Metrology Laboratory

Mechanical Engineering Department

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1.1 VERNIER CALIPER

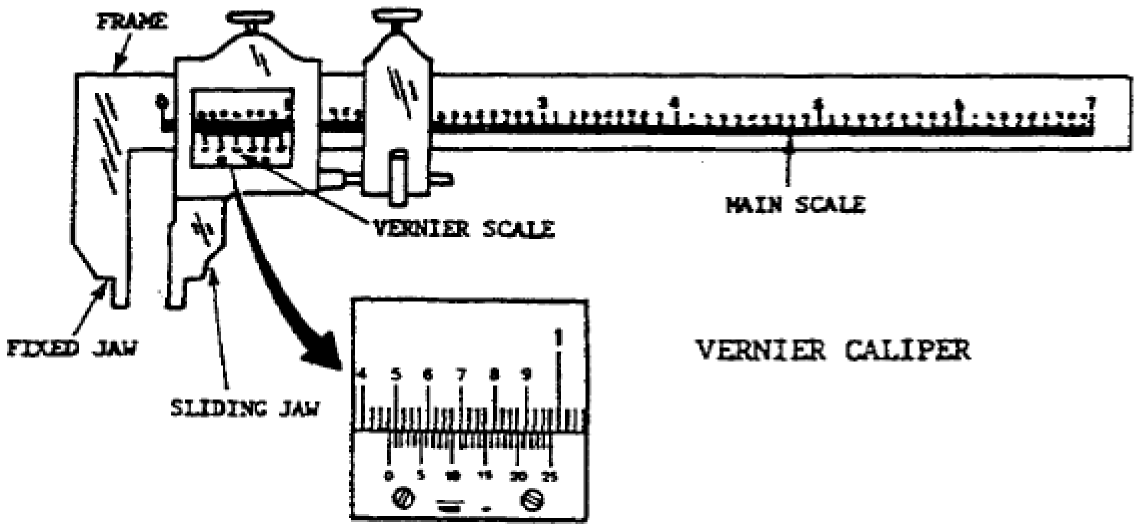
Aim: To measure the dimension of the given specimen using Vernier caliper.

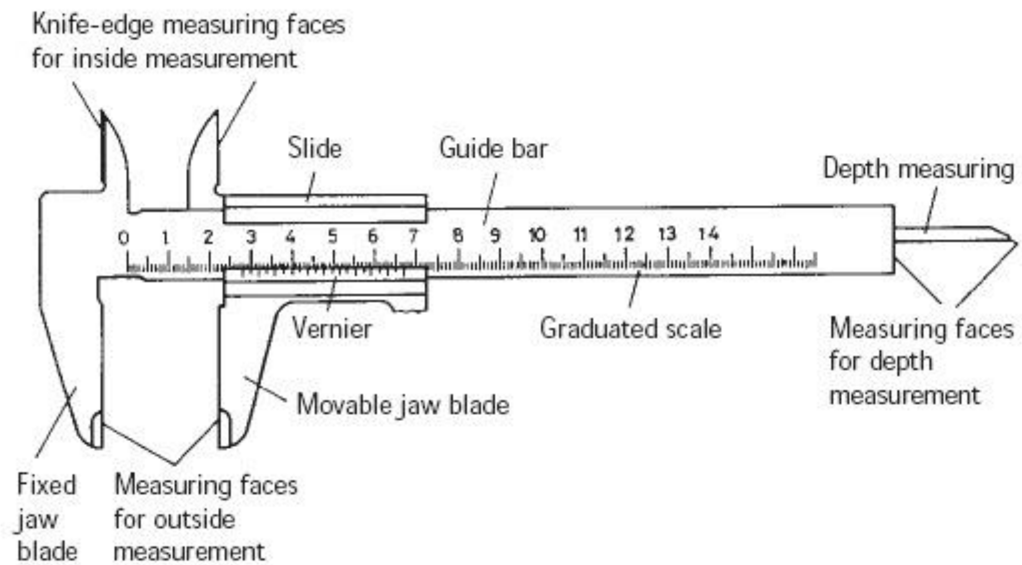
Description: It consists of two steel rules and these can slide along each other. One of the scales is the main scale engraved on an L-shaped frame. A sliding jaw, which moves along the guiding surface provided by the main scale is coupled to a Vernier scale. When two measuring surfaces are in contact with each other scale shows zero reading. Adjusting screw can do the final adjustment of the movable jaw. The three types of Vernier caliper are called A type, B type, C type. Type A has jaws on both sides for external and internal measurement and also has a blade for depth measurement. Type B is provided with a jaw on one side for external and internal measurement. Type C has jaws on both sides for measurement and marking operations.

Procedure: When two measuring surfaces are in contact with each other scale shows zero reading. The fine adjustment of the movable jaw is adjusted so that the two measuring tips just touch the part to be measured. A large number of the main scale represents a number in mm or inch.

Vernier calipers do not obey Abb's law. So excessive measuring force should not be used. Take care to avoid parallelism error while reading the Vernier scale. Do not apply the Vernier caliper on rotating work. For big work pieces use large scale Vernier calipers to avoid position errors. Vernier calipers must be used at a shorter length of the main scale. The measuring instrument is properly balanced in the hand and lightly held in such a way that only fingers of the hand must be used to improve the sense of the touch.

Specimen





Least Count =

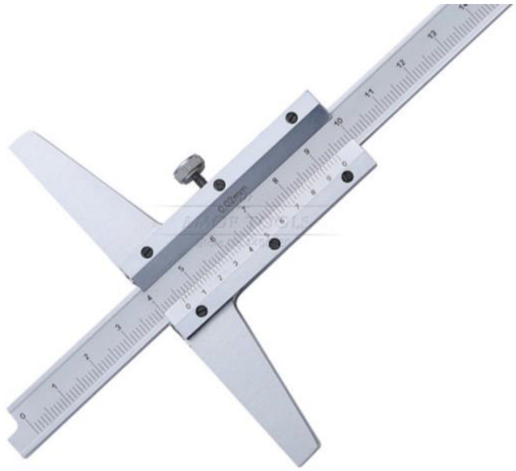
Error =

Actual Reading = M.S.D + Vernier scale reading (V.S.D)

Observations:

S. NO	M.S.D	V.S.D	Actual Reading
1			
2			
3			
4.			

Depth gauge: This is used to measure the depth of hole or recess. The reference plane must be flat and normal to measuring axis.



Least Count =

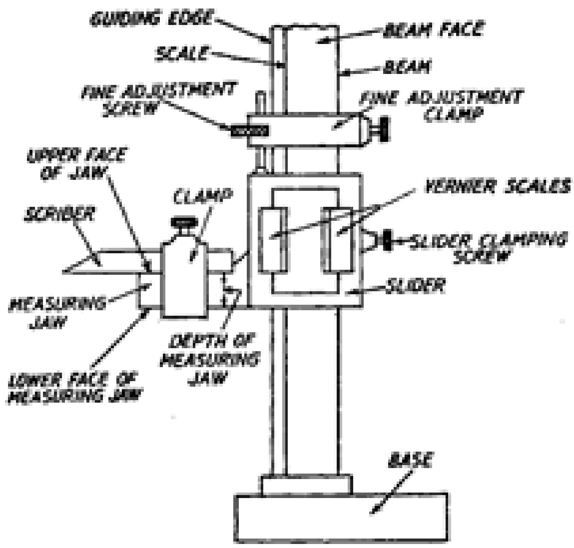
Observations:

S. NO	M.S.D	V.S.D	Actual reading
1			
2			
3			
4			

Specimen

Vernier Height Gauge

This is a Vernier caliper equipped with a special base block and other attachment, which make the instrument suitable for height measurement. It is mainly used in the inspection of parts and layout work. It can be used to scribe lines at a center distance above the surface.



Least Count =

Observations:

S. NO	M.S.D	V.S.D	Actual reading
1			
2			
3			
4			

Results:

Instructor's signature: ____________________

Student's signature: ______________

Date: ______________

1.2.MICROMETER

Aim:

Measure the dimensions of the given specimen using external, internal, depth and bench micrometer.

Description:

The micrometer screw gauge essentially consists of an accurate screw having 40 threads per inch and revolves in a fixed nut. The end of the screw forming one measuring tip and the 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 afterward. The plain portion is called: sleeve and its end is a measuring surface. The spindle is advanced or retracted by turning a thimble connected to the spindle. A lock nut is provided for locking a dimension by the precise motion of the spindle. A ratchet stop is provided at the end of the thimble cap to maintain sufficient and uniform measuring pressure so that standard conditions of measurement are obtained

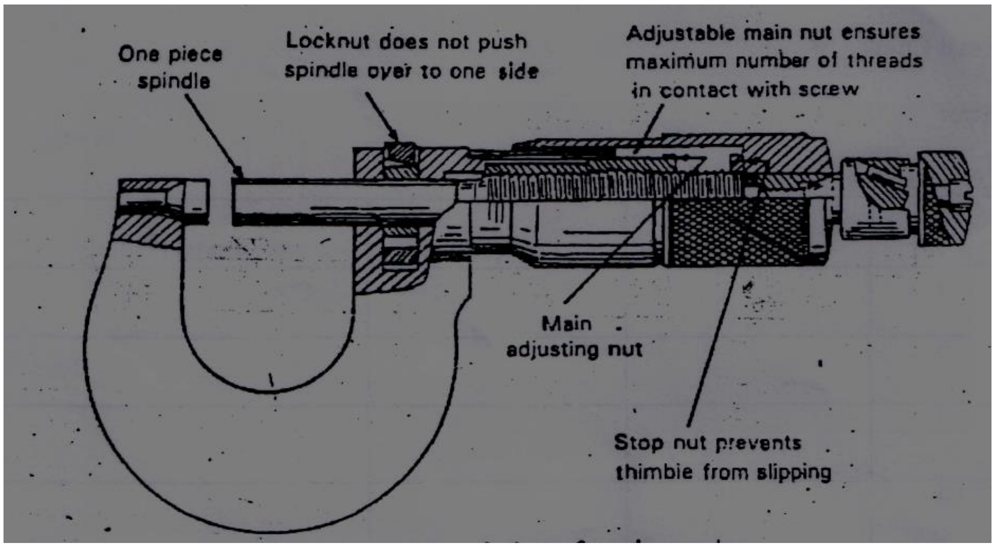
Procedure:

In order to get a good result the part whose dimension is to be measured must be held in the left hand and the micrometer in right hand. Then the micrometer dimension is set slightly lesser than the size of the part and the part is slid over the contact surface of the micrometer. The micrometers are available in various sizes and ranges and the corresponding micrometer should be chosen depending upon the dimension. Different micrometer devices are available for the variety of measurement purpose.

