

GOVERNMENT POLYTECHNIC SHEOHAR



LABORATORY MANUAL

**DEPARTMENT OF MECHANICAL ENGINEERING
IV SEMESTER**

**MEASUREMENTS & METROLOGY
SUBJECT CODE: 2025406**

SESSION: 2022-25

TEACHING AND LEARNING SCHEME: -

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		C	T				
2025406	Measurements & Metrology Lab	0	0	2	0	2	0

COURSE OBJECTIVES

To develop understanding and practical skills in precision measurement techniques, enabling students to accurately measure dimensions, angles, and geometrical features of mechanical components using standard metrology instruments.

COURSE OUTCOMES

CO1: *Measure linear dimensions of components using Vernier calipers and micrometers with accuracy.*

CO2: *Demonstrate measurement of angles using instruments such as sine bar and bevel protractor.*

CO3: *Calibrate and measure geometrical features such as V-threads and spur gears using appropriate metrology tools.*

LABORATORY SCHEDULE

DAY	1ST	2ND	3RD	4TH	5TH	6TH
	(10:00 AM-11:00 AM)	(11:00 AM-12:00 PM)	(12:00PM-01:00PM)	(01:00 PM-02:00PM)	(02:30 PM-03:30PM)	(03:30PM-04:30PM)
MONDAY						
TUESDAY						
WEDNESDAY						
THURSDAY	MEASUREMENTS & METROLOGY LAB					
FRIDAY						
SATURDAY						

MR. Kapil Deo Kumar

Faculty In-charge

MR. Rahul Kumar

Instructor In-charge

General Instructions & Safety Measures

- Read the complete experiment procedure carefully before starting the work.
- Maintain proper discipline and follow all instructions given by the lab instructor.
- Ensure all instruments and workpieces are clean and free from dust, oil, and burrs.
- Check and correct **zero error** of measuring instruments before taking readings.
- Select and use the appropriate measuring instrument for the given task.
- Handle precision instruments like Vernier callipers, micrometres, and slip gauges with utmost care.
- Avoid applying excessive force; use gentle and uniform pressure (especially in micrometres using ratchet).
- Take readings at eye level to avoid **parallax error**.
- Do not touch the measuring surfaces directly with bare hands to prevent damage and inaccurate readings.
- Record observations neatly and perform calculations carefully to ensure accuracy.
- After completing the experiment, clean the instruments and place them in their proper storage cases.
- Immediately report any damaged instrument, error, or abnormal reading to the lab instructor.

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Exp. No.	Experiment Name	Mapped CO
1	Measure dimensions using Vernier caliper and compare with dial/digital	CO1
2	Measure geometrical dimensions of V-thread using thread Vernier gauge	CO3
3	Measure thickness of MS plates using slip gauges	CO1
4	(Repeat/Advanced measurement using micrometer or Vernier instruments)	CO1
5	(Advanced angle measurement using sine bar/bevel protractor)	CO2
6	(Calibration/measurement of gear or thread elements)	CO3

Exp. No.	Experiment Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
1	Measure diameter using micrometer	2	2	–	3	–	–	–	2	–
2	Measure angle using sine bar	2	2	–	3	–	–	–	2	–
3	Measure angle using bevel protractor	2	2	–	3	–	–	–	2	–
4	Measure dimensions using Vernier caliper	2	2	–	3	–	–	–	2	–
5	Measure V-thread using thread gauge	2	2	1	3	–	–	–	3	1
6	Measure thickness using slip gauges	2	2	–	3	–	–	–	2	–
7	Advanced linear measurement	2	2	–	3	–	–	–	2	–
8	Advanced angular measurement	2	2	–	3	–	–	–	2	–
9	Gear/thread calibration	2	2	1	3	–	–	–	3	1

Experiment-I

Measurement of diameter of a wire using micrometre and comparison with digital micrometre.

1) Aim of Experiment

To measure the diameter of a given wire accurately using a micrometre screw gauge and compare the result with a digital micrometre.

2) Practical Significance

- Provides knowledge of precision measurement techniques used in engineering.
- Helps in understanding the accuracy and least count of micrometres.
- Enables comparison between manual (analog) and digital instruments.
- Widely used in quality control, manufacturing, and inspection processes.

