

SUBJECT TITLE : MATERIAL SCENCE AND HEAT TREATMENT
SUBJECT CODE : 5016
PERIODS /WEEK : 4
PERIODS/ SEMESTER : 72
CREDIT : 4

TIME SCHEDULE

MODULE	TOPIC	PERIODS
I	1.1 Structure of solids	17
	1.2 Solid solution and Phase diagrams	
	1.3 Mineral deposits and preparations	
	Test-1	1
II	2.2 Ferrous and non ferrous metals	17
	2.3 Steel manufacturing	
	Test-II	1
III	3.1 Corrosion and Surface engineering	17
	3.2 Heat treatment	
	Test- III	1
IV	4.1 Oxidation, Decarburisation of steel	17
	4.2 Testing of materials and failure analysis	
	Test-IV	1
Total		72

Objectives

Module 1

- 1.1.0 Understand the structure of solids
 - 1.1.1 Explain the structure of atom
 - 1.1.2 Draw the crystal structures
 - 1.1.3 Sate miller indices
 - 1.1.4 Know the crystal imperfections
- 1.2.0 Draw and explain phase diagrams
 - 1.2.1 Understand the mechanism of solidification
 - 1.2.2 Analyse the effects of grain size
 - 1.2.3 Understand types of solid solutions
 - 1.2.4 Construct phase diagram
 - 1.2.5 Draw and explain Iron-carbon equilibrium diagram
- 1.3.0 Know the mineral deposits in India
 - 1.3.1 Know about the mineral deposits in India
 - 1.3.2 Know the mineral ores of Iron, Copper, Aluminum, Nickel and Zinc
 - 1.3.3 Understand dressing process of minerals
 - 1.3.4 Understand the principle of hydro metallurgy

Module 2

- 2.1.0 Classify ferrous and non ferrous metals
 - 2.1.1 List ferrous and non ferrous metals
 - 2.1.2 Differentiate iron, steel and cast iron

- 2.1.3 Classify the cast iron
- 2.1.4 Understand non ferrous metals
- 2.1.5 Understand non ferrous alloys
- 2.1.6 Understand polymers
- 2.1.7 Differentiate thermosetting plastics and thermo plastics
- 2.1.8 Understand rubber and its applications
- 2.1.9 Understand ceramic materials
- 2.1.10 Understand refractory materials
- 2.1.11 Know about composite materials
- 2.1.12 Understand the application of non metals
- 2.2.0 Explain the production of steel
 - 2.2.1 Understand the manufacturing of steel using Bessemer, Open hearth, L.D process and Electric furnace
 - 2.2.2 List the types of steels and their applications
 - 2.2.3 Understand alloy steels

Module 3

- 3.1.0 Understand corrosion and scope of surface engineering
 - 3.1.1 Analyse corrosion mechanism
 - 3.1.2 Understand the impact of corrosion
 - 3.1.3 List the types of corrosion
 - 3.1.4 Determine the corrosion characteristic
 - 3.1.5 Understand corrosion control methods
 - 3.1.6 Select corrosion resistant material
 - 3.1.7 Know surface engineering process
 - 3.1.8 Understand surface coating techniques
 - 3.1.9 Define conversion coating
- 3.2.0 Analyse different heat treatment process
 - 3.2.1 Draw TTT diagram
 - 3.2.2 Understand different annealing methods
 - 3.2.3 Differentiate normalizing and annealing
 - 3.2.4 Explain hardening
 - 3.2.5 Define quenching
 - 3.2.6 Establish the need of tempering
 - 3.2.7 Know Jominey end quench test

