MECHANICAL MEASUREMENT **Course Code : 314019**

Programme Name/s : **Automobile Engineering.**
Programme Code : **AE**
Semester : **Fourth**
Course Title : **MECHANICAL MEASUREMENT**
Course Code : **314019**

I. RATIONALE

The Diploma Automobile Engineer should select various instruments and use them for measurement of physical and functional parameters of automotive components used in different Automobile segments. Additionally, practical knowledge with measuring instruments can help them to maintain the quality of auto components.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Use different measuring instrument for ensuring the quality of automotive components.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use relevant linear measuring instrument and gauges for measurement in automobile engineering situations.
- CO2 - Select relevant instrument for measurement of physical parameters of system.
- CO3 - Measure the different geometrical tolerances of automotive components.
- CO4 - Use relevant instrument for measurement of various functional parameters of automotive components.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314019	MECHANICAL MEASUREMENT	MME	AEC	1	-	2	1	4	2	-	-	-	-	-	25	10	-	-	25	10	50

Total IKS Hrs for Sem. : 2 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe basis of Measurement. TLO 1.2 Explain characteristics of measuring instruments. TLO 1.3 Describe working principle of given Linear measuring instruments. TLO 1.4 Identify errors in given instrument. TLO 1.5 Describe construction and working of given comparators and gauges.	**Unit - I Overview of Measurement** 1.1 Definition of metrology, objectives of metrology, types of metrology, Need of inspection. 1.2 Characteristics of instruments: Least count, Accuracy, Precision, Reliability, Calibration, Hysteresis, Dead Zone, Drift, Sensitivity, Threshold, Repeatability, Reproducibility. 1.3 Linear measuring Instruments: Working principle and calibration of Vernier caliper, micrometer, height gauge and depth gauge. 1.4 Types of Errors and its sources in Measurements. 1.5 Gauges and Comparators: Definition, Classification, Use of comparators, working principle (Merits and Demerits) of Dial indicator, Sigma Comparator and Pneumatic Comparator, Taylor's principle of Gauge design, Plug, Ring Gauges, Snaps gauges, Wringing of Slip Gauges.	Chalk-Board Presentations Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Select Angular measuring instrument for given component and calculate unknown angle. TLO 2.2 Calculate screw thread parameters using given method. TLO 2.3 Explain procedure of measuring the given parameters of gear. TLO 2.4 Describe procedure for examining surface finish of the given component. TLO 2.5 Describe the given Geometrical relationships for the given components.	**Unit - II Angular, Screw Thread, Gear, Surface Measurements and Geometrical Testing** 2.1 Angle measurement: Instruments used in Angular Measurements: Angle Gauges (No Numerical), Bevel Protractor, sine bar. 2.2 Screw thread Measurements: Screw thread terminology, measurement of different elements such as major diameter, minor diameter, effective diameter, pitch, thread angle. 2.3 Gear Measurement: Measurement of tooth thickness by Gear tooth Vernier and Profile projector. 2.4 Surface Roughness Measurement: Meanings of surface texture and definitions, methods of surface measurement - Ra, Rz and RMS values (No Numerical), Taylors Hobsons Talysurf. 2.5 Geometrical Tolerance: Parallelism, Straightness, Squareness, roundness, run out, alignment testing of automobile components.	Chalk-Board Presentations Video Demonstrations
3	TLO 3.1 Select displacement measuring instrument in the given system with justification. TLO 3.2 Explain Working of given pressure measurement instrument. TLO 3.3 Choose relevant instrument for measurement of temperature of given system. TLO 3.4 Describe the procedure for measurement of engine shaft power. TLO 3.5 Explain Working of given speed measurement instrument.	**Unit - III Miscellaneous Measurement** 3.1 Displacement Measurement: working principal of Capacitive transducer, Potentiometer, LVDT. 3.2 Pressure Measurement: Working principal of Pressure Gauge- Bourdon tube, Electrical resistance type pressure measurement devices. 3.3 Temperature Measurement: Working principal of Bimetallic strip gauge, thermometer and thermocouple. 3.4 Shaft power measurement: Eddy Current Dynamometer. 3.5 Speed measurement - Working principal of Tachometer and Stroboscope.	Chalk-Board Presentations Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Interpret ancient measurement system for measurement of length and weight.	1	*Measurement of Length and weight by using ancient measurement system (IKS)	2	CO1

