of Research Design, Need for Research Design, Features of a Good Design, Important Concepts related to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Computer and Internet in Designs.

Unit-IV : Interpretation and Report Writing, Meaning and Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different steps in Writing a Report, Layout of a Research Report, Types of report, Mechanics of writing a Research Report, Precautions for writing a Research Report, Conclusion.

Unit-V : Statistical Techniques and Tools, Introduction of Statistics, Functions, Limitations, Measures of Central Tendency, Arithmetic Mean, Median, Mode, Standard Deviation, Coefficient of Variation (Discrete Series and Continuous Series), Correlation, Regression, Multiple Regression, Sampling Distribution, Standard Error, Concept of Point and Interval Estimation, Level of Significance, Degree of Freedom, Analysis of Variance, One Way and Two Way Classified Data, 'F'-Test

Paper II : Electrical Engineering

Unit-I: D.C circuit Analysis: series and parallel resistor, KCL, KVL, circuit theorems, Nodal analysis, Mesh current analysis. A.C circuit Analysis: R, L, C, R-L, R-C, L-C, R-L-C (series and parallel) circuits excited by sinusoidal AC, Application of KCL.KVL and circuit theorem, series and parallel resonance, Power in AC circuits, concept of power factor and p.f. improvement.

Unit-II: Transformers: Detailed Analysis, phasor diagram, efficiency, voltage regulation, analysis of three-phase transformers, transformer tests, instrument transformers. D.C Machines: Principle of operation, emf and torque equations, equivalent circuits, types of DC machines, DC Generator characteristics, parallel operation, DC Motor Torque speed characteristics, Speed control techniques, DC motor starting, Applications. Induction Machines: Operating principle, Torque equation, Equivalent circuit, no-load and blocked rotor tests, torque speed characteristics, Speed-control techniques, starting, Applications, Induction generator, Synchronous Machines: Voltage equation, windings, tests, characteristics, application, synchronous motor starting, V-curves, Synchronous condenser.

Unit-III : Fault Analysis (Balanced Faults): Faults, types of faults, symmetrical 3-phase

balanced faults, calculation of fault currents, current limiting reactors. Fault Analysis, (unsymmetrical faults) Symmetrical components, sequence impedances, sequence networks, unsymmetrical faults-single line to ground, line to line, double line to ground faults on unloaded alternators and on power systems. Load Flows: Nature and importance of the problem, Network model formulation, algorithm for the formulation of Y bus matrix, Gauss – Seidel & Newton-Raphson method for solving load flow problem, Power System Stability: The stability problem, steady state, dynamic and transient stability, rotor dynamics and swing equation, power-angle curve, equal-Area criterion of stability, Numerical solution of swing equation, Factors affecting transient stability, Automatic Generation Control: Real power balance and its effect on system frequency, load frequency control of single area system-speed governing system. Control of voltage and Reactive Power: Methods of voltage control-injection of reactive power, Economic Operation of Power System. Power System protection, Overcurrent, overvoltage, Differential protection, Distance relays.

Unit-IV: Power semiconducting devices, characteristics, snubber circuits, Gate drive circuits, series and parallel operations of Thyristors ,single-phase and three phase uncontrolled and controlled rectifiers, DC-DC converters (Continuous and Discontinuous conduction modes of operation), AC voltage controllers, Cyclo-converters , Inverter, Pulse Width Modulation Techniques, Variable-frequency Induction motor drives, Converter-Fed DC Motor Drives, Chopper-Fed DC Motor Drives, Electric Drives, Applications of Power Electronics.

Unit-V: Mathematical modeling: Transfer functions, block diagrams, signal flow graphs. First and second order system: sample of first and second order systems, responses of their system to step, ramp, parabolic and sinusoidal inputs, transient, steady state and error analysis, Stability studies: stability and pole locations, stability and Routh Table, stability and frequency response bode plot, polar plot, Nyquist's criterion, root locus, proportional, integral, Derivative (P.I.D) control, state variable modeling Digital control system: Hardware elements of a digital control system, Z-transform, Non linear control systems. Linearization of Non-linear control system about and nominal operating point, analysis and design using linearized models.

