Program : **Diploma in Mechanical Engineering / Tool and Die Engineering / Manufacturing Technology**	
Course Code :**3022**	Course Title: **Material Science and Metrology**
Semester : **3/3/3**	Credits: **3**
Course Category: **Program Core**	
Periods per week: **3 (L:2,T:1,P:0)**	Periods per semester:**45**

Course Objectives:

- To identify the significance of engineering materials, its properties and their various applications in the field of engineering.
- To impart some elementary ideas on engineering measurements, measurement techniques, different types of measuring instruments, testing of machine tools etc.

Course Prerequisites:

Topic	Course code	Course Name	Semester
Basic ideas of applied physics		Applied Physics I&II	1&2
Classification of engineering materials		Applied Chemistry	1

Course Outcomes:

On completion of the course, the student will be able to:

COn	Description	Duration (Hours)	Cognitive Level
CO1	Explain crystal structure, classification of engineering materials, types of steels and ferrous alloys	11	Understanding
CO2	Explain the failure and testing of engineering materials and heat treatment processes.	11	Understanding
CO3	Explain the static and dynamic characteristics of measuring instruments and also to make use of various force/torque measurement techniques.	11	Applying
CO4	Explain the different types of measuring instrument and select suitable measuring device for a particular application and discuss the significance of machine tool inspection/testing.	12	Applying

CO – PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2						
CO2	2						
CO3	3			2			
CO4	3	3		3			

3-Strongly mapped, 2-Moderately mapped, 1-Weakly mapped

Course Outline:

Module outcomes	Description	Duration (Hours)	Cognitive Level
CO1	**Explain crystal structure, classification of engineering materials, types of steels and ferrous alloys.**		
M1.01	Explain crystal structure and classification of engineering materials	2	Understanding
M1.02	Explain the importance of TTT diagram	3	Understanding
M1.03	Classify different types of steels based on the carbon content	3	Understanding
M1.04	Discuss about the different ferrous alloys, its properties use and applications	3	Understanding

Contents:

Crystal structures: Unit cell and space lattice: Crystal systems. Crystal structure for metallic elements: BCC, FCC and HCP.

Ferrous metals and its Alloys: Isomorphs, eutectic and eutectoid systems;

Iron-Carbon binary diagram; effect of slow cooling for various composition- introduction to TTT diagram

Iron and Carbon Steels; Iron ores - Pig iron: classification, composition and effects of impurities on iron; Cast Iron: classification, composition, properties and uses; Wrought Iron: properties, uses/applications of wrought Iron; mild steel -standard commercial grades of steel as per BIS and AISI;

Alloy Steels - purpose of alloying; effects of alloying elements- Important alloy steels: Silicon steel, High Speed Steel (HSS), heat resisting steel, spring steel, Stainless Steel (SS): types of SS, applications of SS -composition, properties and uses.

CO2	**Explain the failure and testing of engineering materials and heat treatment processes.**		
M2.01	Explain the types of failure mechanisms in engineering materials	3	Understanding

M2.02	Explain about destructive and non-destructive testing of engineering materials	2	Understanding
M2.03	Explain the significance and various methods of heat treatment process	2	Understanding
M2.04	Discuss the difference between annealing and normalizing	2	Understanding
M2.05	Discuss about the different nonferrous alloys, its properties uses and applications	2	Understanding

Contents:

Failure & Testing of Materials: Introduction to metal failure; Fracture: ductile fracture, brittle fracture; notch sensitivity; elementary idea on fatigue and creep failure; Destructive testing: Tensile testing of ductile material; compression testing; Hardness testing (brief explanation of Rockwell, Brinell and Vickers test).

Non-destructive testing-Visual inspection, magnetic particle inspection, liquid penetrant test, ultrasonic inspection and radiography.

Heat treatment process- annealing, normalizing- hardening- tempering- mar tempering- austempering- case hardening (cyaniding- nitriding and carburizing)

Non-ferrous metals and its Alloys:

i) Copper alloys: Brasses, bronzes - composition, properties and uses;

ii) Aluminum alloys: Duralumin, hindalium, magnelium - composition, properties and uses;

iii) Magnesium alloys

CO3	**Explain the static and dynamic characteristics of measuring instruments and also to make use of various force/torque measurement techniques.**		
M3.01	Discuss about the significance of engineering metrology	2	Understanding
M3.02	Describe the different methods and standards of measurement	3	Understanding
M3.03	Define the standard terms in metrology	3	Understanding
M3.04	Explain the principle and equipment used for measurement of force and torque	3	Applying

Contents:

Introduction to measurements: Definition of measurement; Significance of measurement; Static and Dynamic Measurements (Elementary ideas only)- Methods of measurements: Direct & Indirect; Generalized measuring system; Standards of measurements: Primary & Secondary; Terms applicable to measuring instruments: Precision and Accuracy, Sensitivity and Repeatability, Range, Threshold, Hysteresis, calibration; Errors in Measurements: Classification of errors, Systematic and Random error.

Measurement of force: Introduction; Force measurement: Spring Balance, proving ring, Strain Gauges- Load cell.

CO4	**Explain the different types of measuring instrument and select suitable measuring device for a particular application and discuss the significance of machine tool inspection/testing.**		
M4.01	Explain the different types of gauges/comparators	2	Understanding
M4.02	Describe the various terms associated with surface texture	2	Understanding
M4.03	Explain the significance of sophisticated measuring instruments	2	Understanding
M4.04	Explain the working of an angular measuring instrument with example	3	Applying
M4.05	Explain the various types of machine tool inspection with example	3	Applying
	Series Test – II		

Contents:

Measuring Gauges and Comparators: Gauges: plain plug gauge, ring Gauge, snap gauge, feeler gauge, thread pitch gauge, limit gauge (GO-NOGO); Comparators: Characteristics of comparators, Types of comparators; Surface Texture: Definition, Terminology of surface finish, Surface roughness tester; Co-ordinate measuring machine.

Linear and Angular Measurement: Concept; Instruments for linear and angular Measurements; Working and Use of precision and non-precision measuring instruments-Dial Gauge-Slip gauge, vernier depth gauge, Universal Bevel Protractor-Clinometer, Sine Bar, Spirit Level; Principle of Working of Autocollimator; Angle Gauges.

Machine tool testing: Parallelism; Straightness; Squareness; Coaxially; roundness; run out; alignment testing of machine tools as per IS standard procedure.

Text / Reference:

T/R	Book Title/Author
R1	Collett, CV, & Hope, AD, "Engineering Measurements", Second edition, ELBS/Longman.
R2	Chapman, WAJ., "Workshop Technology - Part 3" Oxford & IBH Publishing Co Pvt Ltd, New Delhi.
R3	Callister, WD. 1997. Materials science and engineering: an introduction. New York: John Wiley & Sons.
R4	R.K. Rajput, S.K. Kataria Material Science & Engineering – New Delhi, 2004.
R5	Beckwith Marangoni and Lienhard, Mechanical measurements – Pearson Education, 6th Ed.,2006.
R6	K. J. Hume, Engineering Metrology – Kalyani publishers

Online Resources:

Sl.No	Website Link
1	https://www.bipm.org/en/publications/guides/
2	https://www.nist.gov/
3	https://freevideolectures.com/subject/metallurgy-and-material-science/
4	https://nptel.ac.in/courses/113/102/113102080/