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Compare the results of linear parameters of a given job by using Vernier caliper, Micrometer and height / depth gauge. LLO 2.2 Operate linear measuring instrument(s) for measurement of given job.	2	*Measurement of dimensions of component using vernier caliper, vernier height gauge, vernier depth gauge, micrometer and inside micrometer.	2	CO1
LLO 3.1 Check the roundness of a component with the help of mechanical comparators. LLO 3.2 Operate dial gauge for checking the roundness of plain shaft used in any automobile.	3	Roundness checking of the given component using dial indicator / dial gauge.	2	CO3
LLO 4.1 Check the parallelism of a component with the help of mechanical comparators LLO 4.2 Operate dial gauge for checking the parallelism of saddle with main axis of lathe machine	4	*Parallelism checking of the given component using dial indicator / dial gauge.	2	CO3
LLO 5.1 Use different optical flats for measurement of surface flatness. LLO 5.2 Identify the types of observed fringe patterns of optical flats.	5	Measurement of flatness of given component by using optical flats.	2	CO3
LLO 6.1 Inspect specified size attribute of the automotive component by using a pneumatic comparator. LLO 6.2 Use pneumatic comparator for given situation efficiently.	6	Inspection of given size attribute by using a pneumatic comparator.	2	CO1 CO2
LLO 7.1 Use Bevel Protractor and Sine bar for measurement of unknown angle LLO 7.2 Operate Bevel Protractor and Sine bar for angle measurement	7	*Measurement of unknown angle of a component using Bevel Protractor and verification by Sine bar.	2	CO2
LLO 8.1 Use floating carriage micrometer for measurement of major, minor and effective diameter of screw threads. LLO 8.2 Operate optical profile projector for checking thread profile.	8	*Measurement of the screw thread elements by using screw thread micrometer and verification by optical profile projector	2	CO2
LLO 9.1 Measure face width and tooth thickness of a gear by using gear tooth vernier caliper LLO 9.2 Check given gear profile by optical profile projector	9	*Measurement of the gear tooth elements using gear tooth vernier caliper and verification by optical profile projector.	2	CO2
LLO 10.1 Compare given machined surface using Surface Roughness Tester and Surface Roughness Standard Piece.	10	*Measurement of the surface roughness of machined surface by using surface roughness tester.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Measure displacement of micrometer by using LVDT. LLO 11.2 Use LVDT for measurement of linear displacement.	11	*Measurement of displacement by using Linear Variable Displacement Transducer (LVDT).	2	CO4
LLO 12.1 Use Thermocouple for measurement of temperature of given system. LLO 12.2 Measure temperature of a system by using thermometer.	12	Measurement of temperature by thermocouple and Verification by thermometer.	2	CO4
LLO 13.1 Measure Pressure of a given system by using Bourdon Pressure gauge.	13	*Measurement of Pressure by using Bourdon Pressure gauge	2	CO4
LLO 14.1 Measure the speed of rotating shaft by Tachometer or Stroboscope LLO 14.2 Use Tachometer or Stroboscope for measurement of speed of rotating shaft	14	Measurement of speed of rotating shaft by Tachometer or Stroboscope	2	CO4
LLO 15.1 Determine engine torque by Eddy current dynamometer. LLO 15.2 Use Eddy current dynamometer for measurement of engine torque.	15	Measurement of engine torque by Eddy current dynamometer.	2	CO4

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Visit to Automobile service station, observe the different sensors used in cars and prepare a report of the same. (Name, Use, Location, Working, Applications)
- Prepare a report on calibration procedure of Vernier Caliper and Micrometer followed by NABL Lab.
- Prepare comparative study of different contact and non-contact type transducers / sensors.
- Comparative study of various linear measuring instruments like steel rule, Inside-outside micrometer, Vernier Caliper and Digital Caliper on the basis of accuracy, precision, repeatability, errors, etc. with proper justification.

