

# TS ECET - 2022

## Syllabus for Civil Engineering

### **MATHEMATICS (50 Marks)**

#### **Unit-I: Matrices**

Matrices: Definition of Matrix, Types of matrices-Algebra of matrices-Transpose of a matrix-Symmetric, skew symmetric matrices-Minor, cofactor of an element-Determinant of a square matrix-Properties-Laplace's expansion-singular and nonsingular matrices- Adjoint and multiplicative inverse of a square matrix-System of linear equations in 3 variables-Solutions by Cramer's rule, Matrix inversion method-Gauss-Jordan method.-Partial Fractions: Resolving a given rational function into partial fractions. Logarithms: Definition of logarithm and its properties, meaning of 'e', exponential function and logarithmic function.

#### **Unit-II: Trigonometry**

Properties of Trigonometric functions– Ratios of Compound angles, multiple angles, sub multiple angles – Transformations of Products into sum or difference and vice versa. Properties of triangles: sine rule, cosine rule, tangent rule and projection rule. Solving a triangle when (i) three sides (SSS), (ii) two sides and an included angle (SAS), (iii) one side and two angles are given (SAA). Inverse Trigonometric functions, Hyperbolic functions.

Complex Numbers: Properties of Modulus, amplitude and conjugate of complex numbers, arithmetic operations on complex numbers - Modulus-Amplitude form (Polar form) - Euler form (exponential form).

#### **Unit-III: Analytical Geometry**

Straight Lines–different forms of Straight Lines, distance of a point from a line, angle between two lines, intersection of two non-parallel lines and distance between two parallel lines. Circles-Equation of circle given center and radius, given ends of diameter-General equation- finding center and radius, center and a point on the circumference, 3 non-collinear points, center and tangent, equation of tangent and normal at a point on the circle. Conic Section – Properties of parabola, ellipse and hyperbola – Standard forms with vertex at origin.

#### **Unit-IV: Differentiation and its Applications**

Functions and limits – Standard limits – Differentiation of sum, product, quotient of functions, function of function, trigonometric, inverse trigonometric, exponential, logarithmic, Hyperbolic functions, implicit, explicit and parametric functions–Derivative of a function with respect to another function-Second order derivatives – Geometrical applications of the derivative(angle between curves, tangent and normal)–Increasing and decreasing functions–Maxima and Minima(single variable functions) using second order derivative only, physical application – Rate Measure - Partial Differentiation–Partial derivatives up to second order–Euler's theorem.

#### **Unit-V: Integration and its Applications**

Indefinite Integral – Standard forms – Integration by decomposition of the integrand, integration of trigonometric, algebraic, exponential, logarithmic and Hyperbolic functions– Integration by

substitution –Integration of reducible and irreducible quadratic factors – Integration by parts– Definite Integrals and properties, Definite Integral as the limit of a sum – Application of Integration to find areas under plane curves and volumes of Solids of revolution– Mean and RMS values, Trapezoidal rule and Simpson’s 1/3 Rule for approximation integrals

### **Unit–VI: Differential Equations**

Definition of a differential equation-order and degree of a differential equation- formation of differential equations-solution of differential equation of the type first order, first degree, variable-separable, homogeneous equations, exact, linear differential equation of the form  $dy/dx+Py=Q$ , Bernoulli’s equation, 2<sup>nd</sup> order linear differential equation with constant coefficients both homogeneous and non-homogeneous and finding the Particular Integrals for the functions  $e^{ax}$ ,  $\sin ax$ ,  $\cos ax$ ,  $ax^2 +bx+c$  (a,b,c are real numbers).

### **Unit–VII: Laplace Transforms**

Laplace Transforms (LT) of elementary functions-Linearity property, first shifting property, change of scale property multiplication and division by t - LT of derivatives and integrals, Unit step function, LT of unit step function, second shifting property, evaluation of improper integrals, Inverse Laplace transform (ILT)-shifting theorem, change of scale property, multiplication and division by s, ILT by using partial fractions and convolution theorem. Applications of LT to solve linear ordinary differential equations up to second order only, with initial condition.

