SRI SHANMUGHA COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, Affiliated to Anna University and Accredited by NAAC & NBA (ECE)

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DEPARTMENT OF MECHANICAL ENGINEERING

ME8513 - Metrology and Measurements Laboratory

Vision and Mission of the Department

VISION

To prepare competent mechanical engineers capable of working in an interdisciplinary environment contributing to society through innovation, leadership and entrepreneurship

MISSION

M1: To offer quality education which enables them in professional practice and career

M2: To provide learning opportunities in the state-of-the-art research facilities to create, interpret, apply and disseminate knowledge in their profession

M3: To prepare the students as professional engineers in the society with an awareness of environmental and ethical values

PROGRAMOUTCOMES (POs):

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health, safety, cultural, societal and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis, and interpretation of data and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, apply appropriate techniques, resources, modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal, environmental contexts, demonstrate the knowledge and need for sustainable development.

PO8 Ethics: Apply ethical principles, commit to professional ethics, responsibilities and norms of the engineering practice.

PO9 Individual and team work: Function effectively as an individual, as a member or leader in diverse teams and in multidisciplinary settings.

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community with society at large being able to comprehend, write effective reports, design documentation, make effective presentations and receive clear instructions.

PO11 Project management and finance: Demonstrate knowledge, understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 Life-long learning: Recognize the need, ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1 Manufacturing: Modelling, Simulation and Analysis in the field of Manufacturing.

PSO2 Design: Develop and implement new ideas on product design with help of modern CAD tools.

LABORATORY CLASSES – INSTRUCTIONS TO STUDENTS

1. Students must attend the lab classes with ID cards and in the prescribed uniform.
2. Boys-shirts tucked in and wearing closed leather shoes. Girls' students with cut shoes, overcoat, and plait incite the coat. Girls' students should not wear loose garments.
3. Students must check if the components, instruments and machinery are in working condition before setting up the experiment.
4. Power supply to the experimental set up/ equipment/ machine must be switched on only after the faculty checks and gives approval for doing the experiment. Students must start to the experiment. Students must start doing the experiments only after getting permissions from the faculty.
5. Any damage to any of the equipment/instrument/machine caused due to carelessness, the cost will be fully recovered from the individual (or) group of students.
6. Students may contact the lab in charge immediately for any unexpected incidents and emergency.
7. The apparatus used for the experiments must be cleaned and returned to the technicians, safely without any damage.
8. Make sure, while leaving the lab after the stipulated time, that all the power connections are switched off.
9. **EVALUATIONS:**
    - All students should go through the lab manual for the experiment to be carried out for that day and come fully prepared to complete the experiment within the prescribed periods. Student should complete the lab record work within the prescribed periods.
    - Students must be fully aware of the core competencies to be gained by doing experiment/exercise/programs.
    - Students should complete the lab record work within the prescribed periods.
    - The following aspects will be assessed during every exercise, in every lab class and marks will be awarded accordingly:
    - **Preparedness, conducting experiment, observation, calculation, results, record presentation, basic understanding and answering for viva questions.**

LIST OF EXPERIMENTS

Sl.No.	K Level	Name of the Experiment	Relevance to COs	Page No.
1.	K2	Precision measuring instruments used in metrology lab – A Study	CO1	
2.	K2	To build up the slip gauge for given dimension – A Study	CO1	
3.	K3	Thread parameters measurement using Tool Makers Microscope	CO2	
4.	K4	Calibration of dial gauge	CO4	
5.	K3	Determination of taper angle by sine bar method	CO2	
6.	K3	Determination of gear tooth thickness using gear tooth vernier	CO2	
7.	K3	Measurement of thread parameters using floating carriage micrometer	CO2	
8.	K4	Measurement of various dimensions using Coordinate Measuring Machine	CO3	
9.	K4	Measurement of surface roughness	CO3	
10.	K4	Measurement of bores using dial bore indicator and telescopic gauge	CO2	
11.	K4	Force measurement using load cell	CO2	
12.	K4	Torque measurement using strain gauge	CO2	
13.	K3	Temperature measurement using thermocouple	CO3	
14.	K3	Measurement of alignment using autocollimator	CO3	
Content Beyond the Syllabus				
1	K3	Thread parameters measurement using Profile projector	CO2	
2	K3	Displacement measurement – linear variable differential transducer (LVDT)	CO2	
3	K3	Measurement of vibration parameters using Vibration set up	CO3	

COURSE OUTCOME:

C309.1	Apply the knowledge of metrology to maintain quality of product for the safety of environment and society.
C309.2	Determine the quality of product using modern metrology tools
C309.3	Design a measuring equipment to produce high accuracy product
C309.4	Calibrate various measuring equipment to maintain standards
C309.5	Investigate the problem in quality control and give solution with the engineering knowledge

Course Outcomes	**Program Outcomes**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C309.1	3	1	2	3		2	1	1	2			3	2	1
C309.2	3	2	2	3	3	2	1	1	2			3	2	1
C309.3	3	2	3	3		2	1	1	2			3	2	1
C309.4	3	2	2	3		2	1	1	2			3	2	1
C309.5	3	2	2	3		2	1	1	2			3	2	1
C309	**3.0**	**1.8**	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**	**1.0**	**2.0**			**3.0**	**2.0**	**1.0**

FACULTY IN CHARGE **HOD**

Expt.No.01 PRECISION MEASURING INSTRUMENT USED IN METROLOGY LAB – A STUDY

Aim:

To study the following instruments and their usage for measuring dimensions of given specimen

1. Vernier caliper
2. Micrometer
3. Vernier height gauge
4. Depth micrometer
5. Universal bevel protractor

Apparatus required:

Surface plate, specimen and above instruments

Vernier caliper:

The principle of vernier caliper is to use the minor difference between the sizes two scales or divisions for measurement. The difference between them can be utilized to enhance the accuracy of measurement. The vernier caliper essentially consists of two steel rules, sliding along each other.

Parts:

Different parts of the vernier caliper are

1. Beam – It has main scale.
2. Fixed jaw
3. Sliding or Moving jaw – It has vernier scale and sliding jaw locking screw.
4. Fine adjustment clamp – It has fine adjustment clamp locking screw and fine adjustment screw knife edges for internal measurement.
5. Stem or depth bar for depth measurement

Least count:

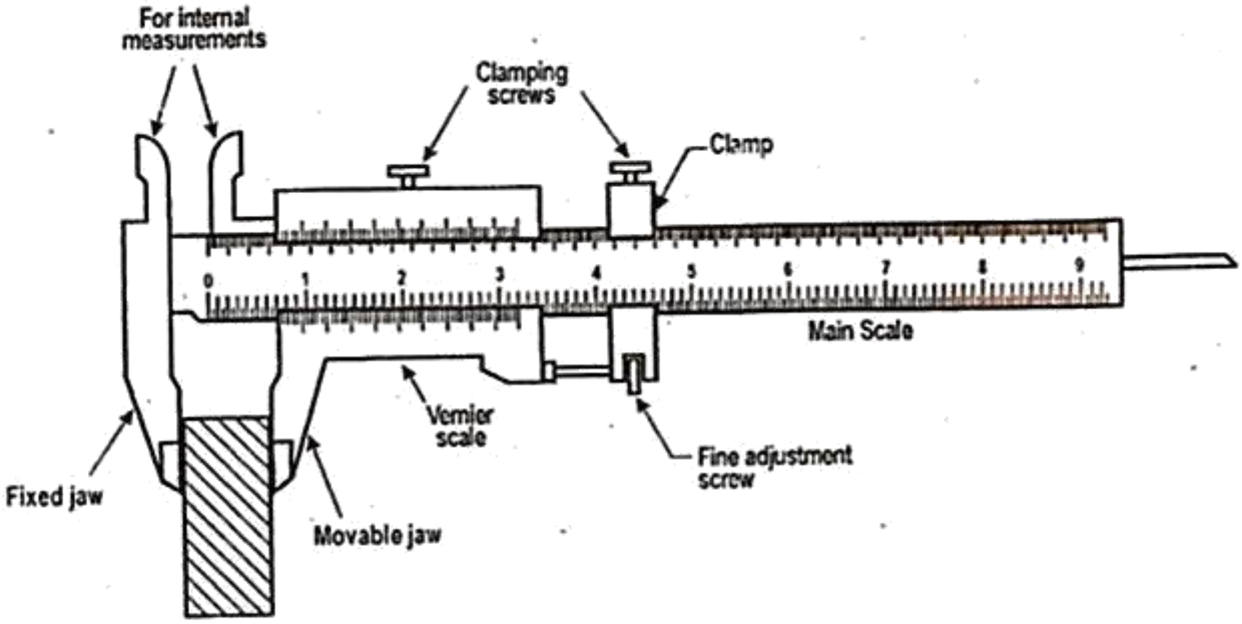
Least count = 1 MSD – 1 VSD

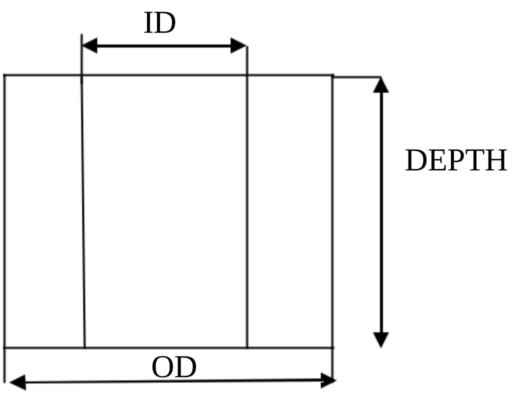
1 MSD = 1 mm

50 VSD = 49 mm

1 VSD = 0.98 mm

Least count = 1 – 0.98 = 0.02 mm





Measurement:

Given Vernier caliper can be used for external, internal depth, slot and step measurement.

Measurement principle:

When both jaws contact each other scale shows the zero reading. The finer adjustment of movable jaw can be done by the fine adjustment screw. First the whole movable jaw assembly is adjusted so that the two measuring tips just touch the part to be measured. Then the fine adjustment clamp locking screw is tightened. Final adjustment depending upon the sense of correct feel is made by the adjusting screw. After final adjustment has been made sliding jaw locking screw is also tightened and the reading is noted.

All the parts of the Vernier caliper are made of good quality steel and measuring faces are hardened.

Types of vernier:

Vernier caliper, electronic vernier caliper, vernier depth caliper

Tabulation:

	Main scale reading (MSR) (mm)	Vernier scale coincidence (VSC)	Vernier scale reading (VSR) (mm)	Total reading (MSR + VSR) (mm)
OD				
ID				
Depth				

Vernier height gauge:

Vernier height gauge is a sort of vernier caliper equipped with a special instrument suitable for height measurement. It is always kept on the surface plate and the use of the surfaces plates as datum surfaces is very essential.

Least count:

Least Count = 1 MSD – 1 VSD

1 MSD = 1 mm

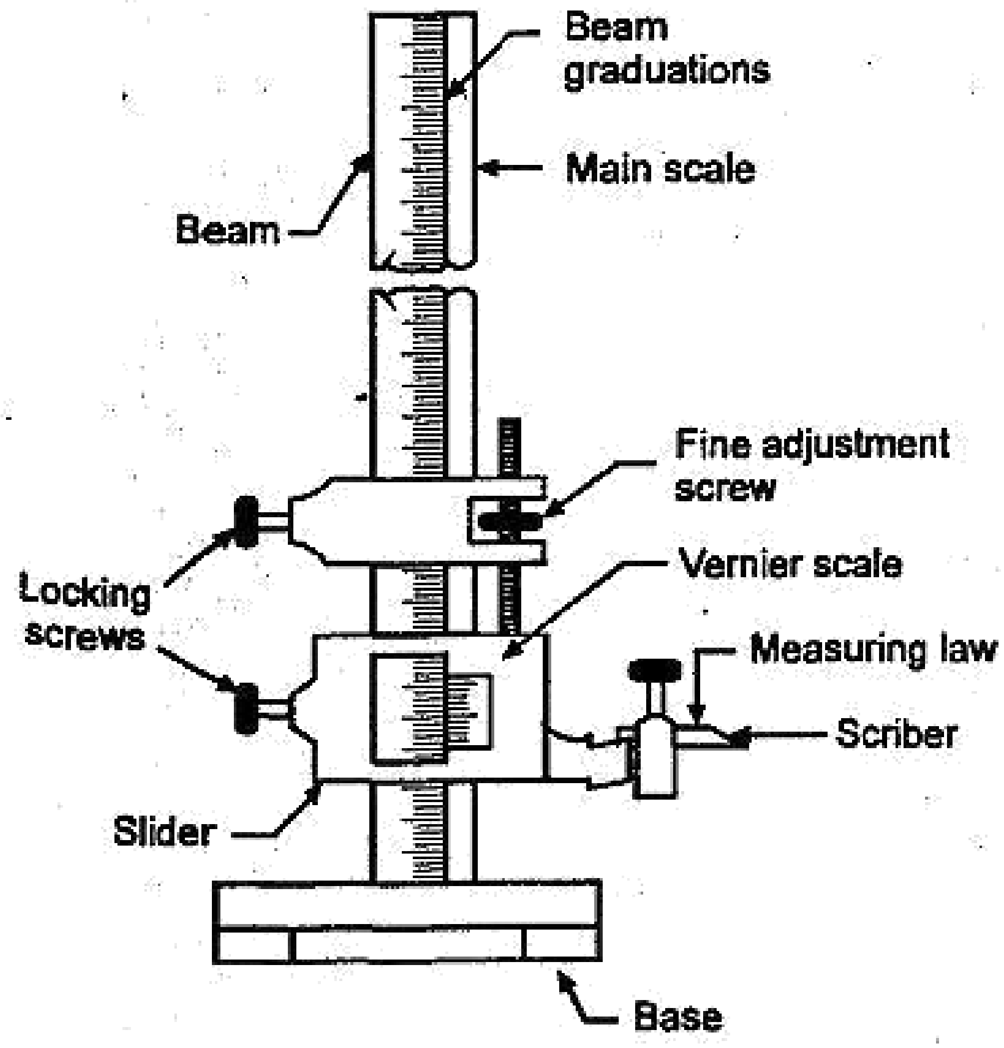
50 VSD = 49 mm

1 VSD = 0.98 mm

Least Count (LC) = 1 – 0.98 = 0.02 mm

Parts:

1. Base
2. Beam – It has main scale.
3. Slider – It has a vernier scale and slider locking screw.
4. Scriber
5. Fine adjustment clamp – It has fine adjustment clamp locking screw and fine adjustment screw.



Material:

All the parts of vernier are made of good quality steel and the measuring faces hardened.

