

TAMIL NADU PUBLIC SERVICE COMMISSION

POST OF PRINCIPAL / ASSISTANT DIRECTOR (TRAINING)

INCLUDED IN THE TAMIL NADU EMPLOYMENT AND TRAINING SERVICE

MATERIALS SCIENCE AND ENGINEERING (DEGREE STANDARD)

UNIT-1 PHYSICAL METALLURGY:

Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers - Phase diagrams - Solid solutions – Solidification - Phase transformation and binary phase diagrams - Iron-iron carbide phase diagram - Classification of Steels and Cast Irons - TTT diagrams - Pearlitic, bainitic, martensitic transformation - Heat treatment process for steels and cast irons - Recovery, recrystallization and grain growth – Hardenability - surface treatments - Ferrous alloys.

UNIT-2 MECHANICAL METALLURGY:

Elastic behavior of materials - Hooke's law - Plastic behaviours - Dislocation theory - Slip and twinning - Cold working, grain size strengthening - Solid solution strengthening - Martensitic strengthening, precipitation strengthening, dispersion strengthening, fiber strengthening - Yield point phenomenon, strain aging and dynamic strain aging - Basic mechanism of ductile and brittle fracture, Griffith's theory of brittle fracture - Izod and Charpy Impacts tests - Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT - Fracture mechanics- modes of fracture, stress intensity factor, strain energy release rate, fracture toughness and determination of K_{IC} - Mechanical testing – tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability.

UNIT-3 EXTRACTIVE METALLURGY:

Steel making processes, physico-chemical principles and kinetic aspects of steel making, oxygen transport mechanism, desulphurisation, dephosphorisation, slag functions, composition, properties and theories - Raw materials for steel making - Acid and Basic Bessemer processes, Side Blown Converter, Open Heart process- - bottom blown processes, combined blown processes, rotating oxygen processes- kaldo and rotor- ingot and continuous casting - Stainless steel making - Furnaces and refractories.

UNIT-4 POWDER METALLURGY

Characteristics and Testing of Metal Powders - Sampling, chemical composition purity, surface contamination etc. - Particle size and its measurement - Apparent and tap density, Green density, Green strength, sintered compact density, porosity, shrinkage - Powder Manufacture and Conditioning - Mechanical methods, atomization, chemical method, Physical methods - Pressureless compaction - Slip casting and slurry casting - Pressure compaction, lubrication, single ended and double ended compaction, isostatic pressing, powder rolling, forging and extrusion, explosive compaction - Sintering - Mechanisms of sintering, liquid phase sintering and infiltration, activated sintering - Hot pressing and Hot Isostatic Pressing, Self propagating high temperature synthesis, Vacuum sintering,

UNIT-5 THERMODYNAMICS OF MATERIALS

The first and second law of thermodynamics, reversibility and irreversibility, criteria of equilibrium - applications to metallurgical systems, solutions, phase equilibria, Ellingham and phase stability diagrams - Thermodynamics of surfaces, interfaces and defects, adsorption and segregation - Concept of Third law - Heterogeneous reaction kinetics-gas-solid, solid-liquid, liquid-liquid and solid-solid systems - Solid state diffusion- Ficks law, mechanism of diffusion

UNIT-6 METAL FORMING

Stress / Strain Rate Tensor - Von Mises, Tresca Yield criteria, comparison of yield criteria - Octahedral shear stress and shear strain - Forming load calculations - Strain Rate Tensor- Forging- Open die forging and Closed die forging, die design, forging in plane strain, calculation of forging loads, forging defects-causes and remedies, residual stresses in forging - Rolling: types of rolling mills, hot and cold rolling, forces and geometrical relationship in rolling, analysis of rolling load, torque and power, rolling mill control, rolling defects – causes and remedies - Direct and indirect extrusion, hydrostatic extrusion, defects and remedies, tube extrusion and production of seamless pipe and tube - Drawing of rods, wires and tubes, Forming methods – Shearing, blanking, bending, stretch forming, deep drawing, defects in formed part - Sheet metal formability, formability limit diagram - High velocity forming-Explosive forming, Electro hydraulic forming.

UNIT-7 CASTING AND MACHING PROCESSES:

Metal casting – patterns and moulds- Testing of moulding sands, sand preparation- casting practices in sand casting, permanent mould casting, investment casting and shell moulding, centrifugal casting, casting defects and repair- Melting practice - alloy steels, cast irons, aluminum alloys, copper alloys and magnesium alloys-, fluxing degassing and inoculation - Metal cutting- Mechanics of chip formation –Tool life – Cutting fluid – tool wear and failure - Machinability.

UNIT-8 WELDING METALLURGY

Metal joining – Soldering, brazing and welding, common welding processes - Thermal cycles in welding, temperature distributions and cooling curves - Formation of different microstructural zones - Phase transformations in weld and heat - affected zones, - Defects in welded joints - testing of weldability-tesing of weldments.

UNIT-9 SURFACE ENGINEERING

Tribology - surface degradation, wear and corrosion, types of wear, adhesive, abrasive, oxidative, corrosive, erosive and fretting wear roles of friction and lubrication - Pourbaix diagram for iron, magnesium and aluminium - Uniform, pitting, intergranular, stress corrosion, Corrosion fatigue, Erosion corrosion - Cause and remedial measures - High temperature oxidation - surface protection methods - corrosion inhibitors - CVD and PVD processes, sputter coating, Laser and ion implantation, Arc spray, plasma spray, Flame spray.

UNIT-10 NON FERROUS METALLURGY

Copper alloys - Properties and applications - Major alloys – Brasses - Cu-Zn alloys, Bronzes, Tin bronze, compositions, properties and uses-Aluminium Alloys - Heat treatable and Nonheat treatable, Age hardening- Magnesium and Titanium Alloys - Properties and uses of Magnesium alloys, Titanium - α , α - β and β Titanium alloys - Titanium aluminides their properties and uses, Nickel and Zinc Alloys - Nickel aluminides, Lead, Tin, Antimony and Precious Metals - characteristics and applications, low melting nature and solder alloys - Gold, Silver and Platinum