

TS ECET-2021

SYLLABUS: 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)-Properties.

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.

Unit-IV: Differentiation and its Applications

Functions and limits – Standard limits – Differentiation from the First Principle – 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 - 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, 2nd 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 (I LT)-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.

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 $(-\pi, \pi)$.

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MODEL QUESTIONS FOR MATHEMATICS

1. If the determinant of the transpose of the matrix $\begin{bmatrix} 2 & 2 & 2 \\ 2 & 2+x & 2 \\ 2 & 2 & 2+y \end{bmatrix}$ is positive, then the point (x,y) lies in

- 1) I and II quadrants 2) **I and III quadrants** 3) II and IV quadrants 4) III and IV quadrants

2. If $f(x)=x^2$ in $(-\pi,\pi)$ and $f(x) = \sum_{n=0}^{\infty}(a_n \cos nx + b_n \sin nx)$, then $a_1 =$

- 1) 4 2) **-4** 3) -4π 4) 4π

3. If $\frac{1}{x^2(x+1)} = \frac{A}{x+1} + \frac{B}{(x)^2} + \frac{C}{x}$ then $A+B+C =$

- 1) 0 2) 3 3) 2 4) **1**

4. The general solution of the corresponding Homogeneous differential equation of $(D^2 + 9)y = \cos 3x$ is

- 1) **A cos 3x + B sin 3x** 2) $A \cos 3x + B x \sin 3x$ 3) $\frac{x \cos 3x}{3}$ 4) $\frac{x \sin 3x}{6}$

5. If $L^{-1} \left\{ \frac{1}{s(s^2+1)} \right\} = \int_0^t f(t) dt$, then $f(t) =$

- 1) **sint** 2) $1 - \cos t$ 3) $\arctan t$ 4) $1 + \sin t$

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SYLLABUS: PHYSICS

(25Marks)

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 -principle of homogeneity in dimensions

Unit-II: Modern physics: Photo electric effect–explanation and its laws-applications of photo electric effect (photocell)-Einstein’s photoelectric equation–critical angle and total internal reflection– optical fibers - principle, working- 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-SI Units-problems - isothermal process-adiabatic process- statements of first law and second law of thermodynamics - two specific heats of a gas-relation between C_p and C_v -problems.

Unit-IV: Elements of vectors: Scalar and vector quantities-examples-types of vectors-triangle law-parallelogram law- expression for magnitude and direction of resultant of two vectors using parallelogram law -resolution of a vector-unit vectors (i,j,k)-dot product and cross product of two vectors- properties of dot and cross products-examples- 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- causes and types of friction-normal reaction-laws of friction-coefficients of friction-methods to reduce friction-advantages and disadvantages 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 and units-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- longitudinal wave and transverse wave - noise pollution-Effects and methods to control Noise Pollution-Beats and echo and their applications -Doppler effect - statement– Physical explanation and applications –Reverberation time -Sabine’s formula-characteristics/conditions of a good auditorium - problems.

Unit-X: Properties of matter: Define terms - elasticity, plasticity – stress and strain – units – Hooke's law – definition of surface tension, examples – angle of contact , capillarity and examples – formula for surface tension based on capillarity (no derivation) –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- statements and explanation of 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 – problems.

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MODEL QUESTIONS FOR PHYSICS

- 1) Dimension of mass in Universal gravitational constant
1) 0 2) 1 3) -1 4) 2
- 2) If $\vec{F} = 2\hat{i} + 3\hat{j} - 4\hat{k}$ and $\vec{S} = 4\hat{i} - 2\hat{j} + n\hat{k}$ then the work done is zero. The value of n is
1) 0 2) $\frac{1}{2}$ 3) $\frac{3}{2}$ 4) 1
- 3) The nature of velocity-time graph of a freely falling body is
1) parabola 2) ellipse
3) **straight line passing through the origin** 4) straight line with +ve y axis intercept
- 4) A particle is performing SHM with a time period T. Then the time taken by the particle to reach half the amplitude from its mean position is
1) $\frac{T}{12}$ 2) $\frac{T}{3}$ 3) $\frac{T}{6}$ 4) $\frac{T}{2}$
- 5) A given mass of gas at 27° is heated in a glass flask at constant pressure so that its volume is doubled. Then the final temperature of the gas is
1) **327°C** 2) 227°C 3) 430°C 4) 530°C

