

**ANNEXURE-III****SCHEME AND SYLLABUS FOR VARIOUS NON-GAZETTED CATEGORIES OF POSTS IN GROUND WATER DEPARTMENT****FOR PC. NO. 01 TO 03:- SCHEME AND SYLLABUS FOR THE POST OF TECHNICAL ASSISTANT (HYDROGEOLOGY), TECHNICAL ASSISTANT (HYDROLOGY) AND TECHNICAL ASSISTANT (GEOPHYSICS) IN GROUND WATER DEPARTMENT****SCHEME OF EXAMINATION**

Written Examination (Objective Type)	No.of Questions	Duration (Minutes)	Maximum Marks
Paper-I: General Studies And General Abilities	150	150	150
Paper-II: Water Resources	150	150	150
<b>Total</b>			<b>300</b>

Name of the Papers	Language of Examination
Paper-I: General Studies and General Abilities	Bilingual i.e., English and Telugu
Paper-II: Water Resources	English Only

**SYLLABUS****Paper-I: GENERAL STUDIES AND GENERAL ABILITIES**

1. Current Affairs – Regional, National and International
2. International Relations and Events.
3. General Science; India's achievements in Science and Technology
4. Environmental issues and Disaster Management
5. Economy of India and Telangana
6. Geography of India with a focus on Telangana
7. Indian Constitution and Polity with a focus on local self Government
8. Society, Culture, Heritage, Arts and Literature of Telangana
9. Policies of Telangana State
10. History of Modern India with a focus on Indian National Movement
11. History of Telangana with special emphasis on Movement for Telangana Statehood
12. Logical Reasoning, Analytical Ability and Data Interpretation
13. Basic English

**PAPER-II WATER RESOURCES****Unit-1 General Geology and Mineralogy**

Origin, age and interior of earth, earthquakes, volcanoes and mountains, weathering, geological work of rivers, wind, groundwater, glaciers, seas and oceans.

Definition of mineral, Classification of mineral into rock forming and ore forming minerals. Physical and optical properties of minerals, silicate structures, olivine family, feldspars, pyroxenes, amphiboles, micas, chlorides, garnets and quartz family.

**Unit-2 Petrology, Structural Geology and Indian Geology**

Definition of rock, rock cycle, igneous rocks-forms, textures, structures, origin, classification and types. Sedimentary rocks- mode of formation, structures and textures, classification. Metamorphic rocks- Types and agents of metamorphism, structure and textures of metamorphic rocks – grades and zones of metamorphism.

Structural geology- strike and dip, folds, faults, joints and unconformities, recognition of folds in the field and recognition of faults in the field

Indian geology-Standard Geological time scale, Principles of correlation, Physiographical subdivisions of India. Achaeans, cuddapahs, vindyans, gondwanas, Deccan traps, siwalliks and recent formations.

**Unit-3 Groundwater Geophysics**

Gravity methods: principles, instruments-survey techniques, Magnetic methods: principles, instruments, and survey techniques, Seismic method; principles, instruments, survey techniques.

Electrical methods: Wenner, Schlumberger, Lee, Dipole-Dipole configurations. Resistivity profiling and instruments. Resistivity sounding, Interpretation techniques. Geoelectrical parameters corresponding to hydrological zones, Application of resistivity in groundwater studies.

Electromagnetic methods: principles, instruments, survey techniques. Induced polarisation methods: principles, relationship between apparent chargeability and apparent resistivity.

EM sounding - profiling-dipole and VLF techniques. Bore hole geophysics: Well logging, basic concepts of logging.

#### **Unit-4 Hydrochemistry**

The water molecule, isotopic composition of waters-physical and chemical properties of water, geochemical processes, geochemical classification of waters, Mechanisms controlling the groundwater chemistry.

Chemical dissolved constituents. Sampling of water from rivers, lakes, ponds, open wells, bore wells. Standard laboratory techniques for the analysis. Bacteriological studies. Interpretation of physical and chemical data of water, plotting on maps, Statistical techniques in presenting hydrochemical data.

#### **Unit-5 Environmental Hydrology**

Ground water pollution- its sources and classification, Water sanitation- water borne diseases, Groundwater quality problems that originate above and below water table. Utility of water, for drinking, agriculture, industry and recreation. Standards of water- Indian, World Health Organisation,

Control measures of groundwater contamination, prediction of contaminants migration and travel times, problem of fluoride and arsenic. Defluorination-Nalgonda method, Activated carbon method of treatment.

