Subject Code: 01ME0403
Subject Name: Material science and Engineering
B. Tech. Year - II (Semester - 4)

Type of course : Engineering Science

Prerequisite : Basic knowledge of Physics, Chemistry.

Rationale : Basic principles of science are used to study the structure-properties relationships of various materials for their proper applications in this subject. Especially study of different types of ferrous and non-ferrous metals and alloys, in terms of their composition, structure, properties and applications; non-destructive testing are included in this course to understand the basic concept of selection and processing of metals and materials for their applications.

Course Outcome :

After completion of this course, student will be able to

1. Enhance the technical knowledge on Engineering materials & its applications.
2. Establish important relationships between internal structure, properties and performance of materials during processing and use.
3. Design the alloy system based on their knowledge of phase diagrams and metal characteristics.
4. Understand different non-destructive testing methods
5. Know the various heat treatment processes for steels.
6. Apply the knowledge of Heat treatment process for emphasizing relation between microstructure and mechanical properties.

Teaching and Examination Scheme :

Teaching Scheme			Credits	Examination Marks					
				Theory Marks			Practical Marks		Total Marks
THEORY	TUTORIAL	PRACTICAL	C	ESE(E)	IA	CSE	Viva (V)	Term Work (TW)	
3	--	2	4	50	30	20	25	25	150

Content :

Sr. No.	Content	Total Hrs.
1	**Introduction of Material science and Metallurgy:** Introduction to properties of materials, Engineering Requirements of materials, Classification of Engineering Materials, Criterion for selection of materials.	03
2	**Metallography:** Macro-examination and Micro examinations, Procedure for preparing the specimen for	*

	macro and micro examination. Microscopic Techniques: Optical Microscope, SEM, TEM.	
3	**Crystal Geometry, Structure and Defects:** Crystal Structure for Metallic Elements, Types of crystal systems, Crystal lattice, Lattice parameter, co-ordination number, Atomic radius, atomic packing factors for various cubic systems, crystal Directions, Lattice Planes and Miller Indices. Defects or Imperfections in Crystals: Point defect, line defect, Surface defect, Volume defect.	**04**
4	**Solidification of Metals and Phase Diagrams:** Solid Solutions: Types Solid Solutions, Hume-Rothery's Rules. Concept of solidification of metals, Solidification of pure metals, Nucleation, Growth, Growth of the new phase, Solidification of alloys, Progressive, Directional solidification & control of solidification to obtain sound casting. **Phase Diagrams:** Objectives & classification of System, phases & structural constituent of phase diagram, Gibb's solid phase rule, Cooling Curves (Time-Temperature Curves), Eutectic, Peritectic & Eutectoid system, Equilibrium diagrams for non ferrous alloys, Lever rule.	**07**
5	**Iron-Carbon Diagram:** Allotropic forms of Iron, Iron- Iron carbide equilibrium Diagram, Development of microstructure in iron–carbon alloys.	**04**
6	**Heat Treatment Processes:** Definition, Purpose & classification of heat treatment processes for various types of special steels, Introduction applications of various case hardening & surface hardening treatments. TTT & CCT curves.	**06**
7	**Ferrous Materials** **Pig Iron, Wrought Iron** **Cast Iron:** Classification of Cast irons Gray cast irons, nodular cast irons, white cast irons, malleable cast irons, chilled. Effect of various parameters on structure and properties of cast irons. Applications of cast irons for different components of machine tools, automobiles, pump, etc. **Steel:** Classification and application of steels, Effect of alloying elements, Specification of some commonly used steels for Engineering applications (e.g. En. AISI, ASTM, IS etc.) with examples. Classification and application of plain carbon steels. Examples of alloy steels such as high manganese steel, Ball Bearing steels, Maraging steels, Spring steels, Tool steels Stainless steels.	**08**
8	**Non- ferrous alloys:** Introduction, Aluminium Alloys, Magnesiumand Beryllium Alloys, Copper Alloys, Nickel and Cobalt Alloys, Titanium Alloys, Refractory and Precious Metals.	**03**
9	**Non-Destructive Testing's (NDT):** Radiography Testing, Dye, Penetration Testing, Magnetic Particle Testing, Ultrasonic Testing. Eddy current testing with their Principle of non-destructive testing, the test methods, relative merits, demerits and applications.	**04**
10	**Powder Metallurgy** Introduction, Methods of manufacturing powders, mixing of powders, compaction, sintering, secondary operation, advantages and limitation of powder metallurgy.	**03**

Distribution of Theory Marks

R Level	**U** Level	**A** Level	**N** Level	**E`** Level	**C** Level
20	**30**	**25**	**15**	**10**	--

Legends: R: Remember**; U:** Understand**; A:** Apply**; N:** Analyze**; E:** Evaluate**; C**: Create

List of Experiments :

1. To understand the construction and working of a Metallurgical Microscope.
2. To study of microstructures for various ferrous and non ferrous materials.
3. To prepare the specimen for microscopic observation.
4. To determine the strength and hardness of ferrous and non-ferrous specimen.
5. To study the effect of Heat treatment process on the Hardness and Tensile Strength of Mild Steel.
6. To show the effect of different quenching media (Oil, Water and Brine) on the hardness of Mild steel.
7. To determine the harden ability of a specimen by Jominy end quench test.
8. To study of powder metallurgy.
9. To determine the surface defect by liquid penetrant test and magnetic particle test.
10. To determine the internal defect by Ultrasonic Test.

List of Assignment :

Assignment should be designed to include the following modules

1. Introduction, Crystal geometry and Crystal Imperfections, Plastic Deformation.
2. Solidification of Metals & alloys, Phase & Phase Equilibrium
3. Non ferrous, Powder Metallurgy, and NDT
4. Alloy steel, Cast Iron
5. Iron Carbon diagram and Heat Treatment

Major Equipment :

1. Metallurgical Microscope.
2. Belt grinder and Polishing Machine.
3. Hardness Tester i.e. Rockwell Hardness test.
4. Muffle Furnace.
5. Jominy end quench tester.
6. NDT equipments.

Design based Examples (DE)/Open Ended Example :

1. Students may be asked for metallography to prepare specimens for microstructure analysis. Moreover they may be asked to provide design of heat treatment cycles of specific types of steels for their applications, e.g., design heat treatment cycle for tool steel.
2. Students may be asked to choose a material for given application based on structure-property-

performance relationship. Also they should give specification and designation of a chosen material.

Reference books :

1. Physical Metallurgy, Sydney H. Avner, Tata McGraw-Hill.
   Material science & Engineering of materials, Donald Askland & Pradeep Phule, Thomson Learning.
2. Materials Science and Engineering, W.D. Callister, John Wiley & Sons.
3. Material Science, O.P. Khanna, Dhanpat rai Publication.
4. Metallurgy for engineers, V. Raghvan, PHI Learning.
5. Material Science and Metallurgy, U.C. Jindal, Pearson Education..

List of Open Base Software/learning website :

1. http://nptel.ac.in/course.php