

DESCRIPTIVE TYPE SUBJECT APTITUDE TEST (SAT) SYLLABUS FOR RECRUITMENT TO THE POST OF ASSISTANT ENGINEER (CIVIL). THIS PAPER-II WILL BE OF (03) HOURS DURATION OF 120 MARKS. THE SUBJECT APTITUDE TEST (SAT) PAPER SHALL HAVE TWO PARTS I.E. PART-I AND PART-II AND COVER THE FOLLOWING TOPICS OF BACHELOR DEGREE IN CIVIL ENGINEERING LEVEL.

PART-I - (60 Marks)

1. Engineering Mathematics:-

Matrix: Algebra Matrices, Related Matrices, Complex matrices (Hermitian and Skew-Hermitian matrices, Unitary matrix), Rank of a matrix, Gauss-Jordan method, Normal form of a matrix, Linear dependence and independence of vectors, Consistency of linear system of equations, solution of linear system of equations, Characteristic equation, Eigen values, Eigen vectors, Properties of eigen values, Cayley-Hamilton theorem and its applications, Reduction to diagonal form, Quadratic form and their reduction to canonical form, **Differential Calculus:** Review of Limits, Continuity and Differentiability, Mean Value Theorem, Partial Differentiation and its geometrical interpretation, Homogeneous functions, Euler's theorem and its extension, Total differentials, Composite function, Jacobian, Taylor's and Maclaurin's infinite series, Indeterminate forms, Errors and increments, Maxima and minima of functions of two variables, Method of undetermined multiples, curve tracing, **Integral Calculus:** Double integrals (Cartesian and Polar), Change of order of integration, Change of Variables, Applications of Double Integrals, Triple Integrals, Change of Variables, Applications of Triple Integrals, Beta and Gamma functions, **Vector Calculus:** Differentiation of vectors, Curves in space, Velocity and Acceleration, Relative velocity and acceleration, Scalar and Vector point functions, Vector Operator 'Del'- Del Applied to Scalar Point Functions (Gradient) and its Geometrical Interpretation- Directional Derivative, Del Applied to Vector Point Function (Divergence and Curl) and their Physical Interpretation, Del Applied Twice to Point function, Del Applied to Products of Point Functions, Integration of Vector, Tangential Line Integral, Normal Surface Integral, Volume integrals, Theorems of Green, Integration of Vector, Tangential Line Integral, Normal Surface Integral, Volume Integrals, Theorems of Green, Stokes and Gauss (without proofs) and their verification and applications, Rotational Fields, Solenoidal Fields, **Fourier Series:** Euler's formula, Dirichlet's Conditions, Functions having points of discontinuity, Change of interval, Expansion of odd and even periodic functions, Half-range series, Typical wave-forms, Parseval's formula, Practical harmonic analysis, **Ordinary Differential Equations:** Brief review of ordinary differential equations, Exact equations, Equations reducible to exact equations, Equations of the first order and higher degrees, Clairaut's equation, Applications of ODEs in concerned engineering branch, Linear differential equations with constant co-efficient, Complimentary functions and particular integral, method of variation of parameters, Equations reducible to linear equations with constant co-efficient (Cauchy's and Legendre's linear equations), initial and Boundary value problems, Simultaneous linear equations with constant co-efficient, Applications of differential equations in concerned

engineering branch, **Partial Differential Equations:** Formulation of Partial Differential Equations (PDE), Solution of PDE, Linear PDE of First Order (Lagrange's Linear Equation), Non-linear Equation of First Order (Standard Forms), Charpit's Method, Homogenous Linear Equation with Constant Coefficients, Non-homogenous Linear Equations, Applications of PDE: Method of separation of variables, Solution of one dimensional wave and heat equation and two dimensional Laplace's equation, **Transforms Theory:** Laplace Transform: Laplace Transforms and their properties, Inverse Laplace Transforms, General Properties of inverse Laplace transforms and Convolution Theorem, Laplace Transforms of periodic functions, Dirac-delta Function, Heaviside's Unit Function, Solution of ODE and linear simultaneous differential equations using Laplace transforms, **Fourier Transform:** Fourier integral representation, Fourier sine, cosine and complex transform, Finite Fourier Transforms and their applications, Probability and Statistics: Review of probability, Conditional probability and sampling theorems, Discrete and Continuous Probability Distribution, Probability Mass & Probability Density Functions, distribution Function, Discrete and Continuous probability distributions, Binomial, Poisson and Normal distributions, **Functions of Complex Variable:** Applications of De Moivre's theorem, Exponential, Circular, Hyperbolic and logarithmic functions of a complex variable, Inverse Hyperbolic functions, Real and imaginary parts of Circular and Hyperbolic functions, Summation of the series- 'C+iS' method, Limit and derivative of complex functions, Cauchy-Riemann equations, Analytic functions and its applications, Complex integration, Cauchy's theorem, Cauchy's integral formula, Series of complex function, Taylor series, singularities and Laurent's series, Cauchy's residue theorem and its application for the evaluation of real singularities and Laurent's series, Cauchy's residue theorem and its application for the evaluation of real definite integrals, **Interpolation:** Least square curve fit and trigonometric approximations, Finite differences and difference operators, Newton's interpolation formulae, Gauss forward and backward formulae, Sterling and Bessel's formulae, Lagrange's interpolation, **Numerical integration:** Integration by trapezoidal and Simpson's rules 1/3 and 3/8 rule, Romberg integration and Gaussian quadrature rule, Numerical integration of function of two variables, **Numerical Solution of Ordinary Differential Equations:** Taylor series method, Picard's method, Euler's method, Modified Euler's method, Runge-Kutta method, Predictor corrector methods, Adam Bashforth and Milnes method, convergence criteria, Finite difference method, **Numerical Solution of Linear and Non-Linear Equations:** Non-Linear Equations: Bisection Method, Regula Falsi Method, Newton-Raphson Method, Iteration Method, Linear Equations: Jacobi and Gauss Seidal Iteration methods, Relaxation method.

