COURSE DESCRIPTION			
Program	**Mechanical Engineering**		
Course Title	**Engineering Materials and Measurements**		
Course Code	**2021**	**Semester**	**II**
Type of Course	**Theory**	**Contact Hours**	**60**
Teaching Scheme (L: T:P:R)	**4:0:0:0**	**Credits**	**4**
CIE Marks	**40**	**ESE Marks**	**60**

Introduction

Engineering Materials and Measurements is a foundation course that introduces students to the classification, structure, properties, and applications of engineering materials, along with the principles of measurement and metrology. It covers atomic structure, bonding, crystallography, mechanical, thermal, magnetic, and electrical properties, heat treatment processes, and material testing, enabling students to understand material behaviour and selection. The course also provides theoretical knowledge of measurement standards, limits, fits, tolerances, linear and geometric measurements, gauges, comparators, and angular measurement techniques for dimensional and quality control. This course equips diploma students with the essential concepts and understanding required for engineering design, quality assurance, and industrial applications.

Course Objectives

1	To impart knowledge of the classification, structure, bonding, crystallography, and microstructure of engineering materials.
2	To familiarize the mechanical, thermal, magnetic, and electrical properties of engineering materials and the principles of heat treatment and material testing.
3	To introduce metrology concepts, measurement standards, limits, fits, tolerances, and linear and geometric measurement techniques.
4	To provide understanding of angular & geometric measurement methods, gauges, and comparators used in engineering measurements.

Course Pre-requisite

Topic	Course code	Course Title	Semester
Basic concepts of applied physics, including units, measurements, mechanics, and thermal properties.	2002A	Engineering Physics for Mechanical, Structural and Industrial Applications	I/II
Classification of engineering materials, atomic structure and material properties.	2003A	Chemistry for Engineering Practices	I/II

Course Outcome

CO	Course Outcome	Blooms Taxonomy Level
CO1	Explain the classification, structure, bonding, crystallography, and microstructure of engineering materials	Understand
CO2	Describe mechanical, thermal, magnetic, and electrical properties and to explain heat treatment and material testing techniques	Understand
CO3	Explain principles of metrology,, measurement standards, limits, fits, tolerances, and to describe linear and form measurements	Apply
CO4	Explain angular & geometric measurement techniques, and identify gauges and comparators used for accurate engineering inspection	Apply

CO-PO mapping

COURSE ARTICULATION MATRIX											
Course Outcomes	PROGRAM OUTCOMES										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	1	-	-	-	-	2
CO2	3	3	2	1	1	2	-	-	-	-	2
CO3	3	3	2	1	1	1	-	-	-	-	2
CO4	3	3	2	1	1	1	-	-	-	-	2
Total	12	11	6	3	3	5	-	-	-	-	8
Correlation Level	3	2.75	2	1	1	1.25	-	-	-	-	2
Legends: 1 - Low; 2 - Medium; 3 - High; No Correlation - "-"											

Teaching and Assessment Scheme

Teaching Scheme/Week				Self-learning (SS)/Week	Total Hours/Semester	Credits C	Examination Scheme						
							Theory			Practical			Total
L	T	P	S				CIE	ESE	Total	CIE	ESE	Total	
4	0	0	0	4	60	4	40	60	100	0	0	0	100

L: Lecture (One unit is of one-hour duration with one credit), T: Tutorial (One unit is of one-hour duration with one credit), P: Practical (One unit is of one-hour duration with 0.5 credit), S: Project (One unit is of one-hour duration with 0.5 credit) SS: Self-Learning, CIE: Continuous Internal Evaluation, ESE: End Semester Examination

