SVR ENGINEERING COLLEGE

NANDYAL-518501, KURNOOL (DIST.) A.P

OFFERING DIPLOMA, B.TECH, M.TECH, MBA COURSES

APPROVED BY AICTE NEW DELHI,

AFFILIATED TO JNTU -ANANTAPURAM.

DEPARTMENT OF
MECHANICAL ENGINEERING

METROLOGY & MEASUREMENTS LAB MANUAL

Subject Code: 15A03711

NAME : ______________________________

CLASS/SEM : ______________________________

ROLL No. :______________________________

ACADEMIC YEAR :__________ **2020-21** __________

INDEX

SECTION-A METROLOGY LAB

SECTION-B MEASUREMENTS LAB

Signature of Staff

B. Tech IV-I Sem. (ME) **L T P C**
0 0 4 2

15A03711 METROLOGY & MEASUREMENTS LABORATORY

Any 6 experiments from each section

Section A:

1. Measurement of bores by internal micrometers and dial bore indicators.
2. Use of gear teeth vernier calipers and checking the chordal addendum and chordal height of spur gear.
3. Alignment test on the lathe and milling machine
4. Study of Tool maker's microscope and its application
5. Angle and taper measurements by Bevel protractor, Sine bars, spirit level etc.
6. Thread measurement by Two wire/ Three wire method.
7. Surface roughness measurement by Talysurf instrument.
8. Use of straight edge and sprit level in finding the flatness of surface plate.

Section B:

1. Calibration of Pressure Gauges.
2. Calibration of transducer or thermocouple for temperature measurement.
3. Study and calibration of LVDT transducer for displacement measurement.
4. Study and calibration of capacitive transducer for angular measurement.
5. Study and calibration of photo and magnetic speed pickups for the measurement of speed.
6. Study and calibration of a rotometer for flow measurement.
7. Study and use of a Seismic pickup for the measurement of vibration amplitude of an engine bed at various loads.
8. Study and calibration of Mcleod gauge for low pressure.

SECTION-A
METROLOGY LAB

Exp. No: 1 **Date:**

MEASUREMENT OF BORES BY INTERNAL MICROMETERS AND DIAL BORE INDICATORS

AIM: To measure the bore dia of a given specimen by using Inside Micrometer.

INSTRUMENTS AND MATERIAL REQUIRED:
a) Inside micrometer
b) Specimen

SPECIFICATION:
a) Inside micrometer: Range 5-30 mm, Least count = 0.01 mm.
b) Specimen: standard size

THEORY AND DESCRIPTION:

INSIDE MICROMETER:

An inside micrometer, also known as an internal micrometer, is a precision instrument for measuring the inside dimension of an object, such as the diameter of a hole or the width of a groove.

This micrometer caliper has 'U' shape frame and spindle. The measuring tips areconstituted by the jaws with contact surfaces which are hardened and ground to a radius.

One of the Jaws is held stationary at the end and second one move by the movement ofthimble. A lock nut is provided to arrest the moment of movable right jaw.

Least Count:

Least Count is the smallest length that can be measured accurately by the instrument.

$$\text{L. C of micrometer} = \frac{\text{Pitch of the screw}}{\text{Total No. of divisions on circular scale}}$$

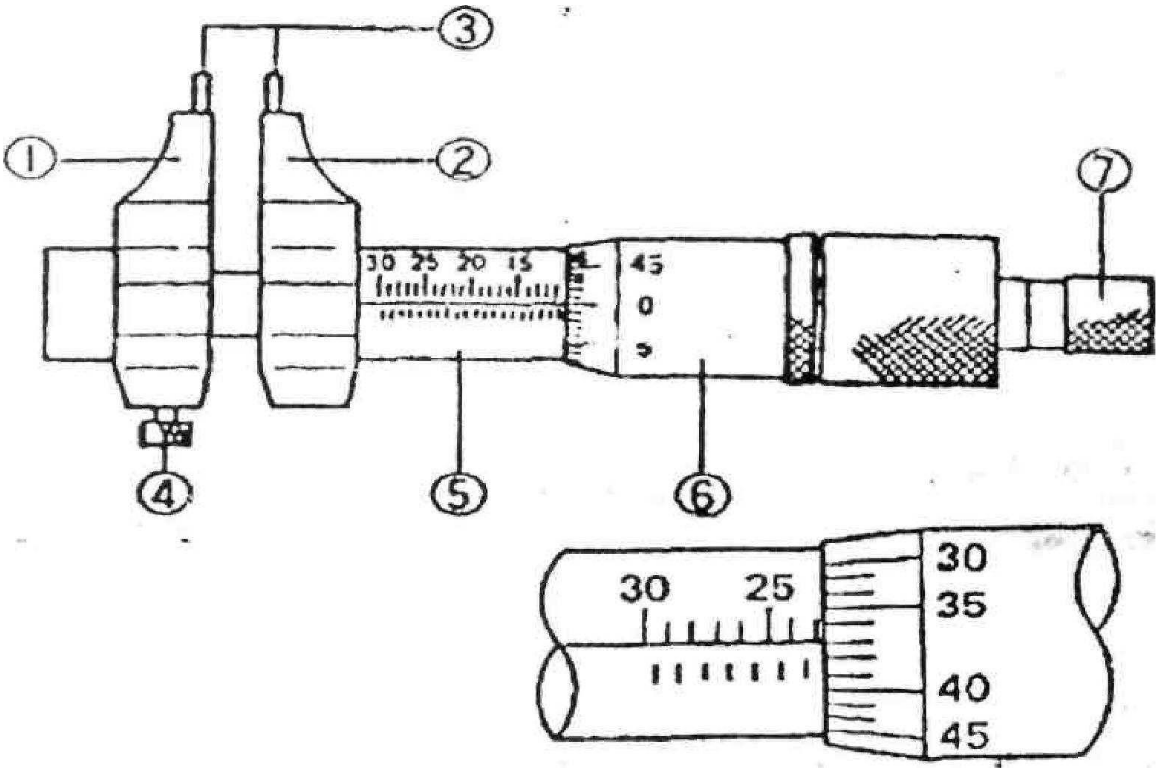
$$\text{Where,} \qquad \text{Pitch of the screw} = \frac{\text{Distance advanced}}{\text{Number of Rotations}}$$

PRINCIPLE:

Inside micrometer works on screw and nut principle. When a screw is turned through nut by one revolution, it advances by one pitch distance. 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 $\frac{\text{pitch}}{\text{n}}$ length. Thus the minimum the screw threads or by increasing the number of divisions on the circumference of the screw the length that can be measured by such arrangement will be $\frac{\text{pitch}}{\text{n}}$ .By reducing the pitch of length value of one circumferential division can be reduced and accuracy of measurement can be increased considerably.

PROCEDURE:
1. Keep the inside micrometer Jaws in the work piece.
2. When two anvils touches the sides of bore, apply pressure with ratchet.
3. See the reading & note down.

INSIDE MICROMETER



1) Left jaw

(2) Right jaw

(3) Contact points

(4) Clamping knob

(5) Sleeve or Barrel

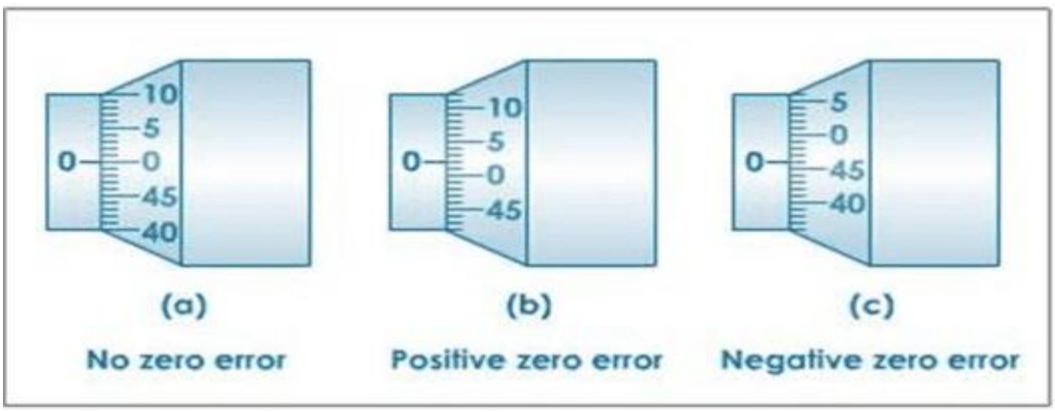
(6) Thimble

(7) Ratchet

Sleeve 22.5mm

Thimble 37mm

Reading 22.87mm



(a) No zero error (b) Positive zero error (c) Negative zero error

TABULAR FORM:

S.NO.	S.R	C.S.R	TR=S.R+ (LC X C.S.R)
1.			
2.			
3.			
AVG			

LC = LEAST COUNT

SR = SLEEVE READING

CR = CIRCULAR SCALE READING

TR = TOTAL READING

PRECAUTIONS:

a) Thimble should be turned with ratchet only and to have standard condition and to prevent excess deformation of work piece.

b) Only after checking the reading with inside micrometer, then use the dial bore gauge.

c) The specimen measured surface should be smooth.

d) See the reading without parallax error.

RESULT:

The bore dia of a given specimen =

CONCLUSION:

Signature of Staff

Exp. No: 2 **Date:**

MEASUREMENT OF CHORDAL THICKNESS& CHORDAL ADDENDUM BY GEAR TOOTH VERNIER CALIPERS

AIM: To measure Chordal Thickness & Chordal Addendum of spur gear by using Gear tooth Vernier Calipers.

INSTRUMENTS AND MATERIAL REQUIRED:

a) Gear tooth Vernier caliper
b) Spur gear

SPECIFICATIONS:

a) Gear Tooth Vernier Calipers – range 0-150 mm, LC = 0.02mm
b) Spur gear size = Standard size
c) Vernier Calipers - range 0-150 mm, LC = 0.02mm

TERMINLOGY OF GEAR TOOTH: Fig (3.1)

Pitch circle diameter (P.C.D): **It** is the diameter of a circle which by pure rolling action would produces the same motion as the toothed gear wheel.

Module (m): It is defined as the length of the pitch circle diameter per tooth. Thus if P.C.D of gear be 'D' and number of teeth 'N', then module (m) = D/N. it is generally expressed in mm.

Diametric pitch: It is expressed as the number of teeth per inch of the P.C.D.

Circular pitch: It is the arc distance measured around the pitch circle from the flank of one tooth to a similar flank in the next tooth. C.P = ΠD/N = Πm

Addendum: This is the radial distance from the pitch circle to the tip of the tooth. Its value is equal to one module.

Clearance: This is the radial distance from the tip of a tooth to the bottom of a mating tooth space when the teeth are symmetrically engaged. Its standard value is 0.157 m

Dedendum: This is the radial distance from the pitch circle to the bottom of the tooth space.

Dedendum = Addendum + clearance = m + 0.157 m = 1.157 m.

Blank diameter: This is the diameter of the blank from which gear is cut. It is equal to P.C.D plus twice the addendum.
Blank diameter = P.C.D + 2m = mN + 2m = m (N+2)

Tooth thickness: This is the arc distance measured along the pitch circle from its intercept with on flank to its-intercept with the other flank of the same tooth.
Normally tooth thickness = 1/2 (C.P) = 1/2 (ΠM)
But thickness is usually reduced by certain amount to allow for some amount of backlash and also owing to addendum correction.

Face of tooth: It is that part of the tooth surface which is above the pitch surface.