2. **Engineering Graphics:-**

Introduction: Importance of Engineering drawing, Engineering Drawing instruments and uses, B.I.S. and I.S.O. Conventions for drawings, Use of plane scales and Representative Fraction, **Projection of Points and Straight Lines:** Introduction to principal planes, Notation System, Projection of line parallel/perpendicular to principal plane, Concept of true length of line, **Projection of Planes:** Concept of different planes, Projections of

planes with its inclination to one principal plane and with two principal planes, Concept of auxiliary plane method for projections of the plane, **Projections of Solids and Sections of Solids:** Classifications of Solids, Projections of right and regular solids with their axis parallel to two and perpendicular to one of the principal planes, axis parallel to one and inclined to two principal planes, axis inclined to all the three principal planes, Section of solids, **Orthographic Projections & Isometric Projection:** Principle of projection, Principal planes of projection, Projections from the pictorial view of the object on the principal planes using first angle projection method and third angle projection method, Full Sectional View, Isometric Projection, **Autocad's Workspaces and User Interface:** The Drawing Area, Accessing Autocad Commands, Starting, Saving, and Opening Drawings, Closed User Interface, User Interface and Start-up Tutorial, Coordinates, World Coordinate System/User Coordinate System, Coordinate Systems tutorial, Drawing Using Coordinates Tutorial, Drawing Commands, Text & Modifying Commands, Object Snap Commands.

3. **Engineering Physics:-**

Semiconductor Device Physics: Energy bands in solids, the E-k diagram, Density of states, Occupation probability, Fermi level and quasi Fermi levels, Fermi-Dirac Statistic, Effective mass, conductivity as a function of temperature p-n junctions, Schottky junction and Ohmic contacts, **Laser Physics:** Concept of laser, spontaneous and simulated emission, elementary idea about Lasers, basic principles involved in laser, three and four level laser system, coherence, characteristics of laser light; ruby; He-Ne, CO₂ and semiconductor lasers, applications of lasers, **Fibers Optics and photonics:** Optical Fiber, Physical structure and basic theory, modes in optical fibers, step index fibers, losses in optical fibers, sources and sensors for optical fibers, applications of optical fibers in communication, **Electrostatics and Electrodynamics:** Gauss's Law in dielectric medium, Equation of continuity, displacement current, Maxwell's equations, wave equation for electromagnetic radiation, Electromagnetic wave propagation in free space and isotropic dielectric medium, Poynting theorem & Poynting vector, **Quantum Mechanics:** Need of quantum mechanics, Compton effect, Born's concept of wave function, eigen function and eigen values, operators in quantum mechanics, expectation values, time dependant Schrodinger's wave equations and its applications viz., particle in one dimensional potential well, **Superconductivity and Ultrasonics:** Introduction and discovery of superconductivity, superconductivity materials, Meissner effect, critical magnetic field and critical current, type-1 and type-2 superconductors, isotope effect, theory of superconductivity ultrasonic's, generation, properties and applications.

4. **Applied Mechanics:-**

Introduction to Statics: Particle and Rigid body, Types of forces, Transmissibility of a force, Vector algebra, **Two dimensional force system:** Resolution of forces, Moment of forces, Couple, Resolution of a coplanar force by its equivalent force-couple system, Resultant of forces, free body diagram, equilibrium, **Centre of Gravity and Moments of inertia:** Centroid of plane, curve, area, volume and composite bodies MI with respect to

different axis, parallel axis theorem, Mass moment of inertia, **Virtual work and Energy method:** Principle of virtual work; Application of virtual work principle to machines; Mechanical efficiency; Work of a force/couple, potential energy and equilibrium, **Concept of Friction:** Law of Coulomb friction, Angle of Repose, Coefficient of friction, large and small contact surfaces, Belt friction, Equilibrium of a belt, Bearing friction, **Kinematics of Rigid body:** Introduction, Plane Motion of Rigid Body, Velocity and Acceleration under Translation and Rotational Motion, Relative Velocity, **Kinetics and Rigid Body:** Introduction, Force, Mass and Acceleration, Work and Energy, Impulse and Momentum, D'Alembert's Principles and Dynamic Equilibrium, **Impulse Momentum Principle:** Impulsive force, Conservation of Linear momentum and Angular momentum, Impact between bodies, **Simple Stresses and Strains:** Normal stress, Shear stress, Bearing Stress, Normal strain, Shearing Strain; Hook's law; Poisson's ratio, Factor of safety, **Bending stress of Beams:** Introduction, Simple Bending Theory, Stress in beams of different cross sections, shear stress, combined stresses, **Torsion:** Introduction, Torsion of shafts of circular section, torque and twist, shear stress due to torque, **Analysis of Truss:** Method of joints, Method of Sections, **Analysis of Frames:** Shear force and bending moment diagram of determinate beams and frame.

5. Engineering Chemistry:-

Environmental Science: Specification of domestic and industrial water, water treatment, water quality parameters, waste/sewage water treatment, BOD, COD, Air quality standard, air pollution and its control, smog formation, Photochemical smog, green house effect and Global Warming, Chemical pollutants, Carbon Credit, Climate Change, Introduction to Environment impact assessment, **Characterisation Techniques:** Introduction to spectroscopy, UV-Visible spectroscopy- Absorption laws, Instrumentation, formation of absorption bands, Chromophore and auxochrome concept, application of UV-Visible Spectroscopy, IR spectroscopy- Principle, Selection rules, spectral features of some classes of compounds, important features of IR spectroscopy and application, Introduction to Thermal methods, instrumentation and applications (TGA, DTA, DSC), **Nanochemistry:** Introduction to nanochemistry: Dependency of optical, electrical and magnetic properties on size of materials, various nanostructures, spherical nanoparticles, nanotubes, nanofibers, nanorods, etc, synthesis, properties and applications of following nanomaterials- Carbon based nanostructures- CNTs and graphene, semiconductors nanoparticles- TiO_2 , Characterisation of nanomaterials: atomic force microscopy (AFM), Scanning electron microscopy (SEM), **Corrosion and its control:** Introduction, Types of corrosion-chemical and electrochemical, Mechanism of corrosion, factors affecting corrosion and different protection methods for corrosion control, **Lubricants:** Introduction, Mechanisms of lubrication, Types of lubricants, properties and different methods for testing of lubricant oils and greases.