Types of vernier gauge:

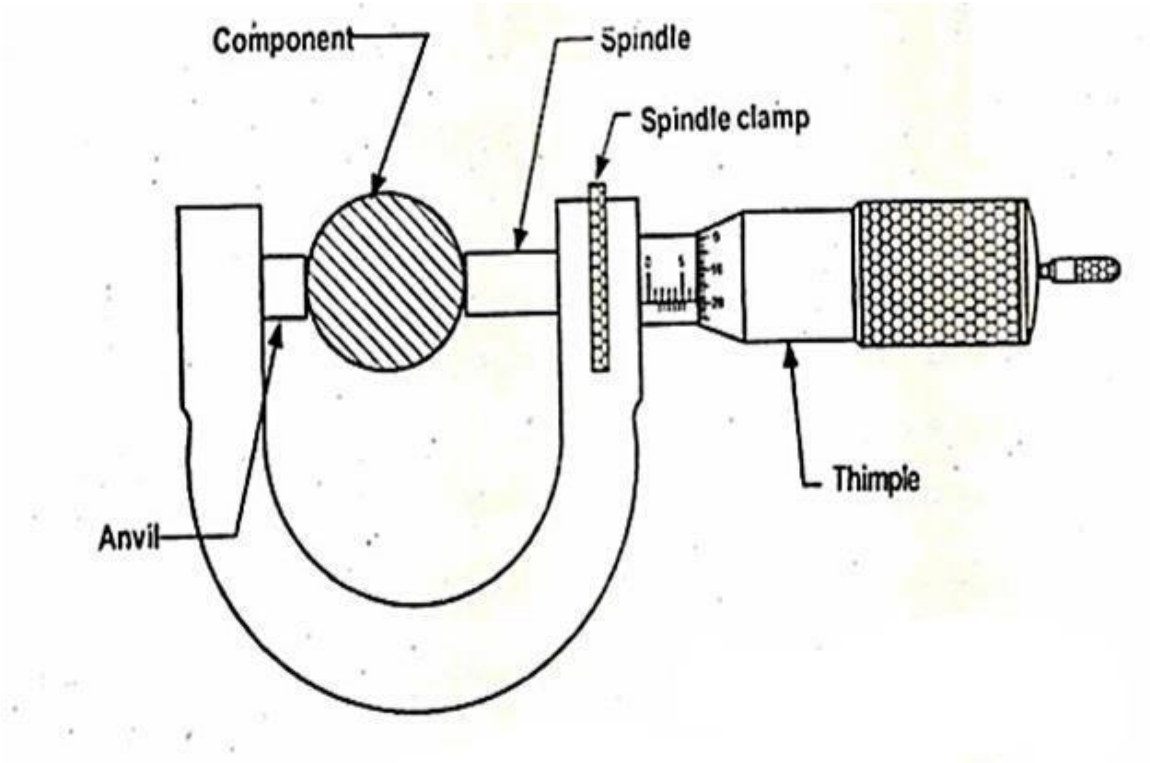
1. Analog vernier height gauge
2. Digital vernier height gauge
3. Electronic vernier height gauge

Tabulation:

Sl.No.	Main scale reading (MSR)(mm)	Vernier scale coincidence (VSC)	Vernier scale reading (VSR)(mm)	Total reading (MSR + VSR)(mm)
1.				
2.				
3.				

Outside micrometer:

The micrometer essentially consists of an accurate screw having about 10 or 20 threads per cm. The end of the screw forms one measuring tip and other measuring tip is constituted by a stationary anvil in the base of the frame. The screw is threaded for certain length and is plain afterwards. The plain portion is called spindle and its end is the measuring surface. The spindle is advanced or retracted by turning a thimble connected to a spindle. The spindle is a slide fit over the barrel and barrel is the fixed part attached with the frame. The barrel & thimble are graduated. The pitch of the screw threads is 0.5 mm.



Least count:

Least Count (LC) = Pitch / No. of divisions on the head scale

= 0.5 / 50 = 0.01 mm

Parts:

1. Frame
2. Anvil
3. Spindle
4. Spindle lock
5. Barrel or outside sleeve
6. Thimble – It has head scale. Thimble is divided into 50 divisions
7. Ratchet stop – Barrel is graduated into steps of 0.5 mm.

The least count of the given micrometer is 0.01 mm.

Measurement:

It can be used for any external measurement.

Types of micrometer:

1. Outside micrometer, 2. Inside micrometer, 3.Depth micrometer, 4. Stick micrometer, 5. Screw thread micrometer, 6. V – anvil micrometer, 7. Blade type micrometer, 8. Dial micrometer, 9. Bench micrometer, 10. Tape screw operated internal micrometer, 11. Groove micrometer, 12. Digital micrometer, 13.Differential screw micrometer, 14.Adjustable range outside micrometer.

Ratchet stop mechanism:

The object of the ratchet stop is to ensure that same level of torque is applied on the spindle while measuring and the sense of the feel of operator is eliminated and consistent readings are obtained. By providing this arrangement, the ratchet stop is made slip off when the torque applied to rotate the spindle exceeds the set torque. Thus this provision ensures the application of same amount of torque during the measurement.

Tabulation:

Sl.No.	Pitch Scale Reading (PSR) (mm)	Head Scale Coincidence (HSC)	Head scale reading (HSR x LC) (mm)	Total Reading (PSR + HSR) (mm)
1.				
2.				

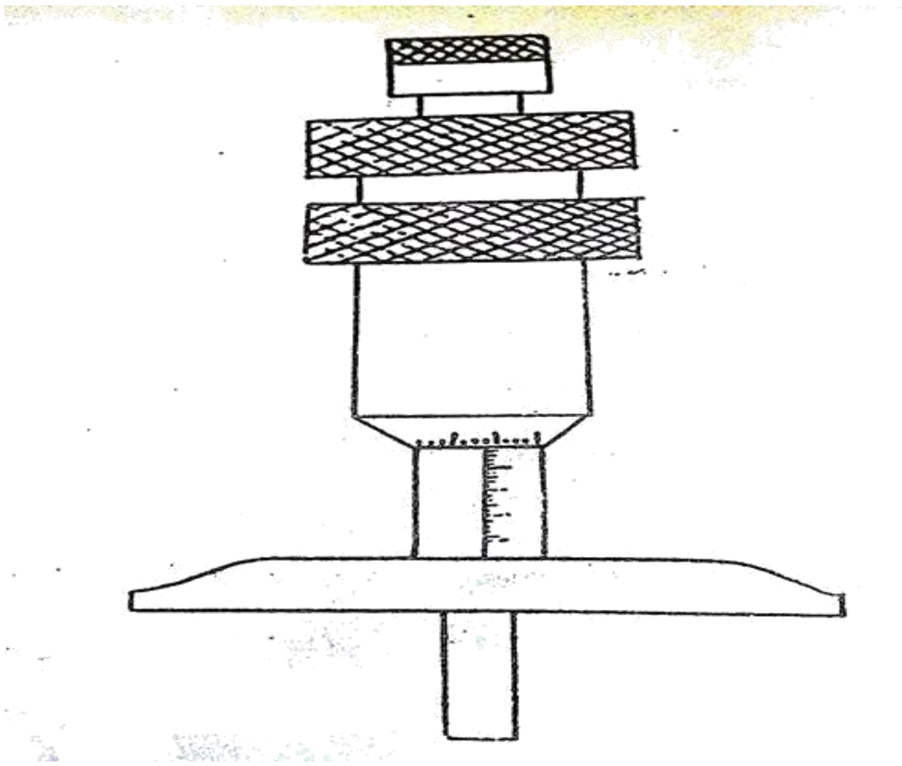
Depth micrometer:

Depth micrometer is a sort of micrometer which is mainly used for measuring depth of holes, so it is named as depth micrometer.

Parts:

1. Shoulder
2. Spindle
3. Spindle lock
4. Barrel or outside sleeve – It has pitch scale.
5. Thimble – It has head scale. Thimble is divided into 50 divisions.
6. Ratchet stop – Barrel is graduated into steps of 0.5 mm.

The least count of the given micrometer is 0.01 mm.



Least count:

Least Count = Pitch / No. of divisions on the head scale = 0.50/50

= 0.01 mm

Measurements:

It can be used for measuring the depth of holes, slots and recessed areas. The pitch of the screw thread is 0.5 mm. The least count is 0.01 mm. Shoulder acts as a reference surface and is held firmly and perpendicular to the centre line of the hole. For large range of measurement extension rods are used. In the barrel the scale is calibrated. The accuracy again depends upon the sense of touch.

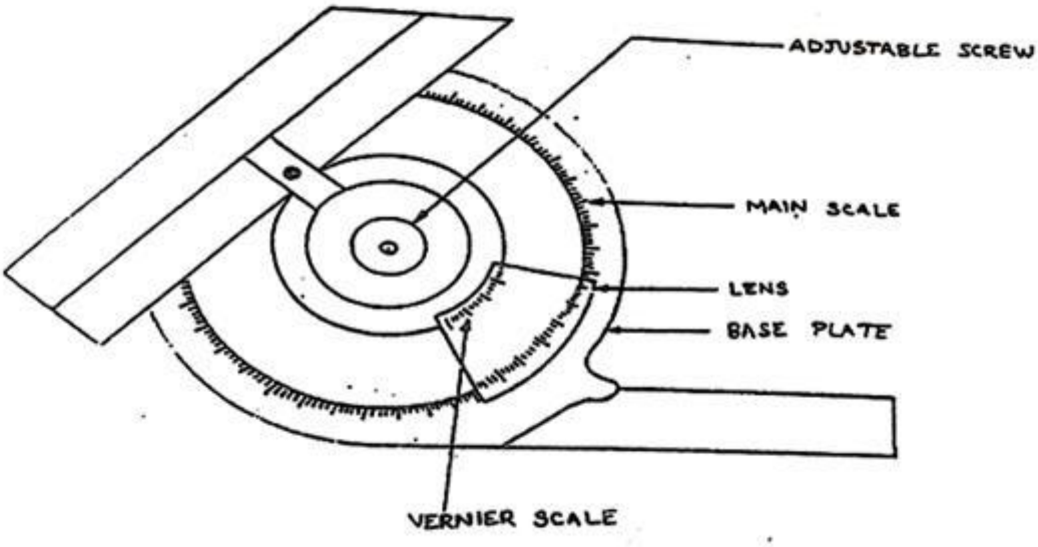
Procedure:

First, calculate the least count of the instrument. Check the zero error. Measure the specimen note down the main scale reading or the head scale reading. Note down the vernier or head scale coincidence with main or pitch scale divisions.

Tabulation:

Sl.No.	Pitch Scale Reading (PSR) (mm)	Head Scale Coincidence (HSC)	Head scale reading (HSR x LC) (mm)	Total Reading (PSR + HSR) (mm)
1.				
2.				

Universal bevel protractor:



Description:

Bevel protractor is an instrument for measuring the angle between the two faces of a specimen. It consists of a base plate on which a circular scale is engraved. It is graduated in degrees. An adjustment plate is attached to a circular plate containing the vernier scale. The adjustable blade can be locked in any position. The circular plate has 360 division divided into four parts of 90 degrees each. The adjustable parts have 24 divisions of to the right and left sides of zero reading. These scales are used according to the position of the specimen with respect to movable scale.

Procedure:

1. Place the specimen whose taper is to be measured between the adjustable plate and movable blade with one of its face parallel to the base.
2. Lock the adjustable plate in position and note down the main scale reading depending upon the direction of rotation of adjustable plate in clockwise or anticlockwise.
3. Note the VSC to the right of zero.
4. Multiply the VSC with the least count and add to MSR to obtain the actual reading.

Least count:

Least Count = 2 MSD – 1 VSD

1 MSD = 1° 24 VSD = 46° => 1 VSD = 23/12

LC = 2 – 23/12 = $1/12^\circ$ = 5’ (five minutes)

Tabulation:

Sl.No.	Main scale reading (MSR) (deg)	Vernier scale coincidence (VSC)	Vernier scale reading (VSR) (deg)	Total reading (MSR + VSR) (deg)
1.				
2.				

The angle of scriber of the vernier height gauge =

Result:

Thus the various precision measuring instruments used in metrology lab are studied and the specimen dimensions are recorded.

Outcome:

Student will become familiar with the different instruments that are available for linear, angular, roundness and roughness measurements they will be able to select and use the appropriate measuring instrument according to a specific requirement (in terms of accuracy, etc).

Application:

1. Quality Department

Viva-voce

1. Define – Metrology
2. Define – Inspection
3. What are the needs of inspection in industries?
4. What are the various methods involving the measurement?
5. Define – Precision
6. Define – Accuracy
7. Define – Calibration
8. Define – Repeatability
9. Define – Magnification
10. Define – Error
11. Define – Systematic Error
12. Define – Random Error
13. Define – Parallax Error
14. Define – Environmental Error
15. Define – Cosine Error

Expt.No.02 BUILD UP THE SLIP GAUGE FOR GIVEN DIMENSION – A STUDY

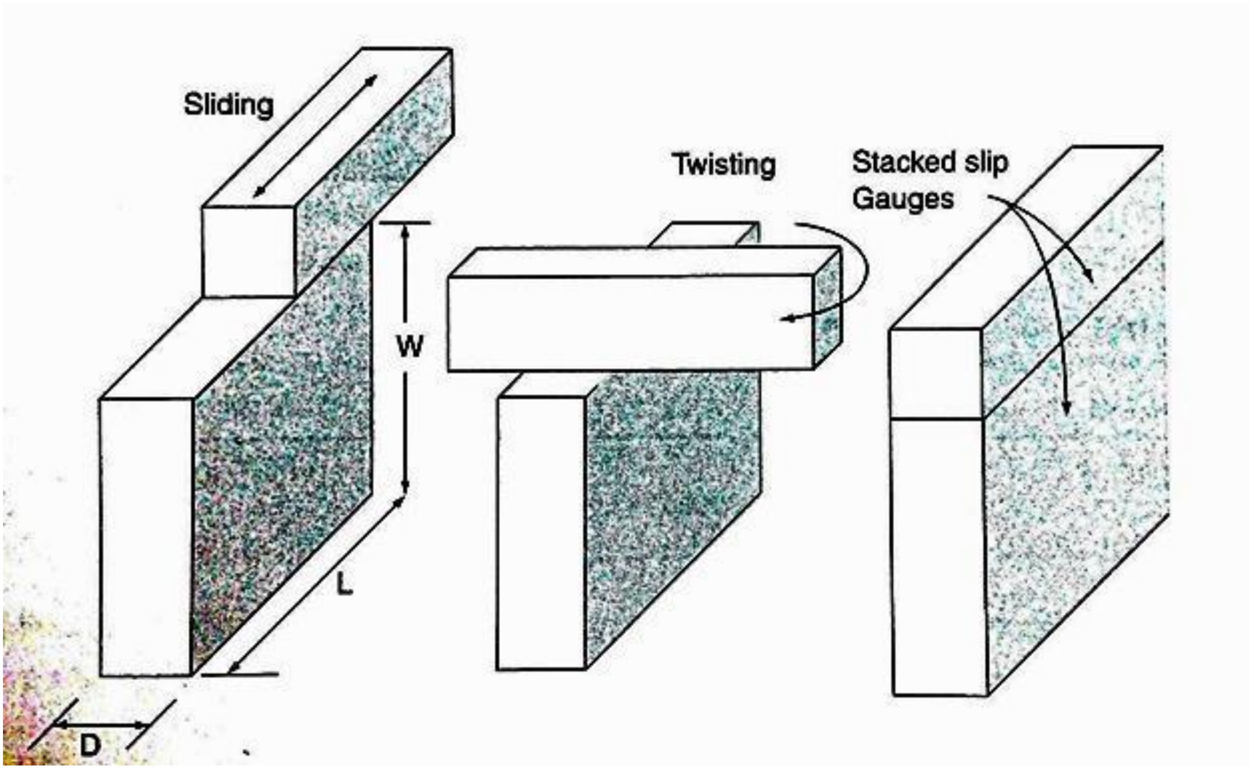
Aim:

To build up the slip gauge for given dimension

Apparatus required:

1. Slip gauges set
2. Surface plate
3. Soft cloth

Diagram:



Description:

Slip gauge are universally accepted standard of length in industry. They are the working standard for linear dimension. These were invented by a Swedish Engineer, C.E. Johansson. They are used

1. For direct precise measurement where the accuracy of the workpiece demand it.
2. For use with high- magnification comparators to establish the size of the gauge blocks in general use.
3. Gauge blocks are also used for many other purposes such as checking the accuracy of measuring instrument or setting up a comparator to a specific dimension, enabling a batch of component to be quickly and accurately checked or indeed in any situation where there is need to refer to standard of known length these blocks are rectangular.

Most gauge blocks are produced from high grade steel, hardened and established by a heat treatment process to give a high degree of dimensional stability. Gauge blocks are also manufactured from tungsten carbide which is an extremely hard and wear resistant material. The measuring faces have a lapped finish. The faces are perfectly flat and parallel to one another with a high degree of accuracy. Each block has an extremely high dimensional accuracy at 20_{o}C.