Flank of tooth: It is that part of the tooth surface which is lying below the pitch surface.

THEORY:

MEASUREMENT OF TOOTH THICKNESS:

Gear tooth Vernier Caliper is used to measure the thickness of gear tooth at the pitch line. The Gear tooth Vernier Calipers consists of two perpendicular Vernier arms with Vernier scale on each arm. One of the arms is used to measure the thickness of gear teeth and other for measuring depth. The caliper is so set that it slides on the top of tooth of gear under test and the lower ends of the caliper jaws touch the sides of the tooth at the pitch line. The reading on the horizontal Vernier scale gives the value of Chordal thickness (w) and the reading on the vertical Vernier scale gives the value of Chordal addendum (d).

Considering one gear tooth, the theoretical values of 'w' and 'd' can be found which may be verified bythe instrument. From fig .3.2

Chordal thickness = w = AB = 2AD

<AOD = θ = $\frac{360°}{4N}$, where 'N' is the number of teeth.

W = 2AD = 2 x AO. Sin θ = 2R. Sin $\frac{360°}{4N}$ (R = Pitch circle radius)

- Module (m) = $\frac{\text{P.C.D}}{\text{Number of teeth}} = \frac{2R}{N}$

  Where, R = $\frac{360}{2}$

- Chordal thickness (w) = $2.\frac{N.m}{2} Sin \frac{360°}{4N}$

  $$= N.m \text{ Sin} \left(\frac{90°}{N}\right)$$

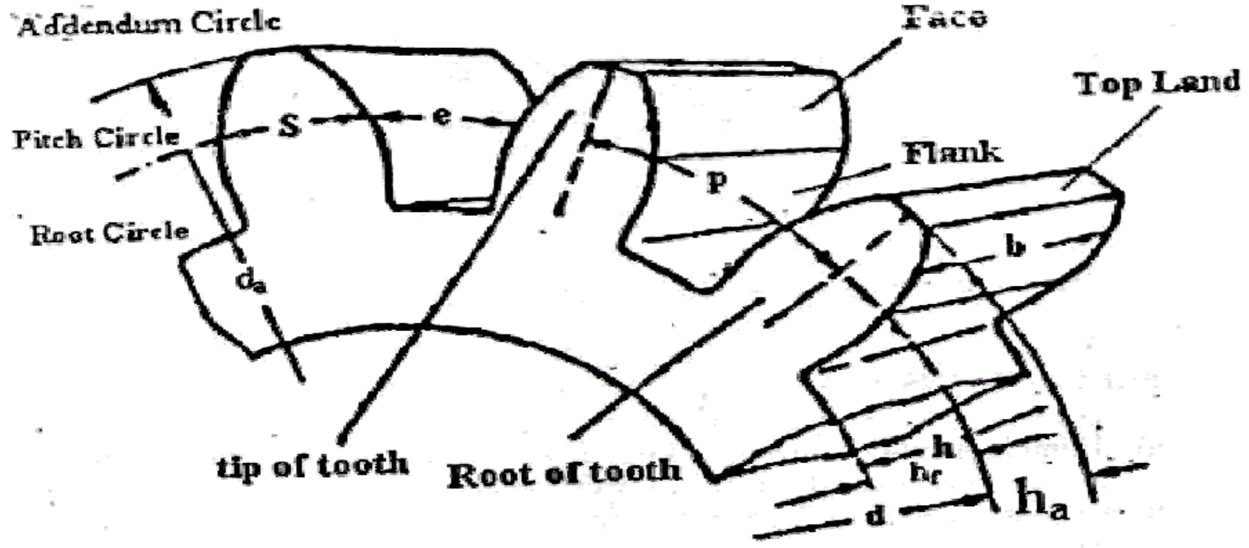
Also from fig (3.2) d = OC – OD.

But OC = OE + Addendum = R+m = [N.m/2]+m and

But OD = R Cos θ = N.m/2 Cos90°/N

- Chordal Addendum (d) $= \frac{N.m}{2} + m - \frac{N.m}{2} \text{Cos} \frac{90°}{N}$

  $$= \frac{N.m}{2}\left(1 + \frac{2}{N} - Cos\left(\frac{90°}{N}\right)\right)$$



h_a - Addendum

h_f - Dedendum

h - Tooth depth

d - Pitch Circle diameter

d_a - Blank diameter

S - Tooth thickness

Fig. (3.1): Gear Tooth Terminolog y

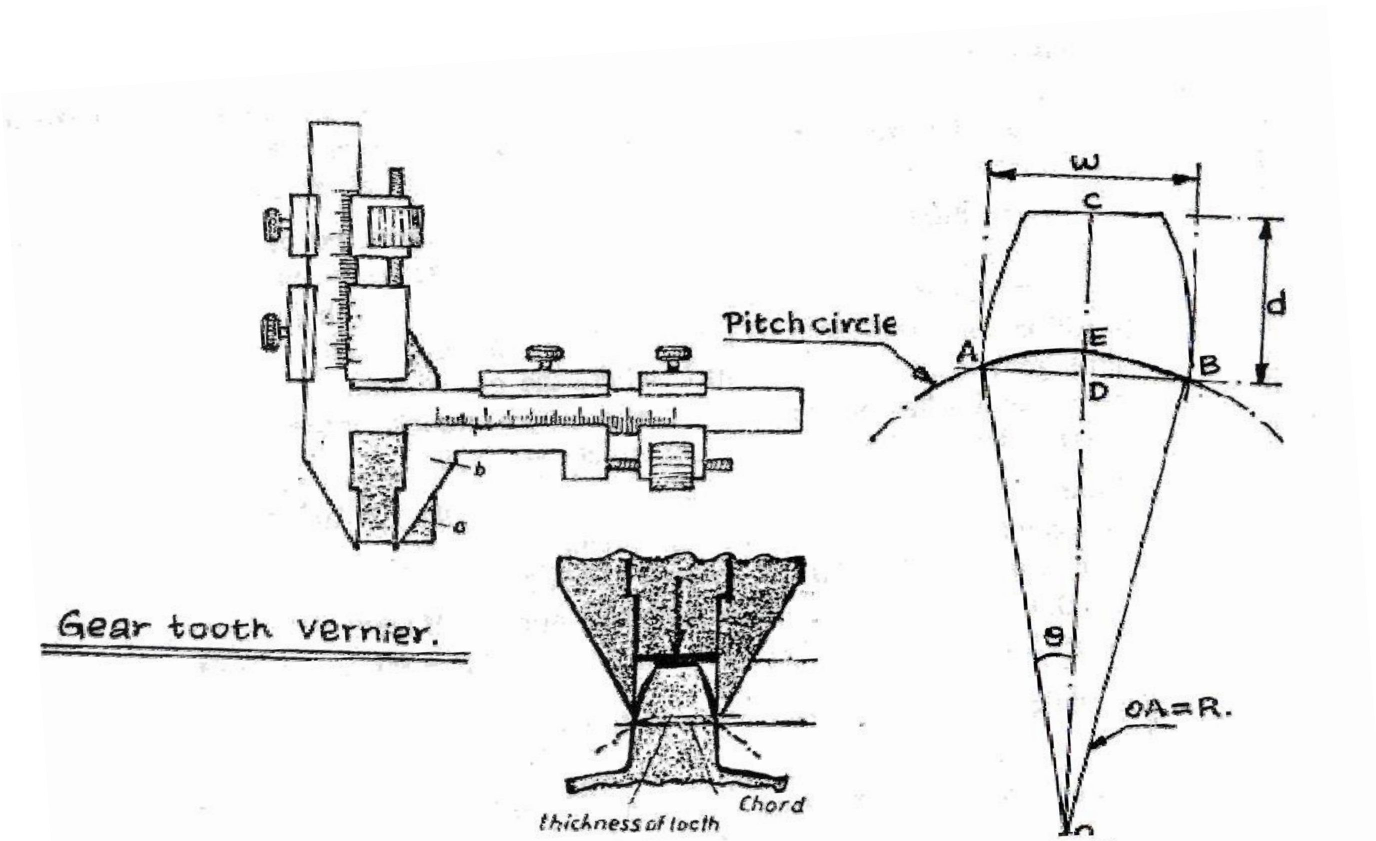


Fig. 3.2

PROCEDURE:

a) Count the number of teeth (N) on the gear,
b) Measure the outside diameter (Do) of the gear.
c) Calculate the module from the relation, m $=\frac{Do}{(N+2)}$
d) Calculate the value of Chordal addendum (d) from equation (3.1)
e) Set the gear tooth Vernier caliper for depth 'd' and measure 'w' i.e., Chordal thickness of tooth.
f) Repeat the measurement on other teeth and determine an average value.

OBSERVATIONS:

a) Number of teeth on gear, N = -------
b) Outside diameter of gear (Do) = -----------

S.No.	Actual readings					
	Chordal tooth thickness, w mm			Chordal tooth addendum, d mm		
	M.S.R	V.S.R	T.R=M.S.R+ (L.C×V.S.R)	M.S.R	V.S.R	T.R=M.S.R+ (L.C×V.S.R)
1.						
2.						
3.						
Avg.				Avg.		

CALCULATIONS:

i) Number of teeth (N)=

ii) module (m) = $\frac{Do}{(N+2)}$ =

iii) Chordal Addendum (d) = $\frac{N.m}{2}\left(1+\frac{2}{N}-Cos\left(\frac{90°}{N}\right)\right)$

=

iv) Chordal Thickness (w) = $N.m\ Sin\left(\frac{90°}{N}\right)$

=

PRECAUTIONS:

i) Don't press the jaws to tight.

ii) See the reading without parallax error.

RESULTS:

The average values of given specimen

1. Chordal addendum =
2. Chordal thickness=

The theoretical value of gear tooth thickness may differ from the measured value due to the manufacturing in accuracies.

CONCLUSION:

Signature of Staff

Exp.No:3 **Date:**

ALIGNMENT TEST ON THE LATHE AND MILLING MACHINE

AIM: To carry the alignment test on lathe machine.

1. Spindle axis parallel to bed.
2. Movement of upper slide parallel to bed.
3. Line of centers parallel to bed.
4. Tail stock parallel to bed.

APPARATUS: Dial indicator, mandrel, dial stand (magnetic type) etc.

Formula:

Deflection £ =**(WL^4) / (48 EI)**

E	=	young's modulus
I	=	moment of inertia
W	=	volume* density
L	=	length of material
D	=	diameter of the mandrel

PROCEDURE:

1. SPINDLE AXIS PARALLEL TO BED:

1. For this test, a mandrel is fitted in the taper nose of the spindle which has a concentric taper shank which is close fit to the spindle nose taper.
2. The plunger of the dial indicator is pressed on the mandrel after keeping the magnetic stand of dial indicator on a suitable rest.
3. Now, the carriage is moved along and the deflection in the dial indicator is being noted.
4. In the horizontal plane, the mandrel is inclined to a direction opposite to the direction of tool pressure.
5. The indicator setup is very important else readings by pointer may be solely due to deflection of indicator mounting and it is difficult to detect and isolate deflection from true deflection.

2. MOVEMENT OF UPPER SLIDE PARALLEL TO BED:

1. Here also the mandrel is fitted in the taper socket of the spindle which has a concentric taper shank, which is a close fit to the spindle nose taper.
2. Here the dial indicator is fixed in the tool post.
3. The pointer of dial indicator is pressed on the mandrel after keeping the magnetic stand of dial indicator on a suitable rest.
4. Now, the upper slide of the carriage is being moved horizontally and the deflections given by dial indicator are noted.
5. The error is not tested in horizontal plane but in vertical plane because of provision of swiveling arrangement.