6. Fluid Mechanics:-

Introduction: Flow characteristics, Classification, Fluid properties, Fluid Pressure and its measurement, hydrostatic forces on submerged bodies, buoyancy and floatation, **Fluid**

Kinematics and Dynamics: Continuity equation, rotational and irrotational flow, circulation and vorticity, velocity potential and stream function, flow net, Euler's equation, Bernoulli's equation and its applications, **Flow through pipes:** Darcy-Weisbach equation, energy losses in pipelines, equivalent pipes, multiple pipe system, siphon, three reservoir problem, **Laminar and Turbulent flows:** Reynolds experiment, Laminar flow between parallel plates, Laminar flow in pipes, characteristics of turbulent flow, Turbulent flow in smooth and rough pipe, Concepts of boundary layer, Boundary layer thickness, momentum integral equation, boundary layer separation and its control, **Dimensional analysis and similitude:** Dimensional homogeneity, Buckingham's π theorem, geometric, kinematic and dynamic similarity, model studies, **Open Channel Flow:** Types of open channels, classification of flows, continuity equation, concept of specific energy, Critical depth, Chezy's and Mannings equation, roughness coefficients, equivalent roughness, Hydraulically efficient channel cross sections.

7. Engineering Geology and Rock Mechanics:-

Introduction: Dynamic Earth; Origin, Age, Interior, Materials of Earth; Silicate Structures and Symmetry Elements, Physical properties, Formation of Rocks; Igneous, Sedimentary and Metamorphic processes and structures, Characterisation; Weathering Processes, Geological work of Rivers, Glaciers, Wind and Sea/Oceans, Deposits and Landforms, Formation of Soils; Engineering Properties of Rocks, Rock as Construction material, Structural Features, Attitude of beds, True and apparent dips, Folds, Joints, Faults, Unconformities, Plate tectonics, Continental drift and sea floor spreading, Geological time scale, topographic maps, outcrops, Three point problems, Depth and thickness problems, **Hydrogeology:** Ground water, Zone of ground water, water table and perched water table, water bearing properties of rocks; occurrence of ground water, springs, selection of sites for well sinking and geophysical investigations (Electrical and Seismic methods), **Earthquake and landslides:** Classification, causes and effects of Earthquake and landslides, seismic curve, seismographs, seismograms, accelograms, seismic problems of India, seismic zones of India, remedial measures to prevent damage for engineering structures, case histories, **Geology of dams and reservoirs:** Types of dams, requirements of dam site, preliminary and detailed geological investigation for dam site, failures of dams and their causes, factors affecting seepage and leakage of the reservoir and the remedial measures, silting of reservoir, **Rock Mechanics:** Rock Mechanics and its relationship with soil mechanics and engineering geology, application of rock mechanics to civil engineering problems, index properties, Strength and failure criteria for rocks and rock masses, Insitu stresses in rocks and their measurement, Strength and deformation behaviour of discontinuities in rocks, Deformation behaviour of rocks and rock masses, Time dependent behaviour of rocks, Application of Rock mechanics of Underground Structures, slopes and Foundations, Improving the properties of insitu rock masses, Rockmass classifications, Terzaghi, RQD, RSR, RMR and Q classification, Rating, Applications, Creep and cycling loading, Weathered rocks, **Tunneling:** Purpose of tunnelling and geological problems connected with tunnelling, basic design and Principles of tunnels in rocks, Types and design of tunnel lining.

8. Surveying & Quantity Surveying:-

Basics of surveying: Introduction, concept of Geoids and reference spheroids, coordinate systems, plane and geodetic surveys, methods of location of a point, errors in measurements, surveying instruments, maps, scales and uses, topographic maps, map layout, **Distance measurements:** Direct and Indirect methods, Chain and tape measurements, Optical methods- tachemeters, sub tense bar, Electronic methods- EDMs, **Levelling:** Methods of height determination, levels and staves, booking and reduction of data, classification and permissible closing error, profile levelling and cross sectioning, errors, reciprocal levelling, Contour-characteristics, uses and methods of contouring, **Measurement of Directions:** Bearing and angles, compass surveying, magnetic bearings, declination, local attraction errors and adjustments, Theodolites-types, uses, methods of observation and booking of data, total station, **Traversing and Triangulation:** Compass and Theodolite traverses- balancing and adjustment of traverses, computation of coordinates, omitted measurements Triangulation-network, strength of figures, selection of stations, inter-visibility, satellite stations, measurements and computations, **Plane Tabling:** Accessories, orientations, and resection, methods, three point problem and solutions, errors in plane tabling, **Curves:** simple circular curves, compound and reverse curves, transition curves and vertical curves, **Earthwork:** area of a traverse, determining area from plans, area of x-section, volume from X-section, corrections, mass haul diagram, **Modern Surveying methods:** Aerial photogrammetry, geometry of aerial photograph, stereoscopy, GPS principles, Satellite navigation system, GPS segment, Receivers, Static, Kinematic and Differential GPS, remote sensing/GIS techniques and application in mapping.

Estimate: Principles of estimation, Units, Items of work, Different kinds of estimates, different methods of estimation, estimation of materials in single room building, Two roomed building with different sections of walls for foundation, floors and roofs, R.B. and R.C.C. works, plastering, white-washing, distempering, painting, doors and windows, and lump sum items, estimates of canals and roads, **Specification of works:** Necessity of specifications, types of specifications, general specifications, specification of bricks, cement, sand, water, lime, reinforcement; detailed specifications for earthwork, cement, concrete, brick work, floorings, D.P.C., R.C.C., cement plastering, white and colour washing, distempering, painting, **Rate Analysis:** Purpose, Preparation of rate analysis, procedure of rate analysis for items: earthwork, concrete works, R.C.C. works, reinforced brick work, plastering, painting, white-washing and distempering, **Valuation:** Gross income, net income, outgoings, scrap values, salvage value, obsolescence, annuity, sinking fund, depreciation, valuations of buildings, **Public Works Account:** Regular and work change establishment, earnest money, security money, retention money, muster roll, measurement book, cash book, examination and payment of bills, first and final bills, administrative sanction, technical sanction.