These slip gauge are available in variety of selected sets both in inch units and metric units. Letter 'E' is used for inch units and 'M' is used for metric standard number of pieces in a set following the letter E or M. For example EBI refers to a set whose blocks are in metric units and are 83 in number. Each block dimensions is printed on anyone of its face itself the size of any required standard being made up by combining the appropriate number of these different size blocks.

If two gauges are slid and twisted together under pressure they will firmly join together. This process, known as wringing, is very useful because it enables several gauge blocks to be assembled together to produce a required size. In fact the success of precision measurement by slip gauges depends on the phenomenon of wringing.

First the gauge is oscillated slightly with very light pressure over other gauge so as to detect pressure at any foreign particles between the surfaces. One gauge is placed perpendicular to other using standard gauging pressure and rotary motion is applied until the blocks are lined up.

Procedure:

1. Build the given dimension by wringing minimum number of slip gauges.
2. Note the given dimension and choose the minimum possible slip gauge available in the set so as to accommodate the last decimal value. The minimum slip gauge value dimension available i.e., 1.12 mm must be chosen followed by 1.5 mm thick gauge block.
3. Follow the above steps to build up the slip gauge of any dimension.

Precautions:

1. Slip gauges should be handled very carefully placed gently and should never be dropped.
2. Whenever a slip gauge is being removed from the set, its dimensions are noted and must be replaced into the set at its appropriate place only.
3. Correct procedure must be followed in wringing and also in removing the gauge blocks.
4. They should be cleaned well before use and petroleum jelly is applied after use.

Tabulation:

Range (mm)	Increment (mm)	No. of pieces

Total = ____________ Pieces

Total length of slip gauge = ________ mm

Given diameter	Slip gauges used	Obtained dimensions

Result:

Slip gauge set is studied and the given dimensions are building up by wringing minimum number of slip gauges.

Outcome:

Students will be able to select proper measuring instrument and know requirement of calibration, errors in measurement etc. They can perform accurate measurements.

Application:

1. Quality Department

Viva-voce

1. Why C.I. is preferred material for surface plates and tables?
2. Why V – blocks are generally manufactured in pairs?
3. Why micrometer is required to be tested for accuracy?
4. Define – Linear Measurement
5. List the linear measuring instrument according to their accuracy.
6. Define – Least Count
7. What are the uses of vernier depth gauge?
8. What are the uses of feeler gauges?
9. What are the uses of straight edge?
10. What are the uses of angle plate?
11. What are the uses of V – block?
12. What are the uses of combination square?
13. What precautions should be taken while using slip gauges?
14. What is wringing?
15. Why the slip gauges are termed as “End standard”?

Expt.No.03 **THREAD PARAMETERS MEASUREMENT USING TOOL MAKERS MICROSCOPE**

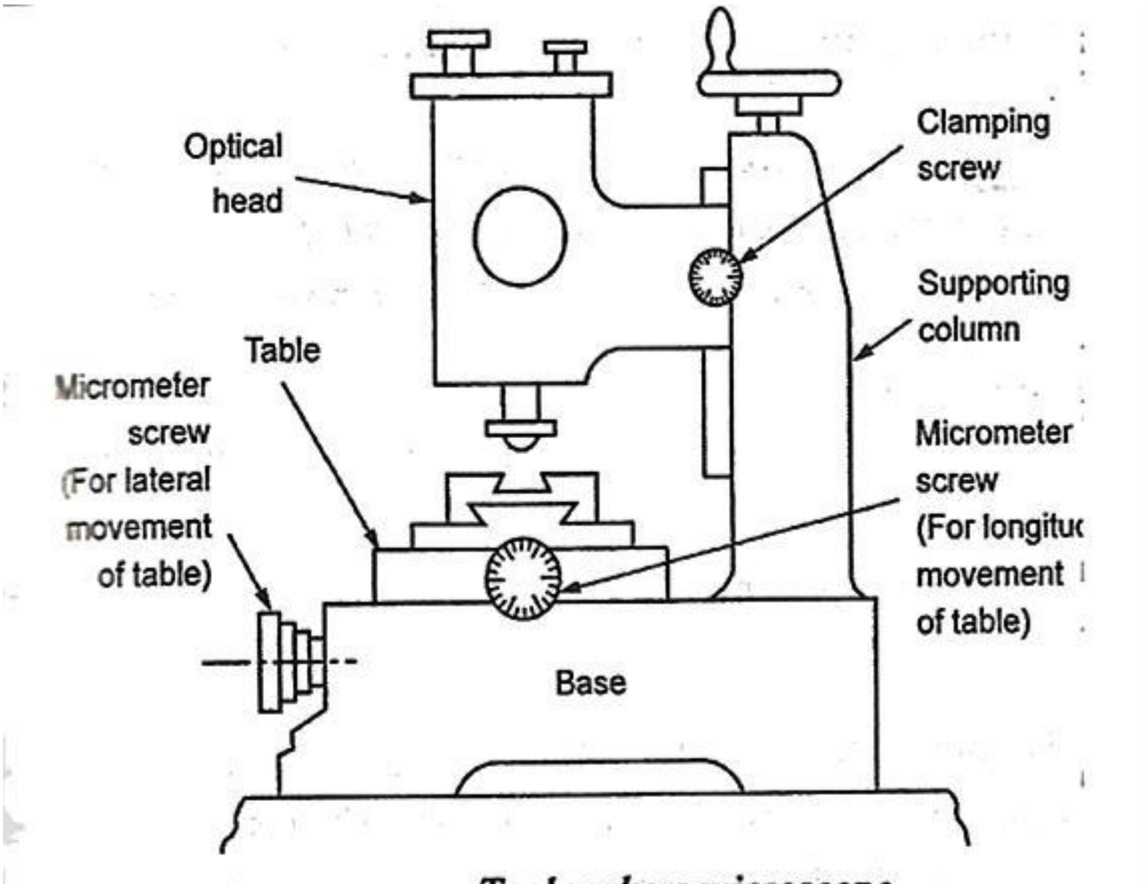
Aim:

To study the tool makers microscope and in the process measure the various dimensions of the given specimen

Apparatus required:

1. Tool makers microscope
2. Specimen

Diagram:



Tool makers microscope

Description:

The tool maker's microscope is designed for measurement of parts of complex forms; for example, profile of a tool having external threads. It can also be used for measuring centre to centre distance of the holes in any plane as well as the coordinates of the outline of a complex template gauge, using the coordinates measuring system.

Basically it consists of an optical head which can be adjusted vertically along the ways of supporting column. The optical head can be clamped at any position by a screw. On the work table (which as a circular base in which there are graduations) the part to be inspected is placed. The table has a compound slide by means of which the part can be measured. For giving these two movements, there are two micrometer screws having thimble scales and verniers. At the back of the base light source is arranged that provides horizontal beam of light, reflected from a mirror by 90 degrees upwards towards the table. The beam of light passes through the transparent glass plate on which flat plates can be checked are placed. Observations are made through the eyepiece of the optical head.

Procedure:

1. Place the given specimen on the work table and switch on all the three light sources and adjust the intensity of the light source until a clean image of the cross wires and specimen are seen through the eyepiece.
2. Coincide one of the two extreme edges between which the measurement has to be taken with vertical or horizontal cross wires and depending upon the other image coincide with the same cross wires by moving the above device. Note the reading.The difference between the two readings gives the value of the required measurement.
3. Note the experiment specimen and the readings.
4. Tabulate the different measurements measured from the specimen.

Determination of thread parameters

Magnification =

S.No.	Parameters	Magnified value (mm)	Actual value (mm)
1.	Outer diameter (O.D)		
2.	Internal diameter (I.D)		
3.	Pitch		
4.	Flank angle		

Result:

Included angle of the tool was measured using tool maker’s microscope and various dimensions of the given specimen are measured.

Outcome:

Students will be able to understand the various parameters of thread and select proper measuring instrument and know requirement of calibration, errors in measurement etc. They can perform accurate measurements.

Application:

1. Machine Shop
2. Quality Department

Viva-voce

1. What is meant by tool maker's microscope?
2. What is the light used in tool maker's microscope?
3. What are the various characteristics that you would measure in a screw thread?
4. What are the instruments that are required for measuring screw thread?
5. Define – Pitch
6. What are the causes of pitch error?
7. Define – Flank
8. What are the effects of flank angle error?
9. What is progressive error?
10. What is periodic error?
11. What is drunken error?
12. What is erratic error?
13. What are the applications of tool maker's microscope?
14. What are the limitations of tool maker's microscope?
15. What are the advantages of tool maker's microscope?

Expt.No.04 CALIBRATION OF DIAL GAUGE USING SLIP GAUGE

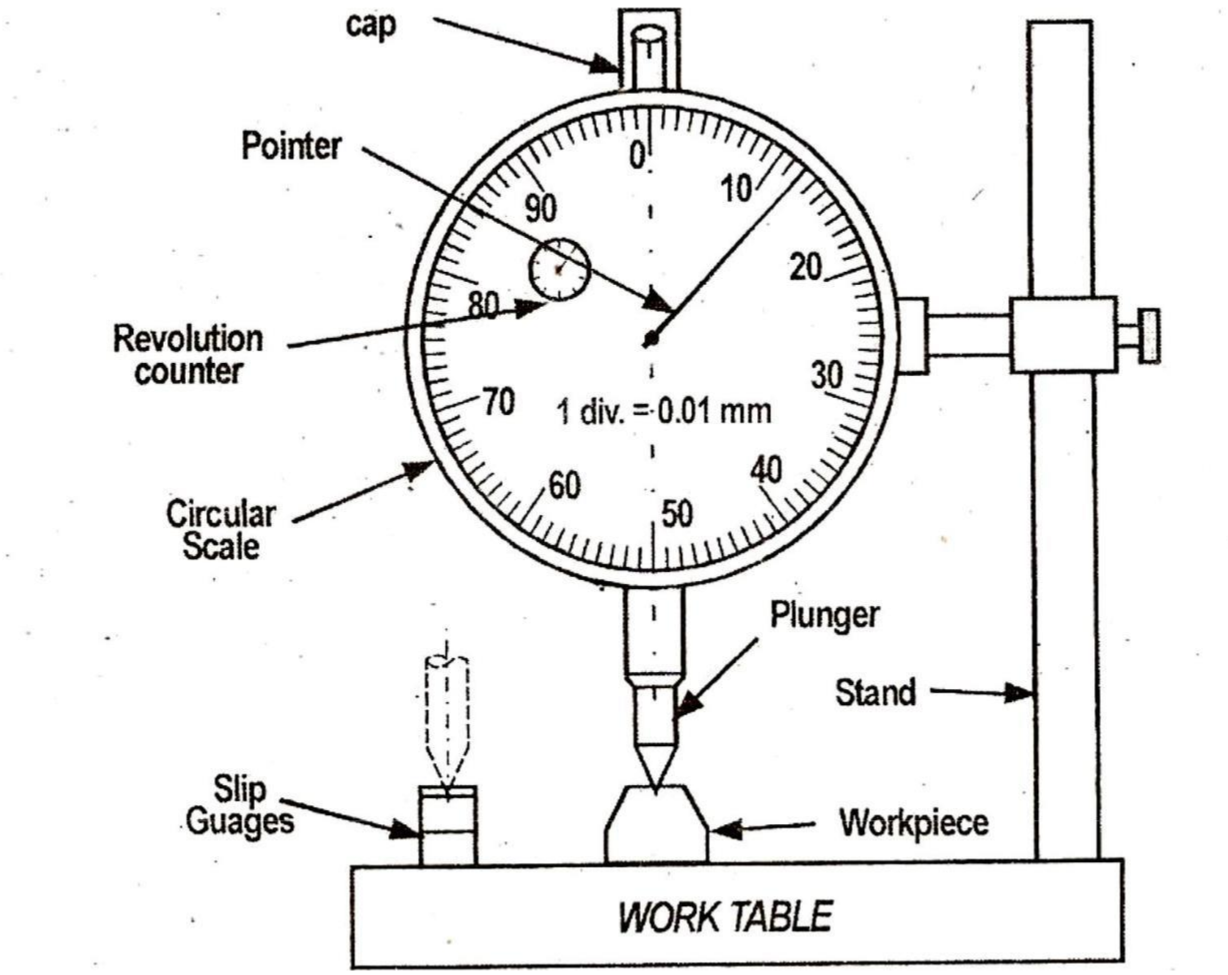
Aim:

To find the accuracy and standard error of the given dial gauge

Apparatus required:

Dial gauge, magnetic stand, slip gauge, and surface plate

Diagram:



Description:

The dial test indicator is a precision measuring instrument which can convert linear motion into angular motion by means of transmission mechanics of rack and pinion and can be used to measure linear vibration and errors of shape.

This instrument has the features such as good appearance, compact size, light weight, high precision, reasonable construction, constant measuring face etc. Rigidity of all parts is excellent. Probe is tipped with carbide balls. A shock proof mechanism is provided for those with larger measuring range.

Types of dial indicator:

1. Plunger type
2. Lever type

Plunger type dial indicator has a resolution counter and each division in main scale is 0.01 mm. In lever type dial test indicator is replaced by ball type stylus.

Procedure:

1. Fix the dial gauge to the stand rigidly and place the stand on the surface plate.
2. Set the plunger of dial gauge to first touch the upper surface of standard slip gauge and set indicator to zero.
3. Raise then the plunger by pulling the screw above the dial scale.
4. Place the standard slip gauge underneath the plunger.
5. Release the plunger and let it to touch the standard slip gauge.
6. Note the reading on the dial scale.

Formulae:

The standard error of dial gauge is calculated by the formula

$$\text{Standard Error} = \sqrt{\frac{\Sigma(\grave{x}-x)^2}{(n-1)}}$$

x = slip guage reading
$\grave{x}$ = Dial guage reading
n = no. of readings.

Tabulation:

S.No.	Slip gauge reading 'x' (mm)	Dial gauge reading (mm)		(x' - x)2
		x'	(x' - x)	
1.				
2				

Result:

Thus the accuracy and standard error of dial gauge is found. The standard error of given dial gauge is

__________.

Outcome:

Students will be able to check the variation in tolerance during the inspection process of a machined part, measure the deflection of a beam or ring under laboratory conditions, as well as many other situations where a small measurement needs to be registered or indicated

Application:

1. Milling Machine
2. Analog versus digital/electronic readout

Viva-voce

1. What is comparator?
2. What are the types of comparators?
3. What is the LC for comparators?
4. What are the applications of comparator?
5. What is meant by plunger?
6. What are the types of dial indicators?
7. Why a revolution counter is not provided in lever type dial test indicator?
8. Draw a line diagram of the operating mechanism of plunger type dial test indicator.
9. Explain the term magnification of a dial indicator.
10. What are the uses of dial test indicator?
11. What are the practical applications of dial test indicator?
12. What precautions should be taken while using dial test indicator?
13. What are the desirable qualities of a dial test indicator?
14. What are the advantages of dial test indicator?
15. What are the limitations of dial test indicator?
16. Distinguish between comparator and measuring instrument.
17. What are the advantages of electrical comparator?
18. What are the advantages of optical comparator?
19. What are the uses of comparator?
20. What are the advantages and disadvantages of mechanical comparator?