Syllabus – Major Topics

Module	Title	Major Topics	Instructional Hours	
			L	T
Module I	Basic Engineering Materials & Structure of Materials	Introduction – Definition, importance, classification of materials Atomic Structure & Bonding – Atomic structure, electronic configuration, bonding types, effect on properties Crystallography – Crystal systems, unit cell parameters, atomic packing factor, BCC, FCC, HCP Ferrous Materials and alloys(Steel, Stainless steel and cast iron) composition, properties, applications Non-Ferrous Materials – Aluminium (and its alloys), Copper (and its alloys), Magnesium, Titanium alloys; composition, properties, and applications. Special Materials – Smart materials, composites	15	
Module II	Properties, Heat Treatment & Material Testing	Mechanical Properties – Elasticity, plasticity, yield, tensile, ductility, toughness, hardness, fatigue, creep Thermal Properties – Thermal conductivity, expansion Magnetic Properties – Magnetic permeability, retentivity, coercivity Electrical Properties – Electrical conductivity, resistivity Heat Treatment Processes – Annealing, normalizing, hardening, tempering, Material Testing Techniques – Metal failure: ductile, brittle, notch sensitivity, fatigue, creep. Types of material testing: Destructive Testing (DT) & Non-Destructive Testing (NDT) (Definition and example- listing for both types)	15	0
Module III	Metrology, Measurement Standards, Limits & Fits, Linear and Form Measurements	Introduction to Metrology – Definition, purpose, accuracy, precision, sensitivity, repeatability, range, errors (systematic, random) Measurement Standards – Units, primary & secondary standards, measurement system components Limits, Fits & Tolerances – Tolerance, allowance, deviation, hole & shaft basis, clearance, interference, transition Linear Measurement Instruments – Vernier caliper, micrometer Form Measurement: Types – straightness, flatness, roundness, cylindricity, squareness, parallelism, concentricity, and coaxiality.	15	0
Module IV	Angular & Geometric Measurement, Gauges, and Comparators	Angular & Geometric Measurement – Bevel protractor, sine bar, spirit level, dial gauge, vernier depth gauge, universal bevel protractor, clinometer, autocollimator, angle gauges Measuring Gauges – Plain plug, ring, snap, Slip ,feeler , thread pitch, GO-NO-GO limit gauges Comparators – Characteristics, types: mechanical, optical, electrical, pneumatic	15	0

Detailed Syllabus

Subtopic	Student Learning Outcome	Mode of delivery (L/T)	Mapped CO	Taxonomy Level	Instructional Hours
Module I					
Introduction – Definition, importance, classification of materials	Explain the classification and significance of engineering materials	L	CO1	Remember	2
Atomic Structure & Bonding – Atomic structure, electronic configuration, bonding types, effect on properties	Describe atomic structure and bonding types and their effect on material properties	L	CO1	Understand	2

Crystallography – Crystal systems, unit cell parameters, atomic packing factor, BCC, FCC, HCP	Identify crystal systems and relate structure to properties	L	CO1	Understand	2
Ferrous Materials & Alloys – Steel, Stainless steel, Cast iron; composition, properties, applications	Explain the types, composition, and applications of ferrous materials	L	CO1	Understand	4
Non-Ferrous Materials – Aluminium (and its alloys), Copper (and its alloys), Magnesium, Titanium alloys; composition, properties, and applications.	Describe non-ferrous materials, their properties and uses	L	CO1	Understand	4
Special Materials – Smart materials, composites	Identify special engineering materials and their applications	L	CO1	Understand	1
Module II					
Mechanical Properties – Elasticity, plasticity, yield, tensile, ductility, toughness, hardness, fatigue, creep	Explain mechanical properties and their significance	L	CO2	Understand	1
Thermal Properties – Thermal conductivity, expansion	Describe thermal properties of materials	L	CO2	Understand	4
Magnetic Properties – Magnetic permeability, retentivity, coercivity	Describe the magnetic behaviour of materials	L	CO2	Understand	1
Electrical Properties – Electrical conductivity, resistivity	Explain electrical conduction properties	L	CO2	Understand	1
Electrical Properties – Electrical conductivity, resistivity	Explain electrical conduction properties	L	CO2	Understand	1
Heat Treatment Processes – Annealing, normalizing, hardening, tempering, case hardening, martempering, austempering	Explain heat treatment methods, their purpose and effects on material properties	L	CO2	Understand	4
Metal failure -ductile, brittle, notch sensitivity, fatigue, creep	Explain different types of metal failure	L	CO2	Understand	2
Material Testing Techniques – Types of material testing: DT & NDT	Explain the types of material testing with examples	L	CO2	Understand	2
Module III					
Introduction to Metrology – Definition, purpose, accuracy, precision, sensitivity, repeatability, range, errors	Define metrology and measurement errors	L	CO3	Understand	2
Measurement Standards – Units, primary & secondary standards, measurement system components	Explain measurement standards and system components	L	CO3	Understand	2
Limits, Fits & Tolerances – Tolerance, allowance, deviation, hole & shaft basis, clearance, interference, transition	Apply knowledge of fits, tolerances, and allowances in components	L	CO3	Apply	4
Linear Measurement Instruments – Vernier caliper, micrometer	Explain different types of linear measurement instruments	L	CO3	Apply	4
Form Measurement – Types: straightness, flatness, roundness, cylindricity, squareness, parallelism, concentricity, coaxiality	Identify and apply geometric measurement techniques	L	CO3	Apply	3
Module IV					
Angular & Geometric Measurement – Bevel protractor, sine bar, spirit level, dial gauge, vernier depth gauge, universal bevel protractor, clinometer, autocollimator, angle gauges	Explain different types of angular measurement instruments	L	CO4	Apply	6
Measuring Gauges – Plain plug, ring, snap, Slip ,feeler , thread pitch, GO-NO-GO limit gauges	Explain the use of measuring gauges for dimensional inspection	L	CO4	Apply	5
Comparators – Characteristics, types: mechanical, optical, electrical, pneumatic	Explain and compare different types of comparators	L	CO4	Understand	4

