INSTITUTE	**FACULTY OF TECHNOLOGY**
PROGRAM	**BACHELOR OF TECHNOLOGY (MECHANICAL ENGINEERING)**
SEMESTER	**4**
COURSE TITLE	**MATERIAL SCIENCE AND METALLURGY**
COURSE CODE	**01ME2403**
COURSE CREDITS	**4**

Objective:

1 The course intends to provide understanding of Engineering Materials to graduate students. The course should enhance their ability to understand structure-property and performance relationship of materials.

2 The course intends to provide understanding of Engineering Materials to graduate students. The course should enhance their ability to understand structure-property and performance relationship of materials.

Course Outcomes: After completion of this course, student will be able to:

1 Students will be able to apply technical knowledge of engineering materials to identify their properties and recommend suitable applications.

2 Students will be able to establish relationships between materials' internal structure, properties, and performance during processing and practical applications.

3 Students will be able to interpret phase diagrams to predict microstructure changes during solidification.

4 Students will be able to evaluate heat treatment effects on materials' mechanical properties and microstructure.

5 Students will be able to apply knowledge of non-destructive testing (NDT) methods to detect various defects.

Pre-requisite of course: Basic knowledge of Physics, Chemistry

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Introduction** Properties of materials,, Engineering Requirements of materials,, Classification of Engineering Materials,, Criterion for selection of materials., Advance Engineering Material Composites: Introduction, Properties and types of matrix materials,, Properties and types of reinforcements,, Manufacturing methods and applications.	7

Contents : Unit	Topics	Contact Hours
2	**Metallography** Macro-examination and Micro examinations,, Procedure for preparing the specimen for macro and micro examination., Microscopic Techniques: Optical Microscope,, SEM, .TEM	4
3	**Non- ferrous alloys** Introduction, Aluminium Alloys, Magnesium and Beryllium Alloys,, Copper Alloys, Nickel and Cobalt Alloys,, Titanium Alloys, Refractory and Precious Metals.	3
4	**Ferrous Materials and Non 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, 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.	8
5	**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 rules.	7
6	**Iron-Carbon Diagram and Heat Treatment Processes:** Allotropic forms of Iron, Iron- Iron carbide equilibrium Diagram,, Development of microstructure in iron–carbon alloys., Heat Treatment: 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.	10
7	**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.	4
8	**Powder Metallurgy** Introduction, Methods of manufacturing powders,, mixing of powders, compaction, sintering,, secondary operation, advantages and limitation of powder metallurgy.	3
Total Hours		**46**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**To understand the construction and working of a Metallurgical Microscope.** To understand the construction and working of a Metallurgical Microscope.	2
2	**To study of microstructures for various ferrous and non ferrous materials.** To study of microstructures for various ferrous and non ferrous materials.	2
3	**To prepare the specimen for microscopic observation.** To prepare the specimen for microscopic observation.	2
4	**To determine the strength and hardness of ferrous and non-ferrous specimen.** To determine the strength and hardness of ferrous and non-ferrous specimen.	2
5	**To study the effect of Heat treatment process on the Hardness and Tensile Strength of Mild Steel.** To study the effect of Heat treatment process on the Hardness and Tensile Strength of Mild Steel.	2
6	**To show the effect of different quenching media (Oil, Water and Brine) on the hardness of Mild steel.** To show the effect of different quenching media (Oil, Water and Brine) on the hardness of Mild steel.	2
7	**To determine the harden ability of a specimen by Jominy end quench test.** To determine the harden ability of a specimen by Jominy end quench test.	2
8	**To study of powder metallurgy.** To study of powder metallurgy.	2
9	**To determine the surface defect by liquid penetrant test and magnetic particle test.** To determine the surface defect by liquid penetrant test and magnetic particle test.	2
10	**To determine the internal defect by Ultrasonic Test.** To determine the internal defect by Ultrasonic Test.	2
Total Hours		**20**

Textbook :

1 Introduction to physical metallurgy, Sidney H. Advner, Tata Mcgraw -Hill, 2008

2 Essentials of materials science and engineering, Donald R. Askeland , Wendelin J. Wright, Cengage, Boston, 2019

References:

1 Fundamentals of Materials Science and Engineering: An Integrated Approach, Fundamentals of Materials Science and Engineering: An Integrated Approach, William D. Callister Jr., David G. Rethwisch , Willey India. , 2021

2 Material Science, and Metallurgy, Material Science, and Metallurgy, O.P.Khanna, Dhanpat rai Publication, 2020

3 Physical metallurgy: principles and practice, Physical metallurgy: principles and practice, RAGHAVAN, V, PHI learning., 2015

4 Material Science and Metallurgy, Material Science and Metallurgy, U.C. Jindal, Pearson Education, 2011

5 Metallurgy for physicists and engineers : fundamentals, applications, and calculations, Metallurgy for physicists and engineers : fundamentals, applications, and calculations, Zainul Huda, CRC Press--Taylor & Francis Group , 2020

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation

Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
20.00	30.00	25.00	15.00	10.00	0.00

Instructional Method:

1 The use of ppt and videos is taken to teach the students

Supplementary Resources:

1 www.nptel.ac.in

2 https://swayam.gov.in/explorer