Expt.No.05 DETERMINATION OF TAPER ANGLE BY SINE BAR METHOD

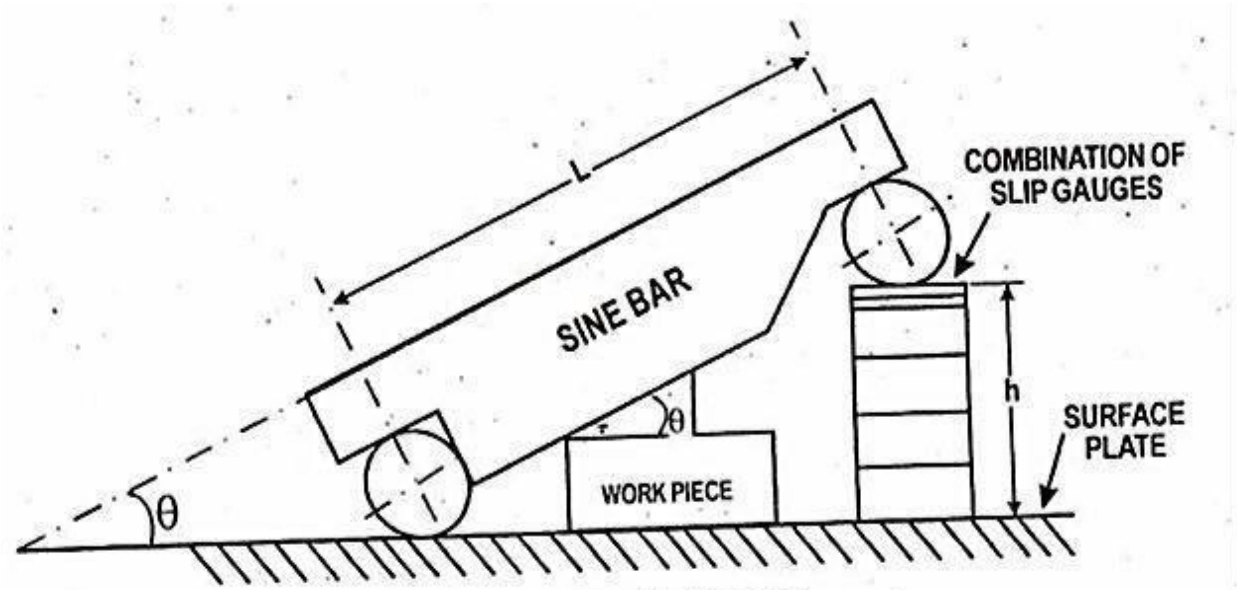
Aim:

To measure taper angle of the given specimen using Sine bar method and compare

Apparatus required:

Sine bar, slip gauges, dial gauge with stand, micrometer, surface plate, bevel protractor, vernier caliper

Diagram:



Measurement of angle Using Sine bar

Description:

The sine bar principle uses the ratio of the length of two sides of a right triangle. It may be noted that devices operating on sine principle are capable of 'self-generation'. The measurement is restricted to 45$_{o}$from accuracy point of view. Sine bar itself is not a measuring instrument.

Accuracy requirements of sine bar:

1. The axes of the rollers must be parallel to each other and the centre distance L must be precisely known.
2. The sine bar must be flat and parallel to the plane connecting the axes of the rollers.
3. The rollers must be of identical diameters and must have within a close tolerance.

Procedure:

1. Fix the dial gaugeon the magnetic stand and place the magnetic stand on the surface plate.Check the parallelism of the sine bar.
2. Place the given specimen above the sine bar and place the dial gauge on top of the specimen. Adjustthe dial gauge for zero deflection.
3. Raise the front end of the sine bar with slip gauges until the work surface is parallel to the datum surface.
4. Check the parallelism using dial gauge.
5. Measure the distance between the centres of the sine bar rollers as ‘L’ and note the height of the slip gauge as ‘H’.
6. Note the included angle of the specimen.

Formulae:

Sin Ө = H/L where Ө = Included angle of the specimen
H = Height of slip gauges
L = Distance between the centre of rollers

Tabulation:

S.No.	L (mm)	H (mm)	Taper angle (Ө)
1.			
2.			
3.			

Result:

The taper angle of the given specimen using sine bar was found to be =

Outcome:

Student will become familiar with the different instruments that are available for angular measurements and they will be able to select and use the appropriate measuring instrument according to a specific requirement (in terms of accuracy, etc).

Application:

1. Flat Surface
2. Granite

Viva-voce

1. List out the various angle measuring instruments.
2. What is the working principles sine bar?
3. How is a sine bar used to measure the angle?
4. What is the application of sine bar?
5. What is the material of sine bar?
6. Why sine bar is not preferred to use for measuring angles more than 45^0?
7. What are the features of sine bar?
8. A 100 mm sine bar is to be set up to an angle of 33^0, determine the slip gauges needed from 87 pieces set.
9. What are the various instruments used for measuring angles?
10. What is sine bar?
11. How sine bar is used for angle measurement?
12. Explain how sine bar is used to measure angle of small size component.
13. Explain how sine bar is used to measure angle of large size component.
14. What are the various types of sine bar?
15. What are the limitations of sine bar?
16. What is sine center?
17. What is sine table?
18. What are the possible sources of errors in angular measurement by sine bar?
19. What are angle gauges?
20. How angle gauges are used for measuring angles?

Expt.No.06 DETERMINATION OF GEAR TOOTH THICKNESS USING GEAR TOOTH VERNIER

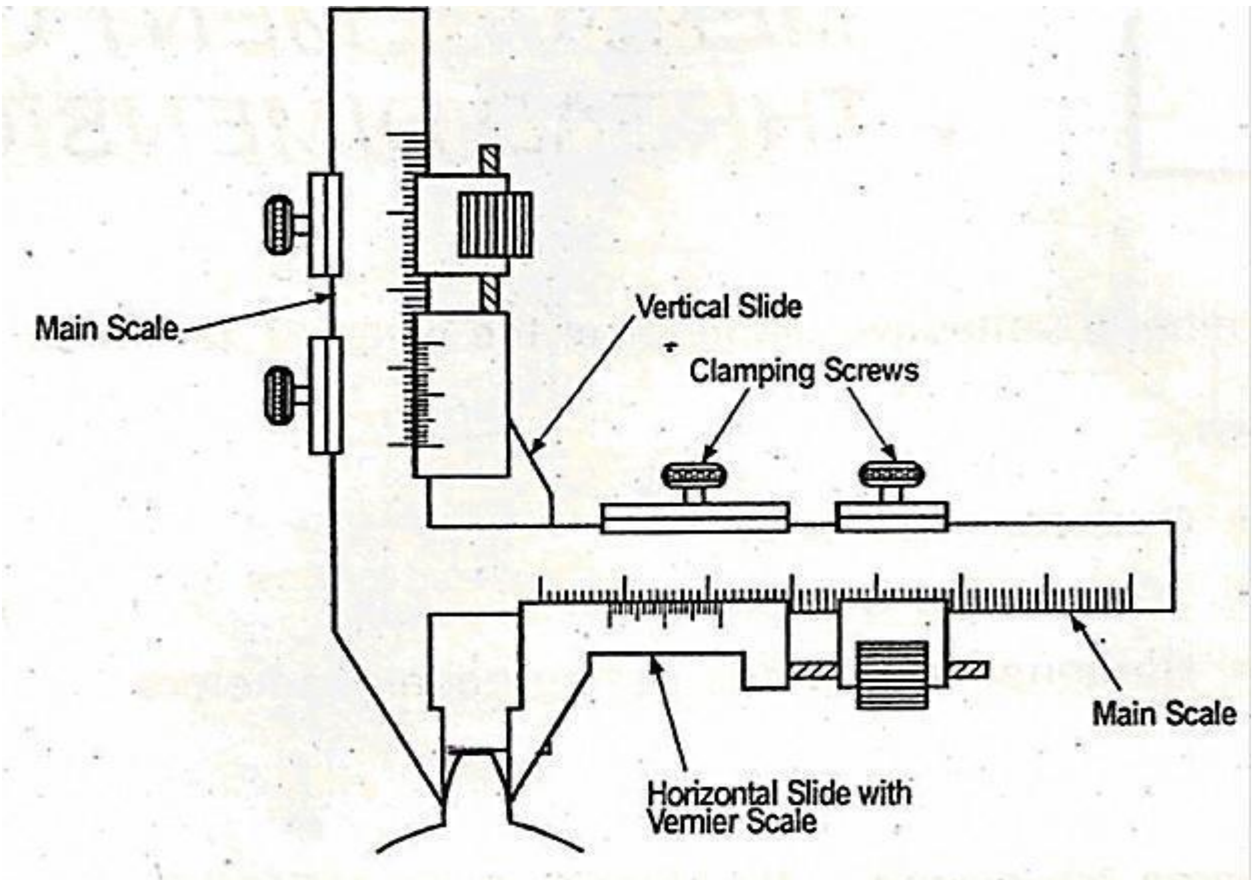
Aim:

To determine the thickness of tooth of the given gear specimen and to draw the graph between the tooth number and the error in thickness

Apparatus required:

Gear tooth vernier, specimen, surface plate and vernier caliper

Diagram:



Description:

The tooth thickness, in general, is measured at pitch circle since gear tooth thickness varies from the tip to the base circle of the tooth. This is possible only when there is an arrangement to fix that position for this measurement by the gear tooth vernier. It has two vernier scales; one is vertical and other is horizontal.

Procedure:

1. Measure initially the outside diameter of the given gear specimen by means of a vertical calculation of vernier caliper. Note the number of teeth. Calculate the module (m) using the formula.

   M = OD/ (Z+2) where z – number of
   teeth M - Module
2. Calculate the theoretical tooth thickness (t) by t = z * m* sin (90/z).
3. Set the vernier scale for the height and tighten.
4. Measure the thickness of each tooth using the horizontal scale. This is measured thickness. It can

   be positive or negative.

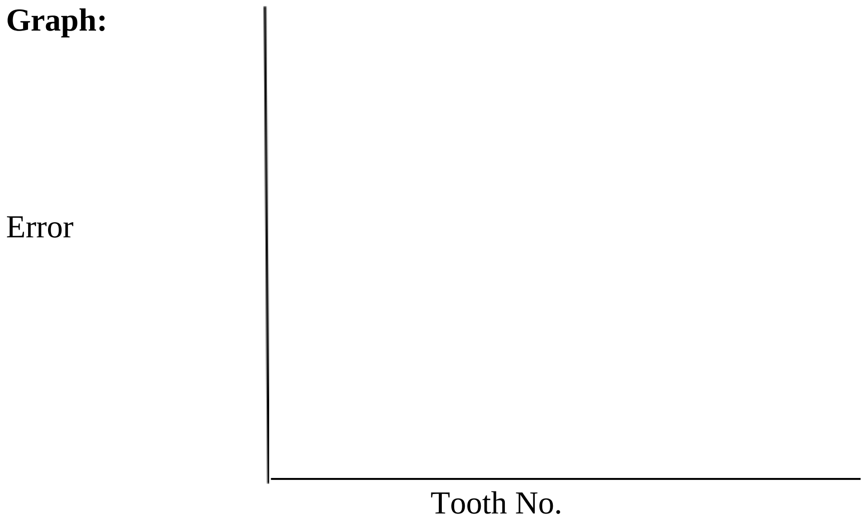
   H = m x [1+ Z/2 (1- Cos 90/Z)]
5. Calculate the error in the tooth thickness i.e,1. measured thickness – Theoretical thickness
6. Draw the graph between the tooth number and the error in thickness.

Tabulation:

Tooth Number	Measured Thickness (mm)	Theoretical Thickness (mm)	Error in tooth thickness (mm)
1			
2			
3			

Tooth Number	MSR (mm)	VSC	VSR (mm)	TR (mm)
1				
2				
3				

Graph:



Result:

The theoretical experiment value of gear tooth thickness is obtained and graph is drawn between error and tooth number in tooth thickness

Theoretical tooth thickness =

Experimental tooth thickness =

Error in tooth thickness =

Outcome:

Students will be able to understand the basic measurement units and able to calibrate various measuring parameters of the gear.

Application:

1. Gear Component
2. Mining

Viva-voce

1. Calculate the setting of a gear tooth vernier caliper for a straight spur gear having 40 teeth and module 4.
2. What is the importance of chordal depth?
3. Define – Chordal width
4. How is the actual profile of the gear tooth determined?
5. What are the manufacturing errors in gear element?
6. Define – Addendum
7. Define – Dedendum
8. Define – Flank of tooth
9. Define – Pitch
10. Define – Pitch Circle
11. Define – Crest of tooth
12. Define – Root of tooth
13. Define – Base Circle
14. Define – Module
15. Define – Angle of Obliquity

<u>Expt.No.07</u> <u>MEASUREMENT OF THREAD PARAMETER USING FLOATING CARRIAGE MICROMETER</u>

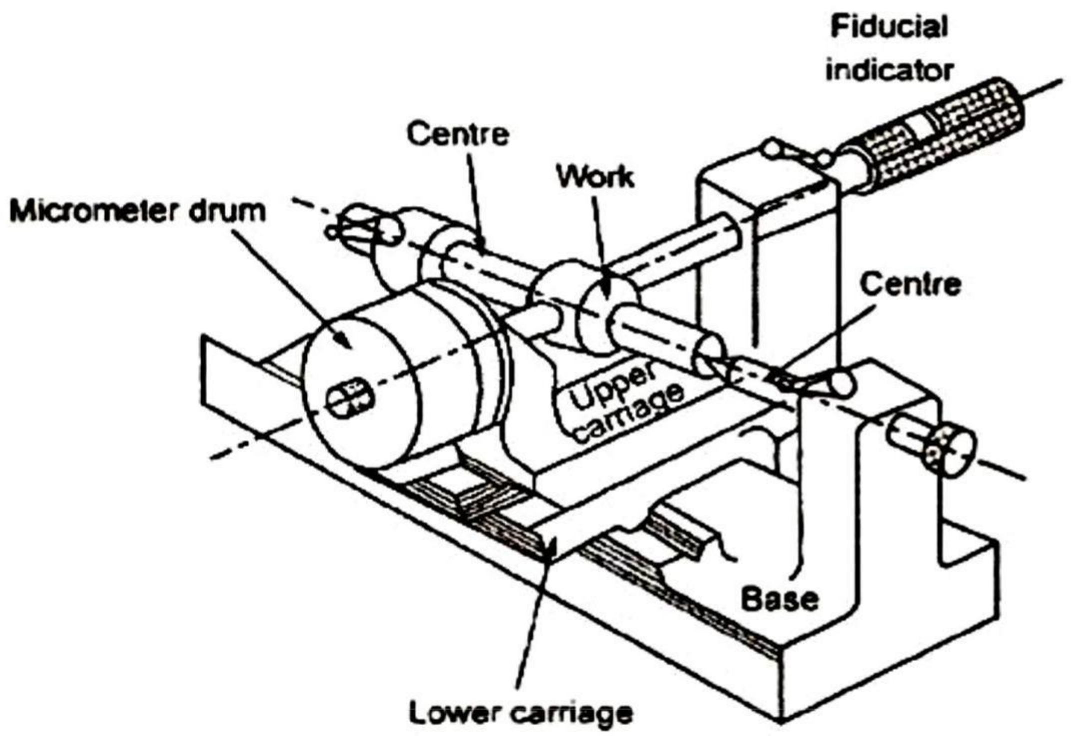
Aim:

To measure the effective diameter of a screw thread using floating carriage micrometer by two wire method

Apparatus required:

1. Floating carriage micrometer
2. Standard wire
3. Given specimen (screw thread)

Diagram:



Description of floating carriage micrometer:

It consists of three main units. A base casting carries a pair of centres on which threaded work piece is to be mounted. Another carriage capable of moving towards centre is mounted exactly above. In this carriage one head with thimble to measure up to 0.002 mm is provided and at the other side of head a fiducial indicator is provided to indicate zero position.

Procedure:

1. For two wire method, place the standard wire over a thread of the screw at opposite sides.
2. For three wire method, place two standard wires on two successive threads and the third wire placed opposite sides of the thread.
3. Measure the diameter over wires (M) using floating carriage micrometer.
4. Repeat this procedure at various positions of the screw and take different readings.

