

Branch Name:	Mechanical Engineering
Program Code:	ET402
Course Title:	Metrology & Instrumentation
Course Code:	2ET4020403
Pre-requisite Course:	Material Science & Technology

Course Objectives:

1. Measure the given mechanical elements and assemblies using linear and angular analog /digital measuring instruments.
2. Check geometrical accuracy of given application.
3. Explain surface roughness checking instruments.
4. Measure and derive important dimensions of various thread forms and gears.
5. Select and use nondestructive testing methods.
6. Check the dimensions using the gauges.
7. Select and measure variables using appropriate sensors and transducers.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No	Topic	Total Hours	Weightage (%)
1	Linear and Angular Measurement • Inspection, quality and quality control-definitions and differences • Define accuracy, precision and error. • Principle of vernier scale and least count. • Surface plates-types, important features, standards/important sizes, applications and precautions in use. • Types, constructional sketch, major parts and their functions, least count, measuring methods and measurement illustration of Vernier Caliper*, Micrometer*, Telescopic gauge*, Height gauge*, Depth gauge*. • Slip gauge- types, applications, and wringing method. • Sketch, major parts and their functions, least count, measuring methods and measurement illustration of Bevel Protector, Sine bar, Angle gauge, Angle Dekkor, Spirit level, Clinometers, Auto collimator • Calibration – concept and need.	10	20
2	Measurement of Geometrical Surfaces • Dial indicators/gauge-types, constructional sketch and applications. • Definition, symbol and measuring methods of: Straightness, Flatness*, Squareness, Parallelism, Perpendicularity, Roundness*, Concentricity, Cylindricity*, Run-out* and Ovality*.	04	10
3	• Measurement of Surface Roughness • Terminology used in connection with surface finish. • Comparison methods to inspect surface finish- concept and applications.	04	10

	• Indication of various surface roughness characteristics with surface roughness symbols-interpretation.		
4	Gear and Thread Measurement • Types of gears • Forms of gear teeth-types and concept • Gear tooth Terminology. • Sketch, major parts and their functions, least count, measuring methods and measurement illustration of gear tooth Vernier. • Derivation to measure gear tooth thickness using Gear tooth Vernier, Constant chord method and Base tangent method. • Gear tooth profile measurement. • Thread-classification, elements, specifications and forms. • Measurement of major and minor diameters. • Three and two wire method of measuring effective diameter of external thread-concept, terminology, best wire size, derivation of equation. • Thread micrometer-sketch, method to use and determination of dimension. • Pitch measurement methods.	08	15
5	Limit gauges, Transducers and Sensors • Limit gauges-classification, sketch and applications* • Comparators-concept, types and applications. • Instrumentation- introduction, performance characteristics. • Static characteristics of instruments • Transducers - concept, classifications, physical quantities which can be measured, advantages and disadvantages. • Electrical transducers - types, working principles and applications. (i) Linear Variable Differential Transformer (LVDT) type pressure gauge. (ii) Resistance type. (iii) Capacitance type. (iv) Inductance type (LVDT). (v) Piezo-electric. • Sensors-classification and applications. • Use of transducers and sensors as a safety measures.	08	15
6	Non-destructive testing • Concept, need and advantages. • Important NDT methods, working and applications.	02	10
7	Temperature, Pressure and Flow Measurement • Introduction • Classification, working principle, construction, advantages, limitations and applications of temperature measuring devices. - a Mercury in glass Thermometer b. Bimetallic Thermometer c. Resistance Thermometer d. Thermister, e. Thermocouple • Classification, working principle, construction, advantage and application of pressure measuring devices. a. Bellows type pressure gauge b. Diaphragm type pressure gauge. c. Bourdon tube pressure gauge	06	20

	d. Dead weight piston gauge • Concept of transducer-based pressure measuring devices • Classification, working principle, construction, advantages, limitations and application of flow measuring devices. a. Bellow type b. Rotating impeller c. Rotating lobes d. Nutating Disc e. Reciprocating piston f. Obstruction • Use of Temperature and Pressure measurement as a safety Measures.		
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List of Practical:

1. Linear and Angular Measurement (In a group of 05 students, students will draw component measured, Instruments used with all parts and maintain the records of measurement using the instruments.)
 - a. Vernier Caliper
 - b. Inside Micrometer
 - c. Outside Micrometer
 - d. Telescopic Gauge
 - e. Height Gauge
 - f. Depth Gauge
 - g. Bevel Protector
 - h. Sine Bar (Measure angle between the two planes with the help of sine bar and slip gauges)
2. Check the Straightness and Flatness of the given object using required instruments.
3. Check the Squireness, Perpendicularity and parallelism of the given object using required instruments.
4. Check the roundness, cylindricity, concentricity, run out and orality of the given object using required instruments.
5. Measure the Gear dimensions of given component using Gear tooth Vernier.
6. Measure the Gear dimensions of given component using suitable method.
7. Study of various limit gauges
8. Study of Transducers and sensors
9. Measure the temperature using thermocouple.