7. Energy Engineering:

Paper I : Research Methodology

Unit-I: Meaning of Research, Function of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Factors which Hinder Research, Significance of Research, Research and Scientific Methods, Research Process Criteria of good Research, Problems encountered by Researchers, Literature Review.

Unit-II: Identification of Research Problem, Selecting the Research Problem, Necessity of Defining the Problem, Goals and Criteria for Identifying Problems for Research, Perception of Research Problem, Techniques involved in Defining the Problem, Source of Problems, Personal Consideration.

Unit-III: Research Design, Formulation of Research Design, Need for Research Design, Features of a Good Design, Important Concepts related to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Computer and Internet in Designs.

Unit IV : Interpretation and Report Writing, Meaning and Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different steps in Writing a Report, Layout of a Research Report, Types of report, Mechanics of writing a Research Report, Precautions for writing a Research Report, Conclusion.

Unit-V : Statistical Techniques and Tools, Introduction of Statistics, Functions, Limitations, Measures of Central Tendency, Arithmetic Mean, Median, Mode, Standard Deviation, Co-efficient of Variation (Discrete Series and Continuous Series), Correlation, Regression, Multiple Regression, Sampling Distribution, Standard Error, Concept of Point and Interval Estimation, Level of Significance, Degree of Freedom, Analysis of Variance, One Way and Two Way Classified Data, 'F'-Test.

PAPER II : ENERGY ENGINEERING

UNIT I :

Energy Systems :

Conventional power generation systems, Renewable energy systems, Solar Energy: solar photovoltaic and thermal systems, Wind Energy: current status, types, measuring instruments, potential assessment, Biomass: gasification, anaerobic and aerobic decomposition, fermentation and incineration and Energy from waste.

UNIT II :

Solar Energy Technology

Earth and Sun Relation, Solar angles, day length, angle of incidence on tilted surface, Sun-path diagrams, Shadow determination, Extra-terrestrial characteristics, Effect of earth atmosphere on terrestrial solar radiation, Measurement and estimation on horizontal and tilted surfaces, Analysis of Indian solar radiation data and applications. Flat-plate Collectors, Effective energy losses, Thermal analysis, Heat capacity effect, Testing methods, Evacuated tubular collectors, Types of Air flat- plate Collectors, Thermal analysis,

Thermal drying, Selective Surfaces, Ideal coating characteristics, Types and applications, Anti-reflective coating, Preparation and characterization. Concentrating Collector Designs, Classification, and performance parameters, Tracking systems, Compound parabolic concentrators, Parabolic trough concentrators, Concentrators with point focus, Heliostats.

UNIT III :

General Mechanical System :

Fluid properties, mass, momentum and energy equation, modes of heat transfer, conduction, convection and radiation, dimensionless parameters, Thermodynamics, system and process, laws of thermodynamics, availability and irreversibility, I.C. engines, Refrigeration and Air Conditioning.

UNIT IV:

Energy Storage Technology :

Different modes of energy storage, Technology Types– Mechanical energy storage: flywheels, compressed air, and pumped hydro, Electrical and Magnetic Energy storage: Batteries, Capacitors, electromagnets, Chemical energy storage.

UNIT V :

Energy Efficient Machines :

Transformers, auto-transformer, DC machines, induction motors, synchronous machines – performance, regulation and parallel operation of generators, motor starting, characteristics and applications

Grid Connected Energy Systems :

Power generation transmission distribution systems concepts, power factor correction, economic operation, fault analysis, Principles of over-current, differential and distance protection, solid state relays and circuit breakers

8. PHYSICS

Paper I: Research Methodology

Unit-I: Meaning of Research, Function of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Factors which Hinder Research, Significance of Research, Research and Scientific Methods, Research Process Criteria of good Research, Problems encountered by Researchers, Literature Review.

Unit-II: Identification of Research Problem, Selecting the Research Problem, Necessity of Defining the Problem, Goals and Criteria for Identifying Problems for Research, Perception of Research Problem, Techniques involved in Defining the Problem, Source of Problems, Personal Consideration.