3) Theory

A micrometre screw gauge is a precision instrument used to measure small dimensions with high accuracy. It works on the principle of a screw and nut mechanism, where rotational motion is converted into linear motion.

The distance moved by the spindle per rotation is called the pitch. The least count (L.C.) of a micrometre is given by:

$$\text{Least Count} = \frac{\text{Pitch}}{\text{Number of divisions on circular scale}}$$

Typically,

Pitch = 0.5 mm

Circular scale divisions = 50

So, Least Count = 0.01 mm

Total reading is calculated as:

$$\text{Total Reading} = \text{Main Scale Reading} + \text{Circular Scale Reading}$$

A digital micrometre directly displays the measurement electronically, reducing human error and improving accuracy.

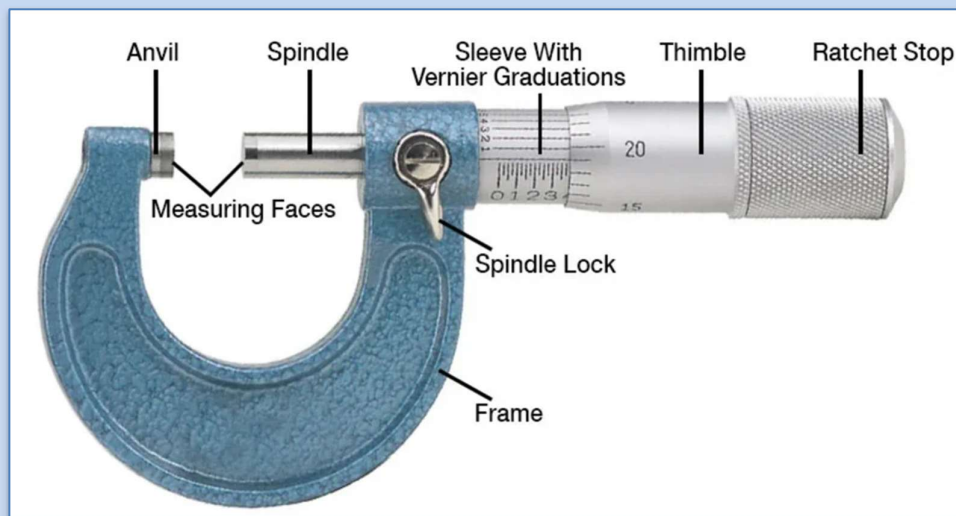
4) Apparatus Required

- Micrometre screw gauge
- Digital micrometre
- Given wire specimen

- Cleaning cloth

5) Procedure

1. Clean the measuring surfaces and the wire properly.
2. Check and note the zero error of the micrometre.
3. Place the wire between the anvil and spindle.
4. Rotate the ratchet until it makes gentle contact with the wire.
5. Note the main scale reading (MSR) and circular scale reading (CSR).
6. Calculate the total reading and apply zero correction if required.
7. Repeat the readings at 3–4 different positions and find the average.
8. Measure the diameter using the digital micrometre directly.
9. Compare both values and note the difference.



6) Observation

Least Count of Micrometre = _____ mm
Zero Error = _____ mm

S. No.	MSR (mm)	CSR (mm)	Total Reading (mm)
1			
2			
3			

Average Diameter (Micrometer) = _____ mm

Diameter (Digital Micrometer) = _____ mm

Difference = _____ mm

7) Conclusion

The diameter of the given wire was measured using both micrometer screw gauge and digital micrometer. The results are nearly identical, with minor variations due to instrumental limitations and human error, confirming that both methods provide reliable and precise measurements.

EXPERIMENT NO. II

Measurement of angle using sine bar with slip gauges.

1) Aim of Experiment

To determine the angle of a given specimen using a sine bar and slip gauges.

2) Practical Significance

This experiment helps in precise measurement of angles, which is essential in machining, tool setting, and inspection of components. It is widely used in industries for angular accuracy and calibration work.

3) Theory

A sine bar is used to measure angles based on the principle of trigonometry. The relation is:

$$\sin \theta = \frac{h}{L}$$

Where:

(h) = height of slip gauges

(L) = length of sine bar (usually 100 mm or 200 mm)

Thus,

$$\theta = \sin^{-1} \left(\frac{h}{L} \right)$$

Slip gauges are used to build up the required height accurately.