Formulae:

1. For best wire size, d = P / 2 Cos
   (x/2) Where, P = Pitch
   d= wire size
   x = angle between two threads
   = 60^o for metric thread
2. Actual effective diameter, E.A = M – 3d + 0.866 p
3. Nominal effective diameter, EN = D – 0.648 p
4. Max. wire size = 1.01 p
5. Min. wire size = 0.505 p
6. Best wire size = 0.577 p

M = Diameter over wires

P = Pitch of thread

For metric thread:

Actual effective diameter (EA) = M – 3d + 0.866 p

Where d = actual diameter of wire

Determination of actual and nominal effective diameter of the screw thread:

Sl.No.	Nominal Diameter (D) (mm)	Diameter over wire ‘M’ (mm)	Actual eff. Diameter E.A (mm)	Nominal eff. Diameter E.N (mm)	Error in effective diameter (E.A – E.N) (mm)
1.					
2.					
3.					

Result:

Thus the actual and nominal effective diameter is measured using three wire method and the error in effective diameter of screw is determined.

Outcome:

Student will become familiar with the different instruments that are available for roundness measurements and they will be able to select and use the appropriate measuring instrument according to a specific requirement (in terms of accuracy, etc).

Application:

1. Wholse
2. Maxxis Rubber India

Viva-voce

1. Define – Pitch
2. Define – Flank Angle
3. What is plug gauge?
4. What is meant by micrometer?
5. What is meant by indicator?
6. What is best – size wire?
7. Calculate the diameter of the best wire for an M 20 x 25 screws.
8. What are the different corrections to be applied in the measurement of effective diameter by the method of wire?
9. What is floating carriage micrometer?
10. What are the uses of floating carriage micrometer?
11. What are the methods are used for measuring effective diameter?
12. Define – Effective Diameter
13. Define – Major Diameter
14. Define – Minor Diameter
15. What are the effects of flank error?
16. Define – Rake Angle
17. Define – Pitch Cylinder
18. What are the effects of pitch error?
19. Define – Pitch Diameter
20. What is meant by angle of thread?

Expt.No.08 MEASUREMENT OF VARIOUS DIMENSIONS USING COORDINATE MEASURING MACHINE

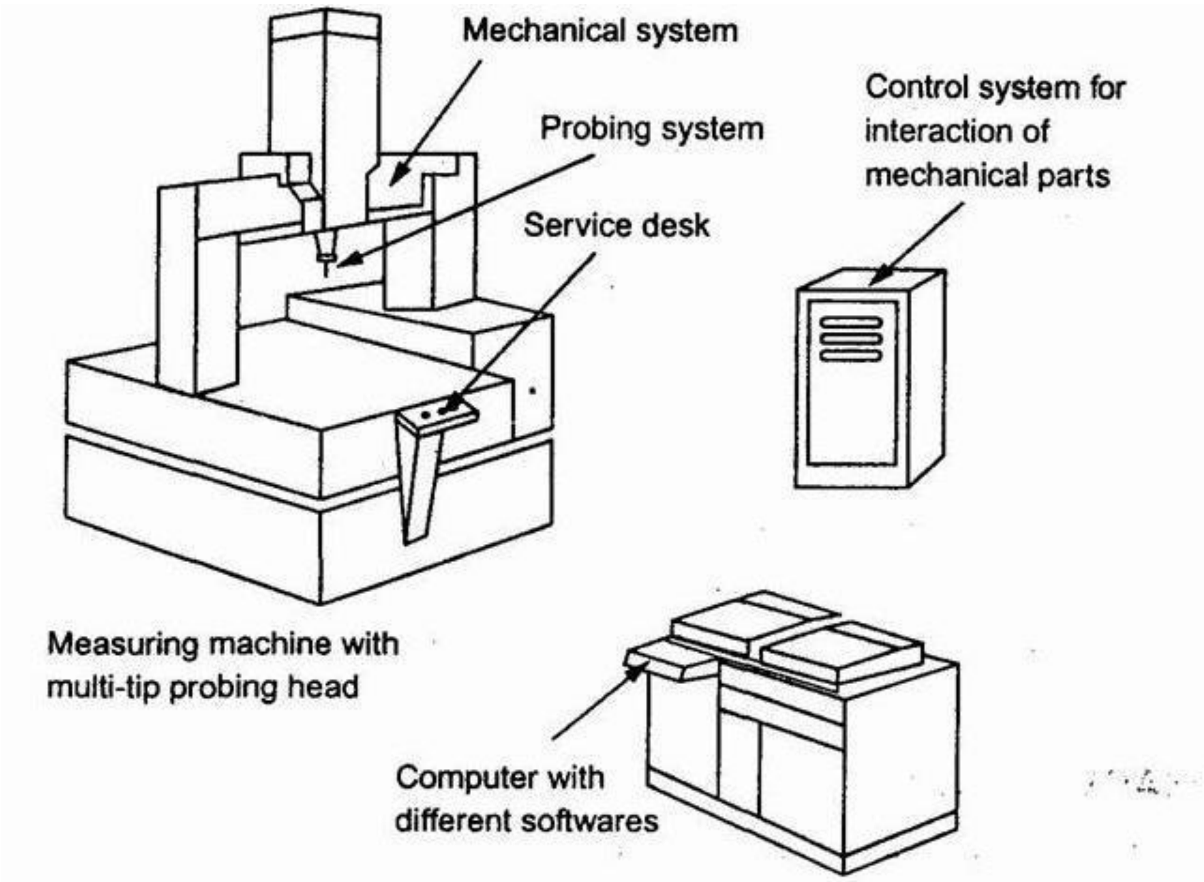
Aim:

1. To study the construction and operation of coordinate measuring machine
2. To measure the specified dimensions of the given component

Instruments used:

Coordinate measuring machine, vernier calipers

Diagram:



Theory:

A coordinate measuring machine (CMM) is a 3D device for measuring the physical and geometrical characteristics of an object. This machine may be manually controlled by an operator or it may be computer controlled. Measurements are defined by a probe attached to the three moving axis of this machine X, Y and Z axes. A coordinate measuring machine (CMM) is also a device used in manufacturing and assembly processes to test a part or assembly against the design intent. By precisely recording the X, Y and Z coordinates of the target, points are generated which can be analyzed via regression algorithms for the construction of features. These points are collected by using a probe that is positioned manually by an operator or automatically via direct computer control (DCC). DCC CMMs can be programmed to repeatedly measure identical parts, thus a CMM is a specialized form of industrial robot.

Parts:

Coordinate measuring machine include three main components:

1. The main structures which include three axes of motion.
2. Probing system
3. Data collection and reduction system – typically includes a machine controller, desktop computer and application software

Machine description:

1. In modern machines, the gantry type superstructure has two legs and is often called a bridge. This moves freely along the granite table with one leg following a guide rail attached to one side of the granite table. The opposite leg simply rests on the granite table following the vertical surface contour.
2. Air bearings are fixed for ensuring friction free travel. Compressed air is forced through a series of very small holes in a flat bearing surface to provide a smooth but controlled air cushion on which the CMM can move in a frictionless manner.
3. The movement of the bridge along the granite table forms one axis of the XY plane. The bridge of the gantry contains a carriage which traverses between the inside and outside legs and forms the other X or Y horizontal axis.
4. The third axis of movement (Z axis) is provided by the addition of a vertical quill or spindle which moves up and down through the center of the carriage. The touch probe forms the sensing device on the end of the quill.
5. The movement of the X, Y and Z axes fully describes the measuring envelope. Some touch probes are themselves powered rotary devices with the probe tip able to swivel vertically through 90 degrees and through a full 360 degrees rotation.

Uses:

They are generally used for:

1. Dimensional measurement
2. Profile measurement
3. Angularity or orientation measurement
4. Depth mapping
5. Digitizing mapping
6. Shaft measurement

The machines are available in a wide range of sizes and designs with a variety of different probe technologies. They can be operated manually or automatically through direct computer control (DCC). They are offered in various configurations such as bench top, free – standing, handheld and portable.

Procedure:

1. Take at least 8 points on sphere ball attached to the granite table.
2. Fix the object whose dimension needs to be measured using the jigs and fixtures.
3. Using joystick, move the probe whose tip is made of ruby slowly and carefully to the surface whose measurements have to be taken.
4. Touch the probe at two places for measurement of a line (starting and ending point).
5. Touch the probe at two places for measurement of a circular profile and for a cylinder touch the probe at 8 points.
6. Measure the same profiles again with vernier calipers (length of line, circle diameter, cylinder diameter) to compare the two readings.

Comments:

1. The machine should be calibrated every time when it is being used.
2. While measuring the profiles, the probe should be moved very slowly as it may damage the ruby if hit with a high force.
3. Care should be taken while performing experiment so that the granite table of the machines should get any scratches.
4. ‘Retract distance’ should be fixed according to the space available in the near vicinity of the profile measurement area.

Observation:

Sl.No.	Feature	CMM reading (mm)	Vernier reading (mm)	Form error (mm)	Difference in two readings (mm)
1	Circle -1				
2	Circle -2				
3	Circle -3				
4	Line				
5	Arc				
6	Cone - Diameter				
	Cone – Vertex angle				
	Cone – Height				
7	Cylinder – Diameter				
	Cylinder – Height				

Result:

Thus the different profile of given object are measured using coordinate measuring machine

Outcome:

Students will be able to measures the geometry of physical objects by sensing discrete points on the surface of the object with a probe and they will be able to know the Various types of probes are used in CMMs, including mechanical, optical, laser, and white light.

Application:

1. Surface Measuring Equipment
2. Photo transistor

Viva-voce

1. What are the types of measuring machine?
2. What is CMM?
3. What are the types of CMM?
4. What are the advantages of CMM?
5. What are the limitations of CMM?
6. What are the possible sources of error in CMM?
7. What is the use of universal measuring machine?
8. What are the applications of CMM?
9. What is the working principle of three axis measuring machine?
10. What is image shearing microscope?
11. What is the use of electronic inspection and measuring machine?
12. What are the types of electronic inspection and measuring machine?
13. What is CMM probe?
14. What are the three main probes are available?
15. What are the types of stylus?

Expt.No.09 MEASUREMENT OF SURFACE ROUGHNESS UING TALYSURF INSTRUMENT

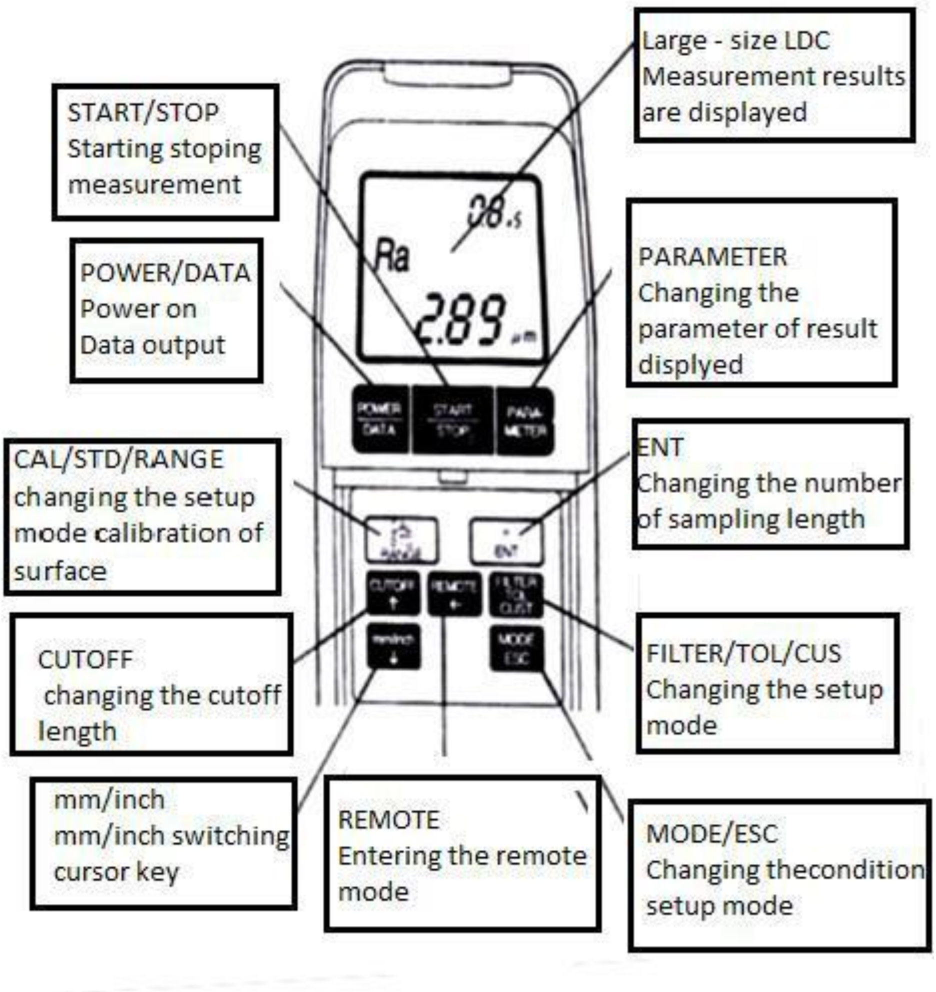
Aim:

To measure the surface roughness using Talysurf instrument

Apparatus required:

Talysurf instrument, work piece, surface plate

Diagram:



Theory:

On any finished surface, imperfections are bound to be there and these take the form of a succession of hills and valleys which vary both in height and in spacing and result in a kind of texture which in appearance or feel is often characteristic of the machining process and accompanying defects. The several kinds of departures are there on the surface and these are due to various causes.

Methods of measuring surface roughness:

1. Surface inspection of comparison methods
2. Direct instrument measurements

In comparative methods the surface texture is assessed by observation of the surface. But these methods are not reliable as they can be misleading, if comparison is not made with surfaces produced by same techniques. The various methods available under comparison method are: (i) Touch Inspection (ii)Scratch Inspection (iii) Microscopic Inspection (iv) Visual Inspection (v) Surface Photographs (vi) Reflected Light Intensity Direct Instrument Measurements enable to determine a numerical value of the surface finish of any surface. Nearly all instruments used are stylus probe type of instruments. This operates on electrical principle.

Procedure:

1. Place the finished component on the surface plate.
2. Fix the Talysurf tester to the vernier height gauge using adopter at a convenient height.
3. Make sure that the stylus probe touches the work piece.
4. Fix the sampling length in the tester.
5. Press the power button so that the probe moves on the surface to and fro.
6. Take the readings of the surface roughness directly from the instrument.
7. Repeat the above process for the remaining specimen and tabulate the readings.

Precautions:

1. The surface to be tested should be cleaned properly.
2. The tester should be fixed to the height gauge properly so that the movement of the probe is exactly parallel to the surface of work.
3. Make sure that the probe gently touches the work.

Tabulation:

S.No	Measurement roughness value, µm Sample direction Ra, Rz	Average Ra	Average Rz	Grade
1.				
2.				
3.				

Result:

Thus the surface roughness is checked for different specimens by Talysurf.

Outcome:

Student will become familiar with the different instruments that are available for roughness measurements they will be able to select and use the appropriate measuring instrument according to a specific requirement (in terms of accuracy, etc).