3. LINE OF CENTERS PARALLEL TO BED:

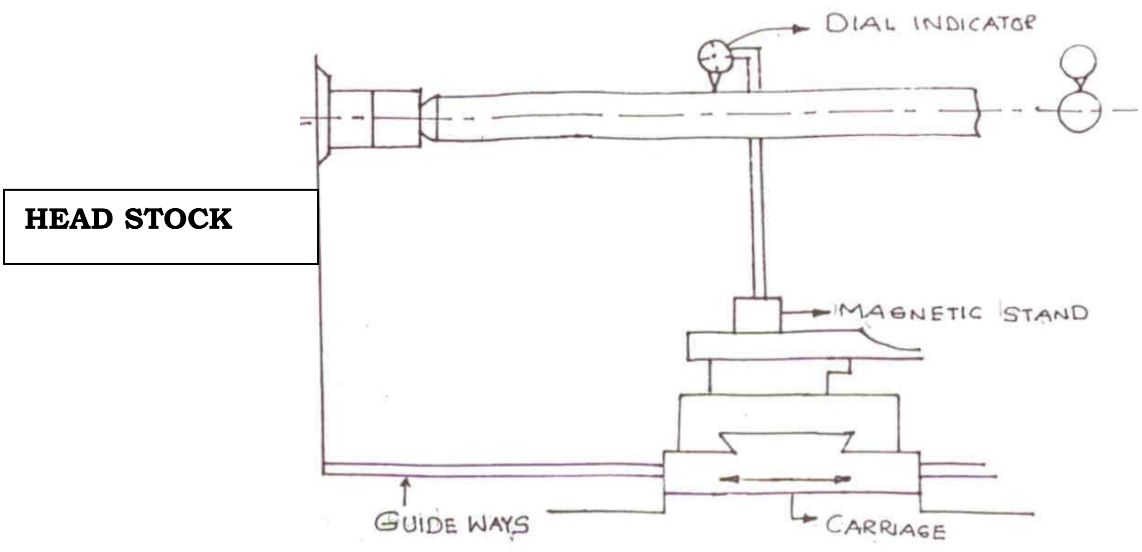
1. The mandrel is being fixed between the two centers.

2. To find out whether axes of both may be parallel to carriage but they may not coincide.
3. The dial indicator is fitted on the carriage and then the pointer is adjusted.
4. Press the mandrel in the vertical plane.
5. The carriage is moved horizontally and the error is being noted down.

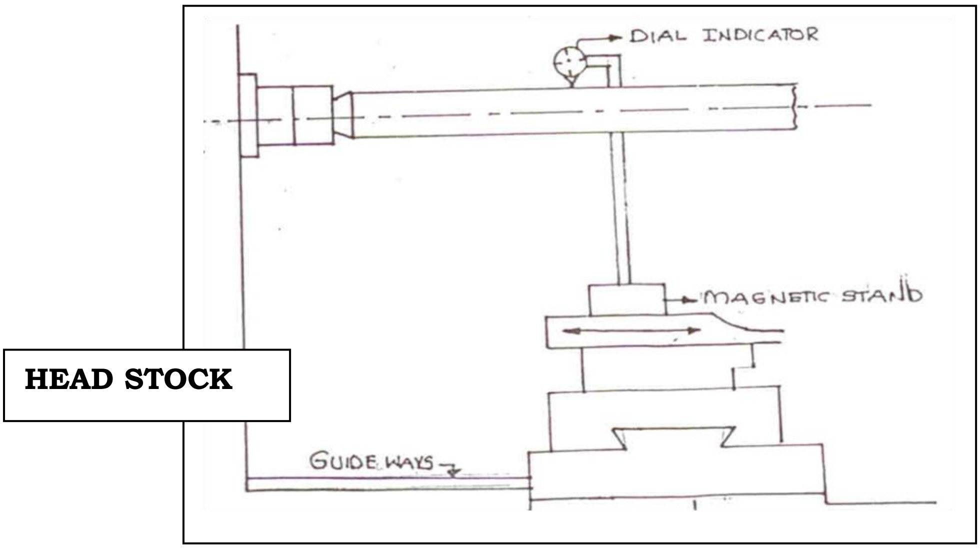
4. TAIL STOCK PARALLEL TO BED:

1. Fixing the dial indicator on the tool post and pressing carries out the test the plunger against the sleeves.
2. Then the carriage is moved along the full length of the sleeve, which will be rising towards the free end in vertical plane.
3. Then the deflections given by the dial indicator are noted down.

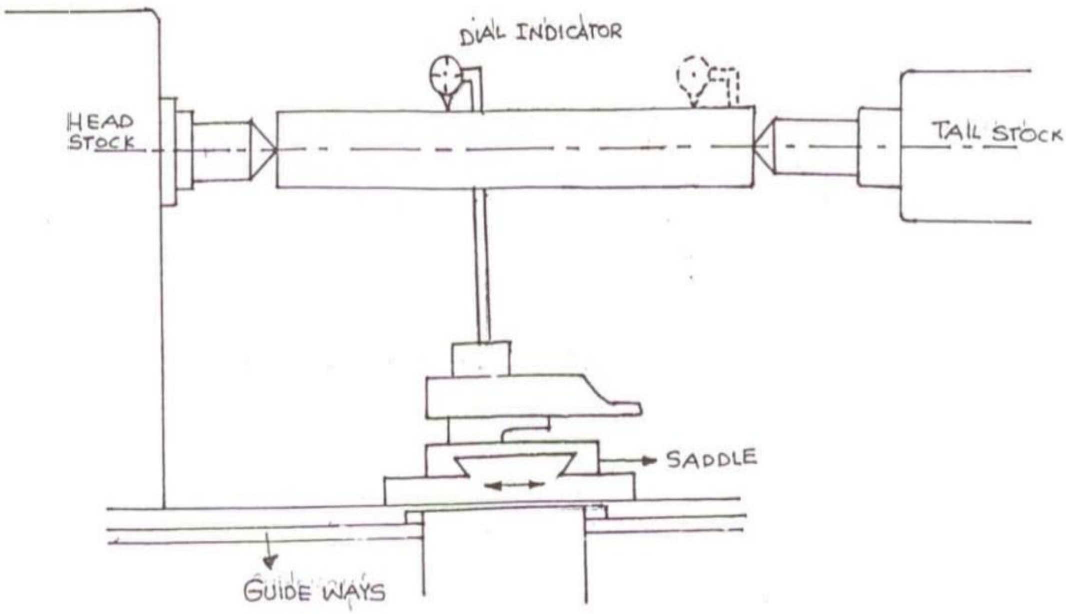
SPINDLE AXIS PARALLEL TO GUIDE WAYS



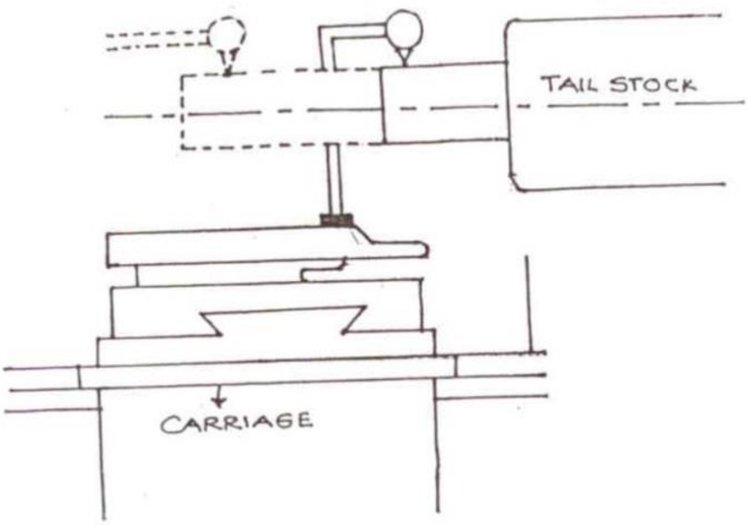
MOVEMENT OF UPPER SLIDE PARALLEL



i) Line of centres parallel to bed :-



Tailstock Parallel to bed :-



RESULT:

S.No	TEST	ERROR(mm/length)
1.		
2.		
3.		
4.		
5.		

CONCLUSION:

Signatureof Staff

Exp.No:4 **Date:**

ANGLE AND TAPER MEASUREMENTS BY BEVEL PROTRACTOR

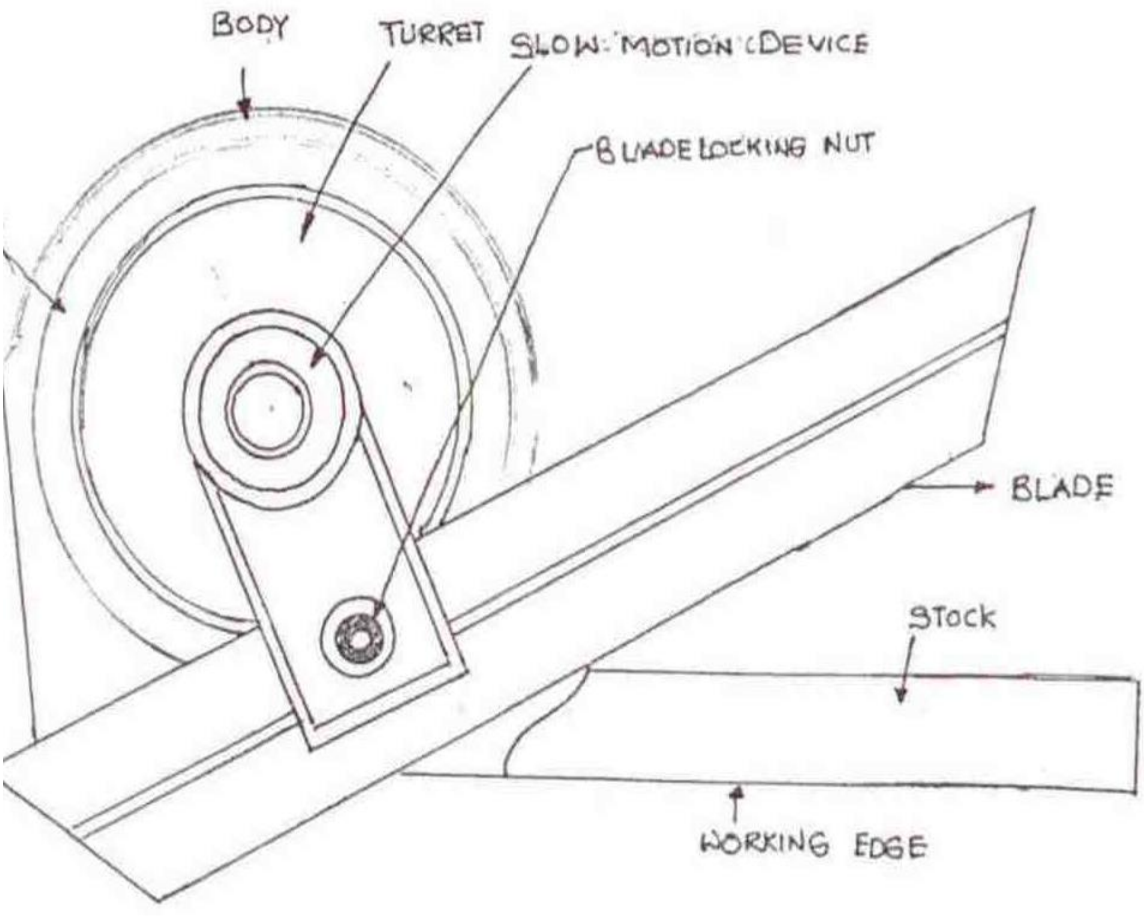
AIM: To Measure Angle of the given specimen by using Bevel Protractor

APPARATUS: surface plate, Angle plate, Feeler Gauges.

