

Vanjari Seethaiah Memorial Engineering College
Patancheru, Medak



METROLOGY LAB

LABORATORY MANUAL

Department of Mechanical Engineering



PREFACE

These lab sessions are intended to make the students understand the different methods of flow rates in pipe flow and open channel flows, conversion of hydraulic energy possessed by the water in running turbines and how pumps are used to increase the hydraulic energy of the water etc.

The Laboratory for Engineering Fluid Mechanics/Hydraulics and Hydraulic Machineries complements the learning experience of the lecture. Laboratory exercises provide opportunities for direct study of fluid behavior. All of the laboratory experiments reinforce material presented during lecture. Some of the experiments will also expose material that is not presented during lecture. You are responsible for the union of the laboratory and lecture experience, not their intersection. Use the laboratory as a chance to enhance your understanding of fluid statics and dynamics. The following Learning Objectives for the laboratory will guide you in taking an active role in your education.

1. Gain familiarity with physical manifestations of fluid mechanics.
You will perform experiments dealing with the basic fluid properties: Viscosity and Pressure.
 - a. Static Fluid Forces.
 - b. Dynamic Fluid Forces.
 - c. The relation between pressure and velocity in a flowing fluid.

These experiments will give you first hand experience with fluid behavior. As a result of performing these experiments you should be able to recognize the effects of fluid pressure and to relate measurements of pressure to velocity in a moving fluid.

In addition to learning about fluid behavior, you should be able to recognize the physical Equipment in the laboratory and explain the basic operating principles of the equipment. You should learn how to operate the equipment properly and safely.

2. Develop and reinforce measurements skills.
You should know how to read gauges, manometers, flow meters, spring scales, and balance scales. You should be able to time events with a stopwatch. You should strive to measure quantities with the maximum precision of the instruments provided in the laboratory.
3. Develop and reinforce skills in documenting observations.
You should develop good habits in the organization and recording of raw data in a notebook, and take care to document the data such that it can be analyzed at a later time. You should sketch the physical apparatus used in the experiment. In doing so, pay special attention to the specific mechanical and operational details that enable the apparatus to achieve the purpose for which it was designed. You should be able to list and describe the steps used to obtain the desired measurements. You should be able to identify whether any actions were taken to improve the outcome of the experiment. Likewise, you should be able to identify any actions that may have contributed to undesirable outcomes.
4. Develop skills at writing laboratory reports.
You will create reports to document your measurements in the laboratory. You will use a writing style and format that is common to technical documentation used in Civil and Mechanical Engineering. Your reports should be complete, yet concise. By writing the report, you should develop a clear understanding of the laboratory exercise, and communicate that understanding in your written words.



SYLLABUS

(55604) METROLOGY AND MACHINE TOOLS LAB

Section A

1. Measurement of lengths, heights, diameters by Vernier Calipers, Micrometers etc.
2. Measurement of bores by internal micrometers and dial bore indicators.
3. Use of gear teeth, Vernier Calipers and checking the chordal addendum and chordal height of spur gear.
4. Machine tool "alignment test on the Lathe.
5. Machine tool alignment test on milling machine.
6. Tool makers microscope and its application.
7. Angle and Taper measurements by Bevel protractor, Sine bars, etc.
8. Use of spirit level in finding the flatness of surface plate.
9. Thread measurement by Two wire method or Tool makers microscope.
10. Surface roughness measurement by Taly Surf.
11. Surface Wear Resistance Test using Electro Spark Coating Device.



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S No	Main Scale Reading (M.S.R)	Vernier Scale Coincidence	V.S.C X L.C	Total Length
a.1				
a.2				
a.3				
b.1				
b.2				
b.3				
b.1				
b.2				
b.3				

Calculations:

**Experiment No. 1****MEASURING OF DIAMETER BY VERNIER CALIPERS****Aim:**

To measure the diameters of the given work piece at various sections using Vernier Calipers.

Equipment Required:

1. Vernier Calipers with Least Count = 1 mm/50 OR 0.02mm
2. Work piece of various cross sections with different diameters.

