COURSE DESCRIPTION			
Program	**Mechanical Engineering**		
Course Title	**Materials and Measurements Laboratory**		
Course Code	**2028**	**Semester**	**II**
Type of Course	**Lab**	**Contact Hours**	**45**
Teaching Scheme (L: T:P:R)	**0:0:3:0**	**Credits**	**1.5**
CIE Marks	**60**	**ESE Marks**	**40**

Introduction

The Materials and Measurements Laboratory is a practical course aimed at providing students with hands-on experience in identifying and measuring engineering materials. Students learn to distinguish ferrous and non-ferrous metals, study their microstructure using microscopes, and understand the effects of heat treatment on material properties. The course emphasizes practical exposure to non-destructive testing methods, including visual inspection and dye penetrant testing. In addition, students develop precision measurement skills through linear and angular measurements using vernier calipers, micrometers, height gauges, dial indicators, sine bars, and bevel protractors. The syllabus also includes the measurement of threads and other critical components, equipping students with the essential skills required for material testing, quality control, and industrial applications

Course Objectives

1	To familiarize properties, microstructure, and classification of ferrous and non-ferrous engineering materials.
2	To familiarize effects of heat treatment and non-destructive testing methods to assess material integrity.
3	To perform accurate linear and angular measurements using standard measuring instruments and gauges.
4	To measure threads and apply metrology principles for precise 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 Practice	I/II

Course Outcome

CO	Course Outcome	Blooms Taxonomy Level
CO1	Apply knowledge of material identification techniques to distinguish ferrous and non-ferrous materials and study microstructure	Apply
CO2	Apply non-destructive testing techniques, including visual inspection and dye penetrant testing	Apply
CO3	Apply linear measurement techniques using vernier calipers, micrometers, height gauges, and dial indicators for accurate dimensional assessment	Apply
CO4	Apply angular measurement and thread measurement techniques for precision engineering applications	Apply

CO-PO mapping

COURSE ARTICULATION MATRIX											
Course Outcomes	PROGRAM OUTCOMES										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	-	3	2	1	-	1	1	-	1
CO2	2	2	1	3	2	2	1	1	1	-	1
CO3	3	3	2	3	3	1	-	1	1	-	1
CO4	3	3	2	3	3	1	-	1	1	-	1
Total	10	10	5	12	10	5	1	4	4	-	4
Correlation Level	2.5	2.5	1.67	3	2.5	1.25	1	1	1	-	1
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	
0	0	3	0	1.5	45	1.5				60	40	100	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

Detailed Syllabus

Expt No.	Experiment name	Practical Outcome	Mapped CO	Taxonomy Level	Instructional Hours
Module I					
1	Study and Identification of Engineering Materials	Ability to identify ferrous and non-ferrous materials using appearance, magnetism, filing and spark test	CO1	Apply	1.5
2	Study of Microstructure	Ability to observe microstructure and identify using charts and density	CO1	Apply	1.5
Module II					
3	Study of Heat-Treated Specimens	Ability to compare hardness and structure of annealed, normalized, hardened and tempered samples	CO2	Understand	3
4	Introduction to Non-Destructive Testing	Study of NDT testing like Visual Inspection (VI), Dye Penetrant Test (DPT), Magnetic Particle Test (MPT)	CO2	Understand	3
5	Non- Destructive Testing (visual inspection)	Ability to perform visual inspection	CO2	Apply	3
6	Non-Destructive Testing (Dye penetrant test)	Ability to perform the Dye penetrant test	CO2	Apply	3
	Series Exam - I		CO2	Apply	3
Module III					
7	Measurement Using Vernier Caliper	Ability to measure external, internal and depth dimensions accurately	CO3	Apply	3
8	Measurement Using Micrometer (Screw Gauge)	Ability to measure thickness and diameter accurately and correct zero error	CO3	Apply	3
9	Measurement Using Height Gauge and Surface Plate	Ability to measure step height and perform layout marking	CO3	Apply	3
10	Measurement Using Dial Indicator	Ability to measure run-out, flatness and alignment errors	CO3	Apply	3
Module IV					
11	Measurement of Angle Using Bevel Protractor	Ability to measure angular dimensions of components	CO4	Apply	3
12	Measurement of Taper Using Sine Bar	Ability to determine taper angle using slip gauges	CO4	Apply	3
13	Measurement of Thread Parameters	Ability to measure pitch, major and minor diameter of screw threads	CO4	Apply	3
14	Measurement Using Feeler Gauge	Ability to measure small gaps and clearances between mating parts accurately	CO4	Apply	3
	Series Exam - II		CO4	Apply	3

Open-ended experiment

Objective:
To encourage creativity, innovation, and application of knowledge by allowing students to design and perform an experiment beyond the prescribed list, using the concepts learned during the course.

Description:
At the end of the laboratory course, each student (or group of students) shall undertake one open-ended experiment. In this activity, students are expected to conceive, design, and implement an experiment of their own choice related to the course outcomes. The aim is to apply theoretical knowledge and laboratory skills to a new or practical problem not explicitly covered in the regular experiments.

Students may choose to:
Modify or extend an existing experiment to explore additional parameters or behaviors.
Integrate multiple concepts from the syllabus into a combined application.
Design a mini-setup or prototype to demonstrate a principle or solve a simple engineering problem.
Perform a comparative study or performance analysis of a circuit/system/component.