PROCEDURE:

1. Clean the specimen and apparatus with good cloth.
2. Place the work edge of the stock as a reference and rotate the adjustment screw until the included angle between the blade and stock.
3. 3. Lock the blade by the knob and read angle and tabulate the reading as shown in table column and find the average value.

FIGURE:



LEAST COUNT FORMULA:

23 Main scale divisions =12 Vernier scale divisions
1 Vernier scale division = 23/12MSD

Least count = 2 M S D- 1 V S D
= 2-23/12
= 1/12
= 5’

OBSERVATIONS:

S.No	M.S.R	V.S.R	ERROR	TOTAL ANGLE =M.S.R (V.S.R×L.C)±ERROR
1.				
2.				
3.				
AVERAGE				

RESULT:

1. Angle of given specimen is measured by using bevel protractor =

CONCLUSION:

Signatureof Staff

Exp.No:5 **Date:**

ANGLE AND TAPER MEASUREMENTS BY SINE BAR

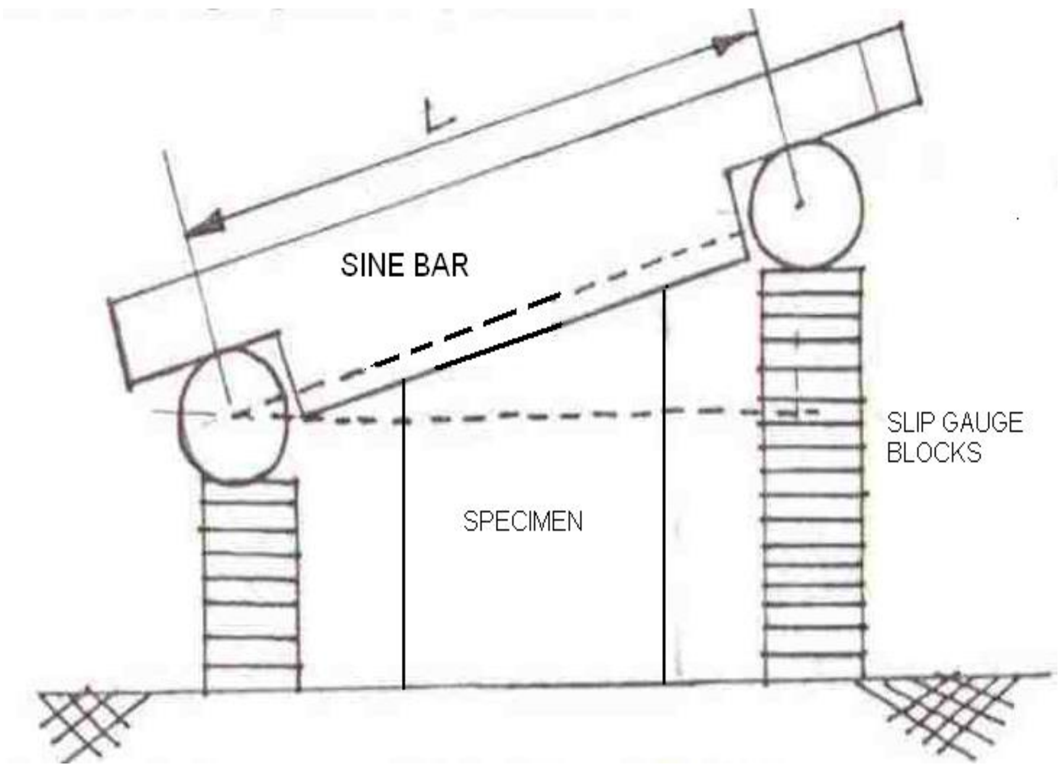
AIM: To Measure Angle of the given specimen by using Sine bar.

APPARATUS: Sine bar, surface plate, Angle plate, Slip gauge blocks.

PROCEDURE:

1. Wipe the surface plate, apparatus, specimen, and slip gauge blocks.
2. Place the component of the upper surface of the sine bar and adjust the height of the slip gauges in order to bring the tapered object approximately horizontal to the ground level. Or place the component ground level and place the sine bar lower surface with angle of tapered surface of specimen.
3. By adjusting the height of slip gauge block and tabulate the reading as shown in tabular column. And calculate the angle.
4. Repeat the procedure with different angles of h_1 and h_2 and calculate the average value.

FIGURE:



FORMULA: $\sin \alpha = \frac{BC}{AB}$

$$= \frac{(h_2+d/2)-(h_1+d/2)}{L}$$

$$= \frac{h_2-h_1}{L}$$

$$\therefore \alpha = \sin^{-1}\left(\frac{h2-h1}{L}\right)$$

OBSERVATIONS:

S.NO	h_1 in mm	h_2 in mm	length	Sin α	α in deg.
1.					
2.					
3.					

RESULT:

Angle of the given specimen is measured by using sine bar =

CONCLUSION:

Signatureof Staff

Exp.No: 6 **Date:**

MEASUREMENT OF LENGTHS, HEIGHTS & DIAMETERS BY VERNIER CALIPERS & MICROMETER

AIM: To measure the length, height and diameter by using Vernier Calipers and Micrometer

INSTRUMENTS AND MATERIALS REQUIRED:

1. Vernier Calipers
2. Micrometer
3. Job(s) or work piece

VERNIER CALIPERS:

THEORY: Vernier Caliper is an Instrument used for measuring distance between or over surfaces or for comparing dimensions of work pieces with such standards as plug gauges, graduated rules etc.

The **Principle of Vernier** is that, when two scales or divisions slightly different in size are used, the difference between them can be utilized to enhance the accuracy of measurement.

LEAST COUNT OF VERNIER:
Least Count is the smallest length that can be measured accurately and is equal to the difference between a main scale division and a Vernier scale division.

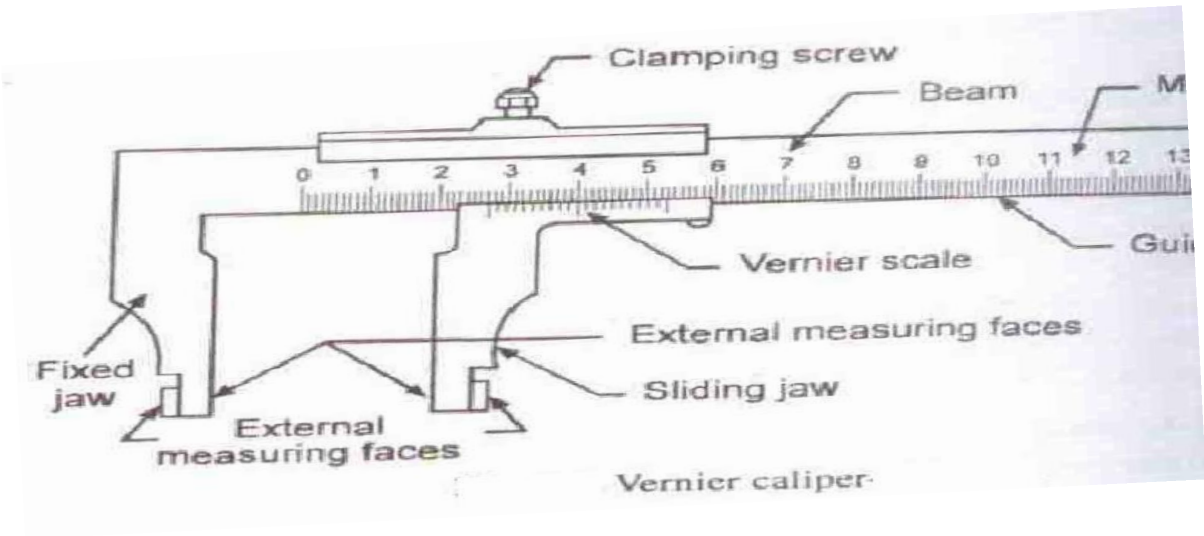
$$L.C = 1 \text{ Main scale division} - 1 \text{ Vernier scale division}$$

$$\therefore L.C = 1 - \frac{49}{50} = 0.02 \text{ mm}$$

(Or)

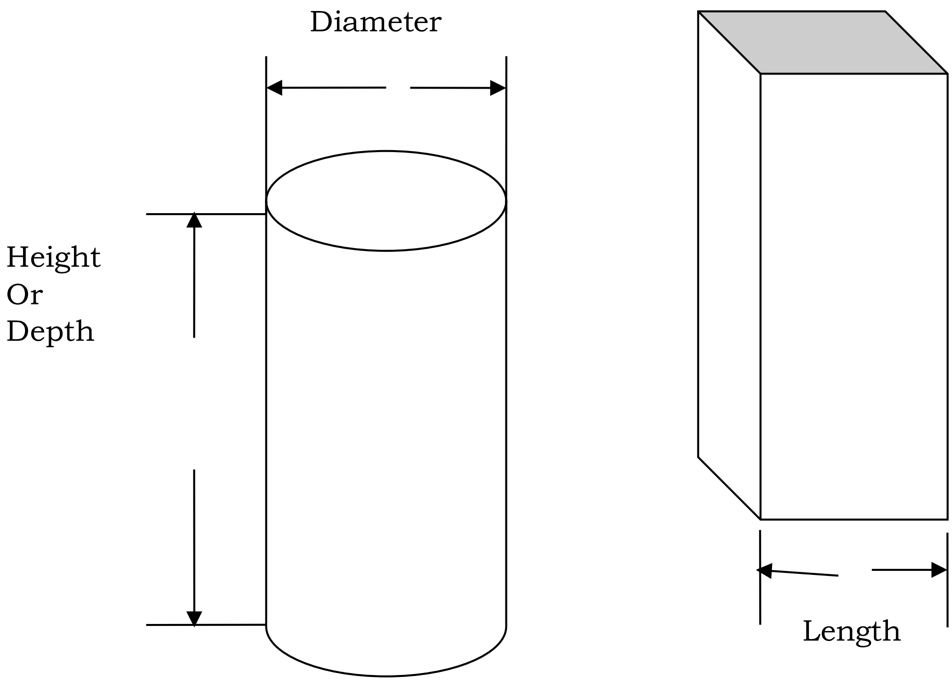
$$L.C = \frac{1 \text{ Main scale division}}{\text{No. of divisions on Vernier scale}}$$

$$\therefore L.C = \frac{1}{50} = 0.02 \text{ mm}$$



PROCEDURE:

1. Close the two Jaws of the Vernier and check the zero error. In this position, the zero of Vernier scale should exactly match with zero of the main scale.
2. Hold the job between the jaws (The internal dimensions or internal diameter may be taken by using upper measuring jaws).
3. Note the number of millimeters and half millimeters on the scale that are coincident with zero on the vernier scale.
4. Find the graduation on the scale that coincides with a graduation on the main scale. Multiply this figure with least count to give the reading in millimeters. Obtain the total reading by adding the main scale reading to the vernier scale reading.
   i.e., Total reading= M.S.R+ (L.C ×V.S.R)
   Where,
   M.S.R = Main scale reading
   L.C = Least count
   V.S.R = Vernier scale reading
5. Repeat this procedure three to four times and then calculate the average value.