Global threat-Elnino effect -Green House Effect-Ozone layer depletion and its impact on hydrological environment-Global Warming- acid rain- its cause and impact on water environment.

#### **Unit-6 Surface Hydrology**

Hydrologic Cycle, Precipitation, Infiltration, run-off, Evaporation & Evapotranspiration, Water Balance Studies, Forecast of climatic Parameters.

The significance of water, Water resources of the earth. Global water budget. Formation of surface water resources; streams, rivers, lakes, swamps, caves, seas and oceans.

Runoff, groundwater runoff, direct runoff, factors affecting runoff. Discharge and discharge measurement, hydrographs: components of hydrograph, base flow separation methods. Unit hydrograph to design flood computation and of inflow to major rivers.

#### **Unit-7 Groundwater Hydrology**

Groundwater in Hydrologic cycle, Occurrence of Groundwater: Aquifer, Aquiclude, Aquifuge and Aquitard, Porosity, Effective porosity, Vertical distribution of Groundwater; Zone of aeration, zone of saturation, Division of subsurface water. Specific retention, specific yield, Storage coefficient. Water movement in saturated soils, Darcy's law. Permeability, Intrinsic permeability. Hydraulic conductivity, Transmissivity, Determination of Hydraulic conductivity.

Groundwater fluctuations: Secular, Seasonal and Short-term fluctuations, Artificial Recharge of Groundwater, salt water intrusion of coastal aquifers, Development of Groundwater in intrusion areas.

Water wells: Dug wells, Bored wells, Driven wells, Jetted wells, Methods for drilling deep wells, Well design, Well completion, Well development, pumping equipment, Protection of wells, Well rehabilitation and Horizontal well.

#### **Unit-8 Hydrologic Modeling**

Concepts of modelling, Process of model development, types of Hydrological models: Physical models and Mathematical models. Introduction to Continuous and Discrete models, Dynamic and Static, Lumped parameter and Distributed parameter models, Block-Box model, Conceptual model, Stochastic and Deterministic models

**Unit-9 Watershed Management**

Watershed: Concept, Characteristics, Size, Shape, Physiography, Climate, Drainage, Land-use, Hydrological parameters. Basic data collection, Integrated Study of Watershed Management. Conditions to develop watershed, types of Watersheds, Integrated studies to develop watersheds. Rain water structures, design and Economic aspects. .

Floods: flood elevation, Flood discharge, flood volume and duration of floods, Flood estimation, causes of flood, factors affecting flood flow, flood flow determination flood control methods, limitations of flood control measures, Flood routing. Watershed and Agricultural Practices, National projects, Appropriate Technology and action plans, Post-operative problems of watersheds.

**Unit-10 Remote Sensing and Geographical Information System**

Electromagnetic Energy: Laws, Distribution and Interaction, concept of incoming short wave and outgoing long wave radiation: passive and active remote sensing, electromagnetic radiation, spectral reflectance curves. Imaging and non-imaging sensors, resolution. Satellite remote sensing, geo-synchronous and sun-synchronous orbits, IRS-satellites and high resolution satellites. Supervised and unsupervised image classifications. Remote sensing applications for meteorological, hydrological, geological studies and urban planning and management.

Basic concepts of geographical information systems, map projections, geographic coordinate system, transformations, map analysis. Data Acquisition and Data Management, Data Processing, Data Modeling, GIS Analysis and Functions. GIS applications to Environmental and natural resource management, software scenario, functions, standard GIS packages.

**FOR PC. NO. 04 SCHEME AND SYLLABUS FOR THE POST OF LAB ASSISTANT IN  
GROUND WATER DEPARTMENT**

**Scheme of Examination**

<b>Written Examination (Objective Type)</b>	<b>No.of Questions</b>	<b>Duration (Minutes)</b>	<b>Maximum Marks</b>
Paper-I: General Studies and General Abilities	150	150	150
Paper-II: Chemistry (Degree Level)	150	150	150
<b>Total</b>			<b>300</b>

<b>Name of the Papers</b>	<b>Language of Examination</b>
Paper-I: General Studies and General Abilities	Bilingual i.e., English and Telugu
Paper-II: Chemistry (Degree Level)	Bilingual i.e., English and Telugu

**Syllabus**

**Paper-I: General Studies and General Abilities**

1. Current Affairs – Regional, National and International
2. International Relations and Events.
3. General Science; India's achievements in Science and Technology
4. Environmental issues and Disaster Management
5. Economy of India and Telangana
6. Geography of India with a focus on Telangana
7. Indian Constitution and Polity with a focus on local self Government
8. Society, Culture, Heritage, Arts and Literature of Telangana
9. Policies of Telangana State
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**Paper-II: Chemistry (Degree Level)**

**1.1 Atomic structure:** Schrodinger wave equation, significance of  $\psi$  and  $\psi^2$  quantum numbers and their significance, radial and angular probability, shapes of orbitals, relative energies of atomic orbitals as a function of atomic number. Electronic configurations of elements; Aufbau principle, Hund's multiplicity rule, Pauli exclusion principle.