Module 4

- 4.1.0 Understand the need of Oxidation, Decarburisation of steel
 - 4.1.1 Understand the mechanism of oxidation
 - 4.1.2 Discuss oxidation preventing methods
 - 4.1.3 Define decarburization
 - 4.1.4 List the finishing operations after heat treatment
 - 4.1.5 Understand straightening process
 - 4.1.6 Know control of heat treating process
- 4.2.0 Analyse failure and understand testing of materials
 - 4.2.1 Explain destructive testing
 - 4.2.2 Understand tests on universal testing machine
 - 4.2.3 Understand Hardness tests
 - 4.2.4 Understand torsion test
 - 4.2.5 Understand fatigue test
 - 4.2.6 Analyse endurance limit

- 4.2.7 Understand Creep test
- 4.2.8 Understand non destructive tests
- 4.2.9 Know failure analysis
- 4.2.10 Differentiate ductile fracture and brittle fracture
- 4.2.11 Understand notch sensitivity

CONTENT DETAILS

MODULE 1

Atomic structure- crystal structure-unit cell- space lattice-BCC,FCC,HCP-miller indices
 metal imperfections –point defects-Vacancy, Scottky, Frenkel, interstially and compositional
 Process of crystallization of pure metals-dendritic solidification-effect of grain size-
 Definition of solid solution- substitutional, interstitial-equilibrium diagrams- system-component,
 alloy, phase, Gibbs phase rule-construction of phase diagram-iron carbon equilibrium diagram
 Ore mineral deposits in India-Ore beneficiation treatment-ores of iron, copper, aluminum
 nickel and zinc-crushing mill- grinding mill –concentration- sorting-electro static separation-
 principles of electro metallurgy, principles of pyro metallurgy (introduction only)

MODULE 2

Ferrous and non ferrous metals-pig iron, wrought iron, cast iron, steel, copper,
 aluminum, lead, tin, magnesium, zinc, nickel- effects of alloying elements - non ferrous alloys-
 brass, bronze, duralumin, hinalium, Y-alloy, monel metal, nichrome, babbitt metal, white metals-
 polymerisation-plastics-thermoplastics and thermo setting plastics (examples and applications)-
 rubber (types and applications)-ceramic materials (types and applications)- refractory materials
 (types and applications) ,glass ,abrasive materials-composite materials
 Steel- plain carbon, low carbon, high carbon steels- manufacturing of steel-bessemer,
 open hearth, LD process, Electric furnace- alloy steels- -stainless steel, high speed steel, silicon
 steel, magnet steel-their applications

MODULE 3

Corrosion mechanism-factors affecting corrosion-types of corrosion –determination of
 corrosion characteristics- corrosion control-corrosion resistant materials-reasons for surface
 engineering- surface engineering techniques- thin film coating- conversion coatings- high energy
 process-finishing operations after heat treatment
 Objectives of heat treatment- TTT diagram- annealing: full annealing, isothermal
 annealing, process annealing, diffusion annealing normalizing- hardening-quenching methods-
 effect of quenching- tempering- tempering methods- case hardening: carburizing, nitriding,
 cyaniding - Jominy end quench test

MODULE 4

Oxidation of steel-means of preventing steel from oxidation-Decarburisation of steel-
 removal of scales-alkaline detergent cleaning process –straightening process –incoming steel
 inspection
 Destructive test and non destructive tests-UTM-Hardness test: Brinell, Vicker's, fatigue
 test- variables affecting fatigue test , endurance limit, creep test, varies creep stages-non
 destructive tests- visual, accoustic,magnetic particle, liquid penetration, X ray, gamma ray, ultra
 sonic test
 Introduction to Failure analysis-fracture: ductile, brittle fracture cleavage- notch sensitivity

References

1. Engineering materials and Metallurgy-R.K.Rajput
2. Material science and engineering –R.K.Rajput
3. Engineering materials –B.K.Agarval
4. Engineering materials and metallurgy-R.Sreenivasan
5. Workshop Technoilogy, Vol I&II-S.K.Hajra Choudhary,S.KBose, A.K.Hajra Choudhary, Nirjhar Roy
6. A Text book of Material science and metallurgy - O.P.Kahanna