ST.ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

ME 8513- METROLOGY AND MEASUREMENTS LAB

LAB MANUAL

(III YEAR-V SEMESTER)

REGULATION 2017

NAME:

ME8513 METROLOGY AND MEASUREMENTS LABORATORY L T P C

0 0 3 2

OBJECTIVES

- To familiar with different measurement equipment and use of this industry for quality inspection

LIST OF EXPERIMENTS

1. Tool Maker‟s Microscope
2. Comparator
3. Sine Bar
4. Gear Tooth Vernier Caliper
5. Floating gauge Micrometer
6. Coordinate Measuring Machine
7. Surface Finish Measuring Equipment
8. Vernier Height Gauge
9. Bore diameter measurement using telescope gauge
10. Bore diameter measurement using micrometer
11. Force Measurement
12. Torque Measurement
13. Temperature measurement
14. Autocollimator

TOTAL: 45 PERIODS

OUTCOMES

- Ability to handle different measurement tools and perform measurements in quality impulsion

INDEX

Ex. No	NAME OF THE EXPERIMENT	STAFF SIGN
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14	Force Measurement	
15	Temperature Measurement using Parallel flow and counter flow	
16	Measurement Of Torque Using Gauge load Cell	

EX. NO:	INTRODUCTION TO METROLOGY
DATE:	

AIM

To study about the basics of the engineering metrology and measurements.

FUNDAMENTALS

Metrology is a "Science of measurement'. The most important parameter in metrology is the length. Metrology is divided into Industrial Metrology and Medical Metrology under consideration of its application and may be divided into metrology of length and Metrology of time under consideration of its quantity. Metrology is mainly concerned with the following aspects

1. Unit of measurement and their standards.
2. Errors of measurement.
3. Changing the units in the form of standards.
4. Ensuring the uniformity of measurements.
5. New methods of measurement developing.
6. Analyzing this new methods and their accuracy.
7. Establishing uncertainty of measurement.
8. Gauges designing, manufacturing and testing.
9. Researching the causes of measuring errors.
10. Industrial Inspection.

FUNCTIONS OF METROLOGY

1. To ensure conservation of national standards.
2. Guarantee their accuracy by comparison with international standards.
3. To organize training in this field.
4. Take part in the work of other National Organization.
5. To impart proper accuracy to the secondary standards.
6. Carry out Scientific and Technical work in the field of measurement.
7. Regulate, supervise and control the manufacturer.
8. Giving advice to repair of measuring instruments.
9. To inspect and to detect guilty of measurement.

APPLICATIONS OF METROLOGY

1. Industrial Measurement
2. Commercial transactions
3. Public health and human safety ensuring.

NEED OF INSPECTION

To determine the fitness of new made materials, products or component part and tocompare the materials, products to the established standard. It is summarized as

1. To conforming the materials or products to the standard.

2. To avoid faulty product coming out.
3. To maintain the good relationship between customer and manufacturer.
4. To meet the interchangeability of manufacturer.
5. To maintain the good quality.
6. To take decision on the defective parts.
7. To purchase good quality raw materials.
8. To reduce the scrap.

BASIC CONCEPTS OF MEASUREMENTS

1. Measurement is the outcome of an opinion formed by observers about some physical quantity.
2. Measurement is an essential part of the development of technology.
3. Measurement is a complex of operations carried out by means of measuringinstruments.

ELEMENTS OF A MEASUREMENT

Measurand: It is a physical quantity or property (length, diameter, thickness, angle etc.).

Reference: Reference is a physical quantity or property and comparisons are made by them.

Comparator: Comparing measurand with some other reference.

NEED FOR MEASUREMENT

1. To determine the true dimensions of a part.
2. To increase our knowledge and understanding of the world.
3. Needed for ensuring public health and human safety.
4. To convert physical parameters into meaningful numbers.
5. To test if the elements that constitute the system function as per the design.
6. For evaluating the performance of a system.
7. To ensure interchangeability with a view to promoting mass production.
8. Check the limitations of DESCRIPTION in actual situation.
9. To establish the validity of design and for finding new data and new designs.

RESULT

Thus the basics of the engineering metrology and measurements were studied

EX. NO.:	MEASUREMENT O F COMPONENTS USING VERNIER CALIPER
DATE:	

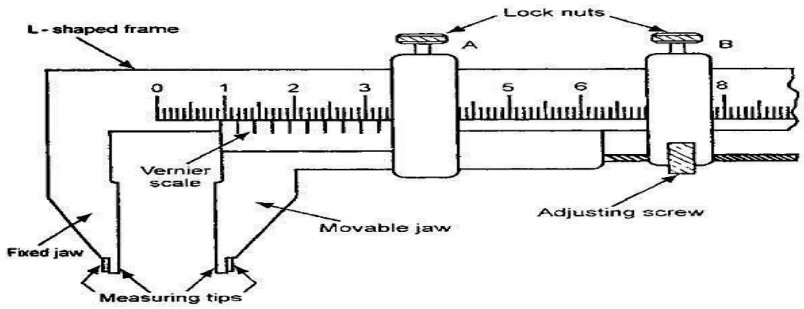
AIM:

To measure the external diameter of the given specimen using vernier caliper.

APPARATUS REQUIRED:

1. Vernier caliper 2. Specimen.

DIAGRAM: VERNIER CALIPER



TABULATION **L.C=0.02mm**

Sl. No.	Specimen's Name & Specification	MainScaleReading (M.S.R)(mm)	VernierScale Division(V.S.D) (Div)	Correct Reading CR=MSR+(VSD× LC) (mm)	Average Reading(mm)
1 2					
3					
4					
5					

FORMULA:

$$\text{Least count} = \frac{\text{main scale reading}}{\text{number of vernier scale dividion}} = 0.02 \text{ mm}$$

DESCRIPTION:

Vernier caliper has two scales namely the main scale and Vernier scale which moves along the main scale. Verniers are used to measure both internal and also external dimensions. The caliper is placed on the object to be measured and the fine adjustment screw is rotated until the jaws fit tightly against the work piece. The readings from the main scale and Vernier scale are taken. The main principle of Vernier is that the two scales of different sizes are used to measure the dimension in high accuracy. The least count of Vernier caliper is 0.02mm.

PROCEDURE:

1. Check the zero reading for error.
2. Place the workpiece to be measured in between the measuring face.
3. Adjust the sliding jaw until there is no further movement of sliding bar.
4. Note the main scale, Vernier reading for the calculation of workpiece dimension.
5. Tabulate the readings. Then the dimension of workpiece is calculated and average value is taken.