**1.2 Chemical periodicity:** Periodic classification of elements, salient characteristics of s,p,d and f block elements. Periodic trends of atomic radii, ionic radii, ionization potential, electron affinity and electro-negativity in the periodic table.

**1.3 Chemical bonding:** Types of bonding, overlap of atomic orbitals, sigma and pi-bonds, hydrogen and metallic bonds. Shapes of molecules bond order, bond length, V.S.E.P.R. theory and bond angles. The concept of hybridization and shapes of molecules and ions. Molecular orbital theory, Molecular orbital energy diagrams of homo diatomic molecules

**1.4 Oxidation states and oxidation number:** Oxidation and reduction, oxidation numbers, common redox reactions, ionic equations. Balancing of equations for oxidation and reduction reactions.

**1.5 Acids and bases:** Bronsted and Lewis theories of acids and bases. Hard and soft acids and bases. HSAB theory.

**1.6 Chemistry of elements:**

- i) **Hydrogen:** Its unique position in the periodic table, isotopes, ortho and para hydrogen, industrial production, heavy water.
- ii) **Chemistry of 's' and 'p' block elements:** Electronic configuration, general characteristics properties, inert pair effect, allotropy and catenation. Special emphasis on solutions of alkali and alkaline earth metals in liquid ammonia. Preparation, properties and structures of boric acid, borates, boron nitrides, borohydride (diborane), carboranes, oxides and oxyacids of nitrogen, phosphorous, sulphur and chlorine; interhalogen compounds, polyhalide ions, pseudohalogens, fluorocarbons and basic properties of halogens. Chemical reactivity of noble gases, preparation, structure and bonding of noble gas compounds.
- iii) **Chemistry of 'd' block elements:** Transition metals including lanthanides, general characteristic properties, oxidation states, magnetic behaviour, colour. First row

transition metals and general properties of their compounds (oxides, halides and sulphides); lanthanide contraction.

1.7 **Extraction of metals:** Principles of extraction of metals iron, nickel, copper, silver and gold.

1.8 **Nuclear Chemistry:** Nuclear reactions; mass defect and binding energy, nuclear fission and fusion. Nuclear reactors; radioisotopes and their applications.

1.9 **Coordination compounds:** Nomenclature, isomerism and theories of coordination compounds and their role in nature and medicine.

1.10 **Environmental Pollution and Control Technologies: Environmental Pollution & control:** Classification of pollution, causes, effects. **Air Pollution:** Primary and secondary pollutants, Ambient air quality standards. **Water pollution:** Sources and types of pollution, drinking water quality standards. **Soil Pollution:** Sources and types, Impacts of modern agriculture, degradation of soil. **Noise Pollution:** Sources and Health hazards, standards, **Pollution from Power projects:** Thermal and Nuclear, **Solid waste:** Municipal Solid Waste management. **Pollution control technologies:** Wastewater Treatment methods: Primary, secondary and Tertiary, Air: Overview of air pollution control technologies, Concepts of bioremediation. Field visit. **Global Environmental Problems And Global Efforts:** Climate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). Deforestation and desertification.

### 1.11 Chemistry of Water

1. **Sources of water & Quality:** Sources of contamination of water, Chemical, Physical and Biological characteristics of water, Drinking water standards, standards and effects of contaminated water, water born diseases & problems.
2. **General purification Methods of water:** Sedimentation, Filtration, Coagulation, Distillation & reverse osmosis and **Disinfection**, Types of Disinfection, ideal Disinfectant, Mechanism of Disinfection, Efficiency of Disinfection, **Chlorination**, Types of Chlorination. **Coagulation:** Types of Coagulation, Mechanism, Efficiency of Coagulation.
3. **Water Softening Method:** Heating, Lime-Soda Process, Caustic- Soda Process, Softening with Calgon, Zeolite process, Ion-Exchange process. Municipal Water Conditioning and Industrial effluent Treatment.
4. **Qualitative & Quantitative analysis:**  
**Qualitative analysis:** Classification of anions and cations. Reactions involved in the Separation and identification of anions and cations. Qualitative analysis of Organic compounds.  
**Quantitative analysis:** Volumetric analysis and Gravimetric Analysis
  - a. **Volumetric analysis:** Theory of Volumetric analysis Types of reactions, Titration curves w.r.t neutralization, redox, precipitation & Complexometric titrations. Theory of Indicators.
  - b. **Gravimetric Analysis:** Theory of gravimetric analysis, Formation of precipitate, conditions of precipitation, Impurities in precipitate. Washing, drying & ignition of precipitates. Principles and applications of Chromatographic techniques, UV,IR and NMR.