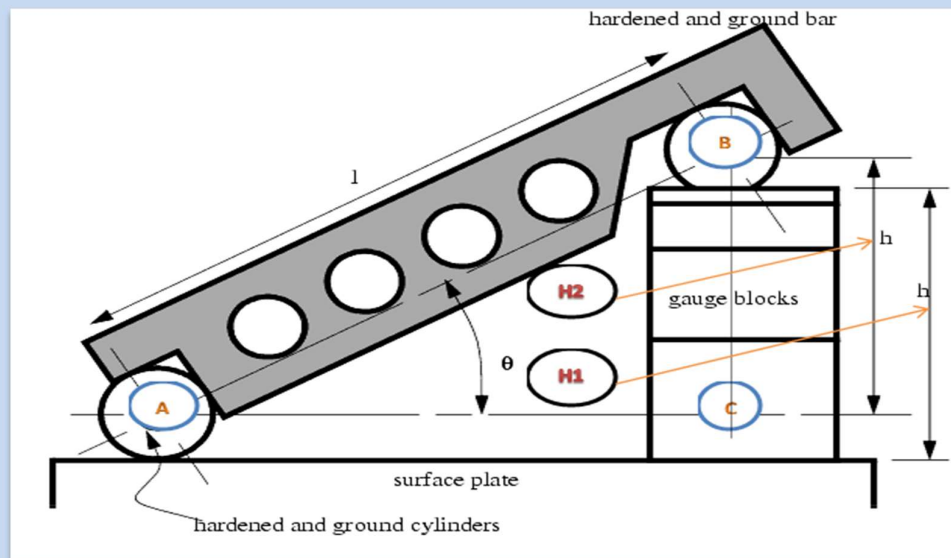
4) Apparatus Required

- Sin bar (100 mm)
- Slip gauge set
- Surface plate
- Dial indicator (if required)
- Given specimen

5) Procedure

- Clean the sine bar, slip gauges, and surface plate.
- Place the sine bar on the surface plate.
- Insert slip gauges under one roller of the sine bar.

- Place the specimen on the sine bar.
- Adjust the height of slip gauges until the top surface of the specimen becomes horizontal.
- Ensure proper contact and alignment.
- Note the total height of slip gauges (h).
- Use the sine formula to calculate the angle.



6) Observation

Length of sine bar (L) = 100 mm

S.No.

Slip Gauge Height h (mm)

7) Result

The angle of the given specimen is found to be approximately using a sine bar and slip gauges.

EXPERIMENT NO. III

Measurement of angle of V-block / Taper shank / Dovetail using bevel protractor.

1) Aim of Experiment

To measure the angle of a given V-block / taper shank / dovetail using a bevel protractor.

2) Practical Significance

This experiment helps in accurate measurement of angles in mechanical components. It is widely used in machining, tool setting, inspection, and quality control processes.

3) Theory

A bevel protractor is a precision instrument used to measure angles accurately up to 5 minutes (5').

It consists of a main scale and a vernier scale. The main scale gives degrees, while the vernier scale provides finer readings.

Least Count = 5 minutes = $5' = 0.083^\circ$

$$\text{Total Reading} = \text{Main Scale Reading} + \text{Vernier Scale Reading}$$

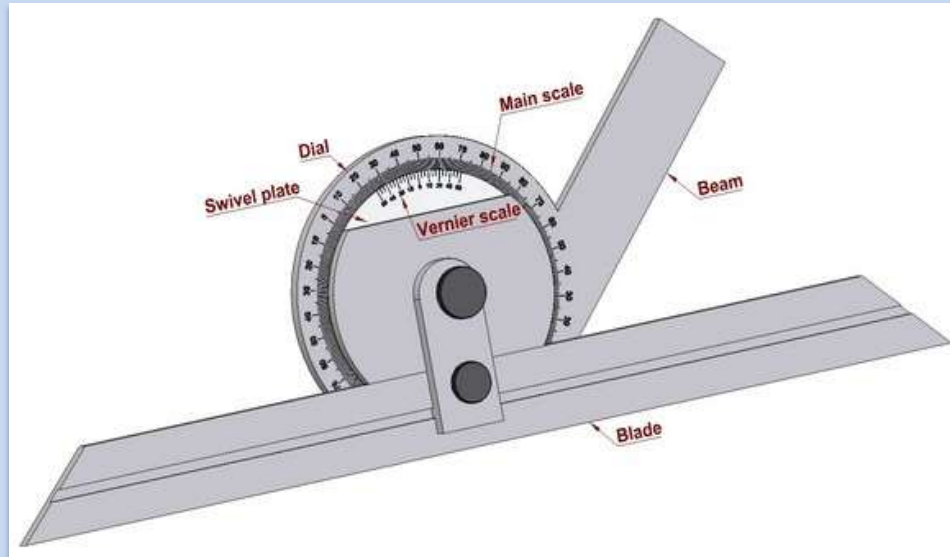
It is commonly used for measuring angles of V-blocks, dovetails, and tapered components.

4) Apparatus Required

- Bevel protractor
- Given specimen (V-block / taper shank / dovetail)
- Surface plate
- Cleaning cloth

5) Procedure

1. Clean the bevel protractor and specimen properly.
2. Place the specimen on a flat surface.
3. Adjust the blade of the bevel protractor along one inclined surface.
4. Align the base of the protractor with the reference surface.
5. Lock the blade carefully to avoid movement.
6. Note the main scale reading (MSR).
7. Note the vernier scale coincidence (VSR).
8. Calculate the total angle reading.
9. Repeat the readings and find the average.



6)Observation

S.No.	Main Scale Reading (°)	Vernier Reading (')	Total Angle (°)
1			
2			
3			

7)Conclusion

The angle of the given specimen is found to be approximatelyusing a bevel protractor. The readings are consistent, indicating accurate measurement.

EXPERIMENT NO. IV

Measurement of dimensions using Vernier caliper and comparison with dial/digital caliper.

1) Aim of Experiment

To measure the dimensions of a given specimen using a Vernier caliper and compare the results with a dial/digital calliper.

2) Practical Significance

This experiment helps in measuring internal, external, and depth dimensions accurately. It is widely used in manufacturing, inspection, and quality control. It also helps in comparing manual and digital measurement techniques.

3) Theory

A Vernier caliper is a precision measuring instrument used to measure linear dimensions. It consists of a main scale and a vernier scale.

Least Count (L.C.) = 0.02 mm (commonly)

Total Reading = Main Scale Reading (MSR) + Vernier Scale Reading (VSR)

A dial/digital caliper provides readings directly (dial or electronic display), reducing human error and improving accuracy.

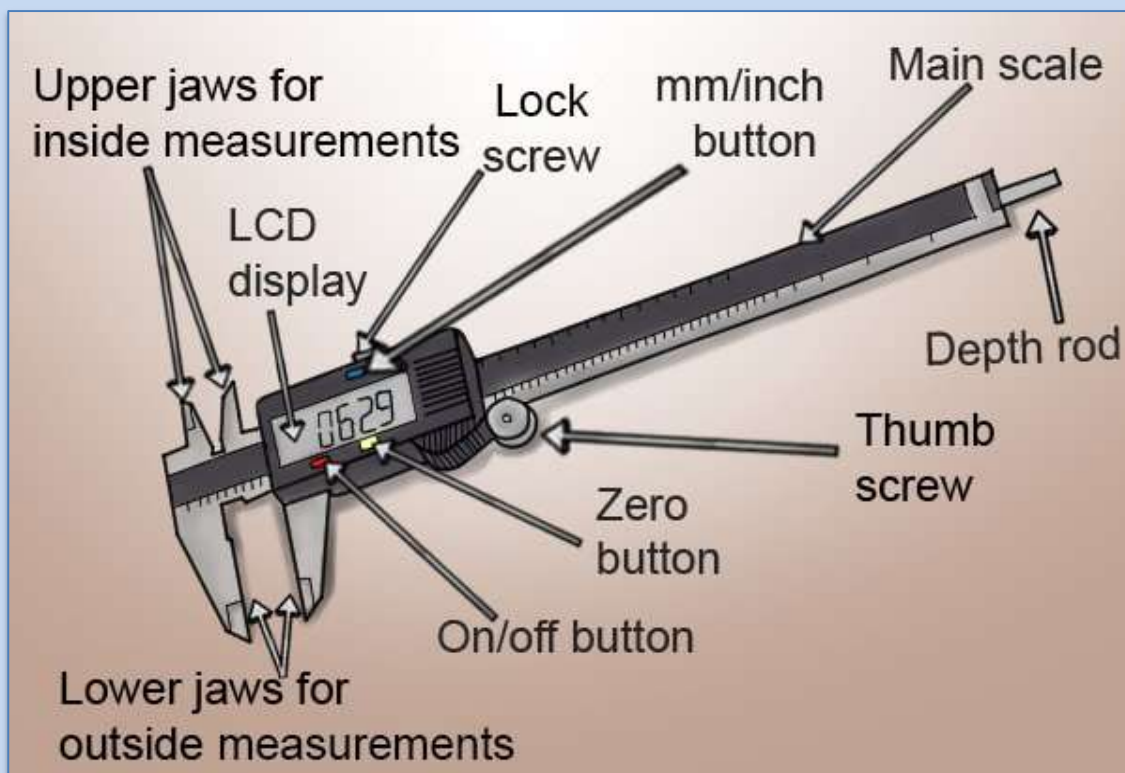
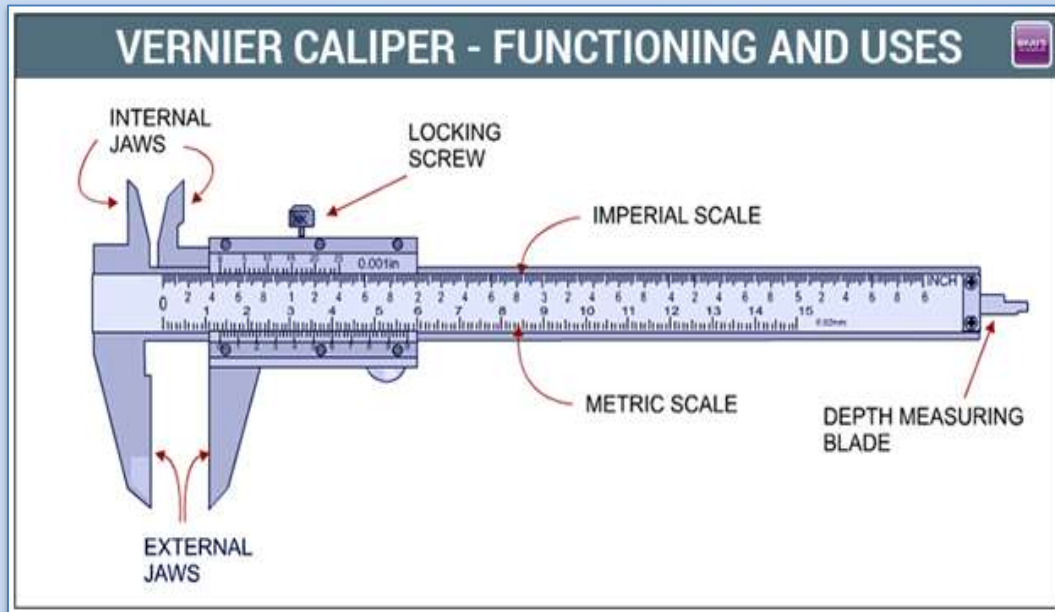
4) Apparatus Required

- Vernier caliper
- Dial/digital caliper
- Given specimen (rod/block)
- Cleaning cloth

5) Procedure

- Clean the caliper and specimen properly.
- Check the zero error of the Vernier caliper.
- Place the specimen between the jaws of the caliper.
- Close the jaws gently and ensure proper contact.
- Note the main scale reading (MSR).
- Note the vernier coincidence (VSR).
- Calculate the total reading.
- Repeat readings at different positions and find the average.

- Measure the same dimension using dial/digital caliper.
- Compare both readings.



6) Observation

S.No.	MSR (mm)	VSR (mm)	Total Reading (mm)
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7)Result

The dimension of the given specimen is approximately 25.04 mm. The readings obtained from Vernier and dial/digital calipers are nearly the same, indicating good accuracy and reliability of measurement.

EXPERIMENT NO. 5

Measurement of geometrical dimensions of V-thread using thread Vernier gauge.

1) Aim of Experiment

To measure the pitch diameter and thread parameters of a V-thread using a thread Vernier gauge.