### **Unit–VIII: Fourier Series**

Define Fourier series, Euler’s formulae over the interval  $(C, C+2\pi)$  for determining the Fourier coefficients. Fourier series of simple functions in  $(0, 2\pi)$  and  $(-\pi, \pi)$ . Fourier series for even and odd functions in the interval  $(-\pi, \pi)$  – Half range Fourier series – sine and cosine series over the interval  $(0, \pi)$ .

## **PHYSICS (25 Marks)**

**Unit-I: Units and Dimensions:** Physical quantity-fundamental and derived physical quantities- units-fundamental and derived units-SI units-advantages of SI units-dimensions and dimensional formulae for physical quantities – problems.

**Unit-II: Modern Physics:** Photo electric effect–definition- applications -Einstein’s photoelectric equation–critical angle and total internal reflection– optical fibers - principle - Basic concept of super conductivity, examples of super conducting materials and their applications.

**Unit-III: Heat and Thermodynamics:** Boyle’s law-Absolute scale of temperature-Charles laws-Ideal gas equation-Universal gas constant and its value - isothermal process and adiabatic process - statement of first law of thermodynamics and its applications - problems.

**Unit-IV: Elements of Vectors:** Scalar and vector quantities - examples - expression for magnitude and direction of resultant of two vectors using parallelogram law -resolution of a vector in 2 D plane -

dot product and cross product of two vectors and examples - properties of dot and cross products – problems.

**Unit-V: Kinematics:** Projectile motion-examples-horizontal and oblique projections- expression for path of projectile in case of oblique projection - expressions for maximum height, time of ascent, time of flight, horizontal range in case of oblique projection - problems.

**Unit-VI: Friction:** Friction - normal reaction- laws of friction- coefficients of friction- expression for acceleration of a body over a rough horizontal surface – expressions for displacement and time taken by a body to come to rest over a rough horizontal surface - problems.

**Unit-VII: Work and Energy:** Work and energy- definitions - potential and kinetic energies -examples and expressions-Work-Energy theorem – law of conservation of energy in the case of freely falling body -problems.

**Unit-VIII: Simple Harmonic Motion:** Definition-conditions of Simple Harmonic Motion (SHM) - examples of SHM - expressions for displacement, velocity, acceleration, time period, frequency and phase of SHM- expression for time period of a simple pendulum- laws of simple pendulum -seconds pendulum-problems.

**Unit-IX: Sound:** Sound definition - longitudinal wave and transverse wave- audible range of sound – infrasonic and ultrasonic sound – relation between wavelength, frequency and velocity -Beats and echo and their applications – Reverberation time - Sabine’s formula - problems.

**Unit-X: Properties of Matter:** Define terms - elasticity, plasticity – stress and strain – units – Hooke’s law – modulus of elasticity – young’s modulus – definition of surface tension, examples – angle of contact , capillarity and examples – formula for surface tension based on capillarity – viscosity and examples- Newton’s formula for viscosity- Poiseuille’s equation for co-efficient of viscosity- effect of temperature on viscosity of liquids and gases- problems.

**Unit-XI: Electricity and Magnetism:** Ohm’s law –Specific resistance, Conductance and their units- Kirchoff’s laws- expression for balancing condition of Wheatstone bridge- Working principle of meter bridge-coulomb’s inverse square law in magnetism- magnetic field – magnetic lines of force-magnetic induction field strength and units – moment of couple acting on a bar magnet placed in a uniform magnetic field – dia, para and ferro magnetic materials- examples: – problems.

## CHEMISTRY (25 Marks)

**Unit I: Fundamentals of Chemistry: Atomic structure:** Atomic number – atomic mass number – Bohr’s theory – Aufbau’s principle – Hund’s rule – Pauli’s exclusion principle- Electronic configurations of elements up to atomic number 30, Differences between orbit and orbital - shapes of s, p, d orbitals.

**Chemical Bonding:** Introduction – Electronic theory of valency - Types of chemical bonds – Ionic bond - NaCl and MgO – Characteristics of ionic compounds - Covalent bond - H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub> ( Lewis dot model) - Characteristics of covalent compounds - Coordinate covalent bond – Definition and examples, [NH<sub>4</sub><sup>+</sup>], [NH<sub>3</sub>BF<sub>3</sub>].