2.1 **Bonding and shapes of organic molecules:** Electronegativity, electron displacements-inductive, mesomeric and hyperconjugative effects; bond polarity and bond polarizability, dipole moments of organic molecules; hydrogen bond; effects of solvent and structure on dissociation constants of acids and bases; bond formation, fission of covalent bonds; homolysis and heterolysis; reaction intermediates-carbocations, carbanions, free radicals and carbenes; generation geometry and stability; nucleophiles and electrophiles.

2.2 **Chemistry of aliphatic compounds:** Nomenclature; alkanes-synthesis, reactions (free radical halogenation) – reactivity and selectivity, sulphonation-detergents; cycloalkanes-Baeyers' strain theory; alkanes and alkynes-synthesis, electrophilic addition; reactions, Markownikov's rule, peroxide effects, 1-3-dipolar addition; nucleophilic addition to electron-deficient alkenes; polymerization; relative acidity; synthesis and reactions of alkyl halides, alkanols, alkanals, alkanones, alkanolic acids, esters, amides, nitriles, amines, acid anhydrides,  $\alpha,\beta$  - unsaturated ketones, ethers and nitro compounds.

2.3 **Stereochemistry of carbon compounds:** Elements of symmetry, chiral and achiral compounds. Fischer projection formulae; optical isomerism of lactic and tartaric acids, enantiomerism and diastereo-isomerism; configuration (relative and absolute); conformations of alkanes upto four carbons, cyclohexane and dimethylcyclo-hexanes their potential energy **D,L** and **R,S** notations of compounds containing chiral centers; projection formulae-Fischer, Newman and sawhorse of compounds containing two adjacent chiral centers; meso and di-isomers, erythro and threo isomers; racemization and resolution; examples of homotopic, enantiotopic and diastereotopic atoms and groups in organic compounds, geometrical isomers; **E** and **Z** notations. Stereo-chemistry of SN1, SN2,E1 and E2 reactions.

2.4 **Organometallic compounds:** Preparation and synthetic uses of Grignard reagents, alkyl lithium compounds.

**2.5 Chemistry of aromatic compounds:** Aromaticity; Huckel's rule; electrophilic aromatic substitution-nitration, sulphonation, halogenation (nuclear and side chain), Friedel-Crafts alkylation and acylation, substituents effect; chemistry and reactivity of aromatic halides, phenols, nitro, diazo, dia-zonium and sulphonic acid derivatives, benzyne reactions.

**2.6 Chemistry of biomolecules:** (i) **Carbohydrates:** Classification, reactions, structure of glucose, D,L-configuration, osazone formation; fructose and sucrose; step-up step-down of aldoses and ketoses; and their interconversion, (ii) **Amino acids:** Essential amino acids; zwitterions, isoelectric point, polypeptides; proteins; methods of synthesis of  $\alpha$ -amino acids. (iii) Elementary idea of oils, fats, soaps and detergents.

**2.7 Beer's Lambert Law and its applications in quantitative analysis:** Basic principles and applications of UV, visible, IR and NMR spectroscopy of simple organic molecules.

**3.1 Gaseous state:** Deviation of real gases from the equation of state for an ideal gas, Vander Waals and Virial equation of state, critical phenomena, principle of corresponding states, equation for reduced state. Liquification of gases, distribution of molecular speed, collisions between molecules in a gas; mean free path, specific heat of gases.

**3.2 Thermodynamics:**

- (i) **First Law and its applications:** Thermodynamic systems, states and processes work, heat and internal energy, zeroth law of thermodynamics, various types of work done on a system in reversible and irreversible processes. Calorimetry and thermochemistry, enthalpy and enthalpy changes in various physical and chemical processes, Joule-Thomson effect, inversion temperature. Heat capacities and temperature dependence of enthalpy and energy changes.
- (ii) **Second Law and its applications:** Spontaneity of a process, entropy and entropy changes in various processes, free energy functions, criteria for equilibrium, relation between equilibrium constant and thermodynamic quantities.