OBSERVATIONS: Vernier Calipers

	Length-			**Diameter-**			**Height-**		
S.No	**Main Scale Reading (M.S.R)**	**Vernier Scale Reading (V.S.R)**	**Total Reading =M.S.R+ (L.C×V.S.R)**	**M.S.R**	**V.S.R**	**Total Reading =M.S+ (L.C×V.S.R)**	**M.S.R**	**V.S.R**	**Total Reading =M.S+ (L.C×V.S.R)**
1									
2									
3									
Avg.				Avg.			Avg.		

Precautions:

1. Before starting the experiment, check the zero error of the vernier.
2. With Vernier Calipers, always use the stationary caliper jaw on the reference point and obtain the measured point by advancing or withdrawing the sliding jaw.
3. Grip the vernier calipers near or opposite the jaws; one hand for stationary jaw and the other hand generally supporting the sliding jaws.
4. Before reading the vernier try caliper again for feel and location.
5. While measuring an outside diameter, be sure that the caliper bar and the plane of caliper jaws are truly perpendicular to work piece’s longitudinal centre line.
6. Vernier caliper must be kept wiped free form grit, chips and oil.

MICROMETER:

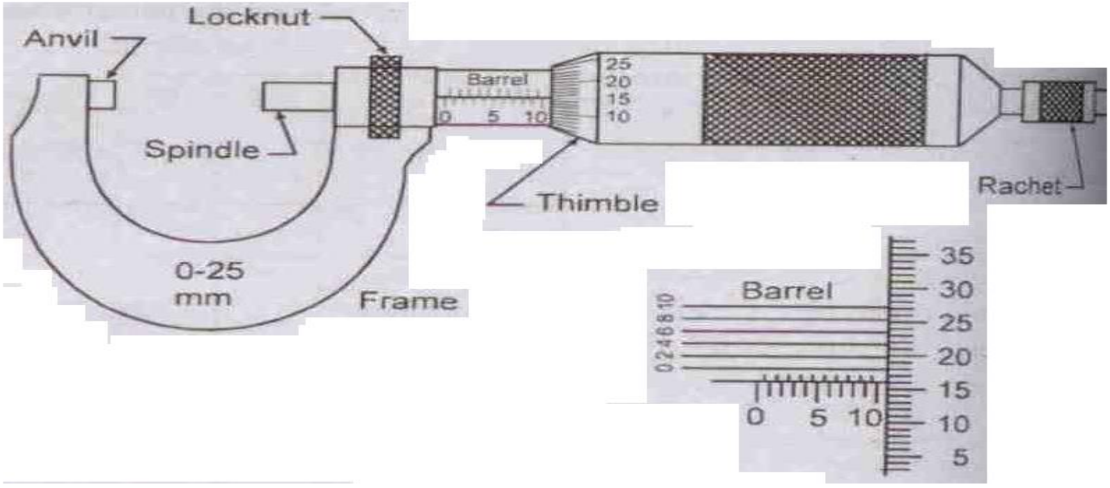
Micrometers are designed on the principle of ‘Screw and Nut’. Figure shows micrometer which is used for quick, accurate measurement. It consists of the following parts

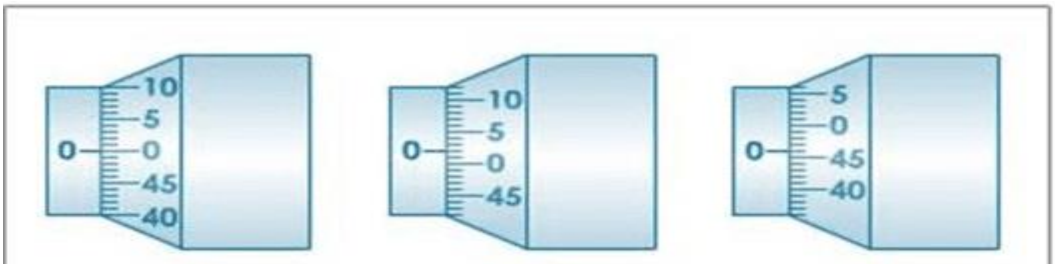
1. Frame
2. Anvil
3. Spindle
4. Thimble
5. Ratchet
6. Locknut.

The Micrometer requires the use of an accurate screw thread as a means of obtaining a measurement. The screw is attached to a spindle and is turned by movement of a thimble or ratchet at the end. The barrel, which is attached to the frame, acts as a nut to engage the screw threads, which are accurately made with a pitch of 0.05mm. Each revolution of the thimble advances the screw 0.05mm. On the barrel a datum line is graduated with two sets of division's marks. The set below the datum line reads in millimeters, and the set above the line reads in half millimeters. The thimble scale is marked in 50 equal divisions figured in fives, so that each small division on the thimble scale represents 1/50 of ½ mm which is 1/100 mm on 0.01mm.

$$\text{L. C of micrometer} = \frac{\text{Pitch of the screw}}{\text{Total No. of divisions on circular scale}}$$

$$\text{Where,} \qquad \text{Pitch of the screw} = \frac{\text{Distance advanced}}{\text{Number of Rotations}}$$





(a) No zero error
(b) Positive zero error
(c) Negative zero error

PROCEDURE:

1. Check the zero reading.
2. Place the job part to be measured in between the measuring faces.
3. Advance the spindle by rotating the ratchet until it begins to slip and clicks are heard. This indicates that there is no further movement of the spindle.
4. Note the readings both on barrel scale and on the circular scale of the thimble. Total reading=M.S.R i.e., reading uncovered on the barrel +L.C×Circular scale reading (C.S.R) i.e., no. of divisions on circular scale which coincide with horizontal line on barrel.
5. Repeat the procedure three to four times and calculate the average values.

OBSERVATIONS: MICROMETER

	Thickness-			**Diameter-**		
S. No	**Main Scale Reading (M.S.R)**	**Circular Scale Reading (C.S.R)**	**Total Reading =M.S.R+ (L.C×C.S.R)**	**M.S.R**	**C.S.R**	**Total Reading =M.S.R+ (L.C×C.S.R)**
1						
2						
3						
Avg.				Avg.		

PRECAUTIONS:

1. Before starting the experiment check the zero error of micrometers.
2. Micrometer should be cleaned of any dust and spindle should move freely.
3. The part whose dimension is to be measured must be held in left hand and the micrometer in right hand.
4. While measuring dimensions of circular a parts, the micrometer must be moved carefully over representative arc so as to note maximum dimension only.
5. The micrometers are available in various sizes and ranges, and the corresponding micrometer should be chosen depending upon the dimensions.

RESULTS:

1. The average values of dimensions using Vernier Calipers:

   Length: ___________mm; Diameter: ___________mm; Height: _________mm

2. The average values of dimensions using Micrometer:

   Thickness: _______________mm; Diameter _______________mm

CONCLUSIONS:

Signature of Staff

METROLOGYLAB VIVA-VOCE QUESTIONS

- **SINE BAR & BEVEL PROTRACTOR**

1. Why is the instrument, is named as sine bar?
2. Which one among bevel protractor and sine bar is precision?
3. What is maximum limit of the angle can be measured by sine bar?
5. Is it possible to measure angle of taper plug gauge by sine bar?
6. What is wringing effect?
7. Why through holes are made in sine bar?
8. How do you specify the length of sine bar?

- **GEAR TOOTH CALIPER**

1. Why it is named as gear tooth caliper?
2. How it differs from ordinary Vernier caliper?
3. How to calculate least count?
4. Is it possible to measure the angle of lathe guide way by using gear tooth caliper?
5. What is Chordal addendum?
6. What is Chordal thickness of gear tooth?

- **PLUG GAUGE & RING GAUGE**

1. What is the use of gauge?
2. What is the difference between ring gauge and plug gauge?
3. Is it possible to measure the angle of plug gauge by using sine bar?
4. Give the practical application of ring gauge & plug gauge?

- **ALLIGNMENT TEST**

1. What is alignment test?
2. What are the static tests?
3. What are the dynamic tests?
4. What is axial slip?
5. What is the need doing true running of live Centre?
6. How do you carry out alignment of both the centers in vertical plane?

SECTION-B
MEASUREMENTS LAB

Exp.No:7 Date:

CALIBRATION OF TRANSDUCER OR THERMOCOUPLE FOR TEMPERATURE MEASUREMENT

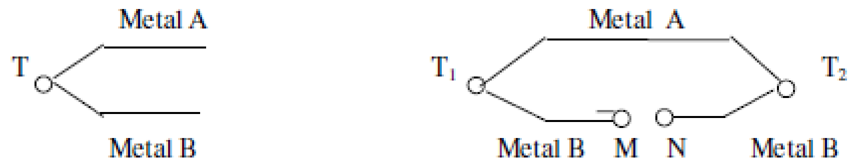
AIM: Temperature measurement by using digital temperature indicator and Thermocouple.

APPARATUS REQUIRED: Temperature transducers, Digital temperature indicator, Thermometer, Electric sterilizer.

THEORY:

THERMOCOUPLE

When two dissimilar materials are brought into contact, a potential develops as a result of an effect known as the “see back effect ". A Thermocouple is a very simple temperature sensor operates based on the see back effect, which results in the generation of a thermoelectric potential when two dissimilar metal are joined together to a junction. The electric potential of the material accepting electrons becomes negative at the interface, while the potential of the material providing the electrons become positive. Thus an electric field is established by the flow of electrons across the interface. When this electric field becomes sufficient to balance the diffusion forces, a state of equilibrium with respect to electron migration is established. Since the magnitude of the diffusion force is controlled by the temperature of the thermocouple junction, the electric potential developed at the junction provides a measure of the temperature.



The electric potential is usually measured by introducing a special junction in an electric circuit. The voltage across terminals M-N can be represented approximately by an empirical equation having the form.

$$E_0 = C_1 (T_1 - T_2) + C_2 (T_1^2 - T_2^2)$$

When C1 and C2 are thermoelectric constants that depend on the material used to form the junction T1 and T2 is junction temperature.

SPECIFICATION:

SENSOR	:	J- type Thermocouple (Fe-K)
DISPLAY	:	31/2 Digital LED Display. 200mV FSD to read up to +/-1999 count
INITIAL & FINAL SET	:	Through single turn Potentiometer.
TEMPERATURE	:	1000 C
TEMP. SOURCE	:	Water kettle.
TEMP. MASTER	:	Glass bead Thermometer.

DIAGRAM:

TABULAR COLUMN:

SL.NO.	ACTUAL READING	INDICATOR READING
	THERMOMETER READING ℃	THERMO-COUPLE ℃

OPERATING PROCEDURE:

1. Check connection made and Switch ON the instrument by rocker switch at the front panel.
2. The display glows to indicate the instrument is ON
3. Allow the instrument in ON Position for 10 minutes for initial warm-up.
4. Pore around 3/4th full of water to the kettle and place sensors and thermometer inside the kettle
5. Note down the Initial water temperature from the thermometer.
6. Adjust the Initial set Potentiometer in the front panel till the display reads initial water temperature.
7. Switch on the kettle and wait till the water boils note down the reading in the thermometer rand set Final set potentiometer till the display reads boiling water temperature.
8. Remove the sensor from the boiling water immerse it in the cold water. Set the cold water temperature using initial set potentiometer.
9. Repeat the process till the display reads exact boiling water and cold-water temperature. Change the water in the kettle with and re heat the water. Now the display starts showing exact temperature raises in the kettle.
10. Note down the readings for every 100 C rise in temperature and tabulate the readings in the tabular column for Indicator reading and thermometer reading.