Student Activities for Self-Learning

Week	Self-Learning description	Hours
Module I		
1	Watch video on classification of ferrous and non-ferrous materials and prepare a comparison table	1.5
2	Study spark test, magnet test and filing test methods through videos and charts	1.5
3	Prepare short notes on material identification methods and microstructure features	1.5
Module II		
4	Review heat treatment basics and structure changes	1.5
5	Study heat-treated specimens and compare annealed, normalized, hardened and tempered samples	1.5
6	Learn fundamentals of non-destructive testing methods (VI, DPT, MPT)	1.5
7	Watch video procedure of visual inspection testing	1.5
8	Watch video procedure and safety precautions of dye penetrant testing	1.5
Module III		
9	Practice reading vernier calipers measurements from sample problems/videos	1.5
10	Practice micrometer readings and zero error correction	1.5
11	Study height gauge and surface plate measurement methods	1.5
12	Understand dial indicator and run-out measurement concepts	1.5
Module IV		
13	Study angular measurement using bevel protractor and sine bar	1.5
14	Review thread parameter measurement concepts	1.5
15	Study feeler gauge usage and clearance measurement applications	1.5
Total Self-Learning hours		22.5

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://nptel.ac.in/courses/112108150	I
2	https://www.sciencedirect.com/topics/engineering/non-destructive-testing	II
3	https://nptel.ac.in/courses/112104250	III

4	https://engineeringtechnology.org/metrology/measuring-devices/	III & IV

Major Equipment/Instruments/Components required for a batch of 30 students

Sl. No.	Particulars	Specifications	Quantity
1	Vernier Calipers	0-150 mm, least count 0.02 mm	10
2	Micrometer (Screw Gauge)	0-25 mm, least count 0.01 mm	10
3	Height Gauge	0-300 mm, least count 0.02 mm	3
4	Surface Plate	Granite, 600x600 mm	2
5	Dial Indicator	0-10 mm, least count 0.01 mm	6
6	Bevel Protractor	0-180°, least count 1′	5
7	Sine Bar	100 mm length, accuracy 0.01 mm	2
8	Limit Gauges (Plug, Ring, Snap)	As per ISO standards	5
9	Slip Gauge Set	1 mm to 100 mm	2
10	Feeler Gauge	0.03 - 1.00 mm	5
11	Non-Destructive Testing Kit	Hands-on for selected experiments	1

Major Software required for a batch of 30 students

Sl. No.	Particulars	Specifications	Quantity
	NIL		

Assessment Methodology – Lab

Mode	Attendance	CE	CA1	CA2	OEE	ESE
		Continuous evaluation	Practical test (first half of experiments)	Practical test (second half of experiments)	Open-ended experiment	Practical
Duration			3 hours	3 hours		3 hours
Exam mark		50	40	40	50	40
Converted to		30	15	15	10	
Marks	5	30	15		10	40
Total marks	60					40
Tentative schedule	End of semester	Every lab slot	7th week	14th week	15th week	

Scheme of Evaluation - Practical (Continuous Internal Evaluation)

Sl. No.	Criteria	Description	Marks
1	Preparation & Punctuality	Attendance, timely submission of record, pre-lab preparation, understanding of experiment objectives and theory.	10
2	Experimental Setup & Procedure	Ability to identify components/equipment, correct circuit connections/setup, systematic and safe execution of the procedure.	10
3	Observation & Data Recording	Accuracy and neatness of readings, correct use of units, tabulation, and systematic recording of results.	5
4	Analysis & Result Interpretation	Proper calculations, graphical representation, result verification, discussion, and logical conclusion.	10
5	Viva Voce / Concept Understanding	Clarity of theoretical concepts, explanation of procedure, ability to answer questions related to the experiment.	10
6	Workmanship, Discipline & Teamwork	Laboratory discipline, care of instruments, teamwork, attitude, and safety practices.	5
Total			50

Scheme of Evaluation - Practical Test & End Semester Evaluation

Category	Things to evaluate	Marks
Write-up / Procedure (before experiment)	Aim, circuit diagram/flowchart, stepwise procedure.	10

Experiment Setup & Execution	Correct circuit connections / coding / setup. Handling of instruments/software. Accuracy of execution.	10
Observation & Result / Output	Proper tabulation of readings. Calculations/graphs/program output. Correctness of result / expected outcome.	8
Viva Voce	Conceptual understanding of experiment. Related theoretical knowledge.	8
Record	Completion & neatness of practical record. Proper certification by faculty.	4
Total		40

Scheme of Evaluation - Open-ended experiment

Category	Things to evaluate	Marks
Originality and Relevance of the Idea	Assesses how creative, innovative, and relevant the chosen experiment is to the course objectives.	10
Clarity of Objectives and Experimental Plan	Evaluates how clearly the student defines the aim, scope, and systematic plan of the experiment.	10
Correctness of Execution and Data Recording	Checks the accuracy, safety, and neatness in performing the experiment and recording observations.	10
Analysis, Interpretation, and Presentation of Results	Measures the student’s ability to analyze data, interpret outcomes, and present results logically.	10
Teamwork and Innovation Demonstrated	Judges the level of collaboration, initiative, and creativity shown during the experiment.	10
Total		50