Reference Books:

1. Mechanical measurements and instrumentation, R.K.Rajput, KATSON
2. Engineering Metrology and Measurements, N.V. RAGHAVENDRA & L. KRISHNAMURTHY, OXFORD University press
3. Mechanical Measurement, Sirohi R.S., Radha Krishnan H.C., New Age International.
4. Practical Engineering Metrology, K.W.B.Sdarp, Pitman
5. Engineering Metrology, R.K.Jain, Khanna Publications.
6. Metrology & Measurement, Anand Bewoor & Vinay Kulkarn, Tata McGrawHill
7. Industrial Instrumentation & Control, S K Singh, Tata McGrawHill
8. Mechanical Measurement, Beckwith & Buck, Narosa publishing House
9. Mechatronics, W.Bolten, PEARSON

List of Open-Source Software/learning website:

1. <https://www.youtube.com/watch?v=xgQYvEELbfc> (Vernier Caliper).
2. <https://www.youtube.com/watch?v=O8vMFFYNIf0> (Micrometer)
3. <https://www.youtube.com/watch?v=h98HPVuWjLA> (depth micrometer)
4. https://www.youtube.com/watch?v=SmXfGan_NXQ (telescopic gauge)
5. <https://www.youtube.com/watch?v=eVpoJzLJa0U> (surface roughness)

6. <https://www.youtube.com/watch?v=3Od7vnoMwGg>(surface roughness)
7. <https://www.youtube.com/watch?v=XnLiTPGE6pk> (three wire thread measurement)
8. <https://www.youtube.com/watch?v=Gdvtw0pTAOs> (thread pitch)
9. <https://www.youtube.com/watch?v=qMgXGedDffw> (dial indicator)
10. <http://www.youtube.com/watch?v=lc4dsNvm2Ks> (principle of mechanical measurement).
11. <http://www.youtube.com/watch?v=nv3GuJArjNU> (Transducers).
12. <http://www.youtube.com/watch?v=iMlZApq1CQ0> (pressure measurement).
13. <http://www.youtube.com/watch?v=JKuoQ5FV2c8> (temperature measurement).
14. <http://www.youtube.com/watch?v=QItuf6lNvmI> (Capacitive sensors)
15. <http://www.youtube.com/watch?v=inLkCOwVgyM> (force sensors).
16. http://www.youtube.com/watch?v=_fQSMVf3hdM (calibration).
17. <http://www.youtube.com/watch?v=ZymDMUuVuyY> (geometrical Tolerance).
18. <http://www.youtube.com/watch?v=5eaSkU6Ecik> (flatness measurement).
19. <http://www.youtube.com/watch?v=1JNCe9fwRUw> (Measuring Perpendicularity)
20. <http://www.youtube.com/watch?v=eJ8a0k8kQIE> (Roundness and cylindricity).
21. <https://youtu.be/jTfUFQ-sbas> (Types of Gear in Hindi).
22. <https://youtu.be/ococqpOzbt8> (Gear Tooth Terminology in Hindi).
23. <https://youtu.be/suWlbCsIomg> (measurement of gear tooth thickness in Hindi).
24. <https://youtu.be/FR8Jxr-b3ds> (Gear Tooth Vernier Caliper).
25. <https://youtu.be/ZKx7jQYj0jk> (Constant chord method in Hindi).
26. <https://youtu.be/lyo2POzjslY> (David brown gear tooth form testing).
27. <https://youtu.be/RuAnfLllaDY> (Tool room microscope as projection method for small gear).
28. <https://youtu.be/DYUsqEzV5pY> (Parkinson's gear tester in Hindi/English).

Course Learning Outcomes (CLO):

1. Learn to measure the given mechanical elements and assemblies using linear and angular analog /digital measuring instruments.
2. Acquire the fundamentals of checking geometrical accuracy of given application.
3. Acquire fundamentals to measure and derive important dimensions of various thread forms and gears.
4. Identify the techniques for mass inspection using gauges.
5. Select and use nondestructive testing methods.
6. Understand to select and measure variables using appropriate sensors and transducers.

Mapping of CLO with PO and PSO

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO1	H												L	L		
CLO2	L	L	L				M		L				H	M		
CLO3	L		L										M	L		
CLO4	L	L	L										M	L		
CLO5				M					L				M		M	
CLO6	L			L	L							L	M	M	L	

H: High, M: Medium, L: Low