9. Water Resource Engineering:-

Introduction: Hydrological cycle, Water budget equation, Watershed, **Abstractions:** Precipitations-Types, Measurement, Computation of average rainfall over a basin,

Evaporation, Transpiration, infiltration, Φ -index, weather systems, **Runoff:** Factors affecting, runoff computation, rainfall-runoff correlation, flow mass curve, flow duration curve, **Hydrographs:** Flood hydrograph, base flow separation, Unit and S-hydrograph from simple and complex storms, synthetic and instantaneous unit hydrograph, **Floods:** flood discharge estimation, flood control, reservoir and channel routing, **Groundwater Hydrology:** Darcy's Law- concept and applications, Well Hydraulics- Steady and unsteady state, **Open Channel Flow:** Types of open channels, classification of flows, continuity equation, concept of specific energy, critical depth, Chezy's and Mannings equation, roughness coefficients, equivalent roughness, Hydraulically efficient channel cross sections, **Gradually Varied Flow:** Equations of GVF, Slope Profiles, Computations of GVF Profiles, **Rapidly Varied Flow:** Hydraulic Jump- Concept and computations, Principles of energy dissipation, Jump as Energy dissipaters, tail water rating curve and jump height curves, **Irrigation:** water requirements of crops: Soil moisture and crop-water relations, Consumptive use of water, duty and delta, irrigation efficiencies, computation of channel and reservoir capacity based on crop water requirements, irrigation methods, irrigation scheduling, **Canals:** Canal classification, Design of stable channels, regime theory and design of unlined canals, Water logging: Causes, preventive and curative measures, **Water Resources Management:** Water resources availability and demand; Water use sectors- Domestic, Industries and Agriculture; Sustainable water resources development, Integrated Water Resources Management (IWRM).

10. Soil Mechanics:-

Soil Properties: Soil mechanics, rock mechanics, foundation engineering, soil formation, soil structure, soil map of India, Basic definitions phase diagram, water content, specific gravity, void ratio, porosity, unit weight, weight volume relationships, index properties of soil and their determination, classification of soils, degree of saturation, density index, **Permeability, Seepage:** Darcy's law and its validity, seepage velocity, discharge velocity, constant and variable head permea-meter, pumping in & out tests, permeability of stratified soils, factors affecting permeability, laplace's equation flow potential flow net and its properties, different methods of drawing flownets, seepage pressure, quick sand, exit gradient, piping, design of filter, principle of total and effective stresses, capillarity conditions in soil, effective and pore pressures, **Stress Distribution:** Effective and pore pressures, Effective stress principle, Stress distribution in soil, assumption in elastic theories, Boussinesq's equation for point, line, circular and rectangular loads, Westergaad's formula for point load, comparison of Boussinesq's and Westergaad's equation, concept and use of pressure bulbs, principle and use of New mark's influence chart, contact pressure, **Compaction:** Mechanism of compaction, objective of compaction, measurements of compaction, factors affecting compaction, optimum moisture content, Standard Proctor test, Modified Proctor test, effect of moisture content and compactive effort on dry density, zero air void curve, compaction of cohesion less soils, field compaction, field control of compaction, **Consolidation:** Mechanism of consolidation, (e-log) curves, basic definitions, estimation of pre consolidation pressure, normally consolidation and over consolidation ratio, Terzaghi's theory of one dimensional

consolidation, assumption, governing equation, standard solution, laboratory determination of consolidation properties of soil, magnitude and rate of consolidation, settlements, secondary consolidation, compression characteristics of clays and settlement analysis, **Shear strength:** Normal, shear and principal stresses, Columb's equation, Mohr's stress circle, Mohr-Columb failure criteria, laboratory determination of shear parameters of soil by direct shear tests, triaxial test, unconfined compression test, Vane shear test, Consolidated drained, consolidated undrained and unconsolidated undrained shear test, pore pressure parameters, Lambe's p-q diagram.

11. Building Materials and Construction:-

Basic Structural Building Materials: Principle Properties of Engineering materials: Physical & Mechanical, Clay product- Clay Brick and Tiles: Classification, tiles, Limes: Classification and applications, Cement: Composition, Types, Manufacturing of Ordinary Portland Cement, rate of hydration, special types, Fine and Coarse aggregate, Source, impurities, Classification, Characteristics, Timber: Classification, seasoning, defects, wood product and its applications, **Transformed Material:** Mortars: Classification, characteristics, functions of ingredient, Cement concrete and Special concrete: Types, Physical properties, **Service Material:** Ceramic products: Classification, refractories, glass, properties of ceramic materials, Ferrous and non-ferrous Metals and alloys: Properties, Uses, Paints, Distemper & Varnishing, Basic Constituents, Types, Composition, Defects, application, **Structural Components of building and building specification:** Foundation: Type, application, Masonry: Stone, brick and Confined, Types, Bonds, defects, Walls, Design Consideration, Constructional details, Types of load bearing and non-load bearing walls, Floor and Roofs, Type, Ground/ Upper; Flat/Slopped, Beam/Band-Plinth, sill, Lintel-Types and details, Stairs, Ramps- classification, application, Form work; Requirements, Load Applied, Scaffolding, **Non Structural Components of building and building specification:** Plastering, Pointing: Type, methods, defects, Doors and Windows, Ventilators: Locations, Sizes, types, Dampness and Water Proofing: Causes, Prevention methods, damp- proofing treatment, Materials used, **Building service:** Plumbing-Fitting, Fixture, System, Termite Proof; Materials used and Method of application, Fire protection, Fire safety requirement, Fire extinguishing equipment, Thermal Insulation: Basic definitions, Materials used, methods, Acoustics & Sound insulation: characteristics, sound insulation, Acoustical design, ventilation: functional requirement, systems.

12. GIS and Remote Sensing:-

Remote Sensing: Remote sensing system; Physics of remote sensing, EMR characteristics and interaction in atmosphere and with ground objects, spectral properties of water bodies, vegetation, soil etc., resolution, sensors and platforms, types of resolution, image processing, classification, geometric and radiometric distortions, geo-referencing, digital image processing, image enhancement, transformations and classification, visual interpretation techniques, applications of remote sensing for earth resource management, applications of optical and microwave remote sensing techniques

in civil engineering, **Geographic Information System:** introduction to GIS, spatial data models, databases and database management systems, coordinate systems and geo referencing, GIS analysis functions, statistical modelling, digital elevation models and their applications, data visualization methods, exporting data modern trends in GIS, applications of GIS.

13. Earthquake Resistant Design of Structures:-

Introduction: Seismic design Philosophy- Earthquake ground motions, inelastic seismic response, **Theory of vibrations:** Conversion of Structures into equivalent mathematical model for vibration analysis, Vibration of single, two and multi storey building frames, **Earthquake resistant Reinforced concrete buildings:** Codal provisions for design against earthquake IS: 1893-2016, IS: 13920-2016, **Earthquake resistant Masonry buildings:** Behaviour of masonry during earthquakes, codal provisions for earthquake resistant masonry, IS: 4326-2013, IS: 3827-1993, IS: 13828-1993.