RESULT:

Thus the dimension of the given specimen was measured by using vernier caliper.

1. Specimen I. .....
2. Specimen II. .....

VIVA QUESTIONS:

1. Which of the following instruments is most accurate
   a) Vertical caliper b) Manometric screw gauge c) Optical projector d) Mechanical comparator e) Slip gauges
2. Which of the following characterizes the dispersion of the results obtained in a series of measurements of the same value of a quantity measured
   a) Absolute error b) Relative error c) Root mean square deviation d) Uncertainty of measurement e) Variation of indication.
3. A surface gauge is used for
   a) Leveling the surface plate b) Checking the surface finish c) Laying out the work accurately d) Finding the depth of the surface e) Finding the flatness of surfaces.
4. Parasitic error is caused due to
   a) Improper use of measuring instrument b) Changes in ambient conditions c) Wrongdesign of instrument d) Deflection of stylus e) Errors in computation.
5. A feeler gauge is used to check
   a) Radius b) Screw pitch d) Unsymmetrical shape e) Thickness of clearance

EX. NO:	MEASUREMENT O F COMPONENTS USING VERNIER HEIGHT GAUGE
DATE:	

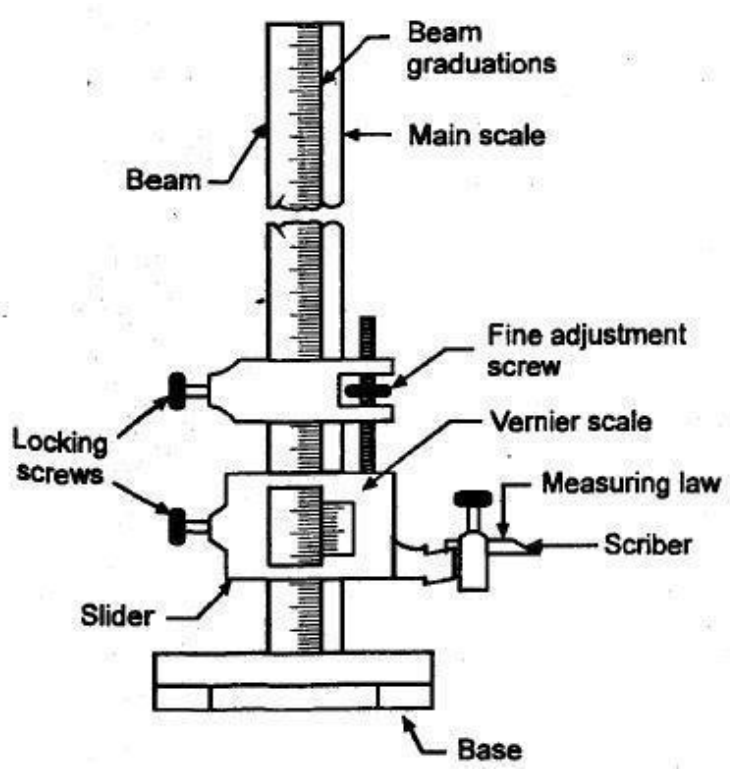
AIM:

To measure the height of given work piece by using vernier height gauge.

APPARATUS REQUIRED:

1. Vernier caliper. 2. Flat table. 3. Specimen.

DIAGRAM: VERNIER DEPTH GAUGE



TABULATION: **L.C=0.02mm**

Sl. No	Specimen Name and Specification	Main scale Reading (MSR) in mm	Vernier Scale Division (VSD) indiv	Correct Reading CR =MSR+(VSD x LC) in mm	Average Reading inmm
1					
2					
3					
4					
5					

DESCRIPTION:

A vernier depth gauge is one type of vernier caliper. The graduated scale is directly slide through the base but the vernier scale remains stationary. This instrument is mainly used for measuring the depth of holes, recesses and distance from a plane. The range trueness and squareness of vernier depth gauges should be correct. Otherwise the rest of the depth gauges will be inclined. The base and anvil should be firmly rested on the surface of the part to be measured. If it is not so the base may be lifted above the surface of the part. Sometimes the base may be affected by a trifle effected when the applied force increases. The least count of vernier depth gauge is 0.02mm.

PROCEDURE:

1. Check the zero reading for error.
2. Place the workpiece to be measured in between the measuring face.
3. Adjust the sliding jaw until there is no further movement of sliding bar.
4. Note the main scale, vernier reading for the calculation of workpiece dimension.
5. Tabulate the readings.
6. Then the dimension of workpiece is calculated and average value is taken.

RESULT:

Thus the dimension of the given specimen was measured by using vernier height gauge.

a. First step mean value : ----------
b. Second step mean value : ----------
c. Third step mean value : ----------

VIVA QUESTIONS:

1. Self – compensating capillary tube is used in the filled – in – system thermometer to eliminate or minimize
   a. Elevation effectb. Immersion effect c. Barometric effect d. Temperature effect
2. Tolerances are specified
   a) To obtain desired fits b) Because it is not possible to manufacture a size exactly c) To obtain high accuracy d) To have proper allowances e) To have proper inspection
3. Which of the following is the most important characteristics of a measuring instrument in general
   a) Precision b) Accuracy c) Repeatability d) Sensitivity e) Readability
4. Sensitivity and range of instrument have
   a) Direct relationship b) Linear relationship c) Inverse relationship d) Unpredictable relationship e) No relationship
5. Systematic errors are
   a) Randomly distributed b) Regular repetitive in nature d) Unknown errors
   c) Distributed in both +ve and –ve sides of mean value) Unpredictable nature.

EX. NO:	MEASUREMENT O F COMPONENTS USING VERNIER DEPTH GAUGE
DATE:	

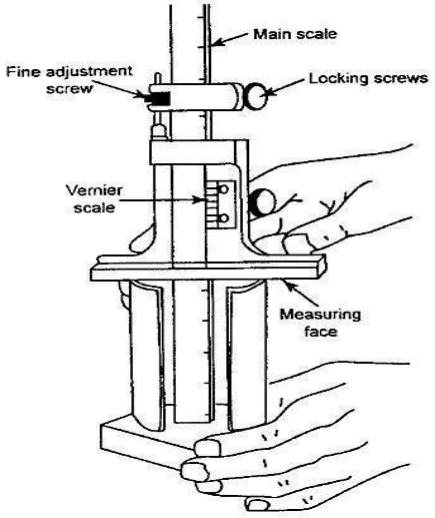
AIM:

To measure the depth of the given specimen using the vernier depth gauge.