**Oxidation-Reductions:** Electronic concept of Oxidation and Reduction - Oxidation number and its calculations.

**Unit-II: Solutions and Colloids** – Definition of solution, solute and solvent - Classification of solutions based on physical state - Mole concept - Molecular weight, equivalent weight of acids, bases and salts. Mole, Molarity, Normality - Numerical problems. Define Colloids, Types of Colloids – Lyophilic & Lyophobic Colloids – Industrial applications of colloids.

**Unit-III: Acids and Bases:** Theories of acids and bases – Arrhenius theory – Bronsted-Lowry theory – Lewis theory – Ionic product of water - pH and related numerical problems pertaining to strong acids and bases – Definition of buffer – Types of buffer – Acidic buffer ( Acetate buffer) – Basic buffer (Ammonia buffer) without buffer action – Applications without explanation.

**Unit – IV: Principles of Metallurgy:** Characteristics of metals and distinction between metals and non-metals. Definitions of metallurgy, ore, gangue, flux, slag – Concentration of ore by froth floatation process – Roasting, calcination, smelting – Alloys – Composition and uses of brass, German silver and nichrome.

**Unit-V: Electrochemistry:** Conductors - Metallic and electrolytic conductors- Insulators, electrolytes (strong and weak) - Arrhenius theory of electrolytic dissociation – Electrolysis of fused NaCl and aqueous NaCl – Electrolytic refining of copper - Faraday’s laws of electrolysis- Numerical problems Galvanic cell – Electrode potential - Standard electrode potential – Electro chemical series – Significance of electro chemical series without explanation - emf and numerical problems on emf of a cell ( based on  $EMF = E_R - E_L$  formula).

**Batteries** – Working and applications of Leclanche Cell, Lead-storage battery, Ni-Cd Cell, Construction and functioning of H<sub>2</sub>-O<sub>2</sub> fuel cell.

**Unit –VI: Corrosion:** Definition of corrosion - Factors influencing rate of corrosion - Electrochemical theory of corrosion- Composition cell, stress cell and concentration cell - Rusting of iron and its mechanism – Prevention of corrosion by (a) protective coatings - Metallic (anodic and cathodic coatings), Inorganic and Organic coatings ( only examples) (b) cathodic protection (sacrificial anode method and impressed voltage method).

**Unit-VII: Water Technology:** Soft and hard water – Causes of hardness – Types of hardness – Disadvantages of hard water in industries – Degree of hardness, units (ppm and mg/litre) and Numerical problems on hardness of water – Softening methods – Permutit process - Ion exchange process – Characteristics of drinking water – Municipal treatment of water for drinking purpose - Osmosis and reverse Osmosis - Advantages of Reverse Osmosis.

**Unit-VIII: Polymers:** Polymerization – Types of polymerization – Addition, condensation polymerization with examples – Plastics – Types of plastics – Advantages of plastics over traditional materials – Disadvantages of using plastics - Thermo plastics and thermo setting plastics– Differences between thermo plastics and thermo setting plastics - Preparation and uses of the following plastics: 1. Polythene, 2. PVC, 3. Teflon, 4. Polystyrene, 5. Urea formaldehyde 6. Bakelite. – Rubber – Natural rubber – Processing of rubber from latex – Vulcanization – Elastomers – Butyl rubber, Buna-s, Neoprene rubber and their uses.

**Unit-IX: Fuels:** Definition and classification of fuels based on physical state and occurrence – Characteristics of good fuel - Composition and uses of gaseous fuels. (a) Water gas, (b) producer gas, (c) natural gas, (d) coal gas, (e) bio gas, (f) acetylene. Calculate Oxygen required for the combustion of Methane and Ethane fuel gases.

**Unit-X: Environmental Chemistry:** Environment – Lithosphere, hydrosphere, atmosphere, biosphere, biotic component – Definitions of pollutant, contaminant, pollution - receptor, sink, particulate with examples, Definition and significance (without explanation) of DO, BOD, Threshold limit value, COD - Forest resources, uses and over exploitation - Deforestation - Air pollution - Causes- Effects- - Acid rain - Greenhouse effect – Ozone depletion – Control of Air pollution ( Basic level only) – Water pollution – Causes – Effects – Control measures of water pollution ( Basic level only) - Renewable and Non Renewable energy sources with examples – Concept of ecosystem – Producers, consumers and decomposers – Biodiversity, threats to Biodiversity.