Proper care and use of a micrometer are necessary if its accuracy is to be preserved and adjustment be kept the minimum. All the parts of the. micrometer are kept free from dust 1 2X1G free matters. During the adjustment, the play can be eliminated by inserting the C spanner in the slot or the hole of the adjustment and turning it clockwise. Inspect the micrometer for damage before taking a reading.

External Micrometer

In the external Micrometer, an anvil is provided which occupies a fixed position in relation to the main nut in which spindle moves. A frame carries the anvil and the main nut. The fixed index line is marked upon the barrel and angular graduation around the left and chamfered end of the thimble.



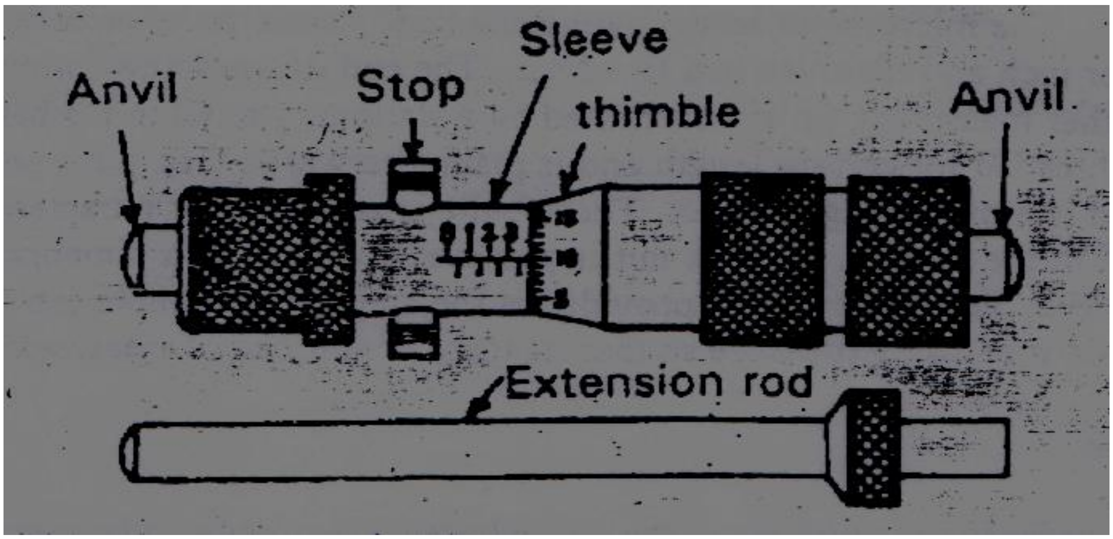
Least Count =

Error =

Sl. No.	M.S.D	V.S.D	Actual Reading
1			
2			
3			
4			

Inside Micrometer

For measurement of large internal dimensions, inside micrometer is employed. It consists of measuring head, extension rod, and spacing collar. Using the extension rod the distance between the contact surfaces is varied by rotating the thimble up to the extension of the screw length. Greater distance measurements are obtained by the use of different extension rods and spacing collars.



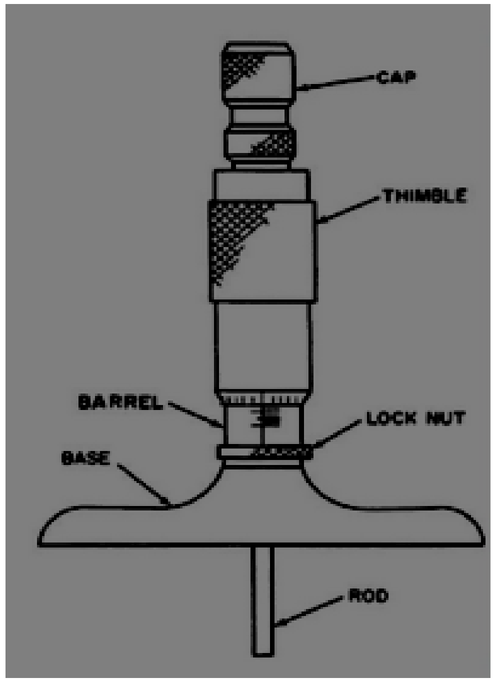
Least Count =

Error =

Sl. No.	M.S.D	V.S.D	Actual Reading
1			
2			
3			
4			

Depth Micrometer

It is used for measuring the depth of holes, slots and recesses area. It has got one shoulder, which acts as a reference surface. For large ranges of measurement, extension rods are used. The scales are calibrated in reverse direction.



Least Count =

.

Error =

Sl. No.	M.S.D	V.S.D	Actual Reading
1			
2			
3			
4			

Digital Micrometer

To improve the readability additional Vernier scale is provided in the digital micrometer. Construction is similar to external micrometer except the readout can be made using a digital counter.

Least Count =

Error =

Sl. No.	M.S.D	V.S.D	Actual Reading
1			
2			
3			
4			

Instructor's signature: ____________________

*Student's signature:*_______________

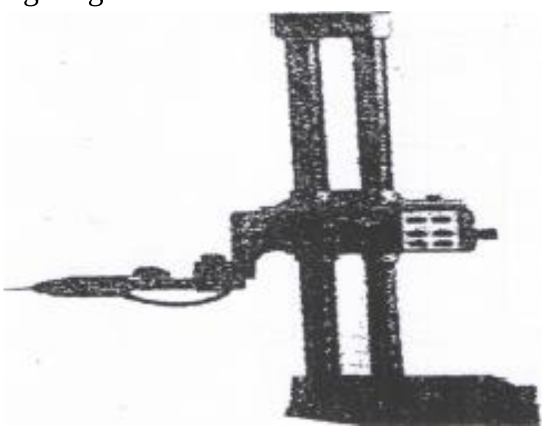
Date: _______________

1.3. DIGITAL HEIGHT GAUGE

Aim: Measure the height upward and downward from the reference plane of the given specimen using digital height gauge.

Description: It combines the best features of the Vernier caliper and the dial comparator gauge in one instrument and greatly reduces the problem of the operator sense of feel. It is used for measuring height, center distance of holes, surface, and edges plus checking of squares and height or proportional surface. It is also used for setting of measuring instruments and tools. By means of a hand crank, it is easy to operate for checking of parallelism and for setting procedure. Measuring head can be locked at any desired point. It has a direct counter and dial indicator, which allows starting a measurement from any desired height upward or downward. ·

Procedure: Clean the both surfaces of the base and scriber tip with a clean cloth and set zero properly. When shifting the slide, loose the slide clamp and turn the feed wheel slowly. For quick movement of the slider turn the feed wheel by a knob. To the height upwards from the reference surface take a reading from the top counter and larger figure on the dial. When shifting the slide downwards from a reference surface take the reading from the bottom counter and small figure graduation counts clockwise on the dial.



FIQ.9 - Height gauge

Least count =

Hl = Digital scale reading + Dial reading x Least count

H2=

H=H1-H2=

Instructor's signature: ___________________

Student's signature: _____________

Date: _____________

1.4. HEIGHTMASTER

Aim: Measure the width of the parallel bar accurately

Description: The main housing supports the inside mechanism and is designed and made rugged, stable and easy to carry construction. The reference part of the height master is the three point feet fixed on the bottom of the housing. Turning the micrometer head can move up and down the stack of the gauge blocks. The feed screw of the micrometer head of 0.5 is of 0.5 mm pitch and the thimble reference head is divided into 250 division allows reading upto 0.002 mm. Top block, Measuring block, the Bottom block is stacked and fixed in a staggered fashion. The sliding of the stack block is made by operating a feed screw mechanism of the micrometer head.

Procedure: The height measurement with the height master is to transfer the height of the workpiece by the means of lever head or test indicator of the height master by setting gauge block exactly to the height. First reading is made on the count of 10 mm on the reference scale. A face in between 70 mm and 80 mm graduation scale is read as 70 mm. The second step is reading on the counter, which has a least count of 0.01 mm. Third Step is reading in the micrometer head, one division on the thimble represents 0.002 mm.