APPARATUS REQUIRED:

1. Vernier depth gauge. 2. Specimen.

DIAGRAM: VERNIER DEPTH GAUGE



TABULATION: L.C=0.02mm

Sl. No	Specimen Name and Specification	Main scale Reading (MSR) in mm	Vernier Scale Division (VSD) indiv	Correct Reading CR =MSR+(VSD x LC) in mm	Average Reading inmm
1					
2					
3					
4					
5					

DESCRIPTION:

A vernier depth gauge is one type of vernier caliper. The graduated scale is directly slide through the base but the vernier scale remains stationary. This instrument is mainly used for measuring the depth of holes, recesses and distance from a plane. The range trueness and squareness of vernier depth gauges should be correct. Otherwise the rest of the depth gauges will be inclined. The base and anvil should be firmly rested on the surface of the part to be measured. If it is not so the base may be lifted above the surface of the part. Sometimes the base may be affected by a trifle effected when the applied force increases. The least count of vernier depth gauge is 0.02mm.

PROCEDURE:

1. Check the zero reading for error.
2. Place the workpiece to be measured in between the measuring face.
3. Adjust the sliding jaw until there is no further movement of sliding bar.
4. Note the main scale, vernier reading for the calculation of workpiece dimension.
5. Tabulate the readings.
6. Then the dimension of workpiece is calculated and average value is taken.

RESULT:

Thus the dimensions of the given specimen were measured by using vernier depth gauge.

1. Specimen I : ----------
2. Specimen II : ----------

VIVA QUESTIONS:

1. Tachometers are used to measure
   a. Displacement b. Angular velocity c. Vibration d. Time
2. A parallel combination of thermocouple is used for the measurement of
   a.Small temperature difference between the two junctions b.Large temperature difference between the two junctions
   c. Average temperature of a number of points d. All of these
3. Thermopile is
   a. A combination of a number of thermocouple connected in series
   b. A combination of a number of thermocouple connected in parallel
   c. A combination of a number of thermocouple connected in series & parallel
4. Reference junction compensation in thermocouples can be provided through use of
   a. Hardware only b. Software only c. Both hardware & software
5. Recording is not possible with
   a. Liquid – in – glass thermometer b. Thermocouples c. Filled in system thermometers

EX. NO.:	MEASUREMENT O F COMPONENTS USING MICROMETER
DATE:	

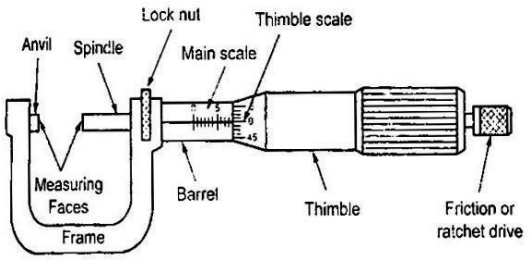
AIM:

To obtain the thickness and diameter of the work piece using the micrometer.

APPARATUS REQUIRED:

1. Micrometer 2. Specimen

DIAGRAM:MICROMETER



TABULATION: **L.C=**

Sl. No	Specimen Name and Specification	Main scale Reading (MSR) in mm	Vernier Scale Division (VSD) indiv	Correct Reading CR =MSR+(VSD x LC) in mm	Average Reading inmm
1					
2					
3					
4					
5					

DESCRIPTION:

The micrometer is a linear measuring instrument. The micrometer has an accurate screw consisting of 10 to 20 threads per cm. This screw rotates inside a fixed nut. The end of the screw acts as one measuring tip and fixed anvil acts as other measuring tip. Threads are cut for certain length on screw and it is left to free remaining portion called sleeve. The spindle moves towards the fixed anvil or away from it by rotating the thimble.

The spindle is placed inside the barrel in such a way to freely to s lide over the barrel. The barrel is firmly fixed with the frame. 20 divisions per cm are made in the barrel. This is the lead screw for one complete revolution. But the thimble has 25 divisions around the circumference. So each revolution is again divided into25 divisions. Therefore each division is equal to 0.02mm. So its least count is 0.02mm

PROCEDURE:

1. Check the zero position for error.
2. Place the specimen to be measured.
3. Adjust the spindle by rotating the ratchet unit at began to slip.
4. Note the reading on the main scale and the thimble scale.
5. By calculating the division on both scales the reading was tabulated.
6. Thus the thickness of the work piece was measured.

a.

RESULT:

Thus the dimension of the given workpiece was measured using micrometer.

Stainless steel : ----------

Mild steel 1 : ----------

Mild steel 2 : ----------

VIVA QUESTIONS:

1. In_____torsion meter the angular deflection of a parallel length of shaft is used to measure torque.
   a. Piezoelectric b. Mechanical c. Absorption d. All the above
2. The speed of a sealed compressor units can be measured by a
   a. Stroboscope b. Vibrating reed tachometer c. Capacitive pick up d. Tachoscope
3. Elastic elements used for measurement of force give
   a. High sensitivity and slow response if they are stiff
   b. Low sensitivity and fast response if they are stiff
   c. Low sensitivity and slow response if they are stiff **d.** None of the above
4. Piezoelectric type of load cells can be used for measurement of
   a. Dynamic force only
   b. Dynamic forces and static forces provided the load cells have a small time constant
   c. Dynamic and static forces provided that the load cells have a large time constant.
5. The average speed measurements are given by

Centrifugal tachometer **b.** Drag cup tachometer **c.** Revolution counter &timer d. Stroboscope

EX. NO.:	CHECKING THE LIMITS OF DIMENSIONAL TOLERANCES USING MECHANICAL COMPARATOR
DATE:	

AIM:

To check the dimensions of a given set of specimen using a mechanical comparator.

APPARATUS REQUIRED:

1. Mechanical comparator. 2. Surface plate. 3. Height gauge.4.Specimens.

DIAGRAM: MECHANICAL COMPARATOR

TABULATION

STANDARD SPECIMEN: Height: Tolerance:

Sl. No	Specimen Height (h) (mm)	Deviation (mm)	Sample Acceptable/ Reject able

DESCRIPTION:

The mechanical comparator is a one of the type of comparator used to only check the specimen. There are graduations in the dial gauge and there is a counter dial in the gauge. There is a plunger, by this sensitive plunger the pointer in the dial gauge points out the reading. By using the slip gauge the values of the specimen was verified.

