ANNEXURE I
METALLURGICAL ENGINEERING

1. ELEMENTARY PRINCIPLES OF METALLURGY: Introduction to metallurgy – ores & ore dressing, Methods of ore sampling – Communition – Screening & Classification - 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 - 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 .

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, OLP, 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. 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 – 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 CO_2 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, Shield 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	MARKS
I	**ELEMENTARY PRINCIPLES OF METALLURGY**	05
II	**FUELS, REFRACTORIES AND PYROMETRY**	06
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**	09
XI	**WELDING TECHNOLOGY**	09
	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