Unit-III: Research Design, Formulation of Research Design, Need for Research Design, Features of a Good Design, Important Concepts related to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Computer and Internet in Designs.

Unit-IV: Interpretation and Report Writing, Meaning and Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different steps in Writing a Report, Layout of a Research Report, Types of report, Mechanics of writing a Research Report, Precautions for writing a Research Report, Conclusion.

Unit-V: Statistical Techniques and Tools, Introduction of Statistics, Functions, Limitations, Measures of Central Tendency, Arithmetic Mean, Median, Mode, Standard Deviation, Co-efficient of Variation (Discrete Series and Continuous Series), Correlation, Regression, Multiple Regression, Sampling Distribution, Standard Error, Concept of Point and Interval Estimation, Level of Significance, Degree of Freedom, Analysis of Variance, One Way and Two Way Classified Data, 'F'-Test.

PAPER II: PHYSICS

UNIT I:

Mathematical Physics:

Dimensional analysis, Vector algebra and vector calculus, Linear algebra, Matrices, Linear differential equations, Elementary probability theory, Binomial, Poisson and normal distributions, Fourier series, Fourier and Laplace transforms, Elements of complex analysis

Classical Mechanics: Newton's law, central forces, Kepler's law and planetary motion, Lagrange and Hamilton's formalisms, Special theory of relativity – Lorentz transformations, time dilation, Length contraction, Relativistic kinematics, Variation of mass with velocity, Mass – Energy equivalence, Relation between energy and momentum.

UNIT II :

Electromagnetic Theory & Acoustic wave:

Gauss's Law and its applications, Laplace and Poisson equations, Magnetostatics: Bio-Savart's law, Ampere's theorem, Electromagnetic induction, Faraday's law, Maxwell's

equations, Scalar and vector potentials, Electromagnetic waves and their reflection, Refraction, Interference, diffraction, polarization, Poynting vector, Energy and momentum, electromagnetic waves, acoustics, acoustical holography, acoustic radiation, acoustic transmission.

Quantum Mechanics: Physical basis of quantum mechanics, Wave – Particle duality, De-Broglie hypothesis, Wave packet and group velocity, , Heisenberg's uncertainty principle, Schrodinger equation (time dependent and time independent), Eigen value problems such as particle- in- a- box, Harmonic oscillator etc.

UNIT III :

Thermodynamics and Statistical Physics: Law of thermodynamics and their consequences, Macro state and microstates, Phase space, Probability ensembles, Partition function, Free energy, Calculation of thermodynamic quantities, Classical and quantum statistics, Degenerate Fermi gas, Black body radiation and Planck's distribution law, Bose-Einstein condensation, First and second order phase transitions.

Atomic and Molecular Physics: Quantum states of an electron in an atom, Electron spin, Spectra of one-and many electron atoms, Relativistic corrections for energy levels of hydrogen, Hyperfine structure and isotopic shift, Width of spectral lines, LS & JJ coupling, Zeeman, Paschen Back and Stark effect, X-ray spectroscopy, Electron spin resonance, Nuclear magnetic resonance, lasers.

UNIT IV :

Solid State Physics: Atomic structure and bonding in materials. Crystal structure of materials, unit cell and space lattices, Miller indices of planes and directions, Concept of amorphous, Single and polycrystalline structures and their effect on properties of materials, Crystal growth techniques, Free electron theory, Band theory of solids, metals, semiconductors and insulators, Hall effect, superconductivity, Fermi level, energy gap.

Nuclear and Particle Physics: Basic nuclear properties, Size, Shape, Charge distribution, Spin and Parity, Mass defect, Binding energy, semi-empirical mass formula, Liquid drop model, Nature of nuclear force, Nuclear shell model, Alpha decay, Beta decay, Gama decay, Laws of radioactivity, Nuclear reactions, Compound nuclei and direct reactions, Controlled and uncontrolled chain reaction, critical mass, fission and fusion, Nuclear reactor, Elementary particles.

