MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY

MECHANICAL ENGINEERING DEPARTMENT

Degree : B.E

Year / Sem : IV / IV (I-SEMESTER)

Course : Mechanical Engineering

Subject Code : ME 432

Subject : METROLOGY AND INSTRUMENATATION LAB

Lab In-charge : Mr. V. Suvarna kumar.

METROLOGY AND INSTRUMENTATION LAB MANUAL

List of Experiments

Syllabus **ME 432**

METROLOGY AND INSTRUMENTATION LAB

Instruction	**3** Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessional	25 Marks

1. Measurement with inside, outside and depth micrometers.
2. Measurement with height gauges, height masters, etc.
3. Measurement of Linear and Angular dimensions with Tool Maker's Microscope - Flat specimens plain, cylindrical specimens with centers and threaded components
4. Measurement with - Dial Indicator / Electrical Comparator / Mechanical Comparator / Dial Bore Gauges, etc.
5. Measurement of angles with Sine bar, Bevel protractor and Precision level, Block level, etc.
6. Measurement of roundness errors with bench centers.
7. Geometrical tests on Lathe machine.
8. Measurement of flatness errors (surface plate) with precision level.
9. Measurement with optical projector.
10. Checking machined components with plug gauges, adjustable snap gauges, indicating gauges,
11. Force measurement with strain gauge type load cell / proving ring / piezoelectric load cell etc.
12. Temperature measurement with thermocouples

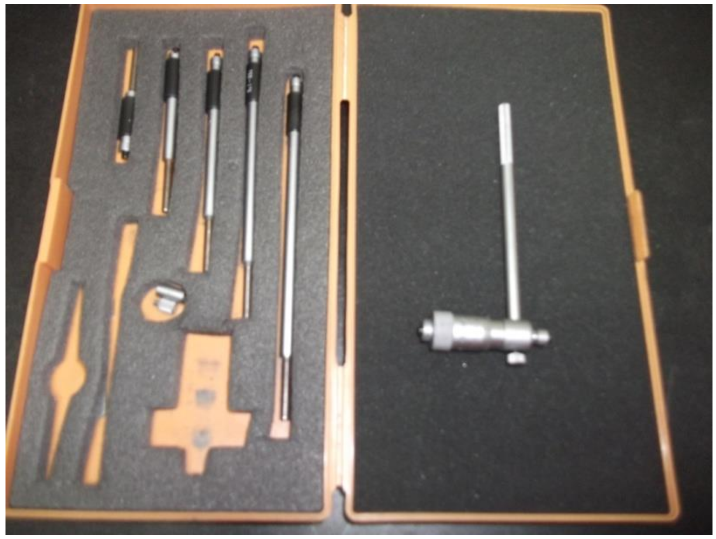
SAFETY PRECAUTIONS

Observe the following safety precautions strictly to ensure the safety of self machine and tools.

- **Know thoroughly about the controls before that the Measuring Instruments.**
- **Use always proper tools and devices in Good condition.**
- **Always wear shoe and apron in the Labs.**
- **Do not let your attention diverted while operating the Instruments.**
- **Observe self discipline.**
- **Parallax error should not be there.**
- **While inspecting or measuring in the Lab temperature between 18 – 20 o C.**
- **Please check with Master piece before starting of any Instrument (It should be Calibrated.**
- **Use proper Jigs and Fixtures for perfect clamping.**
- **Switch off the cell phones inside the Lab.**
- **Proper Lighting should be there.**
- **Taking the readings carefully without parallax error.**
- **Clean the Instruments after using and carefully Hand it over to Lab Technicians.**

Exp. No: 1 A **INSIDE MICROMETER** **Date:**

AIM: To measure the inside diameter of the given specimen.



SPECIMEN SKETCH:

INSTRUMENTS: Inside micrometer.

SPECIFICATIONS:

Least count =

Range =

PRINCIPLE: The inside micrometer works on the screw in a nut principle. When an accurately machined single start screw is rotated by 360° in a fixed nut, it moves axially by a constant distance known as pitch. If the periphery is divided into N divisions, then for each division the screw moves by a distance given by pitch/N.

$$\text{Least count} = \frac{\text{pitch of the screw}}{\text{no of thimble divisions.}}$$

DESCRIPTION:

- Inside micrometer is used for measuring relatively large internal dimensions.
- It consists of four parts 1) Measuring head

  2) Extension rod

  3) Spacing collars

  4) Handle

- Greater distances are obtained by the use of different extension rods and spacing collars.
- Extension rods are provided which allows for the measurement over a specific range.
- The range of measurement can be varied by changing the extension rod and using collars.

