

Subject Code: 1ET1010303	Subject Title: Material Science and Metallurgy
Pre-requisite Subject	Zeal to learn the subject.

Course Objective:

This course will help student to

1. Learn the structure property relationship for various materials.
2. Ability to judge the different material behavior in various conditions.
3. Learn the basic heat treatment processes.
4. Understand the basic concept of selection and processing of metals and materials for their applications.
5. Learn about the method of testing the materials.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture	Tutorial	Practical	Credit	Theory		Practical		Total (T+P)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	-	2	4	70	30	30	20	150

Subject Contents			
Sr. No.	Topic	Total Hours	Weight (%)
01	Introduction to Material Science Metallurgy: Classification of Engineering Materials, Engineering requirements of materials, Criterion for selection of materials for engineering applications through Structure Properties-Performance co- relationship, Semiconductor, Magnetic materials, Dielectric materials, Superconductor, Nano materials.	3	5
02	Science of Metal: Unit Cell, Crystal structure, Bravais lattice, Atomic packing factor, Coordination number, Crystal structures of metallic elements, Crystal structure and correlated properties. Imperfections in crystals and their effect on properties, Solute strengthening.	4	8
03	Phase and Phase diagram: Unary and Binary equilibrium phase diagrams, Gibb's phase rule, Solid solutions and compounds, Hume-Rothery rules, Cooling curves, lever rule, Different reactions like eutectic, eutectoid, peritectic and peritectoid.	4	9
04	Allotropy of Iron: Iron-Carbide equilibrium system, phases and their properties of the Iron Carbide equilibrium diagram, Different reactions of the Iron Carbide equilibrium system, Alloy groups (Wrought Irons, Steels and Cast Irons) of Iron Carbide equilibrium system and their characteristics in general, Equilibrium cooling of Eutectoid, Hypoeutectoid and Hypereutectoid steels, their resultant microstructures and hence correlated properties and applications.	5	15

05	Heat Treatment Processes: Time-Temperature-Transformation Diagram, Isothermal and continuous transformations, Austenitic grain size control grain refinement, Study of effects like temper-brittleness. Different types of Annealing, Normalizing, Hardening and Tempering, Full Hardening and case Hardening methods. Application of above processes to machine components & mechanical equipments such as gears, Shaft bearings, Turbine blades, Crank shafts, Pistons etc.	7	20
06	Steels: Effect of alloying elements such as Manganese, Nickel, Chromium, Molybdenum, Vanadium, Tungsten, Cobalt and Boron, low alloy steels, Stainless steels, Tool and Die steels, High temperature alloys, selection of steels for various machines components and mechanical equipments, Coding of steels as per ASME and ISI.	3	5
07	Cast Iron: Properties of gray, White, Malleable and Nodular cast irons, Effect of silicon, Manganese, Sulphur, Phosphorous and other elements on the properties of cast iron, Use of specific grades of cast iron in mechanical field.	3	8
08	Non-ferrous alloys: Alloys of copper, Aluminium, Magnesium, Titanium, lead, Tin, zinc, Nickel, Manganese, White Metals and bearing alloys.	3	8
09	Powder Metallurgy: Application and advantages, Production of powder, Compacting, Sintering, Equipment and process capability.	3	5
10	Non Destructive testing: Radiography Testing, Dye Penetration Testing, Magnetic Particle Testing, Ultrasonic Testing, Eddy current testing, relative merits, demerits and applications	4	10
11	Development of Special Materials: Ceramic materials, Materials for nuclear reactors, High temperature alloys, Cryogenic materials, Teflon, Araldite etc. Introduction to nano technology & nano science, Field of application of nano materials, Classification, Characterization & application of composite materials.	4	7

Course Outcome:

The students will be able to

1. Understand the basic concept of Material Science and Metallurgy.
2. Know about the ferrous and non ferrous metals and alloys and their applications.
3. Explore different non-destructive testing methods.
4. Identify the Scope and limitations of different materials.

List of References:

1. Callister's Material Science and Engineering, Wiley India, 2nd Edition
2. Smith W F, "Principles of Materials Science and Engineering", McGraw Hill. Edition
3. Khanna O.P."A text book of Material science and Metallurgy", Dhanpat Rai Publications, 2010
4. Avner Sydney H. "Physical Metallurgy", Tata McGraw-Hill.
5. Dieter George E. "Mechanical Metallurgy", Tata McGraw Hill

6. Lakhtin Engineering Physical Metallurgy & Heat-Treatment , By: Y., C.B.S. Publisher
7. Donald R. Askeland, Pradeep P. Fulay, Wendelin J Wright, “The Science and Engineering of Materials”, Wadsworth Publishing Co Inc.

List of Practical:

1. Demonstration of the operation, construction, use and capabilities of a metallographic microscope.
2. To study the procedure of specimen preparation for microscopic examination and to carry out a specimen preparation.
3. To study the microstructure of standard specimen of various Ferrous, Non-ferrous materials with the help of photographic equipment and image system .
4. Demonstration of various specimens of different type of materials to study structure property-performance-processing relationships on photographic equipment and image system
5. To find the internal defects by the use of ultrasonic flaw detector.
6. To show the effect of different quenching media (Oil, Water and Brine) on the hardness of medium carbon steel and cast iron.
7. To understand the concept of hardenability and its relevance to heat treatment procedure to be adopted in practice.
8. To find out the effect of varying section size on hardenability of steel and obtain hardness distribution curves of hardened steel cross-section.
9. Study of different heat treatment processes- annealing, normalizing, hardening and tempering, surface and casehardening to improve properties of steel during processes and applications.
10. To study the procedure of testing, nature of indication, the capability and sensitivity of the liquid Penetrant test the magnetic particle test, eddy current test.
11. To make report on Radiography test.

Note: At least ten practicals should be performed during the laboratory sessions.

List of open Source Software/ Learning website:

<http://nptel.ac.in/courses/122102008/>