UNIT V :

Electronics: Semiconductor devices & physics P-N-Jn. depletion region, barrier potential, Transistors, Bipolar junction Transistors, Field effect transistors, UJT, SCR, Rectifier circuits, Logic gates and symbols, Boolean algebra & Karnaugh map, DeMorgan's theorem, Basic digital logic circuits, Optoelectronic devices including solar cells, photonic devices, Photo detectors and LEDs, Digital techniques and applications (Registers Counters, Comparators and similar circuits), ICs, modulation & demodulation, AM, PM, FM, A/D and D/A convertors, Sensors

9. CHEMISTRY

Paper I : Research Methodology

Unit-I: Meaning of Research, Function of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Factors which Hinder Research, Significance of Research, Research and Scientific Methods, Research Process Criteria of good Research, Problems encountered by Researchers, Literature Review.

Unit-II: Identification of Research Problem, Selecting the Research Problem, Necessity of Defining the Problem, Goals and Criteria for Identifying Problems for Research, Perception of Research Problem, Techniques involved in Defining the Problem, Source of Problems, Personal Consideration.

Unit-III: Research Design, Formulation of Research Design, Need for Research Design, Features of a Good Design, Important Concepts related to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Computer and Internet in Designs.

Unit-IV: Interpretation and Report Writing, Meaning and Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different steps in Writing a Report, Layout of a Research Report, Types of report, Mechanics of writing a Research Report, Precautions for writing a Research Report, Conclusion.

Unit-V: Statistical Techniques and Tools, Introduction of Statistics, Functions, Limitations, Measures of Central Tendency, Arithmetic Mean, Median, Mode, Standard Deviation, Co-efficient of Variation (Discrete Series and Continuous Series), Correlation, Regression, Multiple Regression, Sampling Distribution, Standard Error, Concept of Point and Interval Estimation, Level of Significance, Degree of Freedom, Analysis of Variance, One Way and Two Way Classified Data, 'F'-Test.

PAPER II : CHEMISTRY

UNIT I :

Main Group Elements: S-N compounds Sulphur-phosphorus compounds, Molecular sulphides such as P_4S_3 , P_4S_7 , P_4S_9 and P_4S_{10} , Phosphorus-nitrogen compounds: Phosphazenes. Other P-N compounds, Boron-nitrogen compounds, Metal Complexes, Valence bond theory and its limitations, Ligand field theory: Splitting of d orbitals in different ligand fields, Jahn-Teller effect MO diagrams of complexes with and without n bonds. Spectral & Magnetic properties of complexes.

UNIT II:

Nuclear Chemistry: Nuclear reactions: Types of nuclear reactions. Spontaneous and reduced fission, Principles of working of the reactors of nuclear power plants: Breeder reactor, Nuclear fusion reaction, Analytical Principles: Volumetric methods, Theories of indicators, Acid-base, redox, metallochromic, indicators, Complexation Precipitation Redox

titrations, Gravimetric methods: Mechanism of precipitate formation, Aging of precipitates, Precipitation from homogeneous solutions, Coprecipitation and post precipitation, Contamination of precipitates, Washing, drying and ignition of precipitates, Water treatment: Hardness, Alkalinity, Domestic water treatment Chemical analysis of water, D.O., B.O.D, C.O.D., T.D.S.

UNIT III:

Quantum Mechanics: Introduction to Classical Mechanics: The blackbody radiation, photoelectric effect, Compton Effect and atomic spectra. Failure of classical mechanics to explain these phenomena. Quantum mechanical explanations.

Chemical Kinetics: Theories of reaction rate: Influence of temperature on reaction rate. Arrhenius equation and its limitations, activation energy. Collision theory and absolute reaction rate theory. Free energy of activation and volume of activation. Thermodynamic formulation of reaction rate. Effects of pressure and volume on the velocity of gas reaction.

Surface Chemistry: The colloidal state: Multimolecular, macromolecular and associated colloids. Stability of collides. The zeta potential. Kinetic, optical and electrical properties of colloids: Electrophoresis, electroosmosis, sedimentation potential and streaming potential

Catalysis: Mechanism and theories of homogeneous and heterogeneous catalysis. Acid-base and enzyme catalysis.