Application:

1. Machine Shop
2. Quality Department

Viva-voce

1. Define – Actual Size?
2. What is meant by normal surface?
3. What is meant by profilo-graph?
4. What is Tomlinson surface meter?
5. What is meant by profile?
6. What are the factors affecting surface roughness?
7. Why the surface texture is control?
8. Define – Lay
9. Define – Surface Texture
10. Define – Flaws
11. What is sampling length?
12. What are the methods used for evaluating surface finish?
13. What is form factor?
14. What are the methods used for measuring surface finish?
15. How will you differentiate smooth surface from flat surface?
16. How surface finish is designated on drawings?
17. Define – Primary Texture
18. Define – Secondary Texture
19. What are the types of instrument used for measuring surface texture?
20. Define – waviness

Expt.No.10 **MEASUREMENT OF BORE USING DIAL BORE INDICATOR AND TELESCOPIC GAUGE**

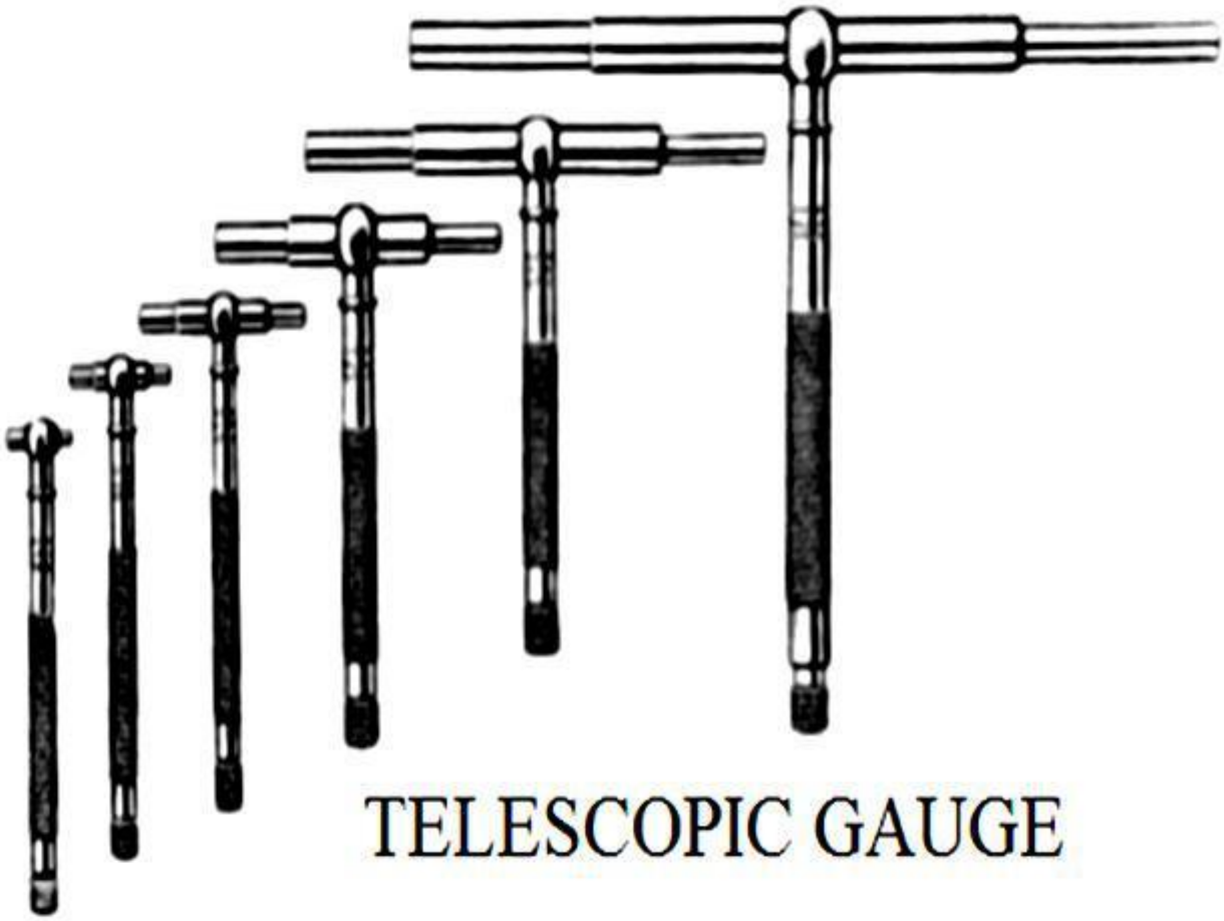
Aim:

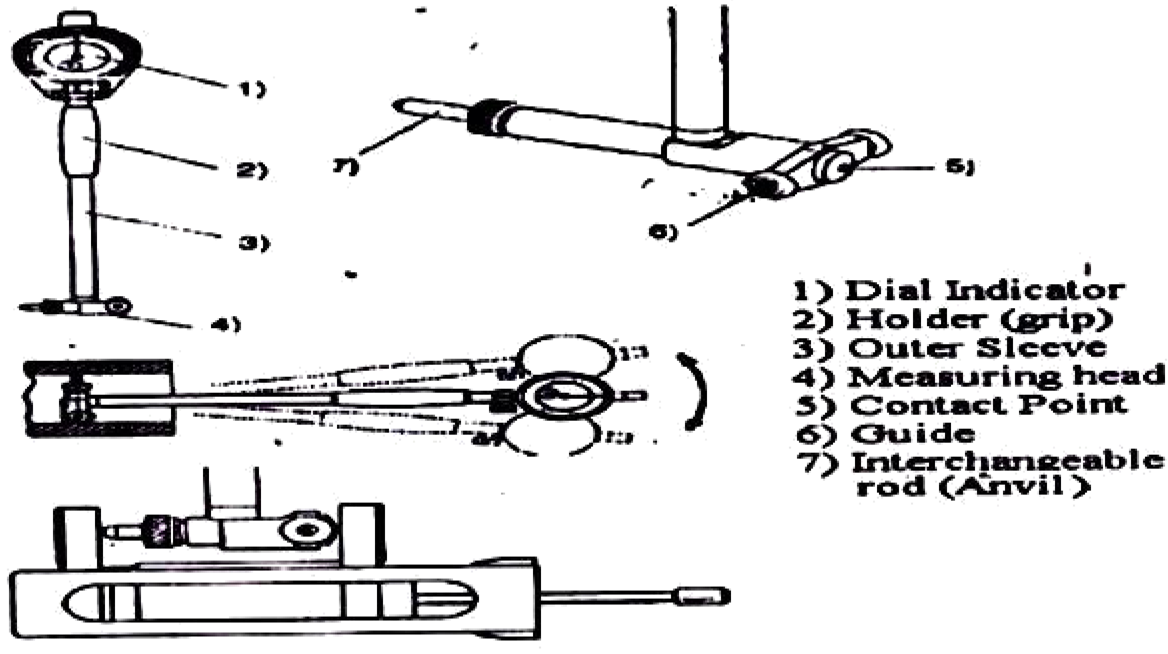
To determine the diameter of bore by using telescopic gauge and checking the same by using dial bore indicator

Apparatus required:

Work piece, vernier caliper, telescopic gauge and dial gauge indicator set with anvil.

Diagram:





INTERNAL DIAL BORE INDICATOR

Procedure:

Bore gauge measurement:

1. Select the extension rod and washer according to the bore diameter to be measured
2. Fix the suitable extension rod and washer with the bore gauge
3. Fix the dial gauge to the bore gauge in its position
4. Insert the bore gauge inside the bore to be measured and hold the gauge in parallel o the axis of the bore. Ensure that the tips on either side of the bore gauge are in touch with inner wall of the bore
5. Note down the reading in the dial gauge and withdraw the bore gauge from the bore
6. Hold the measuring tips of bore gauge between the spindle and anvil of a micrometer and compress the tips by rotating the thimble till the reading reaches the same one as noted earlier
7. Observe and record the micrometer reading as the bore diameter to be measured

Telescopic gauge measurement:

1. Select the telescopic gauge according to the bore diameter to be measured
2. Press the telescopic spindles in the telescopic gauge lock them by locking screw
3. Insert the telescopic gauge inside thee bore to be measured. Release the locking screw to expand the telescopic spindles outwards inside the bore
4. Hold the telescopic gauge in parallel to the axis of bore axis and ensure that the tips of telescopic spindles are in touch with the inner wall of the bore
5. Lock the telescopic spindles and withdraw it from the bore

6. Measure the expanded length of the telescopic spindles using micrometer record them as the inner diameter of the bore

Practical observations:

Rough measurement of bore using Telescopic gauge:

Least count of micrometer = 0.01 mm

Sl.No.	Micrometer reading		Total reading (MSR + TSC * LC) (mm)
	Main scale reading (MSR) (mm)	Thimble scale coincidence	
1.			
2.			

Average reading = ________ mm

Accurate measuring using Bore gauge

Sl.No.	Micrometer reading (d) (mm)	Bore gauge reading (R1) (mm)	Work piece reading (R2) (mm)	Final reading d+ (R1 – R2) * 0.01 (mm)
1.				
2.				

Accurate internal diameter of hole using bore gauge = ______ mm

Result

1. Internal diameter of the work piece by using telescopic gauge is ________mm
2. Diameter obtained by using dial gauge indicator is ___________________mm

Outcome:

Students will be able to measure a bore's size, by transferring the internal dimension to a remote measuring tool (Telescopic gauge).

Application:

1. Automobile
2. Quality Department

Viva-voce

1. What is meant by bore diameter?
2. What is gauge?
3. What is meant by measurement?
4. What is telescope gauge?
5. What is bore gauge?
6. What is contact point?
7. What is the principle of bore gauge?
8. What are the applications of telescopic gauge?
9. What types of materials are used in telescopic gauge?
10. What are the types of instrument used to measure bore diameter?
11. What are the applications of bore gauge?
12. What are the advantages of bore gauge over telescopic gauge?
13. What are the limitations of bore gauge?
14. What is the working principle of telescopic gauge?
15. What are the disadvantages of telescopic gauge?

Expt.No.11 MEASUREMENT OF FORCE USING LOAD CELL

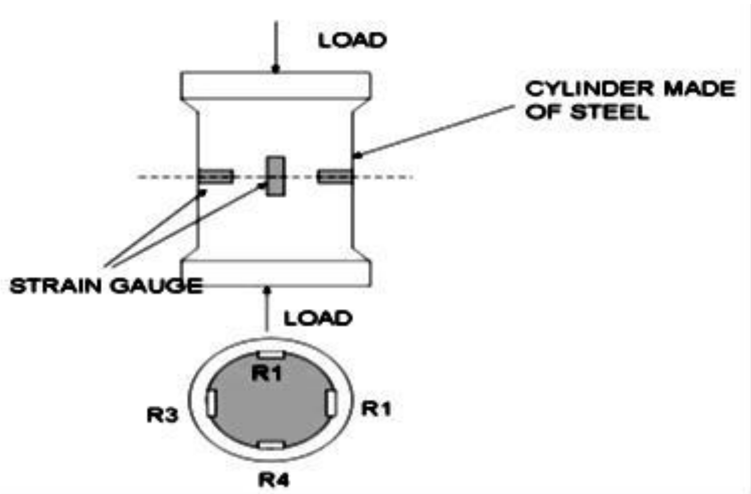
Aim:

To study the characteristic between applied load and the output voltage

Apparatus required:

1. Trainer kit
2. Multimeter
3. Load cell sensor with setup
4. Weights (5 kg)
5. Power chord

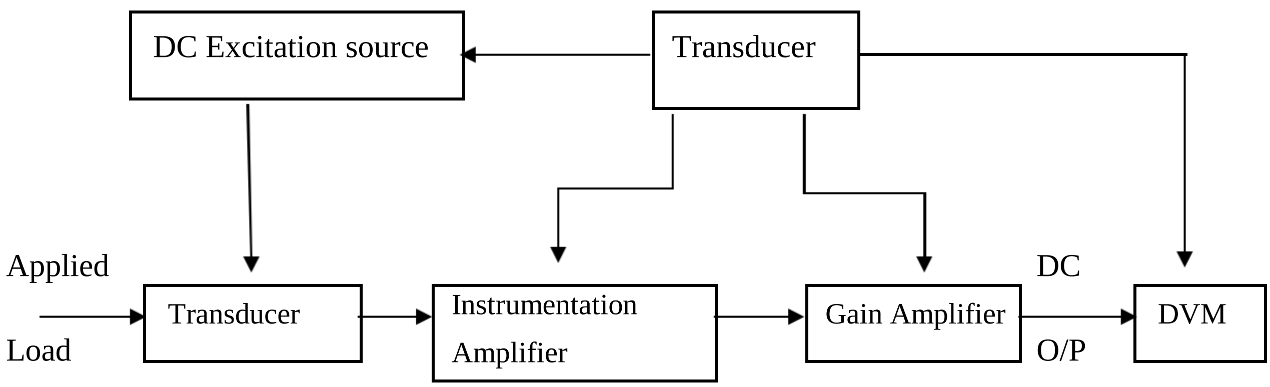
Diagram:



Formulae:

Error (%) = {Applied Voltage – (Displayed Load)/ Applied Load)} x 100

Block diagram:



Interfacing and calibration procedure:

1. Interface the load cell 9 pin ‘D’ type male connector to 9 pin D type female connector, fixed on the module.
2. First unload the beam and nullify the display by using zero adjustment POT
3. Apply the maximum load of 5 kg to the beam and adjust the display to 5 kg by using gain adjustment POT.
4. After the initial adjustment, the unit should not be disturbed until the completion of the experiment.

Safety precaution:

1. During offset adjustment, the beam should not be loaded.
2. The beam should not be disturbed during the experiment.
3. Remove the load from the beam, after completion of the experiment; otherwise wire wound on the strain gauge will get damaged.
4. If you are getting an unsatisfactory reading, then vary the zero and span POT minimum to maximum.
5. Maximum load should not exceed 5 kg.
6. Once calibrated, the setting should not be distributed till the end of the experiment.

Procedure:

1. Install the load cell module and interface the 9 pin D connector with kit.
2. Connect the multimeter in volt mode across T5 and GND for the output voltage measurement.
3. Switch on the module.
4. Initially, unload the beam and nullify the display by using zero adjustment POT (zero calibration).
5. Apply the maximum load of 5 kg to the beam and adjust the display to 5 kg by using gain adjustment POT (gain calibration).
6. Now apply the load to the beam, a force will develop on the beam and measure the output voltage

   (V) across T5 and GND.
7. Gradually increase the load and note down the output voltage (V) and applied load.
8. Tabulate the values of displayed load and applied voltage.
9. Plot a graph between applied load and output voltage (V).

Note: When 1 kg load is applied to the beam, the displayed voltage is 1 kg.

Tabulation:

Applied load (kg)	Output voltage (V)	Displayed load (kg)	% Error

Graph:

1. Applied load (kg) Vs Output Voltage (V)
2. Actual load (kg) Vs % Error

Result:

Thus the characteristic between applied load and the output voltage was studied.

Outcome:

Students will be able to understand the Sensor device (electro-mechanical) which help us to measure a physical parameter (such as temperature, pressure, force, acceleration etc.) by providing analog input to get digital output.

Application:

1. Machine Shop
2. Automobile

Viva-voce

1. What is meant by force?
2. Define – Wheat stone bridge circuit
3. Define – Load
4. What is meant by deflector?
5. What is meant by force indicator?
6. Define – Instrumentation
7. How instrumentations are classified?
8. Define – Transducer
9. What is electrical transducer?
10. How transducers are classified?