14. Bridge Engineering:-

Elements of bridge engineering: Definitions, components of bridge, classification, importance and Site Selection, water way, Site Selection, data drawing, design discharge linear water way, economical span, location of piers and abutments, vertical clearance above HFL scour depth, Traffic projection, investigation report choice of bridge type, selection of Bridge cross-section and longitudinal form, Characteristics of each type, Introduction to bridge codes, Design loads for Road and Railway bridges; General design consideration, **Culverts:** Design of R.C.C. slab culvert (Design of deck slab), Pipe culvert and Box culvert based on variety of IRC vehicle loading, **RC Slab and Tee Girder Bridges:** Design of solid deck slab, Longitudinal beam and Cross beam based on variety of IRC vehicle loading, **Bridge Piers, Abutments, Wing-wall and approaches:** Types and stability analysis of piers and abutments, Loads, abutments and wing wall design, **Bridge Foundations:** Types of Bridge foundations, Pile and well foundations, **Bridge Bearings and expansion joints:** Necessity of bearings, Types of bearings and expansion joints, Design of Elastomeric Bearings, Necessity and types of expansion joints.

15. Building Services:-

Planning of building services: Classification of Buildings base on Occupancy, Consideration in Building Design, Standard of Accommodation, **Plumbing:** Common sanitary fixtures, Layout of Sanitary Fixtures, Water Pipe Sizing in Buildings, Foul Water Drainage in Buildings, Buildings Services Detailing, **Lift and Escalator:** Classification (Types), Lift codes and Rules, Structural Provisions, Design Features of Escalator, **Acoustics and Ventilation:** Material properties, acoustical design of assembly halls and buildings, noise and its control, measuring equipment, Ventilation: Ventilation systems, health and comfort ventilation, natural ventilation and its measurement, Fire protection and equipment, **Illumination:** Laws and principles of illumination, artificial and day lighting, Energy conservation in buildings, Electrical Wiring: Requirements in domestic, office and commercial buildings, Electric light sources- brief description, characteristics, **Thermal Aspects of Building Services:** Thermal environment in building and its control,

factors involved, heat transfer building fabric, thermal properties of building and insulation materials, air conditioning systems, types, design, installation, Solar passive building planning.

16. Geo-synthetics & Ground Improvement Techniques:-

Introduction: Geosynthetics, Types, Advantage and disadvantage, Basic characteristics, Raw material, Manufacturing processes, functions, Selection, Physical properties, Mechanical properties, Hydraulic properties, Endurance and degradation properties, Test and allowable properties, **Applications:** Retaining walls, Embankments, Shallow foundations, Roads, Unpaved roads, Paved roads, Railway tracks, filters and drains, Slopes, Erosion control, Stabilization, Containment facilities, Landfills, Ponds, Reservoir, Canals, Earth dams, Tunnels, Installation survivability requirements, **Analysis and design concepts:** Design methodologies, Retaining walls, Embankments, Shallow foundations, Roads, Unpaved Roads, Paved Roads, Railway tracks, Filters and drains, Slopes, Erosion control, stabilization, Containment facilities, Landfills, Ponds, reservoir, canals, Earth Dams, Tunnels, **Application guidelines:** General guidelines, care and consideration, Geosynthetic selection, Identification and inspection, Sampling and test methods, Protection before installation, Site preparation, Geosynthetic installation, Joints/seams, Cutting of geosynthetics, Protection during construction and service life, Damage assessment and correction, Anchorage, Prestressing, Maintenance, Certification, Handling the refuse of geosynthetics, Specific guidelines related to Retaining walls, Embankments, Shallow foundations, Unpaved Roads, Paved roads, Railway tracks, Filters and drains, Slopes- erosion control, slopes- stabilization, Containment facilities and Tunnels, **Quality Field Performance Monitoring and Economic Analysis:** Concepts of quality and its evaluation, Field performance monitoring, Economic evaluation- Concepts of cost analysis, Experiences of cost analysis, Selected case studies.

Dewatering: Need and objectives of Ground Improvement, Classification of Ground Modification Techniques, Suitability and feasibility, Emerging Trends in ground improvement, methods of dewatering-sumps and interceptor ditches- single, multi stage well points- vacuum well point- Horizontal wells- foundation drains- blanket drains- criteria for selection of fill material around drains- Electro-osmosis, **Grouting:** Chemical grouting, commonly used chemicals, grouting systems, grouting operations, applications, compaction grouting, application and limitation, plant for preparing grouting materials, jet grouting, jet grouting process, geometry and properties of treated soils and applications, **Compaction:** Principles of compaction, Engineering behaviour of compacted clays, field compaction, techniques static vibratory, impact, Earth moving machinery, compaction control, Application to granular soils, cohesive soils, depth of improvement, Environmental considerations, induced settlements, compaction using vibratory probes, vibro techniques, vibro equipment, vibro compaction and replacement process, vibro systems and liquefaction, soil improvement by thermal treatment, preloading techniques, surface compaction, introduction to bio technical stabilization, **Stabilization:** Introduction to soil improvement by adding materials, lime, flyash, cement and other chemicals and bitumen, sand column, stone column, sand drains, prefabricated

drains, lime column, soil-lime column, stabilization of soft clay or slit with lime, bearing capacity of lime treated soils, settlements of lime treated soils, improvement in slope stability, control methods, **Expansive Soils:** Problems of expansive soils- tests for identification- methods of determination of swell pressure, Improvement of expansive soils- Foundation techniques in expansive soils- under reamed piles.