Principle:

Vernier Calipers is the most commonly used instrument for measuring outer and inner diameters. It works on the principle of Vernier Scale which is some fixed units of length (Ex: 49mm) divided into 1 less or 1 more parts of the unit (Ex: 49mm are divided into 50 parts).

The exact measurement with upto 0.02mm accuracy can be determined by the coinciding line between Main Scale and Vernier Scale.

$$\text{Total Reading} = \text{M.S.R} + \text{L.C} \times \text{V.C}$$

Where:

M.S.R – Main Scale Reading

L.C – Least Count

V.C – Vernier Coincidence

Procedure:

1. The Least Count is to be determined.
$$\text{L.C} = (\text{Minimum Main Scale Reading}) / (\text{No. of Vernier Scale Divisions})$$
2. The workpiece is placed between the jaws of Vernier Calipers correctly.
3. The reading on Main scale which is just behind the first Vernier Scale Division is noted as Main Scale Reading.
4. The Division on Vernier Scale which coincides with the line on Main Scale is noted down as Vernier Coincidence.
5. The Diameter can be calculated using the given Formula.

Precautions:

1. Make sure the Vernier Calipers are clean.
2. Clean the measuring faces with paper or cloth.
3. Make sure the workpiece axis is perpendicular to the Vernier Calipers.

Result:

Outside diameter of the work piece No 1:

Outside diameter of the work piece No 2:

Outside diameter of the work piece No 3:



S No	Main Scale Reading	Thimble Scale Coincidence	Zero Error	Thimble Scale Reading	Total Length
a.1					
a.2					
a.3					
b.1					
b.2					
b.3					
b.1					
b.2					
b.3					

Calculations:

**Experiment No. 2****MEASURING OF THICKNESS BY OUTSIDE MICROMETER****Aim:**

To measure the thickness of the given work piece at various sections using micrometer.

Equipment Required:

3. Outside micrometers range = (0-25mm)
4. Work piece of various thicknesses.

Principle:

Micrometer is one of the most common and most popular forms of measuring instrument for precise measurement with 0.01mm accuracy. It works on the principle of screw and nut. We know that when a screw is rotated through one revolution it advances by one pitch distance i.e. one rotation of screw corresponding to a linear movement of a distance equal to pitch of the screw thread.

If the circumference of the screw is divided into number of equal parts say n its rotation through one division will cause the screw to advance through (pitch/n) length.

Least Count of Micrometers:

Least count is the minimum distance which can be measurement accurately by the instruments.

The micrometer has a screw of 0.5mm pitch, with a thimble graduated in 50 divisions to provide a direct reading of pitch/n.

Least count of micrometer

Total Reading = Main Scale Reading + L.C. x (Thimble Scale Coincidence \pm error)

Procedure:

1. The least count is to be determined.
2. The w/p is placed between the two anvils after the instruments are adjusted for zero error.
3. Work piece is held strongly without applying under pressure on the instrument.
4. The value of the main scale is noted down. The main scale division just coincides with the index line. This is called the main scale division which just procedures edge of the main scale is noted down. This is called thimble scale reading (T.S.R).

Diameter of the work piece is given by

$$D = \text{main scale reading} + \text{L.C.} \times (\text{Thimble scale reading})$$

Precautions:

1. First clean the micrometer by wiping off all the dirt, dust and grit etc.
2. Clean the measuring faces of paper or cloth.
3. Set the zero reading of the instrument to before measuring

Observations:

1. First least count of the outside micrometer must be cal
2. The corresponding readings are then enforced into following tables.

Result:

Outside diameter of the work piece No 1:

Outside diameter of the work piece No 2:

Outside diameter of the work piece No 3:



S No	Main Scale Reading	Thimble Scale Coincidence	Thimble Scale Reading	Zero Error	Total Length
a.1					
a.2					
a.3					
b.1					
b.2					
b.3					
b.1					
b.2					
b.3					

Calculations:

**Experiment No. 3****MEASURING OF INTERNAL BORES BY INSIDE MICROMETER****Aim:**

To measure the diameters of the given work piece at various sections using micrometer.

