

SYLLABUS FOR METALLURGICAL ENGINEERING

MATHEMATICS (50 Marks)

Unit-I: Matrices

Matrices of 3rd order: 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 methods.

Partial Fractions: Resolving a given rational function into partial fractions.

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 – Simple trigonometric equations – Properties of triangles – Inverse Trigonometric functions.

Complex Numbers: Properties of Modulus, amplitude and conjugate of complex numbers, arithmetic operations on complex number—Modulus-Amplitude form (Polar form)-Euler form (exponential form)-Properties- De Moivre's Theorem and its applications.

Unit-III: Analytical Geometry

Straight Lines – different forms of Straight Lines, distance of a point from a line, acute 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. Standard forms of equations of Parabola, Ellipse and Hyperbola – simple properties.

Unit-IV: Differentiation and its Applications

Functions and limits – Standard limits – Differentiation from the First Principles – 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 – Derivative as rate measure -Errors and approximations - 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 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 value.

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, nth order linear differential equation with constant coefficients both homogeneous and non homogeneous and finding the Particular Integrals for

the functions e^{ax} , x^m , $\sin ax$, $\cos ax$.

Unit-VII: Laplace Transforms and Fourier series

Laplace Transforms and Inverse Laplace Transforms of Elementary functions. Shifting Theorems of LTs and ILTs.

Define Fourier series, Euler's Formulae Over the interval $(C, C+2\pi)$. Even and odd functions and their Fourier series

Unit-VIII: Probability and Statistics

Define Probability, addition Theorem, conditional Probability, Mean, Median, Mode, Mean deviation and standard deviation.

PHYSICS (25 Marks)

Unit-I: Units and dimensions: Physical quantity-fundamental and derived physical quantities-units-fundamental and derived units-SI units-multiples and sub-multiples in SI units-advantages of SI units-dimensions and dimensional formulae-dimensionless quantities- applications and limitations of dimensional analysis-problems.

Unit-II: Elements of vectors:

Scalar and vector quantities-examples-types of vectors- addition and subtraction of vectors-triangle law-parallelgram law and its cases-polygon law- resolution of a vector-unit vectors (i, j, k)-dot product and cross product of two vectors- characteristics of dot and cross products-examples-problems.

Unit-III: Kinematics and Friction

Equations of motion-acceleration due to gravity-equations of motion under gravity- expressions for maximum height, time of ascent, time of descent, time of flight, velocity on reaching the point of projection in vertical motion--motion of a body projected from the top of a tower-projectile motion-examples-horizontal and oblique projections-expressions for maximum height, time of ascent, time of flight, horizontal range, problems. Friction- causes and types of friction-normal reaction-laws of friction-coefficients of friction- angle of friction-methods of reducing friction-advantages and disadvantages of friction- motion of a body over a rough horizontal surface, a smooth inclined plane and a rough inclined plane-problems.

Unit-IV: Work, Power and Energy

Work, power and energy-definitions and units-potential and kinetic energies-examples and expressions-work-energy theorem-law of conservation of energy-problems.

Unit-V: Simple harmonic motion and Sound

Definition-conditions of SHM-examples of SHM-expressions for displacement, velocity, acceleration, time period, frequency and phase of SHM-time period of a simple pendulum-second's pendulum-problems. Sound-musical sound and noise-noise pollution-Effects and methods of control of Noise Pollution-Beats and echo's-problems-Doppler effect – Explanation, and Applications - Acoustics of buildings-Reverberation-Sabine's formula- characteristics of a good building-problems.

Unit-VI: Heat and Thermodynamics

Expansion of gases-Boyle's law-Absolute scale of temperature-Charles laws-Ideal gas equation-Universal gas constant and its value-SI Units-problems-external work done by a gas-isothermal process-adiabatic process-first law of thermodynamics and its applications to

isothermal process and adiabatic process-two specific heats of a gas-relation between C_p and C_v - problems-second law of thermodynamics and its applications.

Unit-VII: Modern physics

Photoelectric effect – explanation and its laws-applications of photoelectric effect (photocell)- Einstein's photoelectric equation – critical angle and total internal reflection – optical fibers - principle, working , types and applications-concept of super conductivity – its properties and applications.