17. Disaster Management:-

Understanding Disasters: Understanding the concepts and definitions of Disasters, Hazard, Vulnerability, Risk, Capacity- Disaster and Development and disaster management Types, Trends, Causes, Consequences and Control of Disasters, Geological Disasters; Hydro-Meteorological Disasters, Biological Disasters and man-made Disasters Global Disaster Trends- Emerging Risks of Disasters- Climate change and Urban Disasters, **Disasters Management Cycle and Framework:** Disaster Management Cycle- Paradigm shift in Disaster Management Pre-Disaster- Risk Assessment and Analysis, Risk Mapping, Zonation and Microzonation, Prevention and mitigation of Disasters, Early warning system; Preparedness, Capacity Development, Awareness During Disaster- Evacuation- Disaster Communication- Search and Rescue- Emergency operation centre- Incident Command System- Relief and Rehabilitation- Post-disaster- Damage and Needs Assessment, Restoration of Critical Infrastructure- Early Recovery- Reconstruction and Redevelopment; IDNDR, Yokohama Strategy, Hyogo Framework of action, **Disaster Management in India:** Disaster Profile of India- Mega Disasters of India and Lessons Learnt Disaster Management Act 2005- Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management, Role of Government (local, state and national), Non-Government and inter-Governmental Agencies, **Application of Science and Technology for Disaster Management:** Geo-informatics in Disaster Management (Rs, GIS, GPS and RS) Disaster Communication System (Early Warning and its Dissemination) Land use Planning and Development Regulations Disaster Safe Designs and Constructions Structural and Non Structural Mitigation of Disasters S&T Institutions for Disaster Management in India.

18. Air Pollution Control:-

Sources and effects of air pollutants: Classification of air pollutants- Particulates and gaseous pollutants- Sources of air pollution- Source inventory- Effects of air pollution on human beings, materials, vegetation, animals- global warming- ozone layer depletion, Sampling and Analysis- Basic Principles of Sampling- Source and ambient sampling- Analysis of pollutants- Principles , **Dispersion of air pollutants:** Elements of atmosphere- Meteorological factors- wind roses- Lapse rate- Atmospheric stability and turbulence- Plume rise- Dispersion of pollutants- Dispersion models- Applications, **Air Pollution Control:** Concepts of control- Principles and design of control measures- Particulates control by Gravitational, centrifugal, filtration, scrubbing, electrostatic precipitation- Selection criteria for equipment- gaseous pollutant control by adsorption, absorption, condensation, combustion- pollution control for specific major industries.

PART-II-(60 Marks)

1. RCC Design:-

Introduction: Type of loads and load combinations, Properties of concrete and reinforcing steel, design philosophies, limit state, ultimate load method, working stress method, **Design of Flexural members (Beam and Slab) by Limit state Method:** Design of Beams: Singly reinforced, doubly reinforced, rectangular, Flanged beams and lintels, Design of Slabs; One way, two way, flat slab, **Design of Columns by limit state method:** Design of short and long columns subjected to eccentric and axial loading, **Design of Stair Cases:** Types terms used, design of stairs spanning horizontally & longitudinally, Circular/ spiral doglegged, Open well stair, **Design of Footings:** Isolated and Combined footings.

2. Water Supply and Treatment:-

Introduction: Scope and importance of Environmental Engineering and management- Introduction to Environmental pollution- Impact on human health- Significant water quality parameters for Municipal water supplies, Standards and guidelines for water quality parameters, **Demand and Sources of Water:** Water Demand- population forecast- Water quality requirements- Sources and its yield for water requirements- Intake structures- water quality parameters and their significance in domestic use, **Water Treatment:** Design of treatment units such as aeration, sedimentation, coagulation and flocculation, filtration, Disinfection, water softening- Advanced water treatment methods, **Water Distribution Systems:** Pumps and pumping system- Pipes- Pipe appurtenances- Testing of water main- Distribution reservoirs- Distribution methods- Pipe network analysis- Planning of water supply project, **Plumbing and fittings for Water Supply:** House water connection, Design consideration for water piping system and storage of water in building, **Rural Water Supply and Treatment:** Water demand and treatment, techniques for rural area, water problems and remedial measures.

3. Foundation Engineering:-

Stability Analysis: Stability of finite and infinite slopes, Types of failure, different factors for safety, determination of factor of safety by method of slices, Swedish circle, friction circle, Bishop method, Morgenstern Price method, Taylor's stability number, location of critical circle, stability analysis of earth dam slopes for different conditions, design of filters and rock toe, **Earth Pressure:** Different types of earth pressure, States of plastic equilibrium, Rankine's theory and Coulomb's theory, influence of water table, surcharge, wall friction and deformation on earth pressure, application of Rankine's theory and Coulomb's theory to cohesionless and cohesive soils, Culmann's graphical method, stability considerations for retaining walls, effect of earthquakes, design of retaining walls, **Sheet Pile Walls:** Different types of sheet pile walls, fixed and free earth support, design principles of anchored bulkheads, arching in tunnels, open cut strutting and sheeting, **Foundations:** Different types of loads on foundations, types of shallow and deep foundations, footings, rafts, piles, wells, selection of foundation type, dewatering of

foundations, types of exploration, methods of boring, soil samples and sampling, **Shallow Foundations:** Bearing capacity, Terzaghi's theory, effect of foundation size, shape, ground water table, determination bearing capacity from building codes, plate load test, penetration test, static and dynamic cone tests, Housel's approach, bearing capacity of sands and clays, settlements analysis of foundation, permissible settlements, design principles, depth of foundation, principles of floating raft, foundations on non-uniform soils, **Pile Foundations:** Types of pile based on function, Materials and methods of construction, friction and end bearing piles, static formula, Engineering News and Hiley's formula, group action, block failure, settlement of pile group in sand and clays, pile load test, negative skin friction, under-reamed piles, **Well Foundations:** Elements, forces on well, Lateral stability analysis, problem in sinking of wells and remedial measures.

4. Highway Engineering:-

Road Development and Planning: Necessity of transportation planning, Classification of roads, Road patterns, Planning surveys, Highway planning and development in India, **Highway Location and Alignment:** Ideal alignment and factors controlling, Engineering survey for highway location, Drawing and reports, Highway projects, **Highway Geometric Design:** Highway cross-section elements, Sight distances, Design of horizontal alignment, Transition curves and vertical alignment, Design aspects of hill roads, **Traffic Engineering:** Traffic characteristics, Traffic Operation, Traffic studies and data collection, Design of intersections & rotaries, Signalling, Road markings and parking facilities, **Pavement Design:** Design factors, Pavement materials and their characteristic, Design of flexible pavement by CBR method, Group index and Burmister methods, Design of rigid pavements, **Construction of Roads:** Construction of water-bound macadam roads, Bituminous pavements, Cement concrete roads, Construction of joints in cement concrete pavement, **Highway Maintenance:** Pavement failure, maintenance techniques, Evaluation and strengthening of existing pavements.