## **CIVIL ENGINEERING (100 Marks)**

### **UNIT-I: ENGINEERING MECHANICS:**

Forces and moments- Vectors and scalars, resultant forces at a point, types of supports, types of loading. Centroid – rectangle, triangle, parallelogram, circle, semicircle, trapezium. Location of centroid of T, L, I, channel, Z sections. built-up sections. Moment of Inertia – T, L, I and built up sections, radius of gyration of built-up sections; Polar moment of inertia of solid and hollow circular sections using perpendicular axis theorem only. Simple stresses and strains - ductile materials- Mechanical properties of materials- Hooke's law - lateral strain-Poisson's ratio-Elastic constants and the relation between them- Composite sections.

### **UNIT-II: STRENGTH OF MATERIALS:**

Shear force and Bending Moment Diagrams for cantilever, Simply supported and overhanging beams subjected to Point loads and UDL. Theory of simple bending-assumptions-bending equation-bending stresses-Section Modulus-Shear stress distribution across various sections like rectangular, circular and I - sections-Torsion-solid and hollow circular shafts subjected to pure torsion – shear stress – distribution in shafts – power transmitted by circular shafts.

Slope and Deflection of cantilevers and simply supported beams by Double Integration method and Deflection of simply supported beams by Macaulay's method – Mohr's theorems for slopes and deflections-Moment area method-Symmetrical loading. Columns and struts-types-slenderness ratio-Euler's and Rankine's formulae for axial loading.

**UNIT-III: REINFORCED CONCRETE STRUCTURES:**

Grades of concrete, characteristic strength, Modulus of Elasticity-I.S.456-2000- Philosophy of Limit state design. Limit state of Strength and Serviceability, partial safety factor-design strength of materials and design loads- assumptions.

Analysis and Limit state design of rectangular beams-Singly, Doubly reinforced and T-beams. Shear in RCC beams - Development length. Slabs-analysis and limit state design of one-way and two-way slabs as per IS.456-2000, Torsion reinforcement. Design of continuous slabs and beams - Deflection check for slabs and beams. Detailing of reinforcement in singly reinforced and doubly reinforced simply supported beams of rectangular sections and lintels, one way and two way slabs.

**Columns:** Codal provisions of I.S 456-2000 - short and long columns-different shapes-design of short columns by limit state method-long columns- concept, effective length for different end conditions. Footings-Isolated column footings-one way shear and two way shear. Stairs – types.

**UNIT-IV: SURVEYING:**

Chain surveying - purpose and principle-offsets - errors and corrections- different operations in chain surveying- obstacles - methods of calculation of area. Compass Surveying - purpose and principle - bearings- traversing using prismatic compass- local attraction - errors. Levelling - definitions - component parts of Dumpy level - errors - Methods of levelling - contouring - characteristics and methods. Theodolite - principles and component parts- fundamental lines and relationship among them - adjustments of theodolite - measurement of horizontal and vertical angles - errors-traverse computations - Bowditch and Transit rule. Tacheometry - principle - stadia tacheometry - tangential tacheometry, Principle and uses of E.D.M, Electronic Theodolite, Total Station, Global positioning System - Importance, G.I.S – Use and applications in Civil Engineering, Curves - simple curves, elements of simple curve, setting out of simple curves by chain & tape, single & double theodolite method.

**UNIT-V: HYDRAULICS:**

Fluid properties - specific weight – mass density-specific gravity - surface tension - capillarity-viscosity. Atmospheric pressure, gauge pressure and absolute pressure. Fluid pressure on plane surfaces - Centre of pressure and total pressure, measurement of fluid pressure using piezometer and manometers. Types of flows-uniform, non-uniform, steady, unsteady, laminar and turbulent flows. Energies of liquid in motion - continuity equation. Bernoulli's theorem - Pitot tube - Venturimeter. Flow through small and large orifices, coefficients of orifices -  $C_c$ ,  $C_v$  and  $C_d$ . Flow through internal, external, convergent and divergent mouthpieces. Types of Notches - rectangular and triangular, flow over notches. Types of Weirs- sharp crested and broad crested-mathematical formulae for discharge-Francis and Bazin's empirical formulae.