Expt.No.12 **MEASUREMENT OF TORQUE USING STRAIN GAUGE**

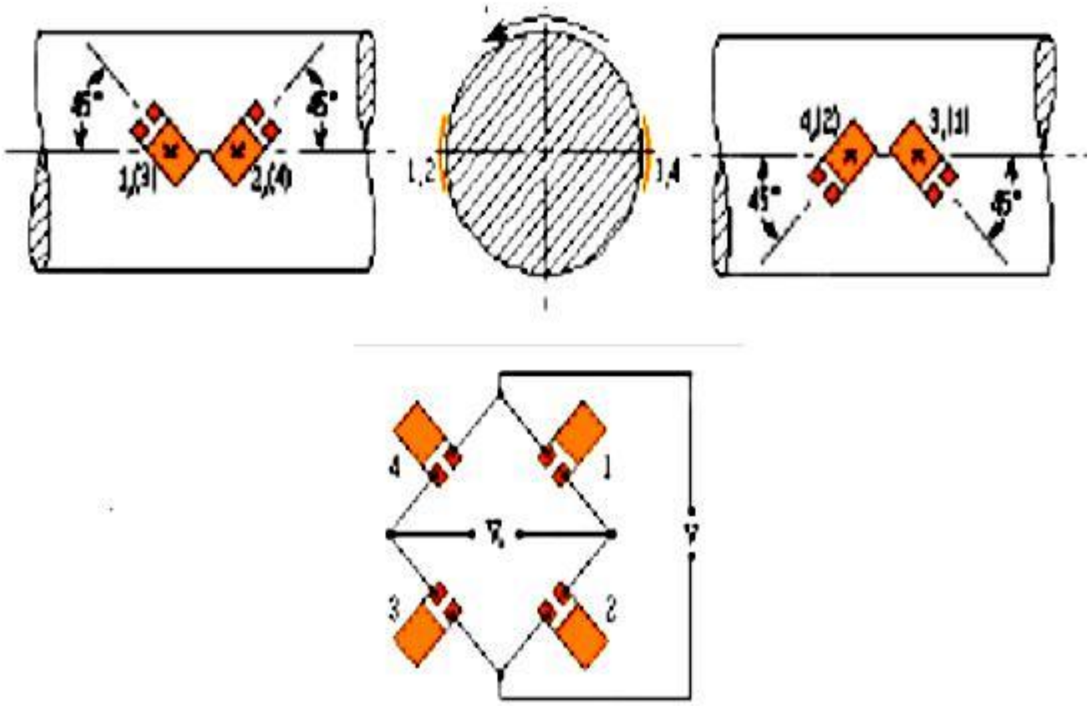
Aim:

To study the characteristics of the developing torque and the signal conditioned sensor output voltage

Apparatus required:

1. Trainer kit
2. Digital Multimeter (V)
3. Torque sensor setup
4. Weights (100 gram x 10 Nos.)
5. Power chord

Diagram:



Interfacing and calibration procedure:

1. Interface the torque sensor 9 pin. 'D' type male connector to '9' pin 'D' type female connector, fixed on the module.
2. First, unload the beam and nullify the display by using zero adjustment POT.
3. Apply the maximum load of 1 kg to the beam and adjust the display to 9.81 Nm by using adjustment POT.
4. After this initial calibration, the unit should not be disturbed until the completion of the experiment.

Safety precaution:

1. During offset adjustment, the beam should not be loaded.
2. The beam should not be disturbed during the experiment.
3. Remove the beam from the shaft, after completion of the experiment otherwise wire wound on the strain gauge will get damaged.
4. If the displayed torque reading are in negative, change the beam connections in opposite to previously connected direction.
5. If you are getting an unsatisfactory reading, then vary the zero and span POT minimum to maximum.
6. Maximum load should not exceed 1 kg.
7. Once calibrated, the setting should not be disturbed till the end of this experiment.

Procedure:

1. Install the torque sensor setup and interface with kit.
2. Switch "ON" the module.
3. Connect the Multimeter in millivolts mode T2 and T3 for bridge output voltage measurement POT.
4. First, unload the beam and nullify the bridge output voltage by using zero adjustment POT.
5. By applying load to the beam, torque will develop on the shaft and measure the bridge output voltage (mV) across T2 and T3
6. Gradually increase the force by applying load and note down the bridge output voltage (mV).
7. Tabulate the readings and plot a graph between developed torque versus bridge output voltage (mV).

Formulae:

Error (%) = {(Actual Torque – Theoretical Torque)/ Theoretical Torque} x

100 Theoretical Torque = mass (m) x acceleration due to gravity (g) x

radial distance

$= 1\text{ kg} \times 9.81\text{ m/s}^2 \times 1\text{ m}$

$= 9.81\text{ Nm}$

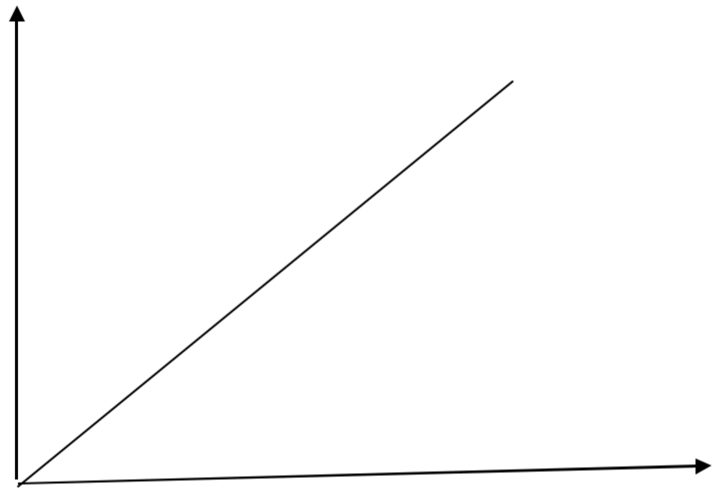
Tabulation:

Sl.No.	Theoretical Torque (Nm)	Bridge output voltage (mV)

Model graph:

The graph between developed torque and bridge output voltage is drawn

Developed torque (Nm) Vs Output Voltage (V)



Sample reading:

Developed Torque (Nm) = 9.81 Nm

Output Voltage (V) = 5 mV

Result:

Thus the characteristics of the torque developed which is due to force applied to beam and the bridge output voltage were studied and graph is plotted.

Outcome:

Students will be able to understand the Sensor device (electro-mechanical) which helps us to measure the strain by providing analog input to digital output.

Application:

1. Machine Shop
2. Turbine

Viva-voce

1. Define – Torque
2. Define – Twist
3. What are the methods used for measuring torque?
4. Define – Strain Gauge
5. What is prony brake?
6. What are the modern devices used for measuring torque?
7. What are the elements of strain gauge?
8. What is the use of slip ring for measuring torque?
9. What is slip ring?
10. What are the types of torque?
11. What are the types of dynamometer?
12. What are the applications of dynamometer?
13. What are the features of dynamometer?
14. What is gauge factor?
15. What are the types of torque measurement?

Expt.No.13 **MEASUREMENT OF TEMPERATURE USING THERMOCOUPLE**

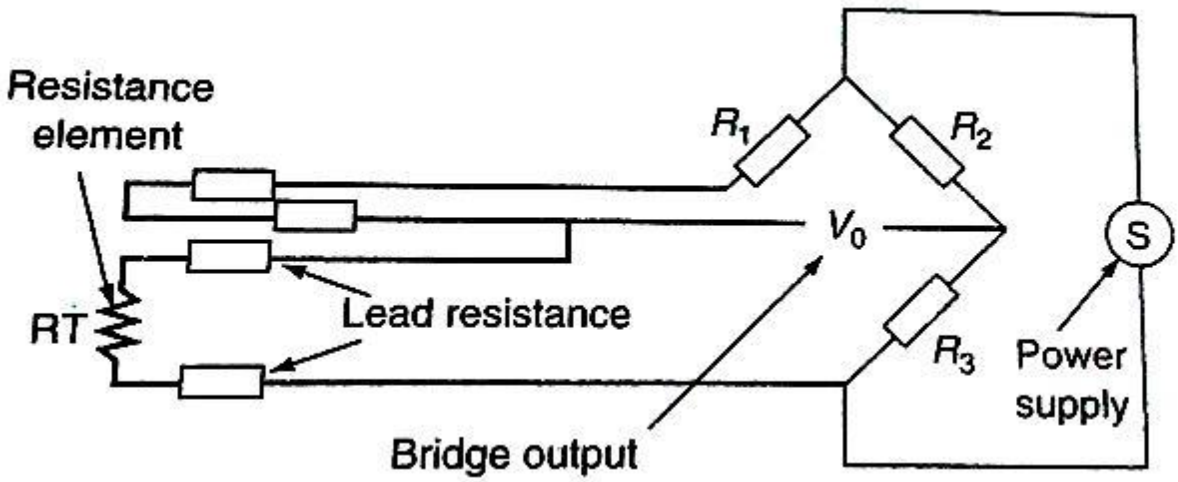
Aim:

To study the characteristics of thermocouple without compensation

Apparatus required:

1. Trainer kit
2. Thermocouple
3. Water bath
4. Thermometer
5. Digital multi meter
6. Power chord

Diagram:



Procedure:

1. Connect the two terminals of the thermocouple across T1 & T2.
2. Position the switch 'SW1' towards 'NO'.
3. Switch 'ON' the unit and note the displayed temperature.
4. If there is any difference in displayed temperature at room temperature, adjust the offset knob 'zero' to set 0_o C in display.
5. Place the Multimeter across T7 and T8.
6. Insert the thermocouple and thermometer into water bath.
7. Switch 'ON' the water bath.
8. Note the actual temperature in thermometer and displayed temperature simultaneously.
9. Tabulate the reading and calculate % error using the above formula

10. Plot the graph actual temperature Vs % error

Formulae:

Error (%) = {(Displayed Temperature – Actual Temp)/ Actual Temp} x 100

Tabulation:

Actual Temperature (^{o}C)	Displayed Temperature (^{o}C)	% Error

Graph

Temperature Vs % Error

Result:

Thus the characteristics of the thermocouple without compensation were studied and graph is plotted.

Outcome:

Students will be able to understand the Sensor device (electro-mechanical) which help us to measure a physical parameter (such as temperature) by providing analog input.

Application:

1. Thermocouple
2. Heat generation

Viva-voce

1. What is meant by total radiation pyrometer?
2. How the mercury in glass thermometer worked?
3. What are the sources of error in thermocouple?
4. Define – Resistance
5. Define – Temperature detector
6. Define – Temperature
7. What are the types of instrument used for measuring temperature?
8. What are the types of electrical temperature sensors?
9. What is optical sensor?
10. What are the applications of liquid in gas thermometer?
11. What are the applications of bimetallic thermometer?
12. What is vapour pressure thermometer?
13. What is thermocouple?
14. What are the types of metal are used in combination to form thermocouples?
15. What are the advantages of thermocouple?
16. What are the disadvantages of thermocouple?
17. Define – Resistance Thermometer
18. Define – Thermistor
19. What is the use radiation pyrometer?
20. What are the advantages of optical pyrometer?

Expt.No.14 **MEASUREMENT OF ALIGNMENT USING AUTOCOLLIMATOR**

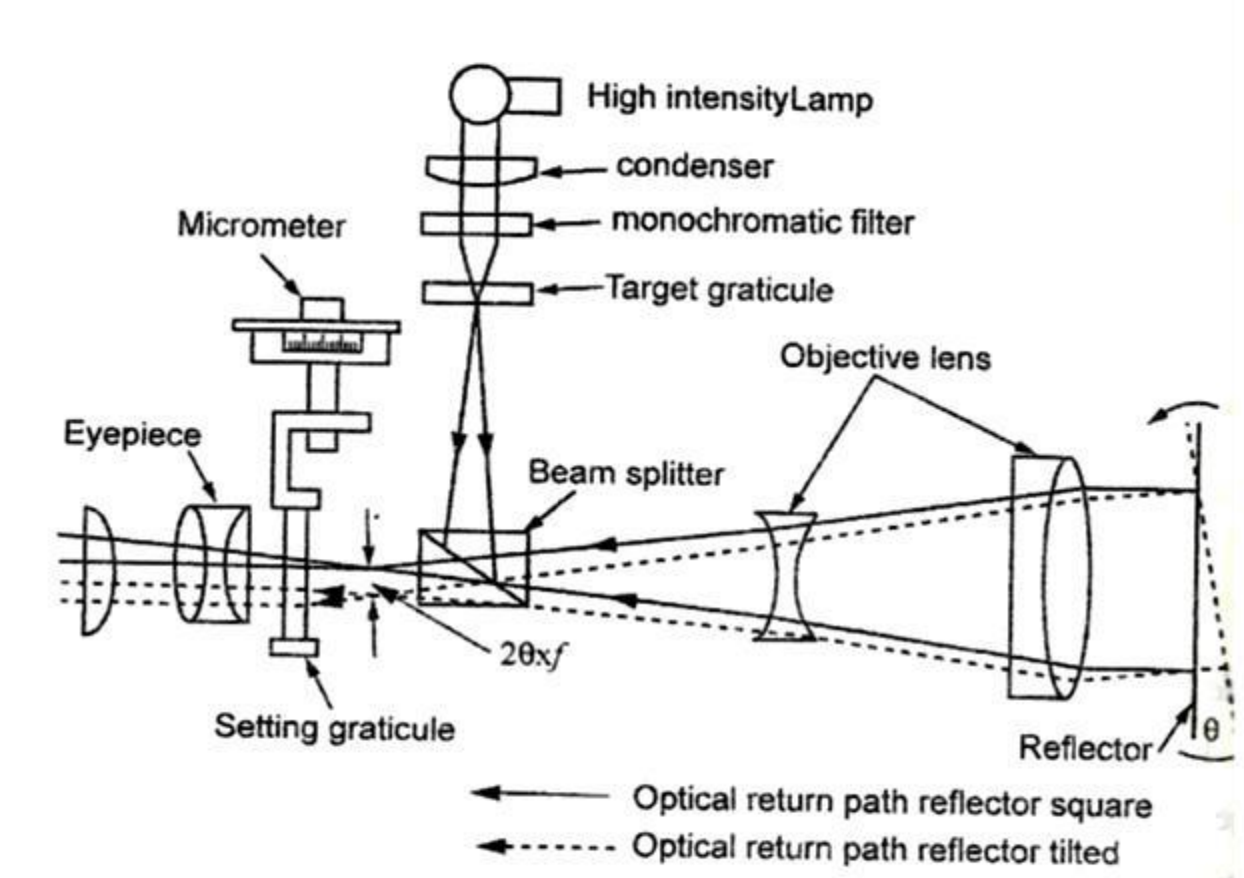
Aim:

To check the straightness & flatness of the given component by using Autocollimator

Apparatus required:

Autocollimator, work piece/ object to be tested

Diagram:



Theory:

1. Definition of straightness – A plane is to be said straight over a given length if the variation or distance of its point from two planes perpendicular to each other and parallel to the generation direction at of the line remain within specified tolerance limits. The reference planes being so chosen that their intersection is parallel to the straight line joining two points suitably located on the line to be tested and two points being close ends of the length to be measured.
2. Principle of the Autocollimator-A cross line 'target' graticule is positioned at the focal plane of a telescope objective system with the intersection of the cross line on the optical axis, i.e. at the principal focus. When the target graticule is illuminated, rays of light diverging from the intersection point reach the objective via a beam splitter and are projected from the objective as parallel pencils

of light. In this mode the optical system is operating as a collimator.A flat reflector placed in front of the objective and exactly normal to the optical axis reflects the parallel pencils of light back along their original paths. They are then brought to focus in the plane of the target graticule and exactor coincident with its intersection. A proportion of the returned light passes straight through the beam splitter and the return image of the target cross line is therefore visible through the eyepiece. In this mode, the optical system is operating as a telescope focused at infinity.

3. If the reflector is tilted through a small angle the reflected pencils of light will be deflected by twice the angle of tilt (principle of reflection) and will be brought to focus in the plane of target graticule but linearly displaced from the actual target cross lines by an amount 2θ* f.
4. An optical system of an autocollimator consists of a light source, condensers, semi-reflectors, target wire, collimating lens and reflector apart from microscope eyepiece. A target wire takes place of the light source into the focal plane of the collimator lenses. Both the target wire and the reflected image are seen through a microscope eyepiece. The eyepiece incorporates a scale graduated in 0.05mm interval and a pair of parallel setting wires which can be adjusted. Movements of wires are effected through a micrometer, one rotation of the drum equals to one scale division movement of the wires. The instrument is designed to be rotated through 90 degrees about its longitudinal axis so that the angles in both horizontal and vertical planes are measured.

Autocollimator:

It is an instrument designed to measure small angular deflections & maybe used in conjunction with a plane mirror or other reflecting surface. An autocollimator is essentially an infinity telescope and a collimator combined into one instrument. This is an optical instrument used for the measurement of small angular differences. For small angular measurements, autocollimator provides a very sensitive and accurate approach.