Suggested Student Activities for Self-Learning

Week	Self-Learning description	Hours
Module I		
1	Read about the classification of materials and atomic structure; prepare short notes	6

2	Study crystallography and crystal systems; make a labelled diagram sheet	6
3	Research ferrous and non-ferrous materials; summarize properties and applications	6
4	Explore special materials (smart materials, composites) and complete Module I Assignment	6
Module II		
5	Study mechanical and thermal properties; summarize key definitions and examples	6
6	Explore magnetic and electrical properties; prepare comparison table	6
7	Read heat treatment processes	6
8	Learn material testing techniques; prepare Module II Assignment (list types, examples, and applications)	6
Module III		
9	Study introduction to metrology and measurement standards; prepare notes	6
10	Study limits, fits, tolerances (tolerance, allowance, deviation, hole & shaft basis, clearance, interference, transition)	6
11	Study linear measurement instruments; prepare an instrument comparison table	6
12	Explore form (geometric) measurements; prepare a diagram sheet; complete Module III Assignment	6
Module IV		
13	Study angular & geometric measurement instruments; prepare diagrams	6
14	Learn measuring gauges and comparators; prepare comparison chart	6
15	Review Module IV topics and complete Module IV Assignment	6
Total Self-Learning hours		90

Learning Resources

TEXT BOOK			
Sl. No.	Title	Author	Publication
1	Material Science and Engineering	V. Raghavan	Prentice Hall India Learning Private Limited
2	Engineering Materials and Metallurgy	R.K. Rajput	S Chand & Company
3	Engineering Metrology	Er. R.K. Jain	Khanna Publishers
4	Engineering Metrology and Measurements	Raghavendra and Krishnamurthy	Oxford University Press

REFERENCE			
Sl. No.	Title	Author	Publication
1	Callister's Materials Science and Engineering:	R. Balasubramaniam	Wiley
2	Metrology And Measurement	Bewoor & Kulkarni	McGraw Hill Education

WEB RESOURCES		
Sl. No.	URL	Modules Covered
1	https://www.coursera.org/learn/materials-science	I & II
2	https://nptel.ac.in/courses/112108150	I
3	https://www.youtube.com/watch?v=HYpgpMymDcI	II
4	https://nptel.ac.in/courses/112104250	III
5	https://engineeringtechnology.org/metrology/measuring-devices/	III & IV

Assessment Methodology – Theory

Mode	Attendance	CA1	CA2	CA3	CA4	CA5	CA6	ESE
		Self-learning activities (Module 1)	Self-learning activities (Module 2)	Self-learning activities (Module 3)	Self-learning activities (Module 4)	Series Exam (2 modules)	Series Exam (2 modules)	Written Exam (theory)
Duration						2 hours	2 hours	2.5 hours

Exam mark		15	15	15	15	50	50	60
Converted to						20	20	
Marks	5	15				20		60
Total	40							
Tentative schedule	End of semester	By 4th week	By 7th week	By 11th week	By 14th week	8th week	15th week	End of semester

Series Examination Pattern- Theory

Time	Module (Series 1/ Series 2)	Part A	Marks	Part B	Marks	Part C (With choice)	Marks	Total
2 hours	Any two modules	2	1	3	3	2	7	25
	Any two modules	2	1	3	3	2	7	25
	Number	4		6		4		50

End Semester Examination Pattern of Question Paper - Theory

Duration	Module	TYPE OF QUESTIONS						
		Part A (2 Questions from each module)		Part B 2 out of 3 questions from each module)		Part C (1 set questions with choice from each module)		Total Marks
		No. of Questions	Marks (1 mark each)	No. of Questions	Marks (3 marks each)	No. of Questions	Marks (7 marks each)	
2.5 hours	1	2	2	3	6	1 set	7	15
	2	2	2	3	6	1 set	7	15
	3	2	2	3	6	1 set	7	15
	4	2	2	3	6	1 set	7	15
		8	8	12	24	4 sets	28	60

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