RESULT:

CONCLUSION:

Exp.No:8 Date:

STUDY AND CALIBRATION OF LVDT TRANSDUCER FOR DISPLACEMENT MEASUREMENT

AIM: To measure the displacement by displacement tutor using LVTD (**L**inear **V**ariable **D**ifferential **T**ransformer) sensors.

APPARATUS: Displacement measurement tutor by using LVTD sensors.

THEORY:

MEASUREMENTOFDISPLACEMENT

Differential transformers, based on a variable Inductance principle, are also used to measure displacement. The most popular variable-inductance transducer for linear displacement measurement is the Linear Variable Differential Transformer (LVDT).The LVDT illustrated in the fig. consists of three symmetrically spaced coils wound onto an insulated bobbin. A magnetic core, which moves through the bobbin without contact, provides a path for magnetic flux linkage between coils. The position of the magnetic core controls the mutual between the center and primary coil and with the two outside or secondary coils.

When an AC carrier excitation is applied to the primary coil, voltages are induced in the two secondary coils that are wires in a series-opposing circuit. When the core is centered between the two secondary coils, the voltage induces between the secondary coils are equal but out of phase by 180^0.The voltage in the two coils cancels and the output voltage will be zero. When the core is moves from the center position, an imbalance in mutual inductance between the primary coil and the secondary coil occurs and an output voltage develops. The output voltage is a linear function of the core position as long as the motion of the core is within the operating range of the LVDT.

SPECIFICATIONS:

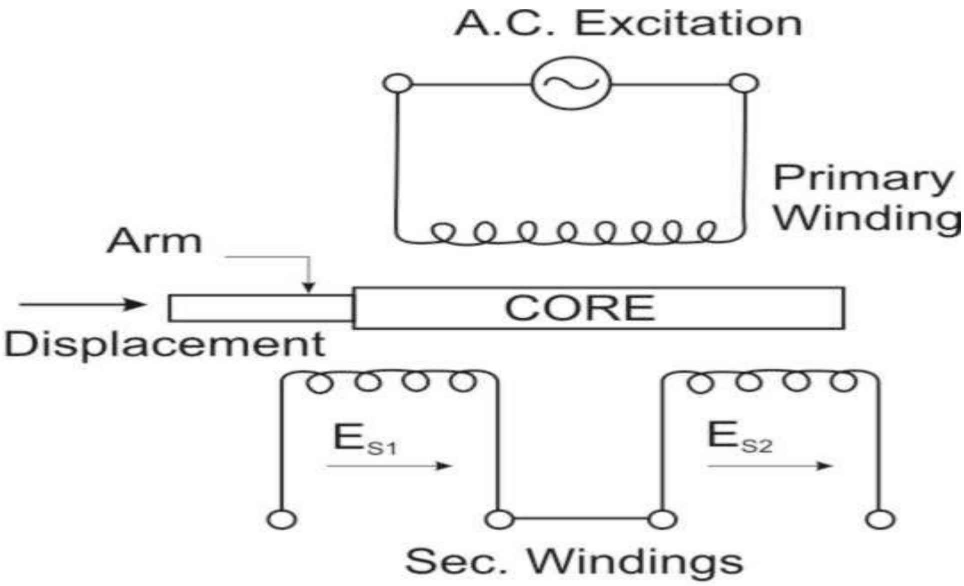
INDICATOR

DISPLAY	:	31/2 digit seven segment red LED display of range 200mV for full scale deflection to read +/- 1999 counts.
EXCITATION VOLTAGE	:	1000 Hz at 1V
OPERATING TEMPERATURE	:	+100 C to 550 C
ZERO ADJUSTMENT	:	Front panel through Potentiometer.
SENSITIVITY	:	0.1mm
SYSTEM INACCURACY	:	1%
REPEATABILITY	:	1%
CONNECTION	:	Through 6 cores shielded cable with Din connector.
FUSE	:	250mA fast glow type.
POWER	:	230 V +/- 10 %, 50 Hz.

SENSOR

RANGE	:	+/- 10.0 mm
EXCITATION VOLTAGE	:	1 to 4 kHz at 1 to 4V
LINEARITY	:	1%
OPERATING TEMPERATURE	:	+100 C to 550 C
CALIBRATION JIG	:	Micrometer of 0 to 25mm length is mounted on the base.

DIAGRAM:



INTERNAL STRUCTURE OF LVDT

TABULAR COLUMN:

A S. No.	B ACTUAL MICROMETER READINGS (MM)	C INDICATOR READINGS LVDT (MM)	D ERROR B-C	E % ERROR

OPERATING PROCEDURE:

1. Connect the power supply chord at the rear panel to the 230V 50Hz supply. Switch on the instrument by pressing down the toggle switch. The display glows to indicate the instrument is ON.
2. Allow the instrument in ON position for 10 minutes for initial warm-up.
3. Rotate the micrometer till it reads “20.0”
4. Adjust the CAL potentiometer at the front panel so that the display reads “10.0”
5. Rotate the core of micrometer till the micrometer reads “10.0” and adjust the ZERO potentiometer till the display reads “00.0”
6. Rotate back the micrometer core up to 20.0 and adjust once again CAL Potentiometer till the display read 10.0. Now the instrument is calibrated for +/-10.0mm range. As the core of LVDT moves the display reads the displacement in mm.
7. Rotate the core of the micrometer in steps of 1 or 2 mm and tabulate the readings. The micrometer will show the exact displacement given to the LVDT core the display will read the displacement sensed by the LVDT. Tabulate the readings and Plot the graph Actual V/s indicator reading.

PRECAUTIONS:

1. Handle all equipment’s with care.
2. Make connections according to the circuit diagram.
3. Take the readings carefully.
4. The connections should be tight.

RESULT:

CONCLUSION:

Exp.No:9 Date:

STUDY AND CALIBRATION OF CAPACITIVE TRANSDUCER FOR ANGULAR MEASUREMENT

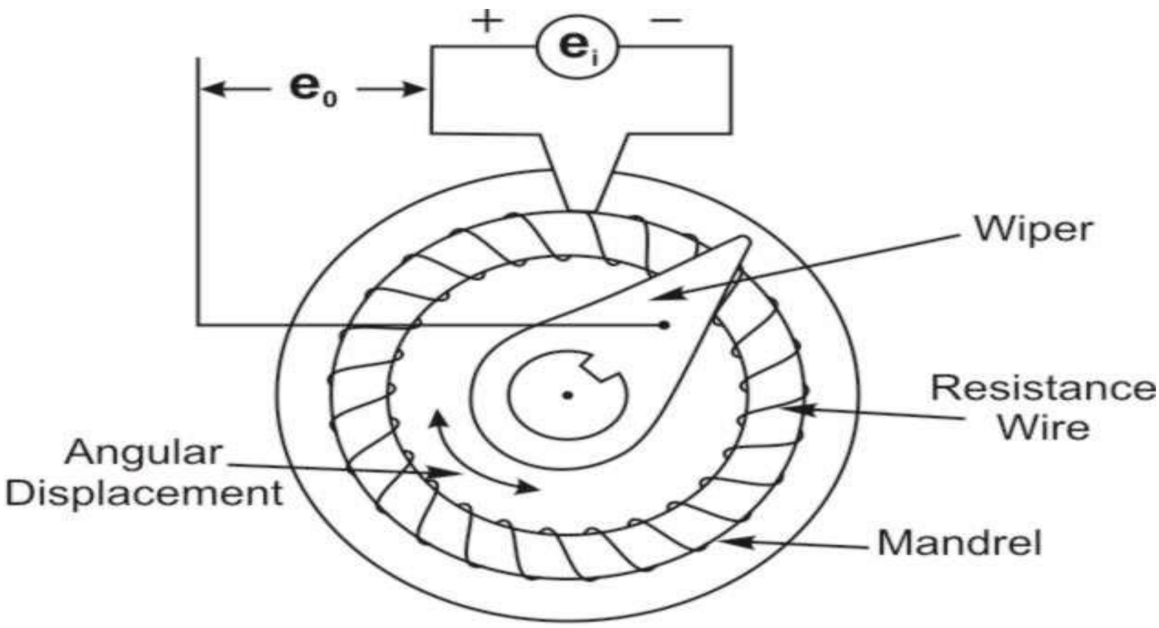
AIM: To measure the angular measurement using angular sensor.

APPARATUS USED: Angular measurement tutor

SPECIFICATIONS:

Sensor	:	Angular Plate capacitance.
Sensor Material	:	Aluminum plates
Dielectric Medium	:	Air
Displacement	:	0-360^{o}
Accuracy	:	5 to 10%
Display	:	3.5 digit LED display to read +/- 1999 counts for+/- 200 mv FSD
Power	:	230V +/- 10% 50 HZ

DIAGRAM:



Angular/Rotary Potentiometer

TABULAR COLUMN:

A S.No	B ACTUAL SCALE READINGS (DEG)	C INDICATOR READINGS CAPACITANCE (DEG)	D ERROR B-C	E % ERROR

OPERATING PROCEDURE:

1. Check connection made to the instrument
2. Allow the instrument in ON position for 10 minutes for initial warm-up.
3. Move the moving plate to Zero position.
4. Adjust the ZERO potentiometer so that the display reads '000'.
5. Pull the Angular sensor from 0 to 360^{o}
6. Note down the reading in the tabular column till (360^{0}).

PRECAUTIONS:

1. Handle all equipments with care.
2. Make connections according to the circuit diagram.
3. Take the readings carefully.
4. The connections should be tight.

RESULT:

CONCLUSION:

Exp.No:10 Date:

STUDY AND CALIBRATION OF PHOTO AND MAGNETIC SPEED PICKUPS FOR THE MEASUREMENT OF SPEED

AIM: To measure the speed by using speed measurement trainer.

APPARATUS USED: speed measurement trainer

CIRCUIT EXPLANATION:

The circuit comprises of mainly five parts such as

1. Power Supply, 2. Oscillator 3. Signal conditioner, 4. Mixer and 5. Counter.

1. POWER SUPPLY:

The power supply required for speed measurement is regulated 6V, 250 mA DC supply. This 6V is used for both signal conditioner and also to drive the display.

2. OSCILLATOR:

Quartz crystal is used to generate oscillating frequency. The crystal Oscillator uses 5V dc and produces an oscillating frequency of 1 kHz. An amplifier is used to amplify the signal to the required level.

3. SIGNAL CONDITIONER:

The signal conditioner gets the input from the sensors in the form of pulses. For every one revolution 60 pulses are produced. These pulses are then amplified to the required level when the calibration is done. These signals are buffered to get pure oscillating frequency.