Assignment

- Prepare a report to interpret effect of errors on the accuracy of instrument and measurement.
- Visit to any nearby automobile service station or industry and list out different gauges used for inspection along with its purpose.
- Prepare a comparative study of different screw threads measuring instruments on the basis of their least count, accuracy, cost, ease of operation.
- Prepare a set of procedure for Pressure measurement with suitable instrument.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Surface Plate-Granite (24 x 36 inch)	1,2,3,4,7,8,9,10
2	Surface roughness Tester (Max Sampling length 0.8 mm) having profile printing facility	10
3	Set of surface roughness standard pieces: Ra (micron) - 0.8 to 50.0, Rz (micron) - 2.5 to 250 including turned, end milled, surface grounded and lapped.	10
4	Inductive transducer – measurement range 0 to 100 mm – sensor – inducive (nonlinear) solenoid type onboard with micrometer, micrometer screw gauge assembly for displacement, bridge balance type circuit Display 3.5 digit display	11
5	Sensor – type K (Cr-AI) thermocouple, sensor assembly and water bath with heating arrangement Display 3.5 digit display	12
6	Bourdon tube C type with LVDT Display 3.5 display for Pressure / Displacement	13
7	Multidigital Stroboscope cum Tachometer for speed measurement – up to 5000 rpm	14
8	Eddy Current Dynamometer - 250 kW (335 bhp)- Max Power, 1200 Nm (886 lbf.ft) – Max Capacity, 8000 rpm- Max Speed	15
9	Vernier Calipers (0-200 mm)	2
10	Vernier Height Gauge and Depth Gauge. (0-300 mm)	2
11	Outside Micrometer (0-25 mm, 25-50 mm)	2
12	Inside Micrometer (0-25 mm)	2
13	Dial indicator (0-25 mm) with magnetic stand	3,4,7
14	Optical flats set range (0.2 μm) Diameter / Thickness 45/12 mm and 60/15 mm	5
15	Pneumatic comparator unit (Range 0 to 10 bar)	6
16	Universal bevel protractor Graduation: 5 min (0-90-0 degrees)	7
17	Sine bar, Sine Center (0-200mm)	7
18	Slip gauge set of M83 (Measuring Range: 1.001 – 1.009, 1.01- 1.49, 0.5 – 9.5, 10-100)	7
19	Screw thread micrometer (Accuracy 0.001-0.006 mm, Dimensions 40 cm x 50 cm x 8 cm)	8
20	Profile projector with gear profile / Thread profile templates Opaque fine grained ground glass screen with 90 deg, 60 deg, 30 deg cross line Location; fitted with graduated ring (0 to 360 deg) L.C. 1 min; Optics Std 10X, 20X, Measuring Range Std 100mm X 100mm; Opt X axis upto 400 mm, Y axis upto 200 mm; Focusing Travel 100 mm; Magnification Accuracy Contour ± 0.05% Surface ± 0.05%; Illumination Countor 24V / 150W halogen lamp with illumination control; Resolution 0.005/0.001/0.0005 mm	8,9

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
21	Gear Tooth Vernier Caliper (0-25 mm)	9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Overview of Measurement	CO1,CO2	4	0	0	0	0
2	II	Angular, Screw Thread, Gear, Surface Measurements and Geometrical Testing	CO2,CO3	6	0	0	0	0
3	III	Miscellaneous Measurement	CO4	5	0	0	0	0
Grand Total				**15**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Continuous Assessment based on Product and Process related performance indicators

Summative Assessment (Assessment of Learning)

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	-	1	3	1	-	2			
CO2	3	-	1	3	1	-	2			
CO3	3	-	-	3	1	-	2			
CO4	3	-	-	3	1	-	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	N.V. Raghavendra and L. Krishnamurthy	Engineering Metrology and Measurement	Oxford University Press, New Delhi, India ISBN-13: 978-0-19-808549-2. (2013)
2	Anand K Bewoor and Vinay A Kulkarni	Metrology and Measurements	Tata McGraw-Hill Education Private Limited, New Delhi, India ISBN (13): 978-0-07-014000-4 (2017)

Sr.No	Author	Title	Publisher with ISBN Number
3	R K Jain	Engineering Metrology	Khanna Publication, New Delhi, ISBN-10:817409153X (2022)
4	R. K. Rajput	Engineering Metrology & Instrumentation	S.K. Kataria and Sons ISBN:9788185749822 (2009)
5	R K Jain	Mechanical and Industrial Measurements	Khanna Publication, New Delhi ISBN: 8174091912 (1995)
6	Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard	Mechanical Measurements	Pearson Prentice Hall ISBN:9780136093763 (2013)

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://onlinecourses.nptel.ac.in/noc20_me94/preview	NPTEL MOOCS course on Engineering Metrology
2	https://onlinecourses.nptel.ac.in/noc23_me09/preview	NPTEL MOOCS course on Mechanical Measurement Systems
3	https://www.youtube.com/watch?reload=9&v=Hi7NUJdznc0	Video Lecture on Engineering Metrology by IIT Madras
4	https://www.youtube.com/watch?v=xPGi2e-gOo8&t=196s	Measurement of screw thread elements
5	https://www.youtube.com/watch?v=ShDbYKmOKH8	Potentiometer Working Principle
6	https://www.youtube.com/watch?v=TqPBDFXyQ_k	Working Principle of Thermocouple, RTD, Thermistors
7	https://www.youtube.com/watch?v=9VpimWrPTaM	Different Pressure measurement instruments
8	https://www.youtube.com/watch?v=_OnGXJA7oX8&t=1215s	Working Principle of Dynamometers

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students