5. Steel Structure:-

Design of connections in steel structures: Bolted and welded connections, assumptions, Different types of joints, design of various types of bolted and welded connections subjected to direct loads and eccentric loads, **Design of tension members:** Selection of section, I.S. specifications, design of axially loaded tension members, design of members for axial tension and bending, end connections, design of lug angles and tension splices, **Design of compression members:** Theory of buckling, design of column, cross section (single and built up sections), design of angle struts, eccentrically loaded columns, column splices, lacings and battens, **Design of beams:** Lateral stability, design of single and built up beams, plated beams and curtailment of flange plates, **Design of column bases and column footings:** Slab base, gusseted base, and Grillage Foundation subjected to Axial & Eccentric loads, **Design of Roof Trusses:** Types of trusses, roofs and side coverage, types of loadings and load combinations, design of members and connections, **Design of Plate Girder and Gantry Girder:** Design of section, stiffeners, splices, design of built up Gantry Girder.

6. Railways and Airports:-

Planning of Railways: Significance of Road, Rail, Air and Water transports Coordination of all modes to achieve sustainability, Route alignment surveys, Soil suitability analysis, Railway stations and yards, passengers amenities, **Railway Design:** Elements of permanent way Rails, Sleepers, Ballast, rail fixtures and fastenings, Track Stress, coning of wheels, creep in rails, signalling and interlocking, Geometric design of railways, gradient, super elevation, Points and Crossings, **Airport Planning:** Air transport characteristics-airport classification- air port planning: Objectives, components, layout characteristics, criteria for airport site selection and ICAO stipulations, Typical airport layouts, Parking and circulation area, Airport Zones, Passenger facilities and Services, **Airport Design:** Runway Design: Orientation, Wind Rose Diagram, Runway length, Geometric design of runways, Configuration and Pavement Design Principles, Elements of Taxiway Design, Runway and Taxiway Makings and lighting.

7. Waste Water Treatment and Management:-

Wastewater Generation, Collection & Conveyance: Wastewater Quantity- Classification of wastewater- Sewerage system for domestic wastewater and storm water- Collections, and appurtenances- Design and layout of sewerage systems- Maintenance of sewerage systems- Physical, Chemical & Biological characteristics and their significance, **Primary Treatment of Wastewater:** Objectives of Wastewater treatment- Treatment methods: Unit Operations and Processes Design criteria- Design of primary treatment system, **Secondary Treatment of Wastewater:** Concepts of Biological treatment and removal mechanism- Aerobic and Anaerobic Systems- Design of suspended and attached growth processes- introduction to extended aeration processes and waste stabilization pond- Design of anaerobic system, **House Drainage & Environmental Sanitation:** General Principles, House drainage system- traps and sanitary fitting- Low cost sanitation system, **Wastewater Disposal:** Alternative disposal methods- Self Purification of stream- Standards for disposal alternatives, Natural purification of polluted streams, **Sludge Handling:** Quantity and quality of sludge, Methods of sludge treatment: sludge digestion and drying beds- Disposal of sludges.

8. Design of Hydraulic structures:-

Reservoir Planning: Investigations, layout, selection of site for hydraulic structures, life of Reservoir, **Structures of Permeable foundations:** Bligh's creep theory, limitations, Khoslas's theory of independent variable, Khosla's corrections, Canal head Works, Design of Weir and Barrages, **Canal structures:** Design of canal falls, Regulators, Cross drainage works: Selection, design aspects of aqueducts, siphon aqueducts, supper passages, canal siphon and level crossings, **Earth Dams:** Types, causes of failure, soils suitability for earth dam construction, typical earth dam sections, estimation of seepage through and below the dam, seepage control, stability of slopes, **Gravity dams:** Design Criteria, forces acting on gravity dams, elementary profile, Forces on gravity dams, stability analysis, **Spillways and Energy dissipaters:** Purpose, different types, details of

ogee, siphon, shaft, chute and side channel spillways, design aspects, Principles of energy dissipation, Energy dissipaters based on water curve and jump height curves.

9. CPM and PERT:-

Construction Management: Significance, Objectives and functions, resources for construction industry, stages in construction, Civil Engineering drawings, work breakdown structure, Pre-tender stage planning, contract stage planning, scheduling, bar charts, limitations of bar charts, milestone charts, preparation of material, equipment, labour, and finance schedule, **Construction Contracts & Specifications:** Types of contracts, contract document, specifications, important conditions of contract, arbitration, **Construction Organization:** Principles of organization, communication in organization, types of organization, temporary services, job layout, **Critical Path Method:** Network techniques, element of a network, rules for developing networks, development logics, numbering events, times computations, activity floats, network updating, Resources profile, resources smoothing and resources levelling, **Cost-Time Analysis:** Cost versus time, direct cost, indirect cost, total project cost, optimum duration, contracting network for cost optimization, **Programme Evaluation and Review Technique:** Probability concept in network, optimistic time, Pessimistic time, most likely time, variance, standard deviation, slack, central limit theorem, probability of achieving completion time.

10. Urban Transportation Planning:-

Elements of Traffic Engineering: Road user, vehicle and road way, Vehicle characteristics, Design speed, volume, Highway capacity and levels of service, PCU Concept and its limitations, Road user facilities-Parking facilities, Cycle tracks and cycleways, Pedestrian facilities, **Traffic Volume Studies:** Traffic volume studies, origin destination studies, speed studies, travel time and delay studies, Parking studies, Accident studies, **Traffic Regulation and control:** Signs and markings- Traffic System Management- Design of at-grade, intersections, Channelization, Design of rotaries, Traffic signals, **Urban Transportation Planning:** Trip generation, Trip distribution, Modal Split, Traffic assignment, **Public Transportation:** Role and design concept of various modes of public transportation within an urban area, **Application of probability and Statistics in Transportation Planning:** Common probabilistic and statistical distribution functions, Concept of Traffic flow modelling and simulation, **Introduction to ITS:** Benefits of ITS, ITS Data collection techniques- Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

11. Harbor Dock and Tunnel Engineering:-

Planning of Harbor: Classification of harbours, major ports in India, administrative set up, harbour economics, Harbor components, ship characteristics, characteristics of good harbour, and principles of harbour planning, size of harbour, site selection criteria and layout of harbors, **Natural Phenomena:** Wind, waves tides and currents phenomena, their generation characteristics and effects on marine structures, silting, erosion and littoral

drift, **Marine Structure:** General design aspects, breakwaters- functions, types general design principles, wharves, quays, jetties, piers, pier heads, dolphin, fenders, mooring accessories- functions, types, suitability, design and construction features, **Docks and Locks:** Tidal basin, wet docks-purpose, design consideration, operation of lock gates and passages, repair docks- graving docks, floating docks, marine railway, **Port Amenities:** Ferry, transfer bridges, floating landing stages, and transit sheds, and transit sheds, ware house , cold storage, aprons, cargo handling equipments, purpose and general description, **Navigation Aids:** Channel and entrance demarcation, buoys, beacons, light house electronic communication devices, **Harbor Maintenance:** Costal protection- purpose and devices, dredging-capital and maintenance dredging, purpose, methods dredgers- types, suitability, disposal of dredged material, **Tunneling:** Alignment, drainage, methods of construction, lighting and ventilation.

