TS ECET-2023

Syllabus for Chemical 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 non-singular 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. Solution of 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: Definition of a complex number, Modulus, amplitude and conjugate of complex number, 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^{nd} 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 theorems, 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 with initial conditions.

Unit–VIII: Fourier Series

Fourier series, Euler's formulae over the interval (C, C+2π) for determining the Fourier coefficients. Fourier series of simple functions in (0, 2π) and (–π, π). Fourier series for even and odd functions in the interval (–π, π) – Half range Fourier series – sine and cosine series over the interval (0, π).

PHYSICS (25 Marks)

Unit-I: UNITS, DIMENSIONS AND FRICTION

Physical quantity - Fundamental and derived quantities – Unit –definitions - S.I units - Advantages of S.I. units - Dimensions and dimensional formula - definitions-units and dimensional formula for physical quantities - Principle of homogeneity - Applications of dimensional analysis–Friction – causes - types of friction - Normal reaction - Laws of static friction - coefficients of friction - expression-rough horizontal surface - expressions for Acceleration, Displacement, Time taken to come to rest and Work done - Advantages and disadvantages of friction - Methods to reduce friction – Problems on friction only.

Unit-II: ELEMENTS OF VECTORS

Scalar and vector quantities – definitions and examples –Graphical representation of a vector - Classification of vectors (Proper vector, Unit vector, Equal vector, Negative vector, Collinear vector and Position vector) Resolution of a vector - Triangle law of vector addition – Parallelogram law of vectors – statement- expression for magnitude and direction of resultant vector –derivation-illustrations (working of sling and flying bird) - Representation of a vector in unit vectors **i**, **j** and **k**– Scalar product of vectors-definition- application to work done by force – properties of scalar product - Vector product of vectors –definition – Right hand thumb rule and right hand screw rule - application to moment of force - properties of vector product - area of parallelogram and triangle in terms of vector product - related problems

Unit-III: MECHANICS

Projectile motion – definition - examples - Horizontal projection – Time of flight and Horizontal range – derivations - Oblique projection – Expression for path of a projectile in oblique projection - derivation– Maximum height, Time of ascent, Time of descent, Time of flight, Horizontal range and maximum horizontal range - derivations – Circular motion, angular velocity, time period and frequency of revolutions–Definitions– Relation between linear velocity and angular velocity - derivation–centripetal force – centrifugal force – definitions and expressions only- application (banking of curved path) - angle of banking- expression only - related problems

Unit-IV: PROPERTIES OF MATTER

Elasticity and plasticity- definitions – examples - Stress and Strain – definitions and expressions - elastic limit - Hooke's law – statement - modulus of elasticity - Young's modulus – Derivation – Cohesive and adhesive forces - Surface tension - Illustrations - Capillarity –angle of contact – definition- examples for capillarity- Formula for Surface tension based on capillarity (no derivation) – Viscosity - Illustrations of viscosity - Newton's formula for viscous force – derivation - Coefficient of viscosity - Poiseuille's equation - Effect of temperature on viscosity of liquids and gases– streamlines - laminar flow - turbulent flow - Reynold's number - equation of continuity – statement - related problems.

Unit-V: HEAT AND THERMODYNAMICS

Heat – expansion of gases - Boyle's law –concept of absolute zero - Absolute scale of temperature – Charles' laws - Ideal gas equation – derivation - value of universal gas constant 'R' –Isothermal and Adiabatic processes - Differences between isothermal and adiabatic processes - Internal energy and external work done – Expression for work done – derivation – first law of thermodynamics – application of first law to isothermal and adiabatic processes - second law of thermodynamics – specific heat of a gas – molar specific heat of a gas – definitions – derive relation between C_P and C_v - related problems.