UNIT IV:

Thermodynamics: Intensive and extensive properties, Exact differentials, Intrinsic energy, enthalpy, entropy, free energy and their relations and significances, Maxwell relations, Thermodynamic equations of state, Joule Thomson effect, Joule-Thomson coefficient for van der Waals' gas, The third law of thermodynamics, Spectroscopy: Energy levels in molecules, rotational, vibrational, electronic NMR and ESR spectroscopy, Principles of organic chemistry: Inductive, mesomeric, electromeric effect, Carbocations, carbanions, carbens. Addition, Elimination, Substitution reactions

UNIT V:

Chemistry of Polymers: Types and mechanism of polymerization reactions. Step-growth, free radical, addition, ionic polymerizations. Copolymers. Characterization of polymers. Manufacture and applications of polyolefins, thermoplastics, polyamides, polyesters, polyurethanes, epoxies and industrial polymers. Chemistry of natural products: Biosynthesis of terpenes and alkaloids. Carbohydrate protein and nucleic acid.

Organic Photochemistry: Photochemical processes. Energy transfer, sensitization and quenching. Singlet and triplet states and their reactivity. Photoreactions of carbonyl compounds,

10. Mathematics

Paper I : Research Methodology

Unit-I: Meaning of Research, Function of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Factors which Hinder Research, Significance of Research, Research and Scientific Methods, Research Process Criteria of good Research, Problems encountered by Researchers, Literature Review.

Unit-II: Identification of Research Problem, Selecting the Research Problem, Necessity of Defining the Problem, Goals and Criteria for Identifying Problems for Research, Perception of Research Problem, Techniques involved in Defining the Problem, Source of Problems, Personal Consideration.

Unit-III: Research Design, Formulation of Research Design, Need for Research Design, Features of a Good Design, Important Concepts related to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Computer and Internet in Designs.

Unit IV : Interpretation and Report Writing, Meaning and Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different steps in Writing a Report, Layout of a Research Report, Types of report, Mechanics of writing a Research Report, Precautions for writing a Research Report, Conclusion.

Unit-V : Statistical Techniques and Tools, Introduction of Statistics, Functions, Limitations, Measures of Central Tendency, Arithmetic Mean, Median, Mode, Standard Deviation, Co-efficient of Variation (Discrete Series and Continuous Series), Correlation, Regression, Multiple Regression, Sampling Distribution, Standard Error, Concept of Point and Interval Estimation, Level of Significance, Degree of Freedom, Analysis of Variance, One Way and Two Way Classified Data, 'F'-Test.

Paper II: Mathematics

Real Analysis: Elementary set theory, finite, countable and uncountable sets, real number system as a complete ordered field, Archimedean property, continuity, uniform continuity, differentiability, mean value theorems.

Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral, Improper Integrals, monotonic functions, types of discontinuity, functions of bounded variation,

Metric spaces, compactness, connectedness. normed linear spaces.

Linear Algebra: Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations, Eigen values and eigen vectors, 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.

Algebra: Permutations, combinations, pigeon-hole principle, inclusion-exclusion principle,

Fundamental theorem of arithmetic, divisibility in \mathbb{Z} , congruences, Chinese Remainder Theorem, Euler's ϕ -function, primitive roots.

Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, Sylow theorems.

Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain. Fields, finite fields, field extensions.

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

Complex Analysis: Algebra of complex numbers, 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, Taylor series, Laurent series, calculus of residues

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 homogeneous and non-homogeneous linear ODEs, variation of parameters.

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 eigen functions, resolvent kernel.

Linear Programming Problem: 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.

Probability & Statistics. Probability spaces, conditional probability, independence, Discrete and Continuous random variables, distribution and densities functions, bivariate distributions and their properties. Expectation of Random Variables. Methods of estimation, properties of estimators, confidence intervals
Various measure of central tendency, Various measure of dispersion, moments, skewness, and kurtosis, correlation, and regression, curve fitting by the method of least squares.