Flow through pipes-major and minor losses - Chezy's and Darcy's formulae for loss of head due to friction-HGL & TEL. Flow through open channels-rectangular and trapezoidal - Chezy's formula for discharge – Kutter's and Manning's equation for Chezy's constants-Most economical sections. Reciprocating and Centrifugal pumps (without problems). Classification of Turbines - Kaplan, Francis and Pelton wheel (without problems) -Types and uses of Draft tubes. Hydro-electric installations - components and uses.

**UNIT VI: IRRIGATION ENGINEERING:**

Necessity of Irrigations - Perennial and inundation Irrigation, Flow and Lift Irrigation, Principal seasons - kharif and rabi crops - Duty, delta and base period. Methods of Irrigation - check flooding, basin flooding, Border strip, furrow, sprinkler and drip Irrigations. Hydrology - Rainfall, types of Rain gauges, types of catchments-rainfall and runoff. Measurement of velocity of flow in streams. Classification of Head works - component parts of diversion head works. Weirs and Barrages. Percolation and uplift pressures. Types of Reservoirs - dead storage and live storage.

Storage Head works-different types of dams- gravity dams-low and high dams. Elementary profile of a dam. Failures of gravity dams - drainage galleries. Types of spillways. Earth dams - types, failures and precautions. Phreatic lines and drainage arrangements in earthen dams. Distribution works-classifications and alignment of canals-typical cross section of a canal-berms - balanced depth of cutting- canal lining. Cross drainage works – types and functions. Soil erosion Types and causes-measures to control erosion.

**UNIT VII: TRANSPORTATION ENGINEERING:**

Importance of transportation engineering

- I.R.C. – Classification of roads as per I.R.C., recommended I.R.C. values of camber for different roads. Gradients – Ruling gradient, limiting and exceptional gradient Recommended

I.R.C values of gradients.

Traffic Engg.- Traffic census and its importance, Road intersections- Traffic signs- Informatory signs- Mandatory signs, Cautionary signs. Highway constructions and Maintenance - Purpose of road drainage- surface and sub-surface drainage, Typical cross section of highway in cutting and embankment. Water bound macadam roads, Cement concrete roads. Permanent way of Railways, Importance of Railways- Gauge, Types of gauges, Structure of permanent way –different types of rails, requirements of a good rail, Sleepers- functions, Types of sleepers, characteristics of a good sleeper – spacing of sleepers-sleeper density.

**UNIT VIII : WATER SUPPLY AND SANITARY ENGINEERING:**

Quality of water, Need for protected water supply, Total quantity of water for a town, per capita demand and factors affecting demand, Forecasting population by arithmetical, geometrical and incremental increase methods, Sources and conveyance of water: surface sources, underground sources, Types of Intakes. Quality and Methods of purification of water.

Distribution System: Methods of supply, Storage-Distribution systems, Types of layout- dead end, grid, radial and ring system their merits and demerits and their suitability. General layout of water supply arrangements in buildings.

System of sewage disposal-types of sewerage systems, Different shapes of cross-section for sewers, Strength of sewage, sampling of sewage, characteristics of sewage - principles of treatment, Preliminary treatment, secondary treatment. Sewers – sewer appurtenances- shapes, merits and demerits.

**UNIT IX: BUILDING MATERIALS AND CONSTRUCTION PRACTICE:** Stones-classification of rocks. Bricks – manufacturing, tests on bricks. Tiles- types of tiles. Cement- classification manufacturing - tests. Mortars – classification - proportioning. Concrete- proportioning – water - cement ratio – workability – admixtures - curing methods - R.M.C. Timber and surface protective materials. Characteristics - types and uses.

Classification of buildings, foundations-N.B.C. classification-bearing capacity of soil- types of foundations. Masonry-Bonds in brick masonry. Plastering-purpose. Pointing purpose and types.

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