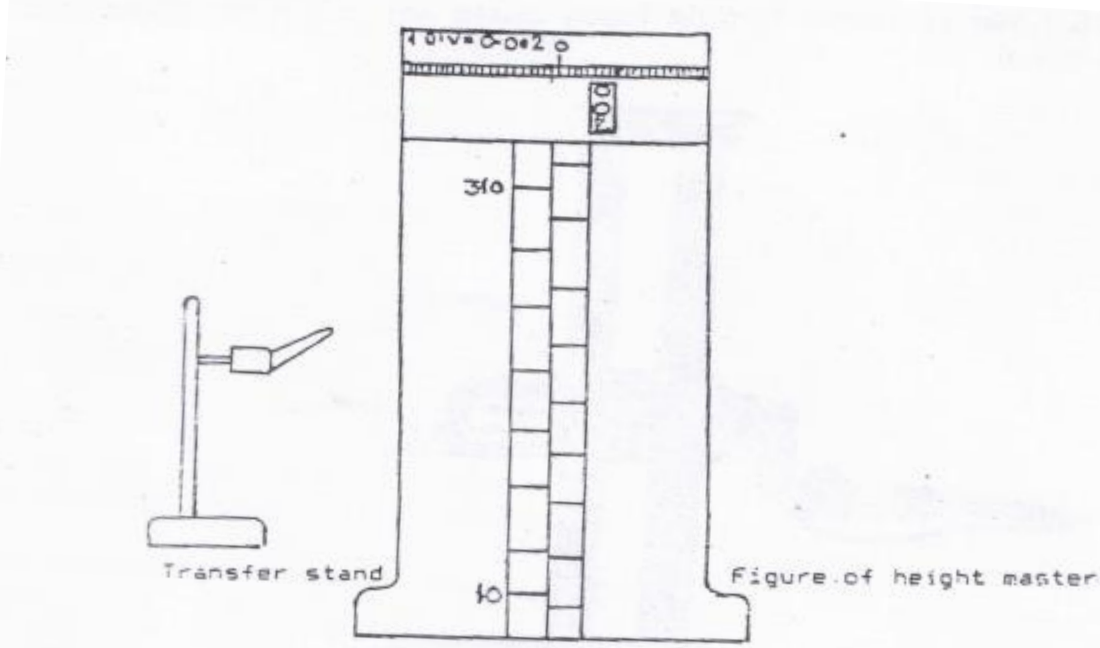


FIG.10

Specimen

Observation : Reference reading =
Digital main scale reading =
Vernier Reading =
Width =

Result: Width of the parallel bar =

Instructor's signature: ___________________

Student's signature:______________
Date: ______________

2.0 MEASUREMENT USING SLIP GUAGES

2.1 CALIBRATION OF MICROMETER, VERNIER AND HEIGHT GAUGE

Aim: Calibrate the given micrometer, Vernier caliper and height gauge and draw the calibration curve for error versus instrument reading.

Procedure:

When checking a micrometer for its maximum measuring error. Compare its reading with the size of the gauge block. In this case, slip gauges of known dimension are used and error if any in the micrometer is determined using a slip gauge. Similarly, the error in the Vernier calipers and height gauges can be determined

Observation:

Micrometer

S.No	Actual reading	Micrometer reading	error
1			
2			
3			
4			

Vernier Caliper

S.No	Actual reading	Micrometer reading	error
1			
2			
3			
4			

Height gauge:

S.No	Actual reading	Micrometer reading	error
1			
2			
3			
4			

Result:

Maximum error on micrometer =

Maximum error on Vernier caliper =

Maximum error on Height gauge =

Instructor's signature: ___________________ ***Student's signature:***______________

Date: ______________

2.2 CALIBRATION OF SNAP GAUGE, RING GAUGE AND PLUG GAUGE

Aim: Measure the dimension of the given snap gauges, ring gauges and plain plug gauges

Procedure:When checking a snap gauge, insert the gauge block or gauge combination of the required size (equal to upper and lower limit of the snap gauge) between the measuring faces of the gauge. If there is a clearance of the fit is too tight, change the size of the gauge block and insert it again. The actual size of the snap gauge will be determined by the gauge block which remains in the measuring faces unsupported but falls out when thelength is reduced by 1 microns.

The internal measurement of the ring gauge uses block accessories. In this case, the thickness of the end pieces is to be added to the length of the gauge block. Plain plug gauges can be measured directly using the rectangular jaws and holder of the gauge block accessories.

Observations:

Snap gauge

First trail	GO	NOGO	selection

Ring Gauge

First trail	GO	NOGO	Selection

Plain gauge

First trail	GO	NOGO	Selection

Figures of Snap Gauge, Ring Gauge, and Plain Gauge:

Result:

Upper and lower value of snap gauge = (upper)
= (Lower)

GO and NOGO value of the ring gauges = (GO)
(NOGO)

GO and NOGO value of the plunge gauge = (GO)
(NOGO)

Instructor's signature: ____________________

*Student's signature:*______________

Date: ______________

2.3 MEASUREMENT OF MEAN DISTANCE BETWEEN SURFACE AND SPACING BETWEEN TWO HOLES

Aim:- 1.Determine the mean distance between the two plain surfaces
2.Determine the distance between the two holes of the given specimen

Procedure:

When checking the distance between the axes of theplane surface. Take account of theactual size of the shaft and select the gauge block accordingly. Insert die gauge block between the plain surface. If the fit is too loose or too tight, change the gauge block size and repeat checking.
To determine the spacing between two holes. First two spindles are selected which exactly fit the given holes. Then diameters of the two pins are found out using the slip gauges. Then the pins are inserted in the two holes and the distance between the axis of the shaft is measured. The center distance can also be measured which is equal to slip gauge length plus the diameter of the spindle.

Observation:

First trail
Selection

Second trail
Selection

Spindle diameter

First Trial
Selection

Specimen Figures

Result:-

Mean distance between the surfaces =
Distance between the two holes =

Instructor's signature: ________________ ***Student's signature:***____________
Date: ____________

2.4MEASURMENT OF DOVE TAIL ANGLE AND TAPER PLUG ANGLE

Aim :

1. Measure the dovetail angle of the given specimen
2. Measure the taper angle of the given taper plug

Procedure :

First, two finished identical cylindrical pins are selected and their diameter is determined using slip gauges. The pins are placed on the two sides of the dovetail face and distance is measured using slip gauges. Let it be L1. The equal distance (h) slip gauges are placed from the bottom face of the dovetail on either side and insert the slip gauges in between spindles placed on the side. Measure the distance. Let it be L1. Dovetail angle = a =Tan‘1[2h/(L1-L2)].

The Same procedure can be adopted for the taper angle measurement of the taper plug. In this case to measure the outside diameter spindles with slip gauge accessories are used.

Observation :

L1=

L2=

H=

a=

Result :

Dovetail angle =

Taper plug angle =

Specimen :

Instructor's signature: ____________________

Student's signature:_______________

Date: _______________

2.5CHECKING ANGLE PLATE

Aim:

Check the perpendicularity of the given angle plate

Procedure:

Perpendicularity of the angle plate is determined using a try square and slip gauge combinations. Try square has exact 90 or perpendicular since it is tested with an optical collimator. By keeping the try square with known distance from the face of the angle plate using slip gauge and insert the slip gauge combination at above the try square and note down the reading.

Error in the angle of the angle plate is the arc tangent error in the two-slip gauge combination to the height where they are kept.

Result: ***Perpendicularity = 90 ±***

Specimen:

Instructor's signature: ___________________ *Student's signature:*______________

Date: ______________

3.STUDY ON LIMIT GAUGES AND CONTOUR GAUGES

Objective:

1) To understand the tolerance limit of the gauges.
2) To know the working procedure of the limit and contour gauges.
3) To study the applications of the gauges.
4) To understand the error in the observation.

Example:

Limit gauges and contour gauges are measuring tools which have no graduated scale and require no reading to be taken and also their use increases checking rate. Gauges of this kind are especially common in batch production. They are used to check workpiece features for size, form and relative position

.

STUDY OF PLUG GAUGE, SNAP GAUGE, RING GAUGE, TAPER GAUGE AND ADJUSTABLE GAUGES.

Aim:

To study the different gauges given and determine its theoretical tolerance and check.

Procedure:

A component after it has been produced must be checked whether it lies between the given limits. When the number of components to be checked is small, the measurement of each component can be made and its size found and then checked if it lies between the required limits. But when the number of components produced is large, then measuring each component is a time-consuming process. In such cases, one uses a limit gauge which can check if a component lies between the two limits. These gauges consist of two gauges corresponding to their maximum and minimum sizes. For gauging holes' limit plug and for shaft snap gauges are used.

Observation:

Generally, the gauging member of the plain plug gauge are made of suitable wear resistant steel and also handle be made of suitable steel. The usual way of designation the plug gauge is by GO and NOGO as applicable to the nominal size and tolerance of the workpiece. The NOGO side is always painted, red band.

Plain plug gauge:

Fundamental tolerance: 16i

Where $i = 0.001D + 0.0453\, D^{1/3}$

$=$

$D = (D1\ D2)^{1/2}$

LIMIT GO

LIMIT NOGO

Figure

Plain ring gauge:

The plain ring gauge made of suitable wear resistant steel and the gauge surfaces are hardened. They are available in two designs GO and NOGO.

Specimen

Figure

Fundamental tolerance: 16i

Where i = $0.001D + 0.0453\, D^{1/3}$

=

$D = (D1\ D2)^{1/2}$

LIMIT GO

LIMIT NOGO

Snap gauges:

Snap gauges for plain work may be either non-adjustable type or maybe of the adjustable type. In the adjustable type,snap gaugesare combined GO and NOGO gauges. The work should pass through GO side of the snap gauge and should not pass through the NOGO side. Do not use excessive force during checking as this leads to errors and early wear of the gauge.

Specimen

Figure-Snap Gauges

Figure- Taper plug gauge

Fundamental tolerance: 16i

Where i = $0.001D + 0.0453\, D^{1/3}$

=

$D = (D1\ D2)^{1/2}$

LIMIT GO

LIMIT NOGO

Taper plug gauge:

A taper gauge is tested by taper plug and taper ring gauge. The most common use of self-holding taper is in the machine spindle nose and tool shanks for the purpose of accurate alignment of the tool and transmitting torque without slip. Torque can be internal or external. For testing the correctness of the taper, three straight lines are drawn with Persian blue about equidistance along the length on the plug and rotated once or twice. If Persian blue marks are rubbed equally all along its length, taper is correct.