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SYLLABUS: CHEMISTRY

(25 Marks)

Unit I: Fundamentals of Chemistry: Atomic structure: Introduction- 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 - H₂, O₂, N₂ (Lewis dot model) - Characteristics of covalent compounds - Coordinate covalent bond – Definition and examples, [NH₄⁺], [NH₃BF₃].

Oxidation-Reductions: Electronic concept of Oxidation and Reduction - Oxidation number and its calculations - Differences between oxidation number and valency.

Unit-II: Solutions: Introduction – Definition of solution, solute and solvent - Classification of solutions based on physical state - Mole concept - Molecular weight, equivalent weight of acids, bases and salts - Molarity, Normality and numerical problems.

Unit-III: Acids and Bases: Introduction – 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 –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).

Unit –VI: Corrosion: Introduction – 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: Introduction – 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: Introduction – 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.

Unit-X: Environmental Chemistry: Introduction – Environment – Lithosphere, hydrosphere, atmosphere, biosphere, biotic component – Definitions of pollutant, contaminant- 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 - Green house 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.

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MODEL QUESTIONS FOR CHEMISTRY

- The number of unpaired electrons present in sulphur.
1) 3 2) 2 3) 1 4) 4
- What is the conjugate base of H_2O .
1) H_3O^+ 2) H^+ 3) OH^- 4) O^{2-}
- Which one of the following cause temporary hardness to water?
1) CaCl_2 2) MgSO_4 3) NaCl 4) $\text{Ca}(\text{HCO}_3)_2$
- 0.4 grams of NaOH is added to 100 ml of 0.1 M NaOH solution and the volume of solution is made to 200ml by adding water. Calculate the molarity of the resulting solution?
1) **0.1M** 2) 0.2M 3) 0.3M 4) 0.4M
- Monomers used for the preparation of Bakelite
1) Urea and formaldehyde 2) aniline and formaldehyde
3) **Phenol and formaldehyde** 4) Phenol and urea

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SYLLABUS: METALLURGICAL ENGINEERING

(100 Marks)

UNIT I : ELEMENTARY PRINCIPLES OF METALLURGY:

Introduction to metallurgy – ores & ore dressing, Methods of ore sampling – Comminution – sizing- concentration. Principles and processes of Pyro, hydro and electrometallurgy – Minerals of commercially important metals.

UNIT II : FUELS, REFRACTORIES AND PYROMETRY:

Classification of solid, liquid and gaseous fuels – Testing and properties of important fuels- Manufacture and characteristics of Metallurgical Coke – Gasification of solid fuels

- Combustion of fuels – Properties, manufacture and selection of Refractories, Principles and operation of important pyrometers- Heat transfer.

UNIT III : METALLURGICAL THERMODYNAMICS:

Introduction and applications of thermodynamics – First Law of thermodynamics - Thermo chemistry - Second Law of thermodynamics - Ellingham diagrams - Fugacity, activity and equilibrium constant - Phase equilibria – Solutions.

UNIT IV : PHYSICAL METALLURGY:

Structure of Metals and Alloys – Solidification – Binary thermal equilibrium diagrams - Iron-carbon diagram - important non- ferrous binary alloy systems – Microscopic and macroscopic examination of metals and alloys.