CHEMISTRY (25 Marks)

Unit – I: Fundamentals of chemistry:

Atomic structure: Introduction-Fundamental particles – Bohr's theory – Quantum numbers – Aufbau principle – Hund's rule – Pauli's exclusion principle- Electronic configurations of elements up to atomic number 20, shapes of **s, p, d** orbital's.

Chemical Bonding: Introduction – types of chemical bonds – Ionic bond taking example of NaCl and MgO –characteristics of ionic compounds and covalent bond taking example H_2 , O_2 , N_2 , HCl , characteristics of covalent compounds-Coordinate covalent bond- Metallic bond .

Oxidation-Reductions:concepts of Oxidation-Reduction ,Oxidation number and its calculations, differences between oxidation number and Valency

Unit-II: Solutions: Introduction solution classification of solutions, solute, solvent, concentration, mole concept,–Molarity,–Normality, equivalent weight using acids, bases and salts, numerical problems on Molarity and Normality.

Unit-III: Acids and Bases: Introduction – theories of acids and bases – Arrhenius, Bronsted – Lowry theory – Lewis acid base theory – Ionic product of water - p^H and related numerical problems – buffers solutions – Applications.

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-hand picking, levigation, froth floatation – extraction of crude metal – roasting calcination, smelting – alloys – composition and uses of brass, German silver and nichrome.

Unit-V: Electrochemistry: Conductors, insulators, electrolytes - Arrhenius theory of electrolytic dissociation – electrolysis – Faraday's laws of electrolysis- numerical problems – Galvanic cell – standard electrode potential – electro chemical series –emf and numerical problems on emf of a cell.

Unit –VI: Corrosion: Introduction - factors influencing corrosion - electrochemical theory of corrosion- composition cell, stress cell and concentration cells– rusting of iron and its mechanism – prevention of corrosion by (a) coating methods, (b) cathodic protection (sacrificial and impressive voltage methods).

Unit-VII: Water Technology: Introduction –soft and hard water – causes of hardness – types of hardness –disadvantages of hard water – degree of hardness, units and Numerical problems–softening methods – permutit process – ion exchange process – qualities 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 – Rubber – natural rubber – processing from latex – Vulcanization – Elastomers – Butyle 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 – understand the terms lithosphere, hydrosphere, atmosphere bio sphere, biotic component, energy component pollutant, receptor, sink, particulate, DO, BOD, Threshold limit value, COD- Air pollution - causes-Effects- Forest resources ,uses and over exploitation ,deforestation acid rain, green house effect –ozone depletion – control of Air pollution – Water pollution – causes – effects – control measures. Renewable and Non Renewable energy sources – concept of ecosystem –producers, consumers and decomposers – Biodiversity ,threats to Biodiversity .

METALLURGICAL ENGINEERING (100 Marks)

1. ELEMENTARY PRINCIPLES OF METALLURGY: Introduction to metallurgy – ores & ore dressing, Methods of ore sampling – Communiton – sizing- concentration. Principles and processes of Pyro, hydro and electrometallurgy –Minerals of commercially important metals.

2. 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 – firing of fuels and pulverization - Combustion of fuels – Properties, manufacture and selection of Refractories, Principles and operation of important pyrometers- Heat transfer – Non-conventional energy resources.

3. 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. Fundamentals of Reaction Kinetics.

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

5. 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.

6. 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.

7. 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.

8. 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.

9. MECHANICAL METALLURGY: Plastic deformation of metals – 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 – Thermo mechanical treatments – isoforming and ausforming. Powder metallurgy. Methods of powder production, characterization, Compaction, Sintering and applications of Powder Metallurgy.

10. 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.

11. 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. Soldering and brazing– Weld ability, factors affecting weld ability – Heat affected zone, Microstructure – Post weld treatments – Welding defects – Inspection and testing.

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METALLURGICAL ENGINEERING

1. Which of the following is the criterion for the phase transformation $\alpha \rightarrow \beta$ to take place?
1) $\Delta G > 0$ 2) $\Delta G < 0$ 3) $\Delta S < 0$ 4) $G_{\beta} - G_{\alpha} = 0$
2. Which of the following is the hardest phase that appears in Fe- Fe₃C phase diagram?
1) Cementite 2) Martensite 3) Ferrite 4) Austenite
3. Which of the following is not a strengthening mechanism?
1) Strain hardening 2) Annealing
3) Cold working 4) Precipitation hardening

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