Unit-VI: CONSERVATION LAWS AND ENERGY SOURCES

Work and Energy - Potential Energy and kinetic energy–examples – expressions for PE and KE - derivations - Work-Energy theorem – derivation – Law of conservation of energy – examples - Law of conservation of energy in the case of freely falling body – proof – Illustration of conservation of energy in the case of simple pendulum– Non renewable and renewable energy sources - related problems

Unit-VII: WAVES AND SOUND

Wave motion – definition and characteristics – audible range – infrasonic and ultrasonic – longitudinal and transverse waves – examples – Relation between wavelength, frequency and velocity of a wave – derivation –stationary waves- beats - applications of beats - Doppler effect – list the applications – ultrasound and radar in medicine and engineering as special emphasis- echo – definition - applications - relation between time of echo and distance of obstacle –derivation- Reverberation and time of reverberation - Sabine's formula - Free and forced vibrations - Resonance - Conditions of good auditorium - noise pollution – definition – causes, effects and methods to minimize noise pollution - problems

Unit-VIII: SIMPLE HARMONIC MOTION

Periodic motion - Simple Harmonic Motion (SHM)– definition - examples - Conditions for SHM – Projection of circular motion on any diameter of a circle is SHM - Expressions for Displacement, Velocity and Acceleration of a particle executing SHM – derivations - Time period, frequency,

amplitude and phase of a particle in SHM - Ideal simple pendulum – time period of simple pendulum –derivation - laws of simple pendulum-Seconds pendulum- problems

Unit-IX: MODERN PHYSICS

Photo electric effect - Einstein's photo electric equation – Work function and threshold frequency - laws of photo electric effect - applications of photo electric effect – photo cell - concept of Refraction of light - critical angle and total internal reflection - principle of Optical fiber - Applications of optical fiber – LASER – definition and characteristics – principle of LASER - spontaneous emission and stimulated emission - population inversion - examples of LASER – Uses.

Unit-X: MAGNETISM

Magnetic field - magnetic lines of force -properties - Uniform and Non-uniform magnetic field – Magnetic length, pole strength – magnetic induction field strength- definition - Coulomb's inverse square law of magnetism - expression for moment of couple on a bar magnet placed in a uniform magnetic field – derivation - expression for magnetic induction field strength at a point on the axial line of a bar magnet –derivation - Dia, Para and Ferro magnetic materials – examples - related problems.

Unit-XI: ELECTRICITY AND MEASURING INSTRUMENTS

Ohm's law – Ohmic and non ohmic conductors – examples - Temperature dependence of resistance – coefficients of resistance with examples - Specific resistance – units – conductance- series and parallel combination of resistors - moving coil galvanometer - conversion of galvanometer into ammeter and voltmeter with diagram (qualitatively) – Kirchhoff's current and voltage laws in electricity – Expression for balancing condition of Wheatstone's bridge – derivation – Meter bridge –working with neat diagram –Superconductivity-definition-superconductors - definition and examples – applications - related problems.

Unit-XII: ELECTRONICS

Solids – definition – energy bands in solids- valence band, conduction band and forbidden band – Energy band diagram of conductors, insulators and semiconductors – concept of Fermi level - Intrinsic semiconductors - examples - Concept of holes in semiconductors - Doping - Extrinsic semiconductor - P-type and N-type semiconductors - PN Junction diode – Forward Bias and Reverse Bias - Applications of PN diode - Diode as rectifier – principle – principle of Light Emitting Diode and solar cell.

CHEMISTRY (25 Marks)

Unit-I: Fundamentals of Chemistry

Atomic Structure: Introduction - Atomic number - Mass number- Bohr's Atomic theory - Aufbau principle - Hund's rule - Pauli's exclusion Principle- Orbitals, shapes of s, p and d orbitals - Electronic configuration of elements

Chemical Bonding: Introduction - Electronic theory of valency - Types of chemical bonds - Ionic, covalent and co-ordinate covalent bond with examples - Properties of Ionic and Covalent compounds

Oxidation-Reduction: Electronic Concepts of Oxidation-Reduction, Oxidation Number-calculations.

Unit -II: Solutions and Colloids

Introduction-Classification of solutions based on physical state- Molecular weights, Equivalent weights - Expression of concentration - Mole concept, Molarity, Normality, Numerical problems on Mole, Molarity and Normality - Colloids- Types of colloids- Lyophilic and Lyophobic colloids - Industrial applications of colloids.