PROCEDURE:

1. Check the flatness of the surface plate with respect to horizontal using a spirit level.
2. Measure the height of the specimen using a vernier height gauge.
3. Take a standard specimen and get the value in the comparator.
4. Check for the deviation from standard value using the dial gauge.
5. Draw a graph between deviations from the deviation of standard value for number of specimen.

VIVA QUESTIONS:

1. In the microscope the magnification of objective may be called as_____magnification.
   a. Primary b. Secondary c. Both primary and secondary d. Either primary nor secondary
2. A_____is used to obtain enlarged views of distant objects.
   a) Astronomical b. Galilean c. Photo – electric d. All the above
3. _____may be calculated by multiplying the force with the radius of the shaft.
   a) Torque b. Vibration c. Force d. All the above
4. In a_____the angular deflection of a parallel length of shaft is used to measure torque.
   a) Mechanical torsion meter b. Optical torsion meter c. Electrical torsion meter d. Strain – gauge torsion meter
5. _____is used to measure the angular twist of a rotating shaft.
   a) Mechanical torsion meter b. Optical torsion meter c. Electrical torsion meter d. Strain – gauge torsion meter

RESULT:

Thus the dimensions of the given set of specimens are checked using mechanical comparator andthe graph was drawn with number of specimen vs. deviation.

EX. NO.:	MEASUREMENT OF GEAR PARAMETERS USING GEAR TOOTH VERNIER
DATE:	

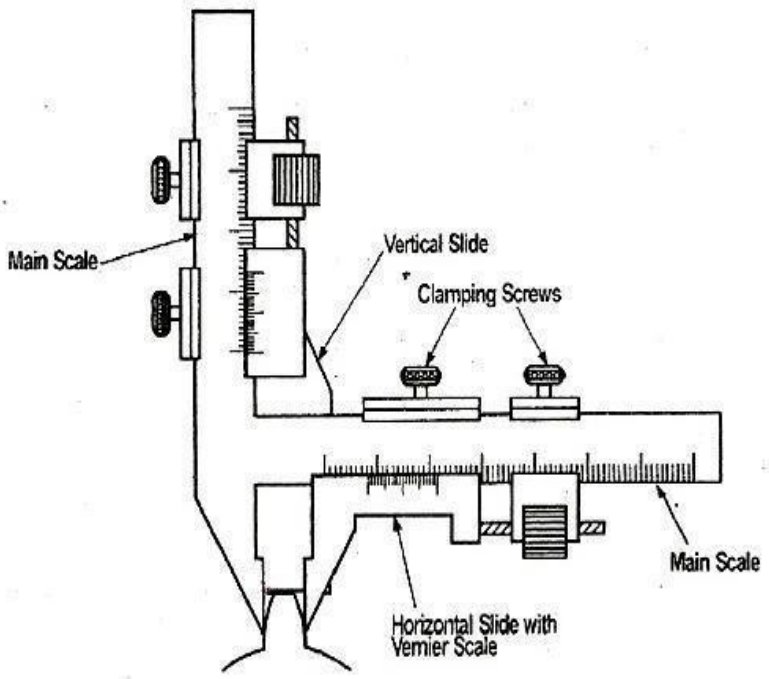
AIM:

To measure the thickness and depth of the gear using gear tooth vernier.

APPARATUS REQUIRED:

1. Gear tooth vernier. 2. Gear blank.

DIAGRAM: GEAR TOOTH VERNIER



Tabulation:

1. Calculating thickness L.C = 0.02 mm

Gear tooth No	Actual reading mm	Measured Reading thickness			Error (mm)
		MSR (mm)	VSD (mm)	Correct reading (mm)	
1					
2					
3					
4					
5					
				Average Error	

2.Calculating Depth

Gear tooth No	Actual reading mm	Measured Reading Depth			Error (mm)
		MSR (mm)	VSD (mm)	Correct reading (mm)	
1					
2					
3					
4					
5					
				Average Error	

FORMULA:

$$Depth\ d = \frac{Nm}{2}\left[1 + \frac{2}{n} - \cos\frac{90}{n}\right]$$

Where, N = no. of teeth, m = module of gear ,

$$m = blank\frac{diameter}{N-2}\ ; thickness\ t = \frac{\pi \times m}{2}\ in\ mm$$

DESCRIPTION:

Gear tooth vernier is also a type of vernier used to measure the depth between the gears and thickness of the tooth in a same operation. This gear tooth vernier having separate main scale and vernier scale for the measurement of thickness and depth. The lower main scale and sliding vernier scale in horizontal direction is used to measure the thickness of the teeth. The main scale and vernier scale in vertical direction is used to measure the depth between teeth.

PROCEDURE:

1. First the number of teeth in gear blank was counted and diameter was measured.
2. Calculate the module of pitch circle diameter of gear.
3. By the above formulas the depth and thickness of the given gear was calculated.
4. Calculate the tooth thickness by normal measuring.
5. Compare the theoretical value with practical value &the error is noted as thedifference.
6. Thus the same procedure for the remaining tooth.

RESULT:

Thus the thickness and depth of the gear tooth was calculated and the error found out.

VIVA QUESTIONS:

1. What represents the departure of the observed readings from arithmetic mean of the group of reading? a. Dispersionb .Deviationc. Variance d. Median
2. _____Mean is defined as the nth root of the product of nth terms.
   a. Standard b. Geometric c. Deviation d. Average

3. _____Method is a non – destructive way of reducing the surface texture visible.
   a. Visual b. Microscopic c. Light section d. None of these
4. _____Microscope can be used to examine surface texture.
   a. Telescope b. Interference c. Tool maker d. Floating carriage
5. Bad reflecting surfaces having surface roughness greater than 1 mm, can't be examined by the _____method. a. Telescope b. Interference c. Tool maker d. Floating carriage

EX. NO.:	MEASUREMENT OF THREAD PARAMETER USING PROFILE PROJECTOR
DATE:	

AIM:

To measure the thread parameter using the profile projector.

APPARATUS REQUIRED:

1. Profile projector. 2. Specimen.

DIAGRAM: PROFILE PROJECTOR

DESCRIPTION:

Profile projector is a relatively simple and accurate instrument to measure the thread parameters. Initially the micrometer reading is set to zero on the scale and the indicator is moved along to bring the stylus and the indicator is adjusted radially until the stylus e ngages between the thread flanks. A light source provides horizontal beam of light which is reflected from a mirror by 90º upwards towards the table.