The principle on which this instrument works is given below. O is a point source of light placed at the principal focus of a collimating lens. The rays of light from O, incident on the lens, travels as a parallel beam of light. If this beam strikes a plane reflector which is normal to the optical axis, it will be reflected back along its own path and refocused at the same point O. If the plane reflector be tilted through a small angle θ, then parallel beam will be deflected through twice this angle, and will be brought to focus at O‘ in the same plane at a distance x from O. Obviously.

OO‘=x=2θ.f, where f is the focal length of the lens.

Applications:

1. For aligning circular & flat surfaces in machining
2. Alignment of beams & columns in construction buildings / industries, steel structures
3. To measure the straightness, flatness and parallelism

Procedure:

1. Make the distance of 100mm internal on the work piece.
2. Set the cross wire so that two cross will coincide.
3. Set the mirror so that the cross wire is visible.
4. Move the reflector on next 100mm mark and adjust it to see reflection of cross wire.
5. Take the reading of reflected crosswire deviated or moved up or down.
6. Measure the distance between two crosswire.

Formulae:

$\tan \theta = X / 100$

$X = (100 \times \tan \theta) \times 1000$ in microns

Where X = Level at position B with respect to position A

θ = Angle/Deviation in degrees/ Seconds (1 Degree = 60 Minutes, 1 Minute = 60 Seconds).

Tabulation:

Sl.No.	Bridge Length (Base length of the reflector)	Cumulative Bridge length (Position of the reflector)	Micrometer final reading (Autocollimator)	Deviation for each 100mm (Θ in degrees)
1.				
2.				
3.				

Result:

The values are analyzed and necessary modification of the surface may be recommended based on the accuracy required on flatness. If the values observed from the micrometer are varying linearly then straightness/flatness can be judged.

Outcome:

Students will be able to understand the optical instruments for non-contact measurement of angles.

Application:

1. Surface Roughness
2. Quality Department

Viva-voce

1. Define – Straightness
2. Define – Tolerance straightness
3. What is flatness?
4. What is autocollimator?
5. What light rays used in autocollimator?
6. What is the use of autocollimator?
7. What is collimating lens?
8. What are the applications of autocollimator?
9. What is meant by target graticule?
10. What is objective lens?
11. What is beam splitter?
12. What is the principle of autocollimator?
13. What are the advantages of autocollimator?
14. What are the limitations of autocollimator?
15. What are the types of measurement uncertainties of autocollimator?

Expt.No.1 THREAD PARAMETERS MEASUREMENT USING PROFILE PROJECTOR

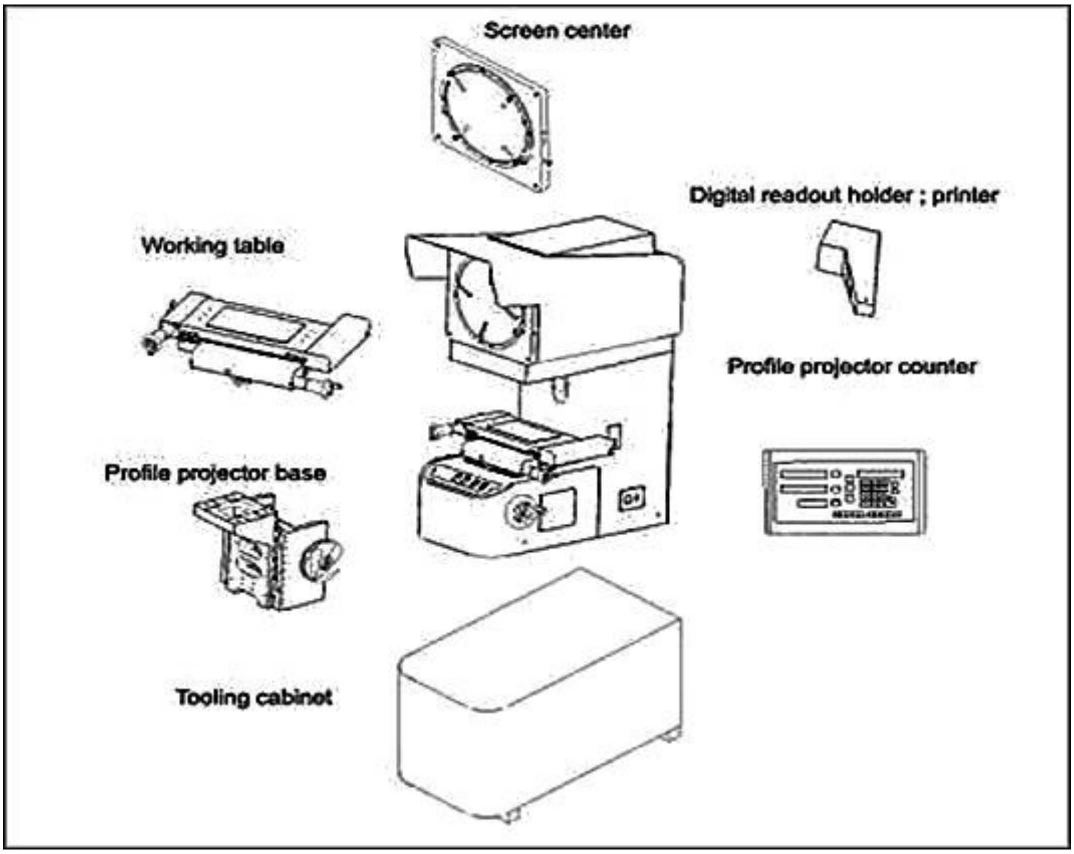
Aim:

To find the parameters of the given thread

Apparatus required:

1. Profile projector
2. Magnification of 10 x
3. Trace paper

Diagram:



Procedure:

1. Place the specimen between the work table centres and switch on the projector.
2. Place the magnification lens in the lens slot.
3. Focus the thread clearly by adjusting focusing knob to view the shadow on the screen clearly.
4. Place the tracing paper and trace the shadow profile.
5. Calculate the error in the pitch from the actual pitch.
6. Measure the major diameter (OD), minor diameter (ID), pitch of the thread and flank from the tracing sheet.

Determination of thread parameters:

Magnification =

Sl.No.	Parameters	Magnified value (mm)	Actual value (mm)
1.	Outer diameter (O.D)		
2.	Internal diameter (I.D)		
3.	Pitch		
4.	Flank angle		

Result:

Parameters of the given thread are determined.

Outcome:

Students will be able to understand the projector magnification of the profile of the specimen, and how the image ratio differs with the distance of the projection screen.

Application:

1. Measurement of Screw
2. Quality Department

Viva-voce

1. What are the various methods used for measuring minor diameter of the thread?
2. What are the various method used for measuring major diameter of the thread?
3. What are the various method used for measuring pitch diameter?
4. What is Taylor's principle?
5. How Taylor's principle is applied to screw thread gauge?
6. What is drunken error in screw threads?
7. What is the effect of flank angle error?
8. What is major diameter?
9. What is the magnification of profile projector in our laboratory?
10. What is the working principle of profile projector?
11. What are the applications of profile projector?
12. What are the advantages of profile projector?
13. What are the disadvantages of profile projector over tool maker's microscope?
14. What is meant by crest?
15. What is meant by root?

Expt.No.2 MEASUREMENT OF DISPLACEMENT USING LVDT

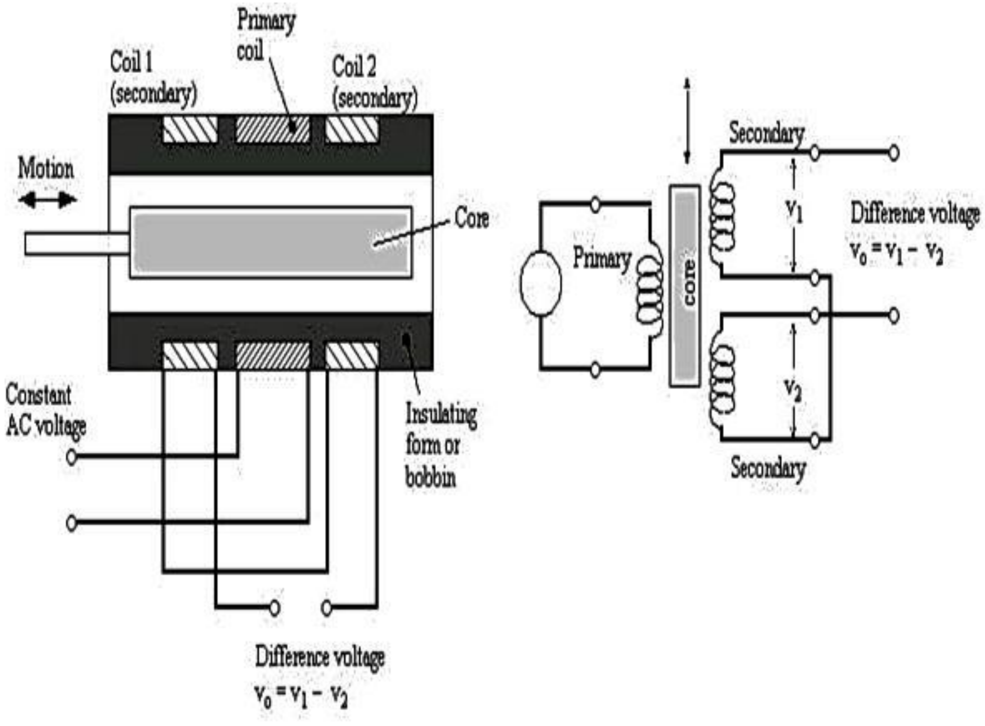
Aim:

To measure the displacement using LVDT and to calibrate it with the millimeter scale reading

Apparatus required:

1. LVDT 2. Patch cords 3. Transducer with digital indicator 4. Millimeter scale

Diagram:



L.V.D.T Schematic Diagram L.V.D.T Circuit

Principle:

Linear variable differential transducer provides an AC voltage output that is proportional to the displacement of core passing through the winding. It consists of three coils. The primary coil is energized by external AC power source. This mutual – inductance device making use of three coils is generally arranged on a cylindrical, concentric, non-magnetic form. Output amplitude and phase depend on the relative coupling between the two pick-up coils and the power.

Within limits, on either side of the null position, core displacement results in a proportional output. This phase relation existing between power source and output changes 180_o through null is relatively simple, low priced and mechanically steady. It is free from temperature effects unlike strain gauge. High output, high sensitivity, less friction and better linearity are its advantages.

Circuit operation:

Excitation power source: The primary winding of LVDT is excited by means of 0.3 kHz power source. The Wien bridge oscillator circuit placed on a suitable p.c.b. generator a stable AC excitation at fixed frequency. The output from this signal generator card is given to the input of complementary power transistors. The power transistors in turn provide the excitation to the primary of the LVDT. The output from secondary is amplified by means of IC. Separate op.amp converts the excitation signal into square waves which serve to provide reference signal for phase sensitive detection. A field effect transistor acts as an analogue switch and phase detached output is generated. in phase,

D.C. output is also proportional to the displacement. Finally a D.C. amplifier is provided with a range selector switch to centre zero meter on the front panel. It is possible to display the core displacements in the range of 0 to 20 mm. The functioning of the phase sensitive the range of 0 to 5 mm, 0 to 10 mm and 0 to 20mm. The functioning of the phase sensitive detector is better understood by observing the wave forms provided along with the circuit diagram.

Procedure:

1. Connect the terminals marked primary of the instrument with the primary terminal of the transducer. The flexible load wires are provided identically to connect one each for terminals marked secondary.
2. Adjust the magnetic – core and bring the pointer mounted on brass rod to zero position. Set the digital meter to zero using the potentiometer.
3. Displace the core to the right in steps of 2 mm and note the corresponding digital meter reading.
4. Repeat the same procedure for core displacement towards left from the centre zero.
5. Find the percentage of error
6. Draw the graphs between:
   a) Input displacement (x-axis) and LVDT reading (y-axis)
   b) Input displacement (x-axis) and percentage error
7. Displace the core in a gentle manner.

Tabulation:

S.No	Displacement in millimeter scale 'x'	Reading in digital meter 'y'	Error (x - y)	Percentage Error = {(x ~ y)/x}* 100
Unit	Mm	mm	mm	%

Result:

Thus the displacement is measured using LVDT and it is calibrated with the meter scale measurement.

Outcome:

Students will be able to understand about the LVDT (linear variable differential transformer) and how the electromechanical sensor used to convert mechanical motion or vibrations, specifically rectilinear motion, into a variable electrical current, voltage or electric signals, and the reverse.

Viva-voce

1. What is meant by transducer?
2. What is LVDT?
3. What is displacement?
4. What is patch chord?
5. What is principle of LVDT?
6. What are the applications of LVDT?
7. What are the advantages of LVDT?
8. What are the disadvantages of LVDT?
9. What is the purpose of strain gauge?
10. How will you calculate displacement using LVDT?
11. What are the elements of LVDT?
12. What is potentiometer?
13. What are the various methods used for displacement measurement?
14. What is load cell?
15. What is quantity meter?

Expt.No.3 MEASUREMENT OF VIBRATION PARAMETERS USING

VIBRATION SET UP

Aim:

To study the various parameters involved in the vibrations of a given system.

To plot the characteristic curves of the given specimen

Instruments Required:

1. Vibration exciter
2. Vibration pick-up
3. Vibration analyzer
4. Power amplifier
5. Oscillator

Description:

1. The mechanical vibration, if not within limits may cause damage to the materials, structures associated with it.

2. Vibration exciter is an electrodynamic device. It consists of a powerful magnet placed centrally surrounding which is suspended the exciter coil. This assembly is enclosed by a high permeability magnetic circuit.

3. When an electrical current is passed through the exciter coil, a magnetic field is created around the coil resulting in the upward or downward movement of the suspended coil depending upon the direction of the current flow in the coil. Thus controlling the frequency of the coil current, the frequency of vibration is controlled. Power amplifier is the control unit for the exciter.

4. Piezo – electric crystals produce an emf when they are deformed. This output emf may be measured to know the value of applied force and hence the pressure.

5. A piezo – electric material is one in which an electric potential appears across certain surfaces of a crystal of the dimensions of the crystal are charged by the application of a mechanical force. The effect is reversible.
6. Common piezo – electric materials include quartz, Rochelle salt, lithium sulphate etc.,

Caution:

Do not remove the fuse cap while power chord is connected to 230V AC mains.

Procedure:

1. Connect power amplifier output to vibration exciter.
2. Place the vibration pick up on vibration exciter spindle.
3. Connect vibration pick up cable to vibration analyzer sensor socket.
4. Select the range 0-100 by two way switch.
5. Note down the displacement, velocity and acceleration from vibration analyzer.
6. Similarly noted above parameters in frequency range of 0-1000 Hz.

Sl.No.	Frequency (Hz)	Displacement (mm)	Velocity (cm/sec)	Acceleration (m/sec2)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Viva-voce

1. What Is Meant By Vibrations?
2. Define Force Vibration?
3. What Is Meant By Logarithmic Decrement?
4. Define Transmissibility?
5. What Is Dry Friction Damper?
6. Mention The Uses Of Vibration?
7. What Is Rayleigh’s Method, Write Its Applications?
8. What Is The Critical Speed Of Shaft?
9. Define Continuous Beam?
10. What Is Meant By Natural Vibration?
11. Define Resonance?
12. Mention Important Types of Free Vibrations?
13. What Is Meant By Viscous Damping?
14. Define Vibration Isolation?
15. What Is An Accelerometer And What Is Its Use?

Result:

Various parameters of vibration such as displacement, velocity and acceleration are studied and the following characteristic curves were plotted.

1.Displacement Vs Frequency =
2.Velocity Vs Frequency =
3.Acceleration Vs Frequency =