**3.3 Phase rule and its applications:** Equilibrium between liquid, solid and vapours of a pure substance. Number of components, phases and degrees of freedom; phase rule and its applications; simple systems with one (water) and two components (lead-silver). Distribution law, its modifications, limitations and applications.

**3.4 Solutions:** Solubility and its temperature dependence, partially miscible liquids, upper and lower critical solution temperatures, vapour pressures of liquids over their mixtures, Raoult's and Henry's law, fractional and steam distillations.

**3.5 Colligative Properties:** Dilute solutions and colligative properties, determination of molecular weights, using colligative properties.

**3.6 Electro-chemistry:** Ions in solutions, ionic equilibria, dissociation constants of acids and bases, hydrolysis, pH and buffers, theory of indicators and acid-base titrations. Conductivity of ionic solutions, its variation with concentration, Ostwald's dilution law, Kohlrausch law and its application. Transport number and its determination. Faraday's laws of electrolysis, galvanic cells and measurements of their e.m.f., cell reactions, standard cell, standard reduction potential Nernst equation, relation between thermodynamic quantities and cell e.m.f., fuel cells, potentiometric titrations.

**3.7 Chemical kinetics:** Rate of chemical reaction and its dependence on concentrations of the reactants, rate constant and order of reaction and their experimental determination; differential and integral rate equations for first and second order reaction, half-life periods; temperature dependence of rate constant and Arrhenius parameters; elementary ideas regarding collision and transition state theory.

**3.8 Photochemistry:** Absorption of light, laws of photochemistry, quantum yield, the excited state and its decay by radiative, non-radiative and chemical pathways; simple photochemical reactions.

**3.9 Catalysis:** Homogeneous and heterogeneous catalysis and their characteristics, mechanism of heterogeneous catalysis; enzyme catalysed reactions (Michaelis-Menten mechanism)

**3.10 Colloids:** The colloidal state, preparation and purification of colloids and their characteristics properties; lyophilic and lyophobic colloids and coagulation; protection of colloids; gels, emulsions, surfactants and micelles.

**FOR PC. NO. 05:- SCHEME AND SYLLABUS FOR THE POST OF JUNIOR TECHNICAL ASSISTANT IN GROUND WATER DEPARTMENT**

**SCHEME OF EXAMINATION**

<b>Written Examination (Objective Type)</b>	<b>No.of Questions</b>	<b>Duration (Minutes)</b>	<b>Maximum Marks</b>
<b>Paper-I: General Studies And General Abilities</b>	150	150	150
<b>Paper-II: CONCERNED SUBJECT (DEGREE LEVEL)</b>	150	150	150
<b>Total</b>			<b>300</b>

<b>Name of the Papers</b>	<b>Language of Examination</b>
Paper-I: General Studies and General Abilities	Bilingual i.e., English and Telugu
Paper-II: CONCERNED SUBJECT (DEGREE LEVEL)	English Only

**SYLLABUS**

**Paper-I: GENERAL STUDIES AND GENERAL ABILITIES**

1. Current Affairs – Regional, National and International
2. International Relations and Events.
3. General Science; India's achievements in Science and Technology
4. Environmental issues and Disaster Management
5. Economy of India and Telangana
6. Geography of India with a focus on Telangana
7. Indian Constitution and Polity with a focus on local self Government
8. Society, Culture, Heritage, Arts and Literature of Telangana
9. Policies of Telangana State
10. History of Modern India with a focus on Indian National Movement
11. History of Telangana with special emphasis on Movement for Telangana Statehood
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**PAPER.II CONCERNED SUBJECT (DEGREE LEVEL)**

**The Planet Earth:** Origin of the Solar System and the Earth; composition of the Earth; Volcanism and volcanic landforms; Interior of the Earth; Earthquakes; Isostasy; Basic elements of Plate Tectonics

**Geomorphology:** Weathering and erosion; Soil formation; Transportation and deposition by wind, ice, river, sea and resulting landforms. Seas - Offshore profile - continental shelf-Continental slope.

**Structural Geology:** Concept of dip, strike, rake and plunge. Classification and origin of folds, faults, joints, unconformities, recognition of faults in the field effects of faults on the outcrops, recognition of unconformities in the field; Definition of overlap, offlap, outlier, inlier, cleavage, schistosity; foliation and lineation.