Unit -III: Acids and Bases

Introduction - theories of acids and bases and limitations - Arrhenius theory-Bronsted-Lowry theory - Lewis acid base theory - Ionic product of water - pH and related numerical problems - Buffer solutions- buffer action - applications of buffer solution.

Unit -IV: Environmental Studies-I

Introduction - environment -scope and importance of environmental studies- important terms - renewable and non-renewable energy sources - Concept of ecosystem, producers, consumers and decomposers - Biodiversity, definition and threats to Biodiversity- Forest resources- Over exploitation-Deforestation.

Unit -V: Water Technology

Introduction -soft and hard water - causes of hardness – types of hardness -disadvantages of hard water - degree of hardness (ppm) - softening methods - permutit process - ion exchange process - drinking water - municipal treatment of water for drinking purpose - Osmosis, Reverse Osmosis - advantages of Reverse Osmosis – Desalination by Electro dialysis - Defluoridation – Nalgonda technique.

Unit -VI: Electrochemistry

Conductors, insulators, electrolytes –Types of electrolytes - Arrhenius theory of electrolytic dissociation - electrolysis -electrolysis of fused NaCl and aqueous NaCl - applications of electrolysis - Faraday's laws of electrolysis- numerical problems.

Unit -VII: Metallurgy

Characteristics of Metals - distinguish between Metals and Non Metals- Ore, Gangue, Flux and Slag - Concentration of Ore -Froth floatation - Methods of Extraction of crude Metal - Roasting, Calcination and Smelting - Alloys-purpose of making alloys - Composition of Brass, German silver, Nichrome, Stainless steel and Duralumin

Unit –VIII: Corrosion

Introduction - factors influencing the rate of corrosion - electrochemical theory of corrosion - composition, stress and concentration cells- rusting of iron and its mechanism - prevention of corrosion - coating methods, Paints-constituents and characteristics of paints-cathodic protection

Unit –IX: Polymers

Introduction - polymerization - types of polymerization - addition, condensation with examples - plastics - types of plastics - advantages of plastics over traditional materials - Disadvantages of using plastics - preparation and uses of the following plastics: 1. Polythene 2. PVC 3.Teflon 4.Polystyrene 5.Urea formaldehyde 6. Bakelite - Rubber - Elastomers –Preparation of Butyl rubber, Buna-s rubber, Neoprene rubber and their uses-Fibres-Preparation and uses of fibres-Nylon 6,6-Polyester

Unit –X: Fuels

Definition and classification of fuels- characteristics of good fuel - Calorific value-HCV and LCV-Calculation of oxygen required for combustion of methane and ethane - composition and uses of gaseous fuels - a) Water gas b) Producer gas, c) Natural gas, d) Coal gas, e) Bio gas and f) Acetylene.

Unit –XI: Electro Motive Force

Galvanic cell – standard electrode potential -electro chemical series -emf of cell – Batteries-Types of batteries-Fuel cells.

Unit –XII: ENVIRONMENTAL STUDIES-II

Introduction- classification of air pollutants based on origin and states of matter - Air pollution; causes and effects - control methods - Water pollution; causes and effects - control measures.

CHEMICAL ENGINEERING (100 Marks)

Unit–I: Material Technology

Mechanical properties of engineering materials and Testing of materials– Structure of metals and alloys- Thermal equilibrium diagram-Production of Iron & Steel - Plain carbon steels, alloy steels– Nonferrous metals & their alloys - Aluminum, copper, nickel, lead, tin, zinc-Miscellaneous materials – Glass, carbon, graphite, rubber, elastomers – glass fibers – Corrosion-causes, types & prevention methods.

Unit-II: Material and Energy Balances

Basic calculations of molarity, molality and normality, analysis of solids, liquids and gases on dry and wet basis- Kinetic theory of gases & Gas laws, Ideal solutions and Non-Ideal solutions, Material balances with and without chemical reactions - Material balance problems related to evaporation, distillation, drying and mixing, Bypass and Recycle streams– limiting component, excess reactant, percentage of conversion, yield and degree of completion - Heat of reaction, heat of formation and heat of combustion – related problems, gross and net calorific values, theoretical air and excess air calculations – Proximate and ultimate analysis**.**

Unit-III: Organic Chemical Technology

Coal chemicals, coking of coal, coal tar distillation, -carbonization-petroleum refining - atmospheric distillation and vacuum distillation, fluid catalytic cracking, catalytic reforming, petrochemicals from methane and ethylene- Pulp and paper industry, Kraft process - Oils, fats and soaps-sugar and fermentation industries– synthetic fibers - rubber industries.