For testing the external taper of the shanks, the taper plug is inserted as far as it goes with slight pressure. At theextremeposition, the shank surface may, however,lies flush with the surface.

Instructor's signature: ________________

Student's signature:____________

Date: ____________

4. LINEAR AND ANGLE MEASUREMENT

COMBINATION SET

Aim:
1. To measure the given taper or angle using combination set
2 To measure the linear dimensions of a given specimen
3 To find out the center of a given shaft.

Description:
One of the most useful tools for layout, checking measuring is the combination set. This is adaptable and commonly used non-precision instrument. It has awide range of application and is the most useful and indispensable tool in theworkshop.
Combination set consists of scales, square head, and protractor and center head. Itconsists of a heavy scale, which is grooved all along thelength. It is in the groove that sliding square head is fitted. Square head is always perpendicular to the scale and it can be adjusted at any place by a locking bolt and nut. The square head also contains a spirit level, which is used to test the surface area for parallelism. The center head attached is used with the scale to locate the center bar stock. For locating the center, the part is held beneath the scale and against the sides of the center head. Three lines are drawn along the scale by rotation of the part every time.
The protractor is also capable of sliding along the scale. It contains a semi-circular disc graduated from 0 to 90 either side of the center. The protractor heads also contain a spirit level.

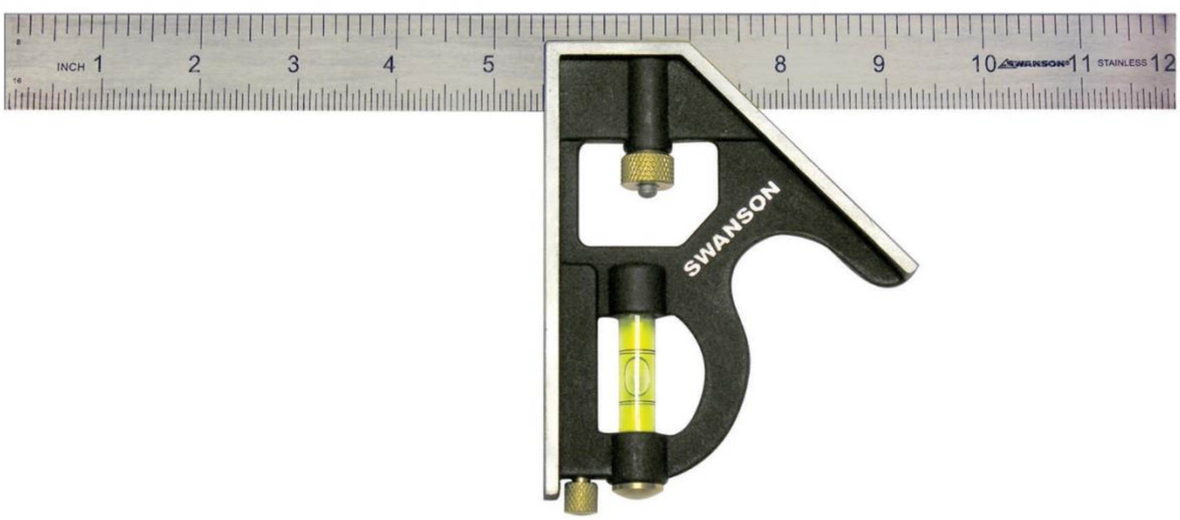


Fig. Combination Square.

Specimen:

Result:

Dimensions and angles are marked on the specimen

Instructor's signature: ______________ ***Student's signature:***______________

Date: ______________

5. ANGLE MEASUREMENT

Aim: Angle on engineering components is usually checked bevel protractor, angle gauge block, levels and sine tables and bars.

Principle:

In thecase of bevel protractor, the blade fixed to the venire can be turned around on an axis of the main scale. This tool serves to measure angles up to 0 to 180. The whole number of degree indicated by the Vernier zero mark on the head scale counting from left to right. The angle 23 between the engraved in the Vernier scale is divided into 12 equal parts to (1/12) x60=5 mins.

Before the use, wipe the protractor and check it for proper zero setting with no clearance between the measuring blade and toolmakers square. The index mark should coincide with the 90-graduation line on the dial. When checking a handheld work part, use your right hand to press the work against and to move it along the slotted blade.

5.1. UNIVERSAL BEVEL PROTRACTOR

Aim: To determine the angle of the given specimen.

Description:

It is used for measuring angles and laying out the angles accurately and precise within 5 min. The protractor dial is slotted to hold a blade, which can be rotated with the dial to the required angle and also independently adjusted to any desired length. The blade can locate in any position. Universal bevel protractors are further classified into types A, B, C and D. In type A and B the Vernier is graduated to reach 5 min of an arc. Whereas in thecase of C the scale is graduated to read in degrees. The difference between A and B is that A is provided with fine adjustments whereas B is not. Type D is graduated in degrees and is not provided with either Vernier or fine adjustment.

Clean the specimen and the apparatus. Place the working edge of the stock as areference and rotate the blade until the included angle between the blade and stock. Lock the blade by lock knob and read the angle.

Specimen

S. NO	M.S.R	V.S.R	Angle
1			
2			
3			

Specimen

S. NO	M.S.R	V.S.R	Angle
1			
2			
3			

Result:

Angle of given specimen 1=

Angle of given specimen 2=

Instructor's signature: ___________________ *Student's signature:*______________

Date: ______________

5.2. OPTICAL BEVEL PROTRACTOR

Aim: To determine the angle of the given specimen.

Description:

In thecase of optical bevel protractor, it is possible to take reading up to theapproximately 5min arc. Readings are taken from a fixed line by means of an optical magnifying system of 40x. The housing is provided with a green glass window in its rear surface through which light is admitted to illuminate the glass dial. The front of the instrument has the reading magnifier protected by a cap. The glass dial is divided into 4-degree scale each reading from 0 to 90. Reading is directly read or detected from 180 degrees depending upon the size of the angle.

Procedure:

The workpiece whose angle is to be measured is placed in alignment with the arm of the optical bevel protractor. The angle can be directly noted.

Specimen 1 **Specimen 2**

S. NO	M.S.R	V.S.R	Angle
1			
2			
3			

S. NO	M.S.R	V.S.R	Angle
1			
2			
3			

Result: Angle of specimen 1 =

Angle of specimen 2 =

Instructor's signature: ________________ *Student's signature:*____________

Date: ____________

5.3. SINE BAR

Aim: 1. Measure the taper angle of a taper block using sine bar.

2. Measure the taper angle of a given taper plug.

3. Set an angle with sine bar and verify it with angle gauges.

Description:

Sine bar is used in conjunction with slip gauges constitute agood device for precise measurement of angle. The sine bar can take any forms according to the purpose of its uses and method of application. It mainly consists of lapped steel bar at each end of which is attached an accurate cylinder. The axes of cylinders are being mutually parallel and parallel to theupper surface of the bar. A nominal distance usually 100mm to 250mm separates the axes.

Procedure:

Place the sine bar and a gauge and with a dial on a precision surface plate. Set the work to be checked on the sine bar. Locate it with side strip to prevent the work from displacement. Find the required size of the gauge block to place under the roller, using the formula h=L Sin α. where L is the distance between the roller axes and (α is the nominal inclination angle of the work measured using universal bevel protractor. Move the stand with the dial gauge along the work to check the parallelism between the work and surface plate. Use the reading of the dial gauge to find the actual deviation. Determine the deviation ▲h = x (L/Li where Li is the length of the workpiece through die dial gauge transverse. X is the dial gauge reading and h is non-parallelism in microns over die length L. This correction ▲h is added to the slip gauge and repeat the experiment until dial gauge reading is zero. Then taper angle α =sin^-1 (h/L). where h is the slip gauge height.

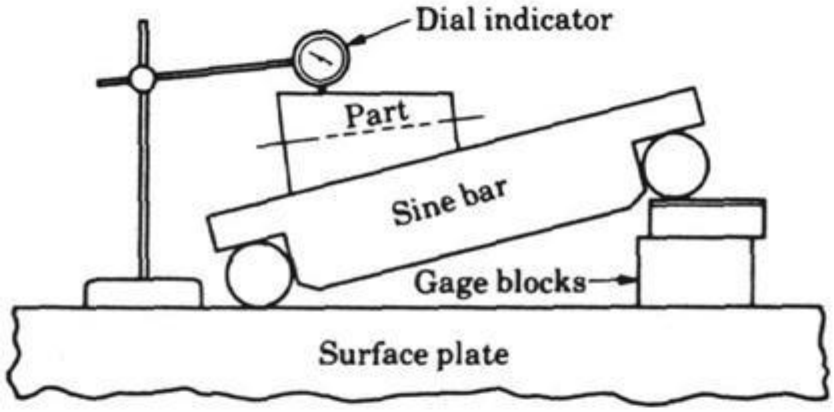


Fig - Sine Bar

Taper Block

L = α (using optical bevel protractor) =

H1=L*sin(α)

Error =

H = H1+Error

Taper Angle = α = Sin^{-1}(H/L)

Taper Plug

L = α (using optical bevel protractor) =

H1 = L*Sin(α)

Error =

H = H1 + Error

Taper Angle = Sin^{-1} (H/L)

Instructor's signature: ___________________

Student's signature:______________

Date: ______________

6.0 Straightness and Flatness Measurement

6.1. CLINOMETER

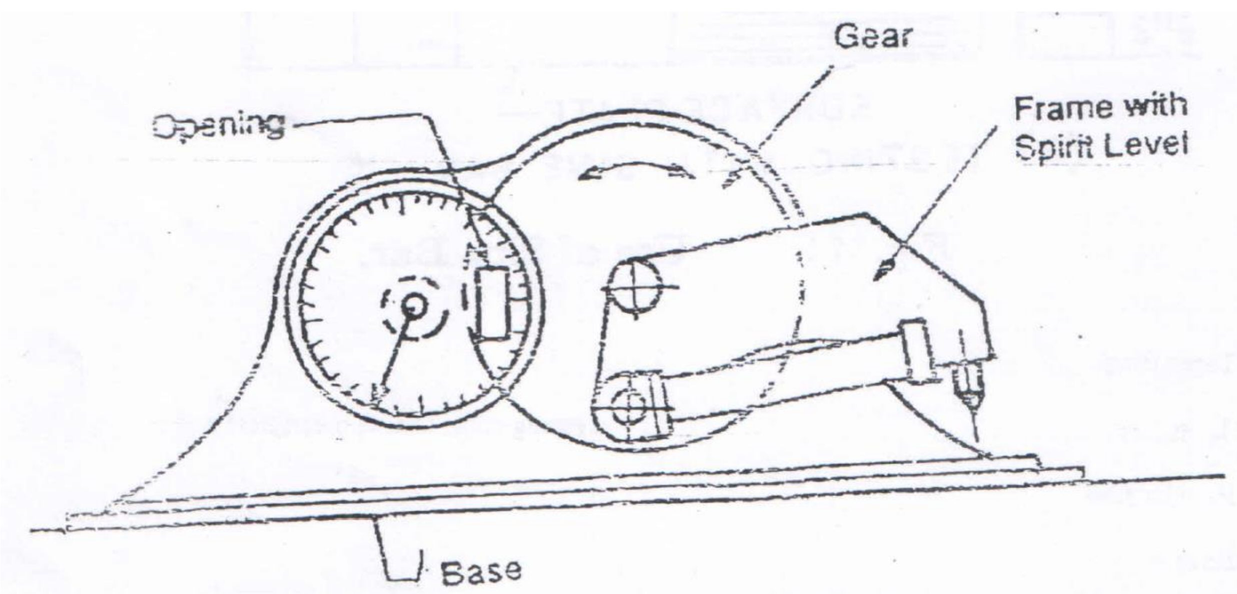
Aim: Determine the straightness and flatness of a given surface plate

Description:

A clinometer is aspecial case of the application of the spirit level. In Clinometer, the spirit level is mounted on a rotating member carried in thehousing. One face of true housing from the box of the instrument. On the housing, there is a circular scale the Clinometer is mainly used to determine the included angle of the two adjacent faces of the workpiece. It is also used for setting theinclinable table.

Procedure:

The straightness and flatness of the surface plate are treated using the Clinometer. Generally, theflatness of
theplate towards 5cm from all the edges is not bothered and hence the distance of about 5cm from all the edges is not considered. Most commonly adopted portion is divided 1 to eight generators. In each generator, the Clinometer is kept at anequal distance from edges and the readings are taken for the various positions. By the cumulative addition of the deviation Ah - Lsina. where L is the length of the Clinometer and a is the inclination. Tnus straightens for each generator is determined. Then for the each generator errors from the datum surface is noted and flatness of the surface is determined.



Observation:

Marking on the surface Plate	Sl No.	α	H= L*Sinα	Cumulative error
	1			
	2			
	3			
	4			
	5			

Result:

Maximum straightness value=

Maximum flatness value=

Instructor's signature: ____________________

*Student's signature:*_______________

Date: _______________

7. Screw Thread Measurements

Screw thread is generally used for transmission or power and motion and acts as faster. In case of plain shaft and hole, there is only one dimension it has to be considered while in case of screw thread there arc at least few important elements required consideration. They are major diameter, minor diameter, effective diameter, pitch and angle of thread form.

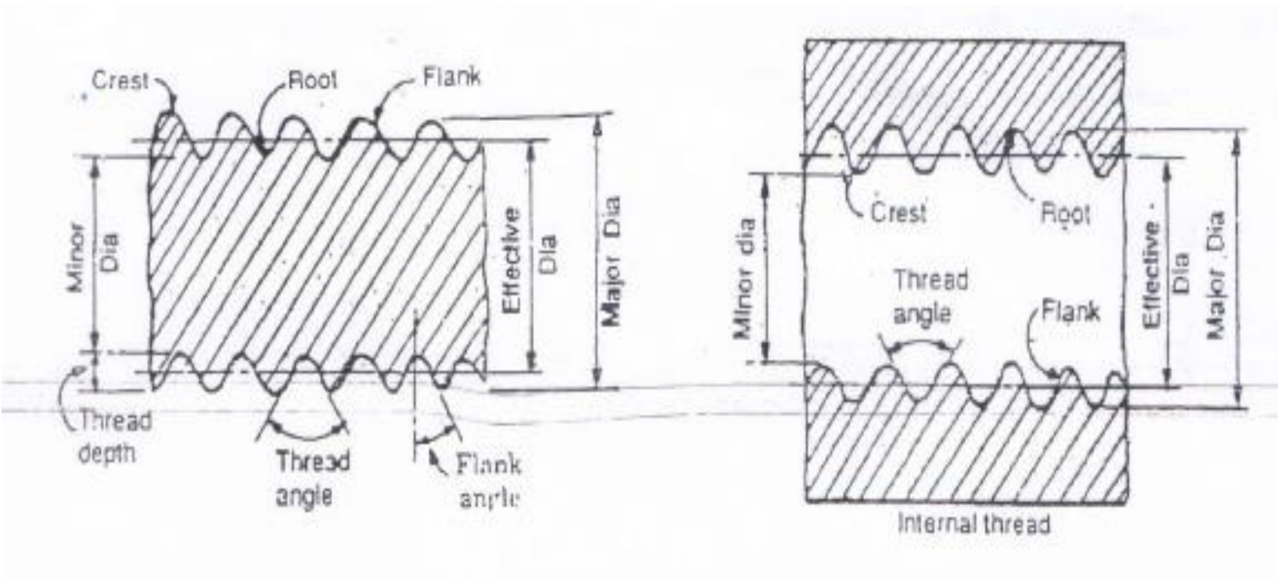


Fig 1.7 (a) External thread and (b) Internal thread

7.1 SCREW PITCH GUAGE

Aim: Determine the pitch of the given thread.

Description: Screw pitch gauges are designed to determine pitch and approximately the profile of screw threads. These gauges are put together in sets with pitch ranges from 0.4 to 6mm for metric thread and 28 to 11 threads/inch threads.

Procedure: The blades made of actual screw threads are chosen depending on the pitch and fit into the given thread. The correct pitch coincide with that pitch which fits into the given thread specimen. Hence, the pitch is found.

Specimen

Initial Reading	Final reading	Difference

Result: Pitch of the given thread =

Instructor's signature: ___________________ ***Student's signature:***_______________

Date: _______________

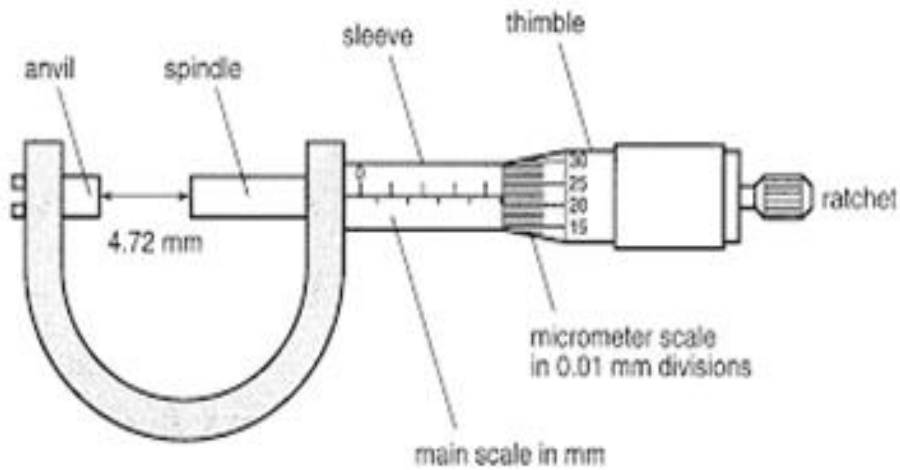
7.2 SCREW THREAD MICROMETER

Aim*:* Determine the effective diameter of the given thread specimen.

Description*:* Screw thread micrometer with measuring inserts (Anvils) is used for measuring the pitch diameter of triangular external thread by the direct absolute method. The measuring capacity ranges from 0 to 350 mm at 25 mm intervals. The inserts are chosen to suit the pitch of the workpiece. Thread according to their designation marks and table and table puts into the instrument casing. The V insert is fit into the suitable board in an anvil and anvil inserts into the board of the spindle.

Procedure*:* With the anvil insert retracted set the micrometer head to zero. Turning the nut to the left side of the insert advance it until it fits over the spindle insert or a setting standard. After the inserts have made contact directly with each other with setting standard, retrace the micrometer screw bring back to zero position. If the setting not accurate enough, correct it by adjusting the anvil insert or by setting the thimble to zero. Readings are taken simultaneously to that of the external micrometer.

Figure of Screw Thread Micrometer:



Specimen

Observation:

S.No	M.S.R	V.S.R	Effective diameter
1			
2			
3			
4			

Result: Effective diameter of the thread =

Instructor's signature: ___________________

Student's signature:_____________

Date: _____________

7.3 MEASURING SCREW THREAD EFFECTIVE DIAMETER BY TWO WIRE AND THREE WIRE METHOD

Aim: 1. Measure the effective diameter by two wire method.

2.Measuring the effective diameter by three wire method.

Description:The Effective diameter of the screw thread may be ascertained by placing two or three wires or rows of identical diameter between the flanks of the thread and measuring distance over outside of this wires.A measuring set consists of three wires of identical diameter.the wire size is chosen corresponding pitch and angle of the thread to be checked.The wire axes should be placed vertically in measurement,so they must be suspended bracket fixed to the instrument used.

Procedure: The best wire diameter is chosen by the formulae d= p/(2*cos(x/2)).where p is the pitch measured using the pitch gauge and and x is the flank angle 60° for metric and 55° for British thread.To carry out the measurement place the one of the in thread groove on one side and second one in thread groove on the opposite side.

In three wire method,two wires are placed on one side of the thread and third one on the opposite side.Bringing the contact kid of the measuring instrument to the wires and measure the dimension m over the wires.which is the starting parameter to compute the pitch diameter.the effective diameter E=T+P

Where,T=M-2*d, d is the diameter of the wire

P=0.866 p-d, for metric thread

P=0.9658 p- 1.657 d (British Thread)

Observation:

1.Two Wire Method

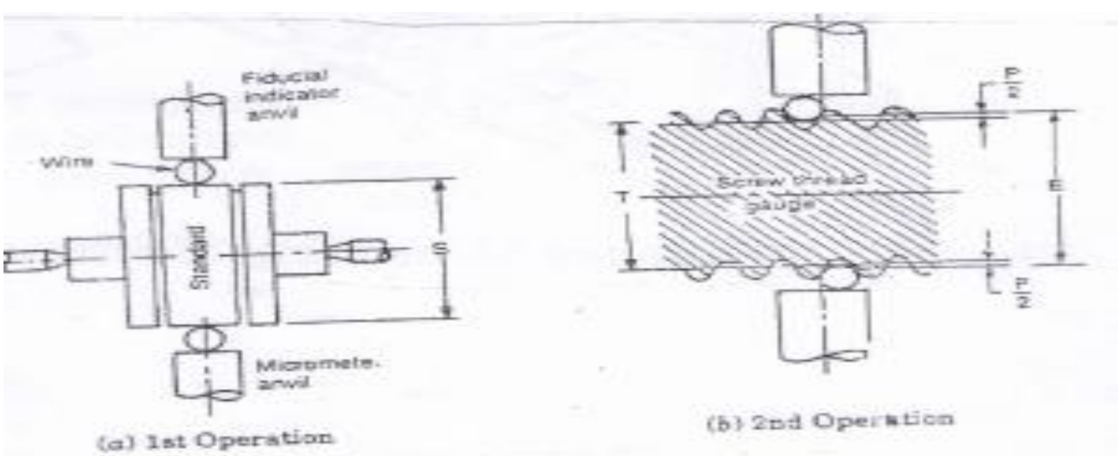


Fig. 18

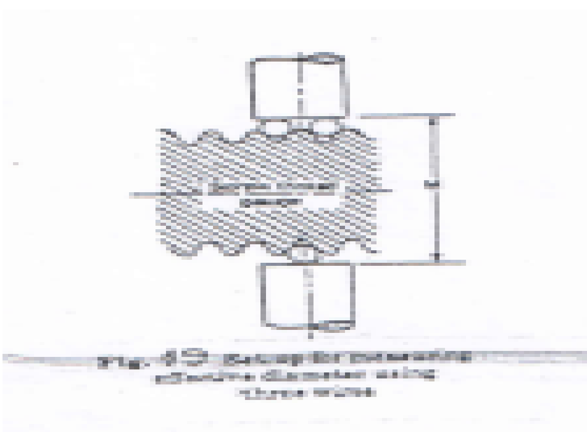
D= p/2 Cos(x/2) =

M=

P=

E=

2.Three Wire Method



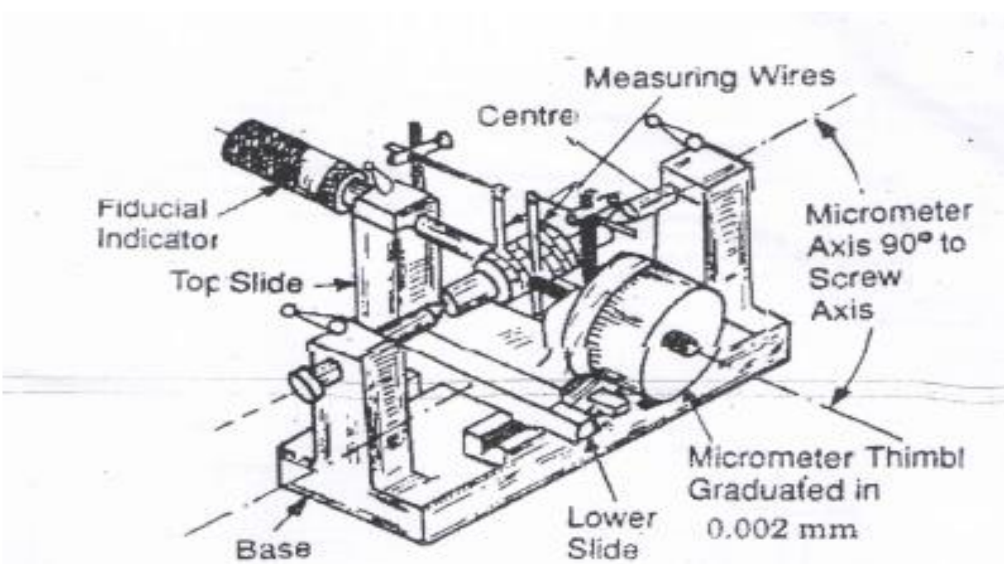


Fig. 20 Diameter Measuring Machine

M=

P=

E=

Result : Effective Diameter by two wire method=

Effective diameter by three Wire method=

Instructor's signature: ____________________

Student's signature:_______________

Date: _______________

8. Gear Tooth Measurement

Gear are mainly used for transmission of power and motion, the accuracy of which gear are manufactured. The gear can be graded on the basis of following accuracy:

1) Kinematics Accuracy
2) Smoothness of gear operation
3) Tooth Bearing Contact.

The most commonly used forms of the gear tooth are Involute and Cycloid.

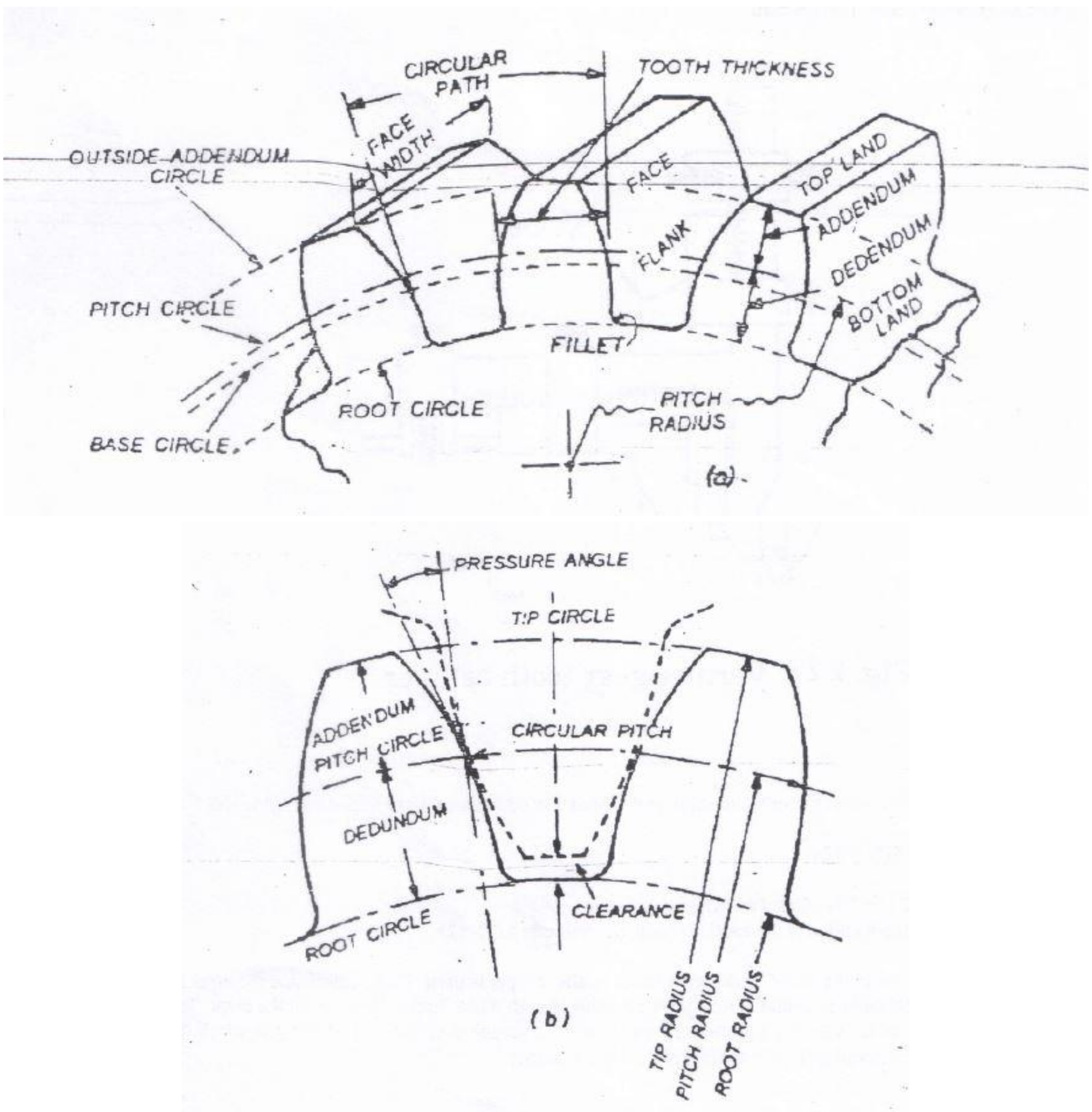


Fig. 21 Gear terminology for spur

8.1 Vernier Gear Tooth Caliper:

Aim: Measure lire given gear tooth thickness using Vernier Tooth Caliper

Description: The Vernier Gear Tooth Caliper is designed to measure the Chordal thickness of Gear tooth. Two sides carrying vernier are movable on mutually perpendicular beams of frame. The vertical slide is coupled to tongue and a horizontal slide to a movable jaw. Gear tooth calipers are available in three sizes for testing gear over a range of module from 1 to 36 mm.

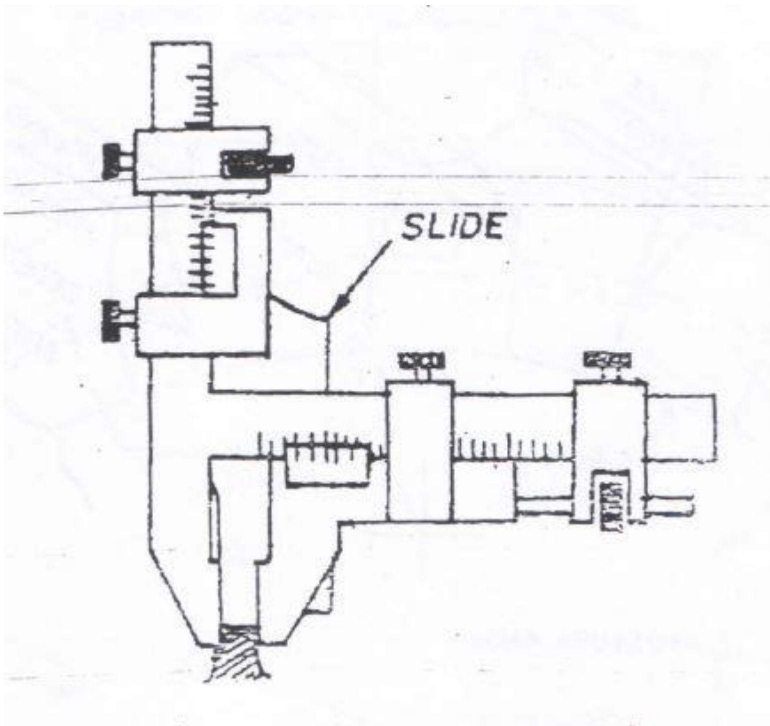


Fig. 22 Vernier Gear Tooth Caliper

Procedure: First using the formula of chord thickness and Chordal w addendum d are found out using the formula

$$w = N\,m\,(\sin(90/N))$$
$$d = (N\,m/2)\,[1 + (2/N) - \cos(90/N)]$$

where N is the number of teeth and m is the module (outside diameter) / (N+2)

Then determine error in chord width. Gear tooth verniercaliper is used. First determine the error in the instrument in the vertical and horizontal vernier jaws coinciding with main frame. Note down the error. The vertical vernier jaw is adjusted for Chordal addendum and place the tongue over the face of the gear tooth. The gear tooth thickness w is measured similarly as the conventional caliper.

Chord addendum (d) =
Calculated Gear tooth thickness (w) =
Measure measured gear tooth thickness ($w-w_m$) =
Percentage of error = $((w-w_m)/w) \times 100\%$ =

Result:
Percentage of Error =

8.2 Tooth Span Micrometer

Aim: Determine the thickness of the gear tooth of a given gear wheel

Description: This instrument is used to measure the variation in the base tangent length. The tooth span micrometer differs from conventional and external micrometer in that anvil and spindle are fitted with replaceable disk type cup. The micrometer is available in measuring capacities 0-25, 25-50, 50-75 and 75-100.

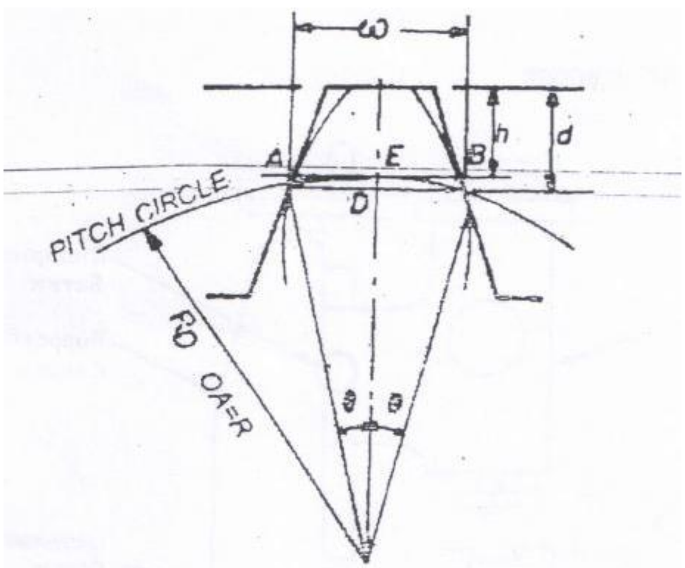


Fig. 23 Chordal thickness method

Procedure: A base tangent length variable is determined by computing mean value of measurement made in several positions of test gear with nominal value compiled by the formula. Variation in the base tangent length measured in different positions defines the mutual positioned accuracy of the gear tooth. Theoretical base tangent length

$$W_t = N\, m \cos(\Phi)[\tan(\Phi) - \Phi - (\pi /2N) + (\pi S /N)]$$

Where N is the number of teeth
m is the module
Φ is the pressure angle 20°
S is the number of teeth.

Observations:

N = M = Φ =

W_t= W_E =

Theoretical Pitch Length (W) =

Measured Pitch Length (W) =

Percentage of error =

Chordal Thickness =

Results:

Instructor's signature: ___________________

Student's signature:______________

Date: ______________

9.OPTO-MECHANICAL MEASURING EQUIPMENT

These types of instruments are designated for precise external and internal measurement for setting standard and product parts directly by precision linear scales (obsolete method) and against the gauge block (comparative method). To measure by obsolete method set the machine to zero, place the parts to be measured and take the reading. In comparative measurement the zero setting is not required and the opto-meter tube alone is used to find the deviation from the setting standard. Tool makers microscope, universal microscope etc. are examples of opto-mechanical equipment.

9.1 Tool Makers Microscope

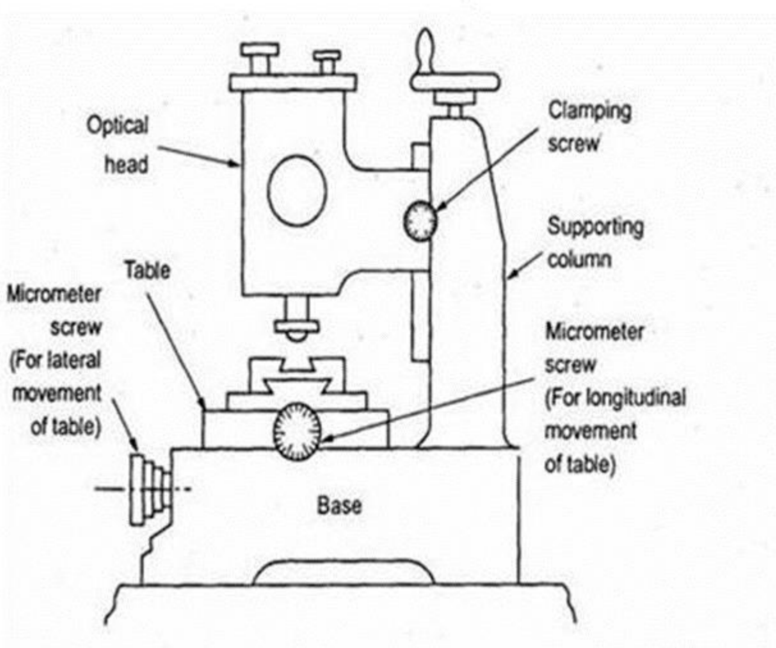


Fig 2.4 Tool Makers Microscope

It is used for linear dimensions,angles,threadelements,tapers and irregular profiles.Tool makers are available in small and large models. Light rays from the incandescent lamp passes through condenser lens,light filter and diaphragm are reflected from a tilting mirror and through lens. Illuminate the test part placed directly on the work tale or held between the centres. The part image is projected by the objective lens on to the focal plane of the eye piece where gratitude positively connected by circular scale dispersed. The image of the test part is viewed. The eye piece reading can be taken from the cross and longitudinal feed micrometer.

Procedure:-

Before measurement chose and set a interchangeable objective lens, then verify and adjust the instrument against the focus bar. Interchangeable objective lens provides variety of magnification should be selected so as to obtain the required diameter of the field of view. All other things are being equal, the possible largest magnification is advisable.

The purpose of the focused beam is to focus the microscope on the horizontal plane coinciding with the work centre line to adjust the centre line in parallel with table travel direction, and to check the centre intersect; the column pivot axis.

. After placing the focal bar along the work centre, put the work centre cradle on the top of the work table and adjust the objective with respect to the optical axis of the microscope and clamp. To focus the microscope and lock the bracket, set the focus bar accurately by moving the table both longitudinally and transversely by micrometer head and check the centre lie for parallelism to the longitudinal moving table. If the centre is not parallel to the table adjust the top slide making sure parallelism is achieved.

i) **Linear Measurement**

To make linear measurement, set the graticule to the zero position, place the parts to be measured so that its side that serves as a datum is coincided with one of the graticule dotted pair line and take the first reading from the micrometer head. Displacethe work table with part until the second side to which the distance to be measured is brought into coincidence with the same graticule line and take another reading from the micrometer head. The difference in both reading will give measuring results.

Specimen

X_1 = M.S.R. + V.S.R. X L.C =
X_2 = M.S.R. + V.S.R. X L.C =
Y_1 = M.S.R + V.S.R. X L.C. =
Y_2 = M.S.R + V.S.R. X L.C. =

Width a = X_2 =X_1= and b= Y_1=Y_2

ii) **Taper Measurement**

Once the taper block to be measured is placed, focus the microscope and bring the horizontal dotted cross hair of thegraticule into coincide with the taper generated and take the first reading of the cross wire position from the micrometer head in the transverse direction. Then move the work table longitudinally as specified length with the aid of respective micrometer head. Bring thegraticule cross hair and transversely on the taper generation once again take the reading.

Specimen

$X_1 =$ $X_2 =$ $X_3 =$
$Y_1 =$ $Y_2 =$ $Y_3 =$

a= Sqrt[$(X_2 \;-- \; X_3)^2 \; - \; (Y_2 \;-- Y_3)^2$]
b =Sqrt[$(X_2 \;-- \; X_3)^2 \; - \; (Y_2 \;-- Y_3)^2$]
c = Sqrt[$(X_2 \;-- \; X_3)^2 \; - \; (Y_2 \;-- Y_3)^2$]
$\alpha = \text{Cos}^{-1}[\;(b^{2\;+}\; c^2 \; - \; a^2)\; / 2bc\;]$

By plotting the points in a graph paper and actually measuring the angles, taper angles can be measured graphically.

iii) **Radius of Curvature**

In order to measure the radius of a curve measure the height h ad chord a of the area segment. For measuring height set the object such that horizontal hairline of the cross wire tangent to the arcs. Take the reading of the cross head micrometer. Next turn the micrometer screw to datum position. Care should be taken that horizontal hairline doesnot exceed the arcs.Take the reading from micrometer head. Thedifference in reading determinesthe height of the arc.Now with the longitudinal micrometer head move longitudinally towards the one side of the curve.

Difference gives the chord length a.

The radius of curvature R= $(a^2 / 2h) + h/2$

Specimen

Graphically it can be determined as follows. Determine X and Y coordinates of the three points on the arc using tool makers' microscope. Plot the points from the graph paper and constructtwo chords. Perpendicular bisectors of each chord which meet at the centre of the arc. Then measure the radius.

Radius of curvature can be measured using two coordinate method by bringing one measured point to (0, 0). Let the other two points be (X_1, Y_1) (X_2, Y_2)by thetransformation of the coordinates.

Then from the equation of the circle one can write

$X_1^2 + Y_1^2 + 2fX_1 - 2gY_1 = 0$
$X_2^2 + Y_2^2 + 2fX_2 - 2gY_2 = 0$

Where f and g are constants. Solving f and g from the numerical values of the coordinate.

R= Sqrt[f^2+g^2]
= Sqrt[$(X_1^2 + Y_1^2)(X_2^2 + Y_2^2)[(X_1^2 - Y_1^2)+(X_2^2 - Y_2^2)]/2[X_1Y_2 - X_2Y_1]$]

X_1= X_2= X_3=

Y_1= Y_2= Y_3=

R=

iv) **Thread Measurement**

Using the longitudinal and transverse feed micrometer, thread parameter like pitch,root diameter, outside diameter, pitch angle can be measured.

Specimen

Pitch =
Outside diameter =
Root diameter =
Results
Linear length a= b=

Taper angle of the taper lock =
Arc radius =
Outside diameter of the thread =
Root diameter =
Pitch =

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Date: ______________

10. MEASUREMENT USING THE COMPARATOR

Comparator works on the relative measurement. It only gives the dimensional difference in relation to a basic dimension.

10.1 MECHANICAL COMPARATOR

Aim: 1) Determine the mean and standard deviation of the batch.
2) Draw the control chart for the given specimen.

Description:

In the comparator mechanical linkages and other mechanical devices can obtain magnification. Instruments of this class are used to check the linear dimension from relative position or surface. Among such instruments, dial indicators finds widest application. When the plunger moves upwards, use outer number on the dial which gives the value in clockwise direction. When the plunger moves downwards, inner number is used and this gives the value in counter clockwise direction. Before measuring check the dial for repeatability.

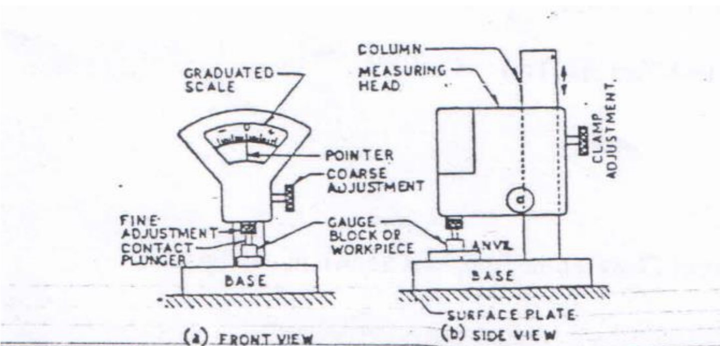

Fig. 25 A typical comparator.

Procedure:

If a large number of parts be split at random into groups, then the grand average of sub groups will be such as the average of the universe. It is observed that average sizes are grouped more closely around the mean size than the size of the individual items. That is the standard deviation of the sub group is less than the standard deviation of the individual items.

Twenty five workpieces are given and observations are made with mechanical comparator in two batch of number 10 and 15 to determine mean and standard deviation of the total quantity and draw the normal distribution curve for the sample. Also determine the number of scrap material in 20 and 30 limit.

Observations:

Sl.No : 1 2 3 4 5 6 7 8 9 10

Batch 1:

Sl.No : 1 2 3 4 5 6 7 8 9 10

Batch 2:

Internal dimension is usually used for automobile industries for rapid checking of piston diameter, cylinder etc. Present apparatus consists of a pressure controller for air supply frame, column of liquid with scale, flexible piping to convey air to the gauge and probe. The height of the liquid is the measure of pressure variation resulting from leakage of air between one or more nozzles incorporated in the gauge and surface of the bore being measured. If the bore exactly matches the reading will be zero. This instrument can be used to explore the ovality, taper etc. First calibrate the comparator using the ring gauge, place the probe in the nominal size ring gauge and adjust the pressure regulator such that the manometer reads zero. Then keep the probe inside the given specimen and note down the reading from the manometer.

Observations:

$\bar{X}$ = [$n_1\bar{x}_1$+ $n_2\bar{x}_2$] / [n_1+n_2]

n_1=10 n_2=20

$\bar{X}_1$=$\sum\bar{x}_1$ / 10 $\bar{X}_2$= $\sum \bar{x}_2$ / 20

Standard deviation (σ^2) = {$n_1\sigma_1^2$ + $n_2\sigma_2^2$ / (n_1 + n_2)} – {n_1 n_2 [$\bar{x}_1$ + $\bar{x}_2$]^2 / [n_1 +n_2]^2}

σ_1 = Sqrt {$\sum$ [x_i - $\bar{x}_1$]^2 / n_1}

σ_1 = Sqrt {$\sum$ [x_i - $\bar{x}_2$]^2 / n_2}

Frequency (f) = 1 / Sqrt {2πσ} × $e^{-(xi - x\ bar) / 2\sigma}$

Result:

Control chart for the sample is shown in the figure.

Instructor's signature: ___________________

Student's signature:_____________

Date: _____________

11. SURFACE TESTER

No matter how good a finish, it is important to work by finessing processes, surface can never be smooth and flat. Instrument for checking surface roughness are available in the contact and contactless types. Perth - o - meter, light sectioning microscope etc. comes under this category.

11.1 PERTH -O- METER

Aim: Determine the Rx, Ra and Rmax of the given profile.

Description:

The principle of contact type instrument is tracing the surface under the examination with a special needle stylus. The sharp pointed tip of the stylus runs across the work surface and its irregularities cause axial movement of the needle. Linear fluctuations of the stylus are transformed into electric signal by a movable electrode to transducer. These signals are magnified and recorded on a surface profile chart. Needle displacements are transmitted to an indicating instrument and with surface analyzer.

Procedure:

Determine the mean line:

First, the mean line is estimated by eye judgement. The total above and below the assumed line are measured and correctness = $\{\sum A_{above} - \sum A_{below}\}$/ Sample length is applied to the assumed mean line to get correct mean line.

1) Calculation of Rz. Ra and Rmax:

Rmax (maximum height of uncertainty) is defined as the distance between two lines parallel to mean line and touching the profile at highest point in the sampling length.

Ra (arithmetic mean deviation) from the mean line of the profile is defined as the average value of the ordinates. (Y1 ……… Yn).

Rz (point height irregularities) is defined as the average difference between the five height peaks and five deepest valleys within the sampling length measured from a line parallel to mean line.

Observations:

X (from a datum point) =

Error = $\{\sum A_{above} - \sum A_{below}\}$ / Sample length =

$\overline{X}$= x +error

Ra =$\sum yi/n$ =

Rmax =

Rz = {(Y1+Y3+Y5+Y7+Y9) - (Y2+Y4+Y6+Y8+Y10)}/5

Result:

Ra =

Rz =

Rmax =

***Instructor's signature:* ________________** ***Student's signature:*_____________**

***Date:* _____________**