2) Practical Significance

- Used for accurate measurement of thread dimensions in bolts and screws.
- Essential for quality control and inspection in manufacturing industries.
- Helps in understanding thread geometry and precision measurement.

3) Theory

A thread Vernier caliper is a special type of Vernier instrument used to measure the pitch diameter of threads.

It has:

- Main scale and Vernier scale
- Thread measuring jaws (pointed tips)

The instrument measures the effective (pitch) diameter, which is the most important parameter for proper fitting of threaded components.

Least Count = 0.02 mm (generally)

$$\text{Total Reading} = \text{MSR} + \text{VSR}$$

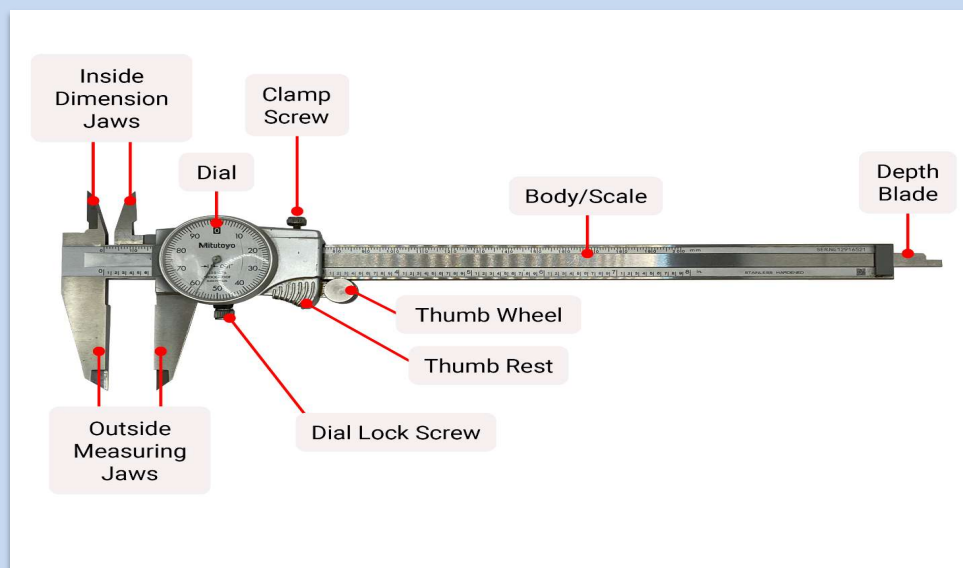
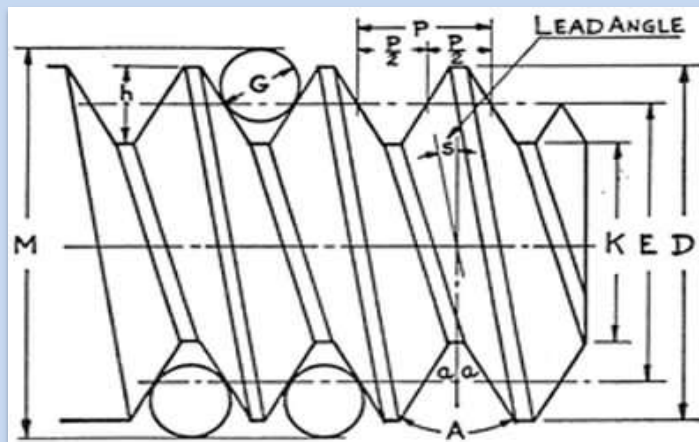
4) Apparatus Required

- Thread Vernier gauge
- Threaded specimen (bolt/screw)
- Cleaning cloth

5) Procedure

- Clean the thread Vernier gauge and specimen.
- Check zero error of the instrument.
- Place the threaded specimen between the thread measuring jaws.
- Adjust the jaws so that they properly fit into the thread grooves.
- Ensure correct alignment with the thread axis.

- Note the main scale reading (MSR).
- Note the vernier scale reading (VSR).
- Calculate total reading.
- Repeat readings at different positions and take average



6) Observation

S.No.	MSR (mm)	VSR (mm)	Total Reading (mm)
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7) Conclusion

The pitch diameter of the given threaded specimen is found to be approximately 10.06 mm using a thread Vernier gauge.