UNIT V : HEAT TREATMENT TECHNOLOGY:

Heat treatment of plain carbon steels - Annealing, Normalizing, Hardening and tempering of steels – TTT diagrams – Hardenability - Grain size, Quenching media. Alloy steels & Effect of alloying elements on plain carbon steels – Stainless steels, tool steels – Case hardening techniques. Special heat treatment techniques such as Austempering, Martempering, sub-zero treatment - Heat treatment of Non-ferrous metals and alloys – Age hardening - Heat Treatment Furnaces and Furnace atmospheres – Heat treatment defects.

UNIT VI : FERROUS EXTRACTIVE METALLURGY:

Iron ores and preparation of iron ores – Burden distribution – Blast furnace profile - Blast furnace plant and equipment – blast furnace reactions - irregularities and recent trends - sponge iron & methods of production – Ferroalloys – types and applications. Steel making by Bessemer, LD, Kaldo, Oxygen Lime (LDAC) process, Open hearth and Electric furnaces – Secondary steel making process – Vacuum treatment of liquid steel - Ingot defects - Continuous casting.

UNIT VII : NON-FERROUS EXTRACTIVE METALLURGY:

Extraction of copper – Pyro and hydrometallurgical methods & refining – Aluminum - Extraction, Anode effect, Refining - Zinc and Lead - Pyro and hydrometallurgical extraction and refining. Extraction of Magnesium by Dows and pidgeon processes - Extraction of Titanium by Kroll's process - Refining of Titanium by Van arke's process-Extraction of Thorium and Zirconium.

UNIT VIII : MATERIAL TESTING:

Tension test. Stress - strain relationships, necking phenomenon. Hardness tests - principles and types. Impact testing - Notched bar impact tests. Transition temperature. Fatigue, Stress cycles, S-N diagram, Factors affecting Fatigue. Creep testing - creep curve, Stress - rupture test. Non-destructive testing- Principles, methods and applications of liquid penetrant, Radiography, Ultrasonic Magnetic particle and Eddy current test.

UNIT IX : MECHANICAL METALLURGY:

Plastic deformation of metals – lattice defects – Slip and Twinning - CRSS –Strengthening mechanisms. Strain hardening - Hot and Cold working - Recovery, recrystallisation and grain growth. Metal forming processes - Rolling, Forging, Extrusion & Sheet metal forming processes and defects.

UNIT X : FOUNDRY TECHNOLOGY:

Patterns: Types, materials and pattern allowances, Moulding Sands - properties and Testing, Moulding Processes and equipment: Sand casting, Die casting, Shell moulding, Centrifugal casting, Investment casting and CO2 process-Cores: Types of Cores and properties, pouring and feeding of castings. Cast irons – types, Melting of cast irons - Grey, S.G and Malleable iron. Aluminum, Copper and Steel Foundry practices. Defects in Castings. Cleaning & Salvage of Castings.

UNIT XI : WELDING TECHNOLOGY:

Basic concepts of Welding - Principles and processes of various welding techniques such as Oxy-acetylene, Shield Arc welding, Inert gas welding- TIG and MIG - Special welding processes - Plasma, resistance, electro slag, electron beam, thermit and Laser. Weld ability, factors affecting weld ability – Heat affected zone, Microstructure – Post weld treatments – Welding defects – Inspection and testing.

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MODEL QUESTIONS FOR METALLURGICAL ENGINEERING

1. The crystal structure of Ferrite at room temperature?
1) FCC 2) **BCC** 3) HCP 4) SC

2. The atomic packing factor of HCP is
1) 0.68 2) **0.74** 3) 0.54 4) 0.36

3. The extraction of magnesium is done by
1) **DOW's process** 2) Bayers Process 3) Kroll's Process 4) Vanarkells Process

4. The pressurized gating ratio is.
1) 1:2:2 2) 0.5:1:1 3) 1:2:4 4) **1:2:1**

5. The ratio of C_2H_2 and O_2 in neutral flame of gas welding is
1) 1:2 2) 1:0.5 3) **1:1** 4) 3:4