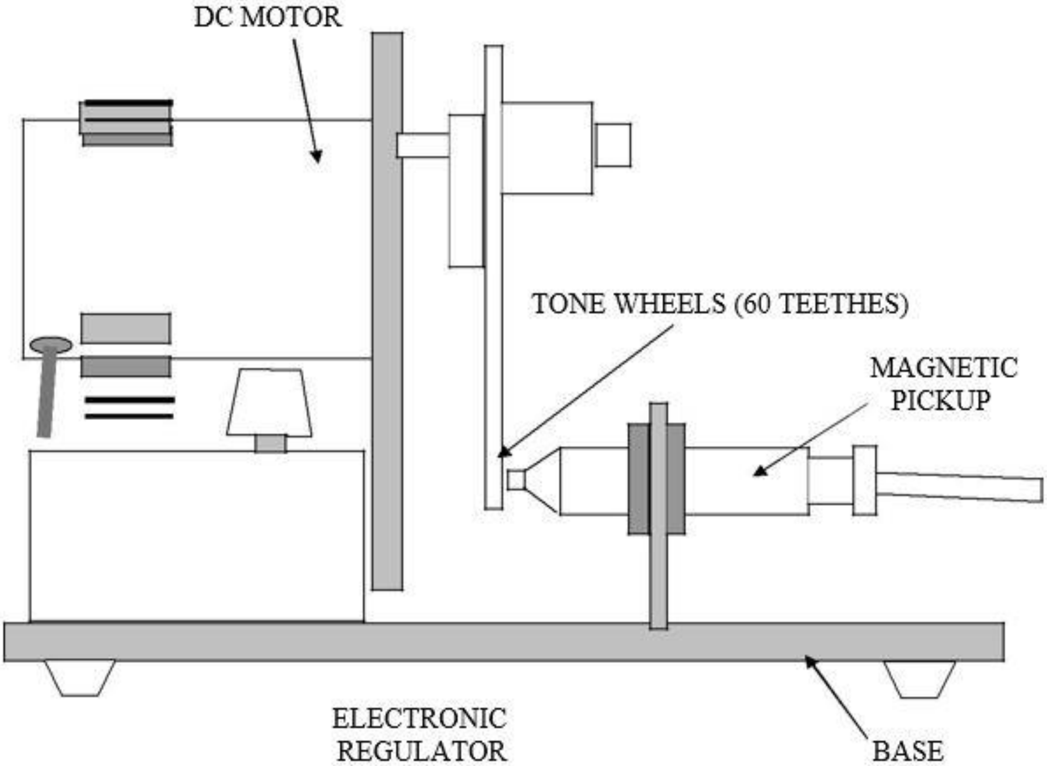
4. MIXER:

The mixer combines the input signal from the sensor with the oscillating frequency. This produces sum-and-difference components. When mixed, a third pulse is produced. The frequency of the pulse is a function of the difference in the two original inputs. If the frequency of one of the source is known and is adjusted to produce zero pulse, then the frequency of the other source is also known by comparison. This procedure for determining frequency is called the heterodyne method. The two signals are heterodyned.

5. COUNTER:

The multiplexer converts the frequency into a simple voltage pulses. Electronic counter uses basic counting device or Event per unit Time meters require that the counted input be converted into a simple voltage pulses, a count being recorded for each pulse. The pulses are counted and displayed through seven segment LED's.

MOUNTING ARRANGEMENT OF SPEED MEASUREMENT SETUP



TABULAR COLUMN:

A SL.No.	B ACTUAL SPEED 0F MOTOR PHOTOREFLECTIVE (RPM)	C MAGNETIC PICKUP (RPM)	D PHOTO REFLECTIEVE (RPM)	E ERROR B-C

SPECIFICATIONS:

MEASUREMENT OF SPEED		
SENSOR	:	a) Magnetic Pickup b)photo electric
MAX. RPM	:	1500 RPM
MOTOR	:	FHP DC motor to rotate at 1500 RPM
MOTOR SPEED CONTROL	:	0-12V variable DC Drive.
TONE WHEELS	:	a) For magnetic pickup : MS wheel of 2 mm thick disk, on the circumference 60 teethes will be cut at equidistant. b) For Photodiode : A small copper disk on which 60 slots will be etched at equidistant.
POWER	:	The instrument works at 230V 50Hz. Supply.

OPERATING PROCEDURE:

1. Before switching ON the instrument ensure that the connections are made properly.
2. Switch ON the instrument by pushing down the toggle switch provided at the rear side of the box, LED display glows to indicate the instrument is ON.
3. Allow the instrument for 10 minutes in ON position for initial warm-up.
4. Select the sensor with the help of the toggle switch.
5. Switch on the electronic regulator. The fan rotates which will rotate the tone wheels.
6. The display will start indicating exact RPM of the motor.
7. Readings can be tabulated for both the sensors. Comparison can be made between two sensors.

PRECAUTIONS:

1. Handle all equipments with care.
2. Make connections according to the circuit diagram.
3. Take the readings carefully.
4. The connections should be tight.

RESULT:

CONCLUSION:

Exp.No:11 Date:

STUDY AND USE OF A SEISMIC PICKUP FOR THE MEASUREMENT OF VIBRATION AMPLITUDE OF AN ENGINE BED AT VARIOUS LOADS

AIM: To Measure the Vibration Parameters i.e. Acceleration, Frequency, Velocity and displacement.

APPARATUS REQUIRED: Vibration Exciter And Vibration Generator.

THEORY: THE SETUP

Vibration Demo is designed as a laboratory set up which can be used to demonstrate the principles of Vibration measurement. It consists of a shaker and control unit. (Ref. Block Diagram Fig.1). The shaker is of the Electromagnetic type; the control unit consists of a signal generator, power amplifier and vibration-meter. The sinusoidal output from the signal generator is amplified by the amplifier and applied to the shaker, which generates vibrations on the spindle. The Accelerometer may be attached to the spindle through the M-5 stud. (Supplied with the accelerometer). Signal output from the accelerometer is connected to the vibration meter, which gives direct read out of acceleration velocity or displacement.

SPECIFICATIONS:

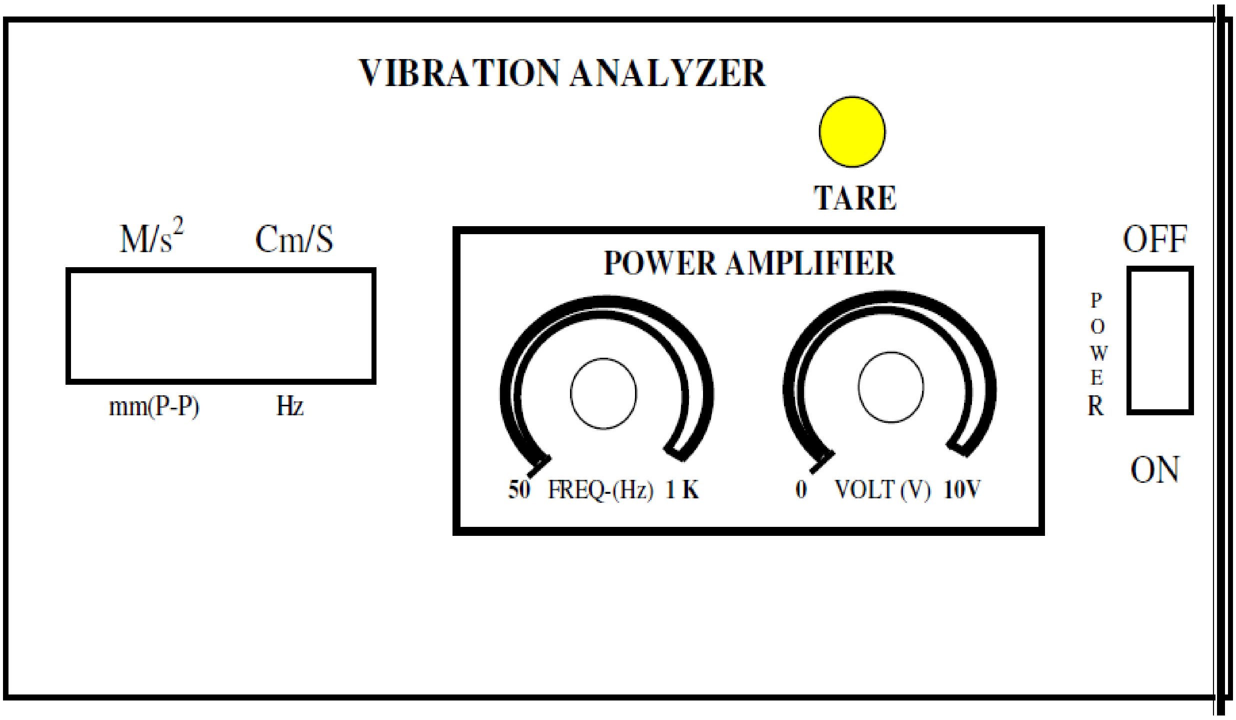
Measurement Range

Acceleration	: 0.1-199.0 m/s2 (peak), (10Hx to 10 KHz).
Velocity	: 0.01-19.99cm (rms), (10Hz to 3 KHz).
Displacement	: .03-1.999mm (pp), (10Hz, to I KHx)
Output	: Analog AC output 2V pK F.S.

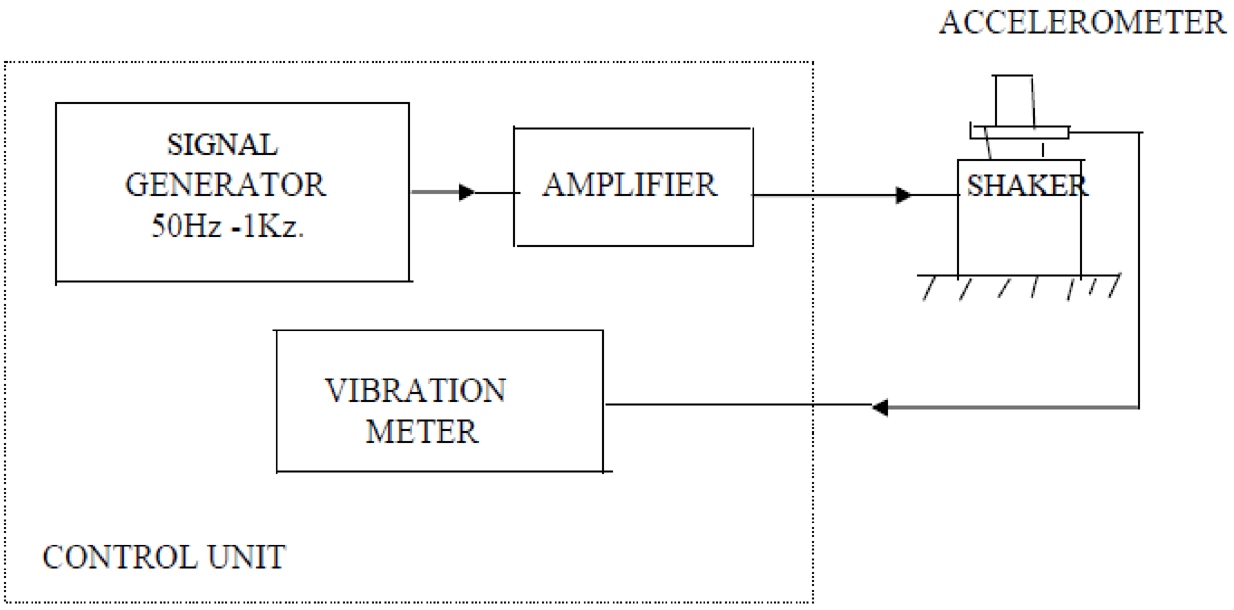
OPERATING PROCEDURE:

1. Connect the sensor to the instrument through the BNC socket provided on the rear mentioned SENSOR.
2. Connect the Vibration generator to the instrument through the cable provided at the rear panel of the instrument marked EXCITER.
3. Connect the instrument to the 230V 50Hz. Supply through cable provided at the rear panel.
4. Keep the FREQ. Pot and the VOLT pot in the minimum position.
5. Switch on the instrument, the display glows to indicate the power is on.
6. Turn the VOLT pot to the max position.
7. Now turn the FREQ pot in steps of 100 Hz. And note down the readings of Acceleration, Velocity and Displacement by selecting the MODE through selector switch.
8. Tabulate the readings in the tabular column. Experiment can be repeated for different voltage levels settable through VOLT knob provided.