12. Solid Waste Management:-

Evolution of Solid Waste Management: Introduction: Solid waste- A consequence of life, Municipal Solid Waste: Generation, Rate Variation, Characteristics (Physical, Biological & Chemical); **Engineering Principles:** Management Options for Solid Waste, Waste Reduction at the Source, Collection Techniques, Materials and Resources Recovery/Recycling, **Waste Handling and Separation:** Transport of Municipal Solid Waste, Routing and Scheduling, Treatment, Transformations, **Disposal of Solid waste and Residue Matter:** Disposal Techniques (Composting, Vermi Composting, Incineration, Refuse Derived fuels, Landfilling), **Sources, Types and Properties of Hazardous waste:** Hazardous Solid Waste: Generation, Rate Variation, Characteristics (Physical, Biological & Chemical), Hazardous Waste Management: **Hazardous waste management:** Exposure and risk assessment, environment legislation, characterization and site assessment, waste minimization, incineration, transportation, storage, landfill disposal.

13. Environmental Impact Assessment:-

Introduction: Environment and its components; Concept of Ecological imbalances, Elements of Environmental Analysis; Current screening process in India; Carrying capacity and sustainable development, evolution of Environmental Impact Assessment (EIA), A step by-step procedure for developing; EIA; Pubic construction; Post monitoring; Impact Case Studies of Industrial EIA and Water resources projects; Brief introduction about Environment legislation and Environment Audit, **Methodologies:** Criteria for the selection of EIA Methodology, EIA Methods, Predictive Models for impact assessment, **Prediction and Assessment of impacts on Soil and Ground Water Environment:** Soil and Ground water, Methodology for the Predictive and Assessment of Impact on soil and Ground water, **Prediction and Assessment of Impacts on Surface Water Environment:** Sources which create Impact concern for the Surface water Environment, Systematic Methods for Evaluation of Impact of Various Developmental Activities on Surface Water Environment, **Prediction and Assessment of Impacts on Biological Environment:** Methodology for the Assessment of impacts on Biological

Environment, Systematic Approach for Evaluation Biological Impacts, **Prediction and Assessment of Impacts on Air Environment:** Sources of Air Pollution, Methods for Assessment of Air pollution impact, **Prediction and Assessment of Impacts on Noise Environment:** Types of Noise, measurements, Effects, and Methods of Assessing Impact of Noise, **Prediction and Assessment of Impacts of Socio-Economic and Human Health Impacts:** Social Assessment, Conceptual Frame work for Socio- Economic Assessment, Assessment of Impacts of Project activities on Human Health, Methodology, Assessment of Impacts of Project Activities on Traffic and Transport Systems, **Application of Remote Sensing and GIS for EIA:** Concepts of Environmental Remote Sensing, GIS Concept and techniques, Application of Environmental Remote Sensing for EIA, Application of GIS for EIA, GIS Environmental Impact Assessment, Possible Approaches, Resource Implications, GIS in Screening, Scoping and Baselines Studies, Database for GIS.

14. Groundwater Engineering:-

Hydrogeological Parameters: Introduction- Water bearing Properties of Rock- Type of aquifer- Aquifer properties- permeability, specific yield, transmissivity and storage coefficient- Methods of Estimation- Ground water table fluctuation and its interpretations- Groundwater development and potential in India, **Well Hydraulics:** Objectives of Groundwater hydraulics- Darcy's Law- Groundwater equation- steady state flow- Dupuit-Forchheimer Assumption- Unsteady state flow- Theis method- Jacob method- Slug test- Image well theory- Partial penetrations of wells, **Groundwater Management:** Need for management model- Database for groundwater management- groundwater balance study- Introduction to Mathematical model conjunctive use- Collector well and Infiltration gallery, **Groundwater Quality:** Ground water chemistry- Origin, movement and quality- water quality standards- Health and aesthetic aspects of water quality- Saline intrusion- Environmental concern and Regulatory requirements.

15. Hydro Power Engineering:-

Turbo Machinery: Governing Equations, Hydrodynamic forces of jets on vanes, Turbines, Classification, impulse and reaction turbines, characteristics curves, draft tubes, governing of turbines, specific speed, unit quantities concept, cavitations, Pumps: classification, work done, minimum starting speed, losses and efficiencies, specific speed, multistage pumps, Cavitation in pumps, **Hydro Power Development:** Sources of energy and their comparative study, investigations and studies for hydropower development, estimation of available water power, flow and power duration curves, firm power and secondary power, plant capacity, installed capacity, constraints in hydropower development operation and maintenance of hydropower plants, small hydropower development, Classification of hydro-power plants based on storage characteristics, operating head, load, capacity, Principle components of hydro-electric scheme, Storage and pondage, economic analysis of storage capacity, aspects of cost allocation for different purposes, reservoir operation using flow duration and flow mass curves, **Hydroelectric Plants:** Layout of hydropower plants, types of power houses, various

components, investigations and studies, safety requirements, Storage zones of a reservoir, reservoir sedimentation, trap efficiency, life of a reservoir, principle of desilting, design of desilting basins, Alignment and location of various type of intakes, trashracks, design of intake structures, Conveyance channels and tunnels, water harmer, surge tanks, design of surge tanks, penstocks classification and layout, hydraulic design of penstocks, hydraulic valves and gates, tail race channels, **Economics of Hydro power installation:** Engineering feasibility, political consideration, economic feasibility, analysis of cost of hydro power, preparation of pre-feasibility report, detailed project report, cost and estimate report.