Equipment Required:

1. Outside micrometers range = (0-25mm)
2. Work piece of various cross sections with different diameters.

Principle:

Micrometer is one of the most common and most popular forms of measuring instrument for precise measurement with 0.01mm accuracy. It works on the principle of screw and nut. We know that when a screw is rotated through one revolution it advances by one pitch distance i.e. one rotation of screw corresponding to a linear movement of a distance equal to pitch of the screw thread.

If the circumference of the screw is divided into number of equal parts say n its rotation through one division will cause the screw to advance through (pitch/n) length.

Least Count of Micrometers:

Least count is the minimum distance which can be measurement accurately by the instruments.

The micrometer has a screw of 0.5mm pitch, with a thimble graduated in 50 divisions to provide a direct reading of pitch/n.

Least count of micrometer

Total reading = main scale reading + L.C x (reading on thimble)

Procedure:

1. The least count is to be determined.
2. The w/p is placed between the two anvils after the instruments are adjusted for zero error.
3. Work piece is held strongly without applying under pressure on the instrument.
4. The value of the main scale is noted down. The main scale division just coincides with the index line. This is called the main scale division which just procedures edge of the main scale is noted down. This is called thimble scale reading (T.S.R).

Diameter of the work piece is given by

$$D = \text{main scale reading} + \text{L.C.} \times (\text{Thimble scale reading})$$

Precautions:

1. First clean the micrometer by wiping off all the dirt, dust and grit etc.
2. Clean the measuring faces of paper or cloth.
3. Set the zero reading of the instrument to before measuring

Observations:

1. First least count of the outside micrometer must be cal
2. The corresponding readings are then enforced into following tables.

Result:

Outside diameter of the work piece No 1:

Outside diameter of the work piece No 2:

Outside diameter of the work piece No 3:



S No	Size of Sine Bar	Center to Center Distance (L)	Slip Gauge Combination (h2)	$h=h_1-h_2$	$\sin(\theta) = h/L$	θ
a.1						
a.2						
a.3						
b.1						
b.2						
b.3						
b.1						
b.2						
b.3						

Calculations:

**Experiment No.4****MEASURING OF TAPER ANGLE BY SINE BAR****Aim:**

To measure the taper angle of a work piece by using sine bar.

Apparatus:

Sine bar, Rollers, Slip gauge, Surface Plate, Clamps Lightening work piece, Taper work pieces.

Principle:

Sine bar is based upon laws of trigonometry. To set a given angle one roller of the bar is placed on the surface plate and the combination of slip gauges is inserted under the second roller as shown in the figure.

If h is the height of the combination of the slip gauges, L is the distance between roller centers,

Then

Therefore, $\theta = \sin^{-1} (h/L)$

Then the angle can be measured as a function of sine. Thus, it is called sine bar.

Requirements of a sine bar:

The axes of the roller must be parallel to each other and the center distance L must be known. The size of the bar is specified by this distance.

The top surface of the bar must have a high degree of flatness.

The roller must be of identical diameters and round within a close tolerance.

Depending upon the accuracy of the center distance, sine bars are graded as of A grade or B grade. Sine bars are guaranteed accurately up to 0.02 mm /meter of length and A grade sine bars are more accurate and guaranteed up to 0.01 mm/meter of length.

Procedure:

1. The sine bar is made to rest on surface plate with rollers contacting the datum.
2. Place the component on sine bar and lock it in position.
3. Lift one end of the roller of sine bar and place a pack of slip gauge, underneath the roller. Height of the slip gauges (h) should be selected such that the top surface of component is parallel to the datum plate.
4. Record the final height of the slip gauge combination for achieving parallelism.
5. Calculate inclination $\theta = \sin^{-1} (h/L)$

Limitations:

1. Sine bar is reliable for angles less than 15° , and the angle above 45° .
2. It is physically clumsy to hold in position.
3. Slightly errors of the sine bar cause larger angular errors.
4. Size of the parts which can be impacted by sine bar is limited.

Result:

The taper angles of the given work piece as measured by sine bar is _____