TABULATION:

1. **Major diameter:** **L.C = 0.01 mm**

Position	MSR	TSR	CR = MSR+(TSR×LC)	Initial – Final Reading
Initial				
Final				

2. **Minor diameter:**

Position	MSR	TSR	CR = MSR+(TSR×LC)	Initial – Final Reading
Initial				
Final				

3. **Angle:** **L.C = 0.01 mm**

Position	MSR	TSR	CR = MSR+(TSR×LC)	Initial – Final Reading
Initial				
Final				

4. **Pitch:**

Position	MSR	TSR	CR = MSR+(TSR×LC)	Initial – Final Reading
Initial				
Final				

5. **Height**

Position	MSR	TSR	CR = MSR+(TSR×LC)	Initial – Final Reading
Initial				
Final				

RESULT:

Thus the Major, Minor, Pitch Angle of the given screw threads were measured by using profile projector.

VIVA QUESTIONS:

1. _____is the mechanical method of measuring vibrations.
   a. Vibrating wedge b. Electrical c. Optical d. Dial gauge
2. _____is the instrument used to measure vibrations under strain gauge usage.
   a. Vibrometers b. Vibration sensor c. Electro – mechanical d. Relativedisplacement
3. The purpose of instrument is to
   a. Allow measurements to be made b. Transmit the information c. Change signals d. All of the above
4. The measurement refer to
   a. Primary signal b. Measured variable c. Output d. Signals
5. The measurand is
   a. Output b. Measured variable c. Secondary signal d. Primary signal

EX. NO.:	**MEASUREMENT OF TAPER ANGLE MEASUREMENT USING SINE BAR AND SLIP GAUGE**
DATE	

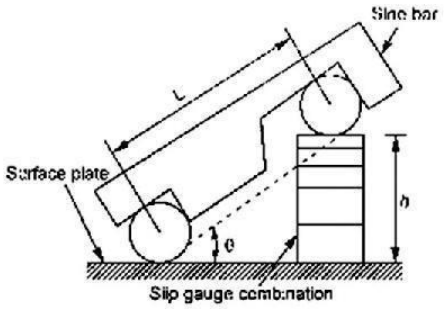
AIM:

To measure the angle of taper surface using the sine bar.

APPARATUS REQUIRED:

1. Surface plate. 2. Sine bar. 3. Slip gauge.

DIAGRAM: SINE BAR AND SLIP GAUGE



TABULATION:

Sl. No	Specimen name and specification	Height of slip gauge (h_1) in (mm)	Height of slip gauge other side (h_2) in (mm)	Angle (θ) in deg θ
1				
2				
3				
4				
5				

FORMULA:

$$Sin\theta = \frac{h}{l}$$

Where,

θ= Angle of taper surface in Degrees, h = Height of slip gauge inmm. l Length between the rollers in mm = 200mm

DESCRIPTION:

Sine bars are always used along with slip gauge as the device for the angle measurement. Generally sine bars are made from high carbon, high chromium and corrosion resistant steel. These materials are highly hardened, ground and establish. In sine bars two cylinders of equal diameter are attached at the ends parallel to each other. The distance between two cylinders is 100mm, 200mm, or 300mm. There are some relief holes was made in the sine bar mainly to reduce the weight also to facilitate handling.

PROCEDURE:

1. The component of parallel on the surface plate for a steady support, the sine bar is placed on the top surface in taper.
2. The slip gauge are added and assured to clear the gaps.
3. Then the height of the slip gauges is measured.
4. Then the angle of taper was found by the above formula.

RESULT:

The taper angle of the given specimen is

a. Using bevel protractor= ----------degrees

b. Using sine bar=----------
---degrees

VIVA QUESTIONS:

1. The sine centers are used for inspection of _____
   a. Taper b. Conical objects c. Desired angles d. All of these
2. _____is a hardened steel block approximately 75 mm long 16 mm wide which has two lapped flat working faces.
   a. Angle gauge b. Taper gauge c. Limit gauge d. All of these
3. The angle between two faces of a component can be simply measured by means of a _____
   a. Protractor b. Bevel protractor c. Sine bar d. Sine center
4. _____is defined as the opening between two lines which meet at a point.
   a. Angle b. Triangle c. Right angle triangle d. All of these
5. Angle is a thing which is generated very easily requiring no _____
   a. Accurate standard b. Standards c. Calibrations d. Absolute standards.

EX. NO.:	**MEASUREMENT OF THREAD PARAMETERS BY USING FLOATING CARRIAGE MICROMETER**
DATE:	

AIM:

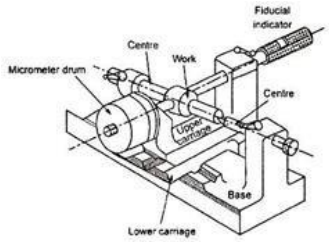
To measure the major, minor and effective diameter of given specimen by using a floating carriage micrometer.

APPARATUS REQUIRED:

1. Floating carriage micrometer 2.. Specimen.

DIAGRAM: FLOATING CARRIAGE MICROMETER

DESCRIPTION:
Floating carriage micrometer is also a micrometer used to measure the major diameter, minor diameter and the effective diameter of a threaded surface. This micrometer having a main scale, thimble scale and an anvil and also a pressure gauge is attached to measure the applying pressure. The least count of the floating carriage micrometer is 0.002mm.



TABULATION:

Parameter	**Diameter in mm**	**Std. Reading 'Rs' (mm)**	**Work piece Reading Rw (mm)**	**Diameter**	
				Max (mm)	**Min (mm)**
Major Diameter					
Minor Diameter					
Effective Diameter					

FORMULA:

Major diameter:

$$D_{max} = D + (R_s - R_w) D_{min} = D - (R_s - R_w)$$

Minor diameter:

$$d_{max} = d + (R_s - R_w) d_{min} = d - (R_s - R_w)$$

Effective diameter:

$$D_{efmax} = (D + (R_s - P) - R_w) D_{efmax} = (D - (R_s - P) - R_w)$$

PROCEDURE:

1. First the indicator of the pressure gauge is set to zero by using initial adjustment then the specimen is placed between two centre's, the standard dimensions in the corresponding values are noted.
2. Then the plug gauge is placed in the two centers for measuring the effective, major and minor diameter.
3. Simultaneously the thread work piece is first measured by placing between the two centers.
4. By placing the prism plug gauge, the readings are noted. By using the formula, we can calculate the R_w of the work piece.

VIVA QUESTIONS:

1. In the optical bevel protractor the glass circle is divided at_____intervals.
   a. 5mm b. 10mm c. 1cm d. 10cm
2. The scale of the dial gauge in dial bevel protractor is divided into
   _____divisions
   .a. 5b. 10 c. 2d. 4
3. The displacement time variation is generally in continuous form with some degree of repetitive nature is_____measurement.
   a. Vibration b. Temperature c. Force measurement d. Pressure measurement
4. _____is the action of single event from a transient with the motion generally decaying.
   a. Acceleration b. Velocity c. Shock d. All of the above
5. _____ of vibrations may be made with a transducer sensitive to amplitude, velocity or acceleration.
   a. Measurement b. Integration c. Differentiation d. None of the above

RESULT:

Thus the diameter of specimen was measured by using floating carriage micrometer.

1. Major diameter of the specimen = ----------
2. Minor diameter of the specimen = ----------

= .....

-

3. Effective diameter of the specimen

EX. NO.:	**MEASUREMENT OF STRAIGHTNESS AND FLATNESS USING AUTOCOLLIMATOR**
DATE:	

AIM:

To measure the straightness and Flatness given specimen using two axis Auto Collimator.

APPARATUS REQUIRED:

Collimator unit, Base, plain reflector, optical Scanner

DIAGRAM: AUTOCOLLIMATOR

TABULATION:

Sl. No	Distance from reference. A-B in mm	MSR in min	Micrometer (sec)	Result – θ in deg	Deviations in mm
1					
2					
3					
4					
5					

FORMULA:

Deviation = Sin θ (A-B)

Where angle θ in rad & Distance A-B in mm

PROCEDURE:

1. Testing square with auto collimator.
2. Level auto collimator unit on a stand a table.
3. Straighten the light.
4. Observe measuring graphical through the eye below.
5. The smallest discussion of linear scale is measured.
6. Bring plain reflector in front of the auto collimator to get reflector.
7. Depending upon the verification in surface.
8. Using micrometer provided for eye piece we can measure the frequency up in lose.

RESULT:

Thus the straightness and Flatness are determined using autocollimator.

VIVA QUESTIONS:

1. A positive check of the dimensional and geometric accuracies of taper shafts can be achieved by using_____taper gauge.
   a. Go b. No go c. May d. none of the above
2. The angle of taper shaft not exceeding _ mm length can be measured by means of standard rollers, slip gauges and micrometer.
   a. 100 b. 95 c. 105 d. 99
3. The_____is an instrument used for comparing the dimensions of a component with a standard of length.
   a. Vernier caliper b. Micrometer c. Slip gauge d. Comparator
4. The comparator should at least be able to record variations of_____mm.
   a. 0.001 b. 0.002 c. 0.0025 d. 0.1
5. Reed comparator is a_____comparator.
   a. Sigma b. Optical c. Electrical d. Mechanical

EX. NO:	BORE DIAMETER MEASUREMENT USING TELESCOPE GAUGE
DATE:	

AIM:-

To Measure the bore Diameter using telescopic gauge.

Apparatus Required

1. Set of telescopic gauges 2. Vernier Caliper 3. Specimen

Introduction to telescopic gauge:

A telescoping gauge is an indirect measuring device, the head of which can be positioned inside holes or openings and then extended to touch the walls. The gauge can then be extracted, and the size of the extended head can be measured with a micrometer or vernier caliper to determine the interior radius of the hole. This is essentially no different from a set of inside calipers, save that the distance which the head extends can be locked after measurement to ensure it's as accurate as possible.

Fig: Telescopic gauge

Mechanics most often use telescoping gages, though anybody working with machinery needing to measure the interior radius or calculate the circumference of a hole or pipe can use them to the same effect. They are typically used to measure the interior radius of the bore or cylinder of a crank case in which the cylinder's pistons would extend and retract. For both internal combustion and diesel engines to work properly, absolutely no air can pass out of the cylinder when the piston extends, compressing the combustible gases within. This means that the circumference and radius of the piston head must match the circumference and radius of the cylinder as closely as possible. This means that precision indirect measuring tools such as telescoping gauges are an absolute necessity.

TABULATION

SPECIMEN	VERNIER SCALE READING			CORRECTION FACTOR mm	ERROR
BORE DIA	MSR	VSR	CR mm		

Procedure:

1. First the appropriate sized gauge is chosen, as they come in many sizes.
2. The spring drive sides of the head are pressed down in the closed position, and locked into place by means of turning the end of the knurled grip.
3. The head of the gauge is extended into the hole so that the length of the gauge's handle is lying parallel with the hole.
4. The grip is unlocked and the poles are situated at either side of the gauge's head extend, striking the sides of the hole.
5. The lock is then tightened again to ensure that the poles don't extend or retract any further.
6. The gauge is carefully removed, where the distance between the holes at the gauge's head are measured.

Result

Thus the given bore diameter was measured using telescopic gauge.

VIVA QUESTIONS:

1. The plate of holes of various sizes, which have been drilled by an are equal to different sizes bits: (a) Pin Gauge(b) Dove tail gauge(c) Sheet metal gauge(d) Drill gauge

2. The diameter of large bore cannot be easily measured by micrometer or vernier etc. can be measured by:

(a) Height Gauge(b) Snap Gauge(c) Pin Gauge(d) All of the above

3. The moderation of neutrons by hydrogen atom is used as the basis for moisture detection in the instrument of:

(a) Profile Gauge(b) Nuclear moisture gauge(c) Dead weight gauge(d) All of the above

4. The two slip gauges in precision measurement are joined by:

(a) Sliding(b) Slipping(c) Assembling(d) None of the above

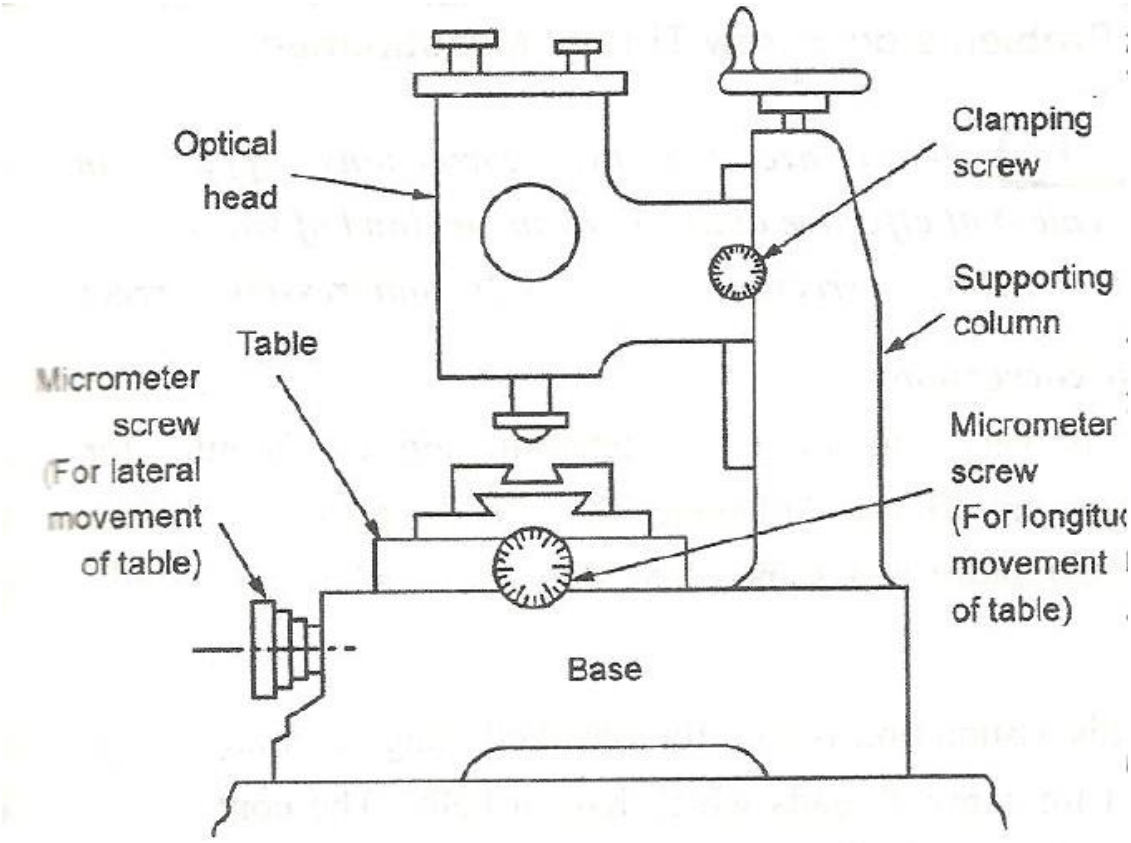
EX. NO:	MEASUREMENT OF THREAD PARAMETER USING TOOL MAKER'S MICROSCOPE
DATE:	

AIM

To measure various dimensions of a given specimen using Tool maker's Microscope.

Apparatus Required

1. Tool maker's Microscope. 2. Specimen 3.Eye piece.



TABULATION

S.NO	Major Diameter of the thread(D) in mm	Minor Diameter of the thread(d) in mm

PITCH OF THE THREAD

S.No.	Initial micrometer readings on thread pitch A (mm)	Final micrometer readings on thread pitch B (mm)	Pitch of the thread B-A (mm)

FLANK ANGLE OF THE THREAD:

S. No.	Intial flank angle A (Deg)	Final flank angle B (Deg)	Flank angle = B-A (Deg)

Procedure:

1. To find the Major and Minor diameter:

One end of screw thread in made to coincide with cross wire & fixed. Reading is taken.

The different between readings given linear measurement.

2. Measurement of pitch:

The contour is get so that the same it an screen. The reading of micrometer is noted. The reading of are subtracted & different is noted.

3. Measurement of thread angle:

   The screw is rotated till linear cross wire coincides with flank of thread profile. The angle of screw rotation and then the same line coincides with flank thread.

RESULT:

The various parameters of the given specimen are measured.

1. Mention the purpose of Goniometric heads in Tool maker's microscope

For these purposes, the microscope is provide with several measuring attachments such as

1. Centre stage for mounting of cylindrical components,
2. Revolving and angle measuring oculars,
3. Double image ocular,
4. Optical feeder, and
5. Projection screen.

2. How do you calibrate the slip gauges?

Comparators are used to calibrate the slip gauges.

3. List the various linear measurements?

(i) Length
(ii) Heights and
(iii) Thickness

4. List out any four angular measuring instrument used in metrology.

(i) Angle gauges
(ii) Divided scales
(iii) Sine bar with slip gauges
(iv) Autocollimator
(v) Angle dekkor

5. What is a comparator?

Comparator is one form of linear measurement device which is quick and more convenient for checking large number of identical dimensions.

6. Classify the comparator according to the principles used for obtaining magnification.

(i) Mechanical comparators.
(ii) Electrical comparators.
(iii) Optical comparators.
(iv) Pneumatic comparators.

7. What is the use of autocollimator in mechanical measurements?

Auto –collimator is an optical instrument used for the measurement of small angular differences, changes or deflection, plane surface inspection etc.

8. Name any two materials commonly used for gauges?

1. Steel
2. Plastic
3. Glass

9. What are the limitations of sine bar?

1. Sine bars are fairly reliable for angles less than 15 degree.
2. It is physically difficult to hold in position.
3. Slight errors in sine bars cause large angular errors.
4. The size of parts to be inspected by sine bar limited.

10. What are the Basic components of comparators?

The Basic components of comparators are

- Sensing Device
- Amplifying system
- Display system

EX. NO:	FORCE MEASUREMENT
DATE:	

AIM

To Measure the force using force indicator.

Apparatus Required

1. Force cell
2. Force Indicator
3. Weight
4. Capacity of proving ring = 2.5 KN

PROCEDURE:

1. Ensure that proving ring along with load all is perfectly in vertical position.
2. Ensure that load cell with socket is connected to the rear side of the load indicator.
3. Apply a small load without any slip in the system.

5. Note down the reading of dial gauge of force indicator.

TABULATION:

S.No	**Applied load (Kg)**	**Indicated load (Kg)**	**Deflection (div)**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

1 div = 0.002 mm

RESULT:

Thus the force measurement has been measured using load cell.

GRAPH:

Applied load Vs Indicated load

VIVA-QUESTIONS

1. **Define force.**

Force may be defined as a cause that produces resistance or obstruction to any moving body or change the motion of a body.

2. **State any two principles of force measurement.**

- Direct methods.
- Indirect methods.

3. **What are load cells?**

Are devices for the measurement of force through indirect methods.

4. **Mention the principle involved in bimetallic strip.**

It is based on change in dimension.

5. **What is a Kentometer?**

It is a device for measurement of absolute pressure.

6. **What is measurement?**

It is the process of comparing the input signal with pre-defined standard and gives out the result. It is a word to tell us about physical quantities such as length, weight, temperature, pressure, force etc.

7. **Mention the various methods used for limiting temperature errors.**

- Minimisation through careful selection of materials and operating temperature ranges.
- Compensation through balancing of inversely reacting elements or effects.
- Elimination through temperature control.

8. **Define effective diameter of thread.**

Effective diameter is the average of minor and major diameter of thread.

9. **What is meant by pressure?**

Force per unit area is known as pressure

10. **What is the unit of force?**

Newton, Kgm^{-2}

EX. NO:	TEMPERATURE MEASUREMENT USING PARALLEL FLOW AND COUNTER FLOW
DATE:	

AIM:

To measure the temperature using parallel flow and counter flow.

Apparatus Required

1. Temperature measuring setup
2. Ammeter
3. Voltmeter
4. Digital indicator
5. Water pipeline

Description

It is the one of the common type temperature measuring device, the envelope comprised of thick walled glass capillary tube, a change in temperature will cause in the liquid to exposed or constant in the steam

Tabulation

PARALLEL

FLOW

S.No	Temperature in °C	Ammeter in A	Voltmeter in V
1	Cold water inlet T1= Hot water inlet T2= Cold water outlet T3= Hot water outlet T4=		

COUNTER FLOW

S.No	Temperature in °C	Ammeter in A	Voltmeter in V

1	Cold water inlet T1= Hot water inlet T2= Cold water outlet T3= Hot water outlet T4=		

RESULT

Thus the experiment is conducted in liquid thermometer the variation of time with temperature is noted successfully.

VIVA-QUESTIONS

1. **List the instruments used for measuring temperature.**
    - Thermo coupling.
    - Electrical thermal resistance.
    - Thermostats.
    - Pyrometers.
2. **List some of the disadvantages of bimetallic thermometers.**
    - Possibility of calibration change due to rough handling.
    - Limitation to local maintaining.
    - Availability of indication type only.
3. **What are the advantages of Filled system Thermometer?**
    - Low cost.
    - Less maintenance requirement.
    - Rugged construction.
    - Absence of need of electric power.
4. **Explain the principle of operation of thermistor?**

    They have negative temperature coefficient of resistance i.e. with increase in temperature the resistance decreases and vice-versa.
5. **Which effect is used in thermocouple?**

    Seeback effect is used in thermocouple.
6. **What is the purpose of protecting tube in a thermocouple?**

    It is used to protect the thermocouple from harmful atmosphere, corrosive fluids and also to prevent from mechanical damage.
7. **Define Seeback effect?**

    If two dissimilar metals are joined together to form a closed circuit, there will be two junction where they meet each other. If one of these junctions is heated, then a current flow in the circuit which can be detected by a galvanometer. The amount of current depends on the difference in temperature between the two junctions and on the characteristics of the two metals. This was observed by Seeback & hence known as Seeback effect.
8. **What is thermopile?**

    When thermocouples are connected in series it is called thermopile.

9. What is the principle involved in fluid expansion thermometer?

Change in pressure in the bulb is taken as an indication of the temperature.

10. What is the working principle of thermocouple?

The basic principle of thermocouple is ‑when two dissimilar metals are joined together an e.m.f will exist between the two points A and B, which is primarily a function of the junction temperature‖. The above said to be principle is *Seeback effect*.

EX. NO.:	**MEASUREMENT OF TORQUE USING GAUGELOAD CELL**
DATE:	

AIM:

To measure the torque using Strain Gauge Load Cell.

APPARATUS REQUIRED:

1. Torque Measurement Equipment 2. Stand 3. Lever 4. Stain Gauge 5. Weight.

Calculation:

1. **Distance : 1 meter**

Sl. No	**Weight added (Kg)**	**Observed torque (kg-m)**	**Calculated Torque (Kg-m)**
1			
2			

1. **Distance : 0.5 meter**

Sl. No	**Weight added (Kg)**	**Observed torque (kg-m)**	**Calculated Torque (Kg-m)**
1			
2			

FORMULA USED:

Calculated Torque = Load x Distance (kg- m)

DESCRIPTION:

Torque is the tangential force to set a body in rotation. It is represented as a vector of aforce for a rigged body undergoing force rotation about a single axis.

Torque = DX,

D = Moment of inertia of body about the axis.

X = Angular acceleration.

Thus torque is the essential tensional twisting about its axis of rotation. In this setup shear type load is used to measure the torque a inverse method of measuring the load with the

output immune to side load and bending moment is based on measurement of shear components. The load cell is balancing a beam supported on both ends.

PROCEDURE:

1. Fix the main frame of transducers rigidity.
2. Connect the cantilever beam with weight pan.
3. Connect transducer wire socket to rear side of indicator.
4. Connect digital indicator at 230V, AC supply.
5. Set zero on indicator, by zero adjust pan provides indicator.
6. Now apply the load gradually and note down reading in upward & downward trend.

VIVA-QUESTIONS

1. Define Torque.

Torque can be defined as a measure of the tendency of a force to rotate the body on which it acts about an axis.

. Differentiate between force and torque?

Force	Torque
• Force is the linear load acting on the member. • The mechanical quantity which changes or tends to change the motion or shape of a body to which it is applied is called force.	• Torque is just a rotational force or force through a distance. It is a moment vector of a force. • It is defined as a measure of the tendency of a force to rotate body on which it acts about an axis.

3. List any two methods employed for measuring torque.

- Torque reaction methods.
- Proney brake.
- Torque measurement using strain gauges.
- Torque measurement using torsion bars.

4. Why laser is preferred in Engineering metrology?

Used in engineering metrology because of its properties such as high precision,

high accuracy, rapid non-contact gauging of soft, delicate or hot moving points.

5. What is the purpose of torque measurement?

The main purpose of torque measurement is to determine the mechanical power required by a machine

6. Name the instrument used for measurement of torque.

- Mechanical torsion meter
- Optical torsion meter
- Electrical torsion meter
- Strain gauge torsion meter