DIAGRAM:



BLOCK DIAGRAM:



TABULAR COLUMN:

S.NO	Frequency in Hz	Indicator Readings		
		Acceleration in M/S2	Velocity in cm/s	Displacement in Mm

RESULT:

CONCLUSION:

Exp.No:12 Date:

STUDY AND CALIBRATION OF MCLEOD GAUGE FOR LOW PRESSURE

AIM: Low pressure measurement by McLeod gauge.

APPARATUS REQUIRED: McLeod gauge, vacuum chamber, vacuum pump.

INTRODUCTION:

Low pressure gauge:

Pressure less than 1mm of mercury are considered to be low pressure and are expressed in either of two units, namely the torr and micron.1 torr is a pressure equivalent to 1mm Hg at standard conditions., one micron is 10-3 torr through common usage the term vacuum refers to any pressure below atmosphere (760mm Hg).this pressure region is divided into 5 segments.

Low vacuum 760 torr to 25 torr

Medium vacuum 25 torr to 10-3 torr

High vacuum 10-3 torr to 10-6 torr

Very high vacuum 10-6 torr to 10-9 torr

Ultra high vacuum 10-9 torr and beyond

The pressure measuring devices for low pressure (vacuum) measurement can be classified into 2 groups

Direct measurement

Where in displacement deflection costs by the pressure is measured and correlated to the applied pressure. This principle is incorporated in nanometers, spiral bourdon tube; flat and corrugated diaphragms and capsules, manometers and gauges are suitable to about 0.1 torr, bourdon gauges to 10 torr and diaphragm gauges to 10^{-3} torr. Below these ranges, that use of indirect vacuum gauges is resorted.

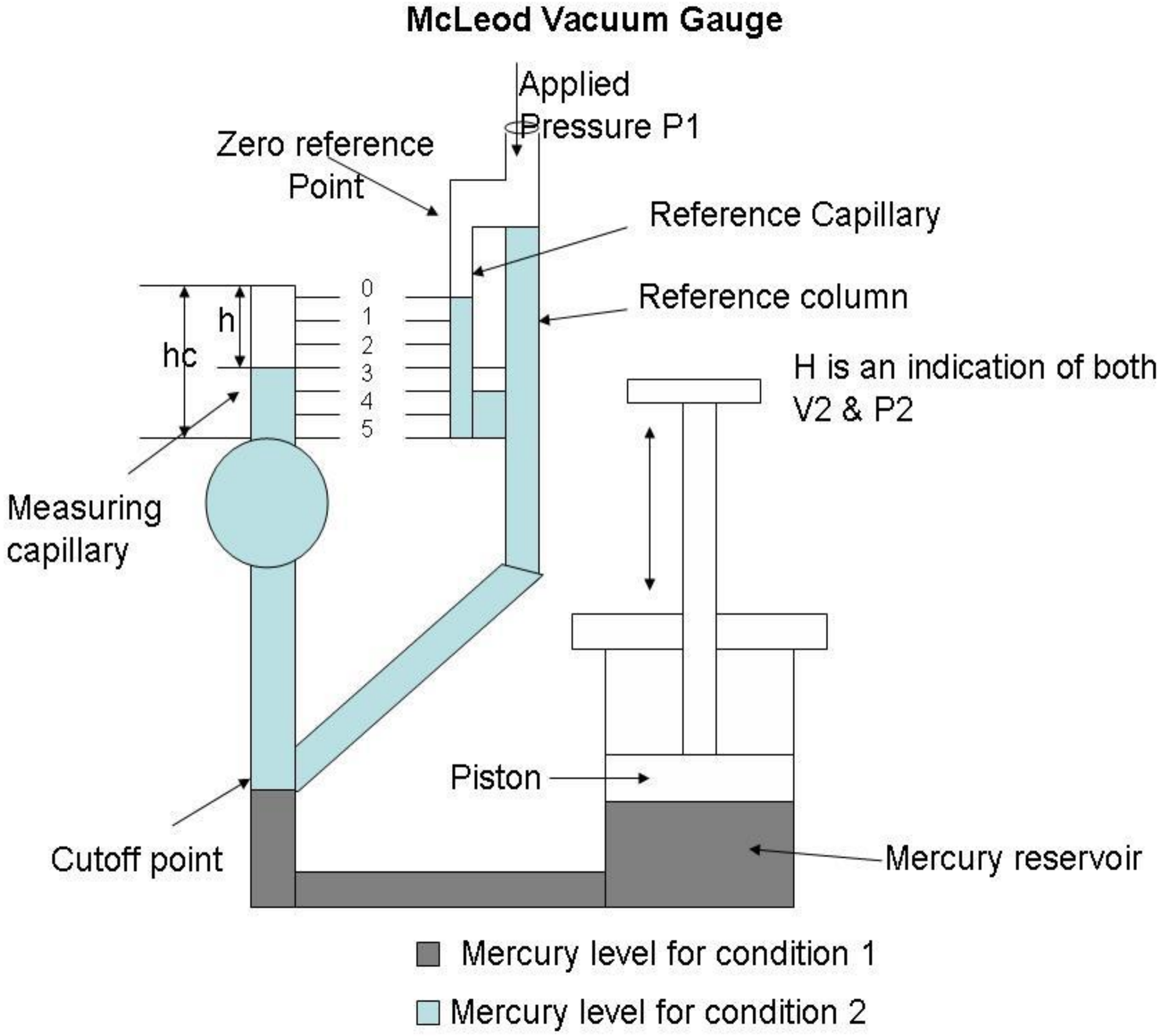
Indirect measurement

(Inferential) gauges wherein the low pressure is detected to measurement of a pressure controlled property such as volume, thermal conductivity etc., the inferential gauge include McLeod vacuum meters attention would be concentrated here on low pressure measurement by the inferential gauges only.

McLeod gauge

The unit comprises a system of glass tubing in which a known volume of gas at unknown pressure is trapped and then isothermally compressed by raising mercury. This amplifies the unknown pressure and allows it is measurements by conventional man metric means.

DIAGRAM:



TABULAR COLUMN:

S.NO.	MCLEOD GAUGE READING
1	
2	
3	
4	
5	
6	

OPERATING PROCEDURE:

1. Connect the tubes (pipes) from vacuum pump to vacuum chamber and vacuum pump to McLeod gauge.
2. Open the outlet wall before starting the vacuum pump.
3. Close the outlet wall after starting the vacuum pump.
4. Keep the McLeod gauge in horizontal position before starting the vacuum pump.
5. Switch ON the vacuum pump.
6. See the reading in McLeod pump by varying perpendicular axis and note down the readings.

PRECAUTIONS:

1. Handle all equipments with care.
2. Make connections according to the circuit diagram.
3. Take the readings carefully.
4. The connections should be tight.

RESULT:

CONCLUSION:

Exp.No:13 Date:

LOAD MEASUREMENT TRAINER

AIM: To Calibrate the Load by Using Load Measurement Trainer

APPARATUS REQUIRED: Load Measurement Trainer, Weights, Digital Load Indicator

THEORY:

FORCE MEASUREMENT (LOAD CELL)

The elastic members used in load cells are links, beams, rings and shear webs. Strain gauges are bonded on the fabricated specimen and the compression or tension load is applied to the specimen the material gets elongated or compressed due to the force applied. i.e. the material get strained. The strain incurred by the specimen depends on the material used and its elastic module. This strain is transferred to the strain gauges bonded on the material resulting in change in the resistance of the gauge. Since the strain gauges are connected in the form of Whetstones Bridge any change in the resistance will imbalance the bridge. The imbalance in the bridge will intern gives out the output inmV proportional to the change in the resistance of the strain gauge.

SPECIFICATIONS:

MEASUREMENT OF LOAD

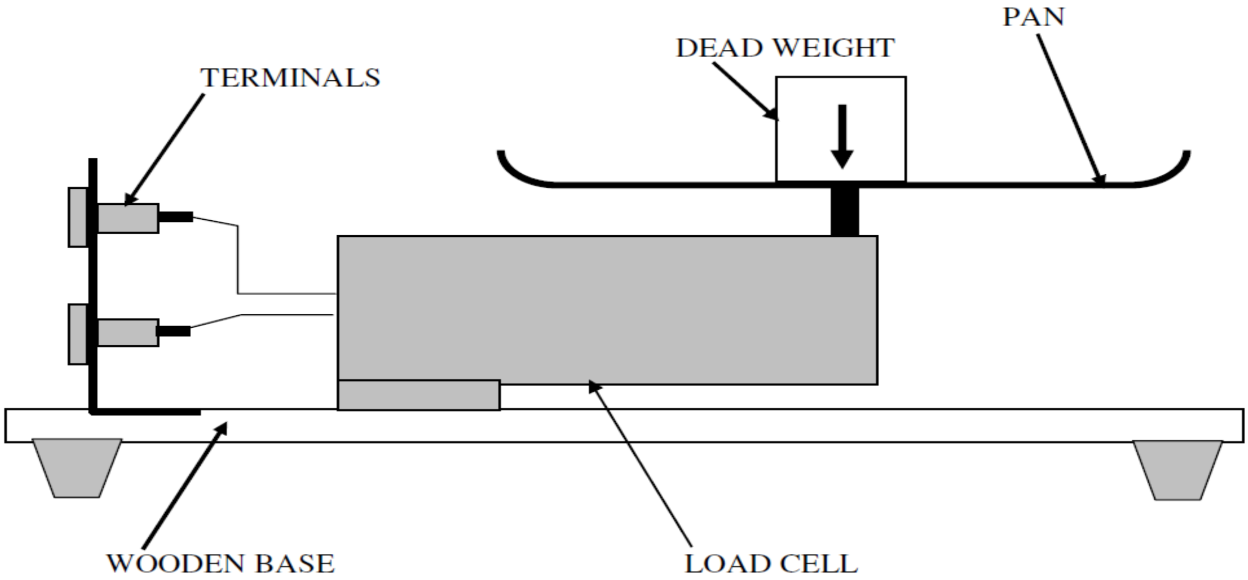
LOAD CELL:

SENSOR	: strain gauges bonded on steel member for load measurement.
TYPE	: Compression.
STRAIN GAUGE RESISTANCE	: 350 ohms ��2%
MAX. LOADING	: 1 Kg.
CONNECTION	: Through four cure shielded cable attached to the load cell.
EXCITATION	: 10V DC
ACCURACY	: 1%
LINEARITY	: 1%
MAX. OVER LOAD	: 125 %

INDICATOR:

DISPLAY	: 3.5 digit seven segment LED display is used for the indicator
EXCITATION	: 10 V DC
ACCURACY	: 1%
TARE	: Front panel Zero adjustment through Potentiometer.
CALIBRATION	: 1.00 Kg Load.
POWER SUPPLY	: 230 V +/- 10% 50 Hz.

DIAGRAM:



BEAM TYPE LOAD CELL MOUNTED ON A WOODEN BASE

OPERATING PROCEDURE:

1. Check connection made and Switch ON the instrument by rocker switch at the frontpanel. The display glows to indicate the instrument is ON.
2. Allow the instrument in ON Position for 10 minutes for initial warm-up.
3. Adjust the Potentiometer in the front panel till the display reads “000”
4. Apply load on the sensor using the loading arrangement provided.
5. The instrument reads the load on the sensor and displays through LED. Readings can be tabulated and % error of the instrument, linearity, Hysteresis can be calculated.

TABULAR COLUMN:

1 SL. NO.	2 ACTUAL LOAD in Kgms	3 INDICATORLOAD in Kgms	4 ERROR in %

RESULT:

CONCLUSION: