

ANNEXURE - I
METALLURGICAL ENGINEERING

- 1. ELEMENTARY PRINCIPLES OF METALLURGY:** Introduction to metallurgy – ores & ore dressing, Methods of ore sampling – Communiton – Screening & Classification - Minerals of commercially important metals - Principles and processes of Pyro, hydro and electrometallurgy –
- 2. FUELS, REFRactories AND PYROMETRY:** Classification of solid, liquid and gaseous fuels – Testing and properties of important fuels-Manufacture and characteristics of Metallurgical Coke - Combustion of fuels – Properties, manufacture and selection of Refractories, Principles and operation of important pyrometers.
- 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
- 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 atmospheres.
- 6. FERROUS EXTRACTIVE METALLURGY:** Iron ores and preparation of iron ores - 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, Open hearth and Electric furnaces –New techniques in steel making – 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 by Van Arkell's process-Extraction of Thorium and Zirconium.
- 8. MATERIAL TESTING:** Tension test. Stress- strain relationships, necking phenomenon – Ductile and brittle fracture – Griffith's theory of brittle fracture - 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 – 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 – Powder metallurgy. Methods of powder production, Characterization, Compaction, Sintering and applications of

Powder Metallurgy.

10. FOUNDRY TECHNOLOGY: Types of foundries – Basic steps in casting - 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. Aluminium, 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, Arc welding, Inert gas welding- TIG and MIG - Special welding processes- Plasma, resistance, electro slag, electron beam, thermit and Laser. Soldering and brazing– Weldability, factors affecting weldability – Heat affected Zone, Microstructure – Post weld treatments –Welding defects –Inspection and testing.

ANNEXURE II
Number of question to be set Unit wise (Total 100)

METALLURGICAL ENGINEERING

UNIT NO	TOPICS	Questions
I	ELEMENTARY PRINCIPLES OF METALLURGY	06
II	FUELS, REFRACTORIES AND PYROMETRY	05
III	METALLURGICAL THERMODYNAMICS	08
IV	PHYSICAL METALLURGY	11
V	HEAT TREATMENT TECHNOLOGY	12
VI	FERROUS EXTRACTIVE METALLURGY	12
VII	NON-FERROUS EXTRACTIVE METALLURGY	10
VIII	MATERIAL TESTING	08
IX	MECHANICAL METALLURGY	10
X	FOUNDRY TECHNOLOGY	10
XI	WELDING TECHNOLOGY	08
	Total	100

ANNEXURE III
MODEL QUESTIONS FOR METALLURGICAL ENGINEERING

1. Rawmaterial for production of Aluminium is -----
 - 1) Bauxite
 - 2) Cryolite
 - 3) Alumina
 - 4) Gibbsite
2. No of slip systems in FCC structure
 - 1) 12
 - 2) 48
 - 3) 16
 - 4) 03
3. ASTM grain size is measured by----- formula
 - 1) $N=2^{n-1}$
 - 2) $n=2^{N-1}$
 - 3) $N=2^{n-1}$
 - 4) $n=2^N-1$
4. In proximate analysis of coal _____ is determined.
 - 1) Hydrogen, Nitrogen, Oxygen & Carbon
 - 2) Moisture, ash, Volatile matter & carbon
 - 3) Hydrogen, ash, Oxygen & Carbon
 - 4) Sulphure, Moisture & Carbon.
5. In Iso-thermal process
 - 1) $dp=0$
 - 2) $dt=0$
 - 3) $dq=0$
 - 4) $dv=0$
6. In LD Process Oxygen is released through the lance at a pressure of _____.
 - 1) 150-175 psi
 - 2) 100-150 psi
 - 3) 200-250 psi
 - 4) <100 psi