Unit-IV: Inorganic Chemical Technology

Water and its treatment, water softening, impurities-treatment-dissolved solids-ion exchange process and Reverse Osmosis (RO) process- Manufacture of chemicals like soda ash, ammonia, Urea, nitric acid, sulphuric acid, phosphoric acid, super Phosphate and industrial Gases (O_2, N_2, H_2, CO_2 and acetylene)- Paints, pigments and varnishes, graphite and silicon carbide and cement. Glass, calcium carbide, NPK Fertilizers

Unit-V: Fluid Mechanics

Flow of incompressible fluids, Newtonian and non-Newtonian fluids, Pressure and manometers ,

viscosity, laminar & turbulent flows, Bernoulli's theorem, friction losses, friction factor – pressure drop, flow meters, different types of pumps for transportation of fluids, Centrifugal pump, Displacement pump, Reciprocating pump, Flow past immersed bodies-packed bed and fluidized bed, Types of fluidization**.**

Unit-VI: Heat Transfer

Conduction–mechanisms of heat flow–Fourier's law, thermal conductivity, steady state conduction- compound resistances in series, heat flow through a cylinder – related problems. Convection–heat flow in fluids-rate of heat transfer, counter current and parallel flows-Overall heat transfer coefficient–LMTD–Fouling factors– Nusselt Number - Prandtl Number. Heat transfer to fluids with and without phase change. Drop wise and Film wise condensation, Heat transfer to boiling liquids, Radiation, laws of radiation, radiation between surfaces – Stefan's law-view factor- Heat Exchange Equipment – types of heat exchange equipment, Evaporation – types of evaporators, evaporator economy, Boiling point elevation, single and multiple effect evaporators– related problems**.**

Unit-VII: Mechanical Unit Operations

Properties of particulate solids Size reduction- methods & laws- crushers and grinders. Different types of equipment for mixing of liquids, viscous masses, dry powders, Differential and cumulative screen analysis, screen effectiveness, average particle size, storage of solids, conveyers, mechanical separations - Screening, froth floatation, electrostatic precipitator, scrubber, cyclone separators, filtration, filtration equipment, sedimentation.

Unit-VIII: Thermodynamics and Reaction Engineering

Basic units of thermodynamics, state and path functions, First law of Thermodynamics, PVT relationships for gases-ideal gas- isobaric-isochoric, isothermal and adiabatic processes – cubic equations of state – Second law of Thermodynamics, Carnot cycle-entropy - refrigeration and liquefaction, chemical reaction equilibria-determination of equilibrium constant and conversion, Temperature effect on reactions- Gibbs free energy - chemical kinetics - classification of reactions - reaction order and molecularity - working of batch, tubular and stirred tank reactors, industrial reactors - space time - space velocity.

Unit-IX: Mass Transfer Operations

Principles of diffusion, Fick's law of diffusion – molecular diffusion - Diffusion in gases - inter phase mass transfer, film theory -wet bulb & dry bulb temperature - Distillation, simple, steam and continuous distillation - Rayleigh's equation reflux ratio– McCabe Thiele method - bubble cab & sieve tray columns- absorption principles - tower packing, channeling, loading & flooding- Adsorption – adsorbents - humidification, extraction and leaching, drying - drying rate curves, time of drying, equipment for drying – crystallization – equipment.

Unit-X: Instrumentation & Process control

Static and dynamic characteristics of an instrument-step input, linear input, sinusoidal input, measurement of temperature, pressure, vacuum, liquid levels, viscosity, density and composition – thermocouples – types of pressure gauges & vacuum gauges for distillation column, evaporator, reactor and extractor. Process instrumentation & Instrumentation diagrams – Process control – components of pneumatic system – hydraulic system – different types of controllers, P, PI, PD & PID Controllers.

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