**Paleontology:** Major steps in the evolution of life forms; Fossils, their mode of preservation and utility in age determination and paleoenvironmental interpretations; Morphology, major evolutionary trends and ages of important groups of animals – Brachiopoda, Mollusca, Trilobita, Graptolitoidea, Anthozoa, Echinodermata; Gondwana plant fossils;

**Stratigraphy:** Definition of stratigraphy, principles of stratigraphy, standard geological time scale. Physiographic divisions of India with their stratigraphic and structural characteristics. Dharwar system, cuddapah system; Vindhyan system; Kurnool system and Gondwana System. Deccan Traps and their Age, Geology of Andhra Pradesh.

**Mineralogy:** Definition of a mineral - Classification of minerals into rock forming and ore forming minerals. Physical properties of minerals Modes of Mineral formation: Chemical properties of minerals - isomorphism, solid solution, polymorphism, allotropy, pseudomorphism, radio-activity; silicate structure. Mineralogy of common rock-forming minerals, **Crystallography:**

Definition of crystal - amorphous and crystalline, States, Morphology of crystals - Parameters, indices; crystallographic notation - parameter. System of weiss, index following classes of symmetry. I. Cubic system - Normal (Galena) II. Tetragonal system - Zircon type III. Hexagonal system - Beryl type IV. Trigonal system - Calcite type. V. Orthorhombic system - Barytes type. VI. Monoclinic System - Gypsum type. VII. Triclinic system - Axinite type.

**Petrology:** Definition and classification of rocks; **Igneous rocks** – forms of igneous bodies; Processes of evolution and diversification of magma; Classification, common structures and textures of igneous rocks, association, and genesis of common igneous rocks. **Sedimentary rocks** –Definitions of diagenetic lithification and cementation, stratification, Sedimentary structures, Classification of sedimentary rocks: clastic - rudaceous, arenaceous, argillaceous, non-clastic - calcareous, carbonaceous, ferruginous, phosphatic, evaporites. Descriptive study of the following sedimentary rocks-Conglomerate, Breccia, sandstone, Grit, Arkose, Graywacke, Shale, Limestone, shelly limestone. **Metamorphic rocks** – Definition of metamorphism, agents of metamorphism, type of metamorphism, grade and zones of metamorphism, Structures of metamorphic rocks - Cataclastic, maculose, schistose, granulose and gneissose. Textures of metamorphic rocks, Classification of metamorphic rocks - concept of metamorphic facies, Descriptive study of the common metamorphic rocks

**Economic Geology:** Physical properties of common economic minerals; ore minerals, gangue minerals (gangue), ore, industrial minerals, tenor and grade; syngenetic deposits, epigenetic deposits, General processes of formation of mineral deposits; Mode of occurrence and distribution of metallic and non-metallic mineral deposits in India; gold, copper, lead, zinc, aluminum, iron, manganese, chromium, uranium and thorium, with respect to their mineralogy, uses. Major mineral resources of Andhra Pradesh. asbestos, baryte, bauxite, coal, limestone, manganese, mica., oil and natural gas.

**Algebra:**Vector Spaces and Subspaces -Null Spaces, Column Spaces, and Linear Transformations -Linearly Independent Sets; Basic concepts on Matrices (Definitions and Notations - Operations on Matrices )- Determinant of a Square Matrix - Non Singular matrix and Singular Matrix Rank of a Matrix, Inverse of a Square Matrix – Matrix Equation – Methods to Solve Linear System of Equations, Eigen values and Eigen vectors; Sets and their representation; Union, intersection and complement of sets and their algebraic properties; Power set; Relation, Types of relations, equivalence relations, functions;. one-one, into and onto functions, composition of functions.

**Calculus:** Limits, continuity and differentiability. Differentiation of the sum, difference, product and quotient of two functions. Differentiation of trigonometric, inverse trigonometric, logarithmic, exponential, composite and implicit functions; derivatives of order upto two. Maxima and minima of functions of one variable, Integral as an anti – derivative. Fundamental integrals involving algebraic, trigonometric, exponential and logarithmic functions. Integration by substitution, by parts and by partial fractions. Properties of definite integrals. Evaluation of definite integrals, determining areas of the regions bounded by simple curves in standard form.

**Statistics:** Measures of Central tendencies, measures of dispersions, Moments, skewness, kurtosis, Probability definitions (classical and statistical) Addition, Multiplication and bayes theorems, simple problems on probability, Correlation & Regression (simple & Multiple), Principal component analysis, Cluster Analysis (Single, complete and average linkage methods, dendogram)