PROCEDURE:

- The diameter of the bore to be measured is roughly estimated using scale and the extension rod of a suitable range is selected .The extension rod is inserted in the micrometer head.
- The specimen to be measured is thoroughly cleaned.
- The zero error of the measurement is checked by using a standard specimen.
- The instrument is held by the handle and placed within the bore.
- One of the surfaces is kept in contact with the internal feature while the thimble is rotated so as to extent the second contact surface as the thimble is rotated the instrument is moved sideward so as to ensure that it is the diameter being measured.
- The instrument is then withdrawn from the hole. Sleeve reading and thimble coincidence are noted.
- The procedure is repeated and a couple of readings are noted. The average of these is taken as the measured value of the dimensions as to reduce error.

FORMULA :

Total value = sleeve reading + (TC×LC)

TABULAR COLUMN:

Section	S.no	Sleeve reading	Thimble coincidence	TC×LC	Total reading	Average value

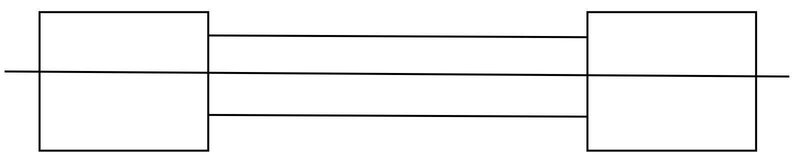
RESULT:

Latest Applications: *(student must write)*

Exp. No: 1 B **OUTSIDE MICROMETER** **Date:**

Aim: To measure the outside diameter of the given specimen.

Specimen sketch:



Instrument used: Outside Micrometer

Specifications: Least count= 0.01mm

Range= 0-25mm

Principle: It works on the screw in nut principle. When an accurately machined single start screw is rotated by 360 degrees in a fixed nut, it moves axially by a constant distance known as the pitch. If the periphery is divided into N divisions, then for each division the screw moves by a distance given by pitch/N.

Least count = (pitch of the screw)/ (No. Of thimble divisions)

Description:

1) The main parts of the outside micrometer are Frame, anvil, spindle, thimble and ratchet stop. The lock nut is provided for locking the dimension by preventing motion of the spindle.
2) The C shaped frame of the outside micrometer is large enough to permit measurements of dia upto the range of micrometer.
3) The measuring faces of the anvil and spindle are made flat and parallel to each other.
4) The ratchet stop is provided at the end of the thimble to maintain sufficient and uniform measuring pressure so that standard conditions of measurement are attained.
5) There are 2 scales on the micrometer, main scale or sleeve scale on the sleeve of the spindle and a thimble scale.
6) The thimble scale divides the circumference into 50 divisions. The combination of these scales gives a least count of 0.01mm

Procedure:

1) The given specimen is thoroughly cleaned.
2) The instrument is checked for any zero errors.
3) The specimen to be measured is placed between the anvil and the spindle faces by using the ratchet. The turning of the ratchet should be stopped once the required pressure is exerted.
4) The sleeve reading and the corresponding thimble coincide with the datum line are noted and the total value is calculated.
5) The procedure is repeated and the readings are taken at the same section so as to reduce the error.
6) The specimen is then removed and the measurement is repeated at 3 different sections A, B and C respectively.
7) The readings are tabulated and the average value is estimated.

Formula:

Total value = sleeve reading + (Thimble coincidence x Least count)

Least count = pitch/No. Of thimble divisions

= 0.5/50 = 0.01mm

Tabular column: All units are in mm

Specimen 1

Section	S.no.	Sleeve Reading	Thimble Reading	TC x LC	Total value	Average

Specimen 2

Section	S.no.	Sleeve reading	Thimble reading	TC x LC	Total Reading	Average

Results:

Specimen 1 : Average diameter at section A =

Average diameter at section B =

Average diameter at section C=

Specimen 2 : Average diameter at section A =

Average diameter at section B =

Average diameter at section C=

Latest Applications: (By the Student

Exp. No: 1 C **DEPTH MICROMETER** **Date:**

AIM: To measure the depths of the given specimen.

SPECIMEN SKETCH:

INSTRUMENTS: Depth micrometer.

SPECIFICATIONS:

Least count =

Range =

PRINCIPLE: The depth micrometer works on the screw in a nut principle. When an accurately machined single start screw is rotated by 360° in a fixed nut, it moves axially by a constant distance known as pitch. If the periphery is divided into N divisions, then for each division the screw moves by a distance given by pitch/N.

$$\text{Least count} = \frac{\text{pitch of the screw}}{\text{No of thimble divisions.}}$$

DESCRIPTION:

- Inside micrometer is used for measuring relatively large internal dimensions.
- It consists of four parts 1) Measuring head

  2) Extension rod

  3) Spacing collars

  4) Handle

- Greater distances are obtained by the use of different extension rods and spacing collars.
- Extension rods are provided which allows for the measurement over a specific range.
- The range of measurement can be varied by changing the extension rod and using collars.

PROCEDURE:

- The diameter of the bore to be measured is roughly estimated using scale and the extension rod of a suitable range is selected. The extension rod is inserted in the micrometer head.
- The specimen to be measured is thoroughly cleaned.
- The zero error of the measurement is checked by using a standard specimen.
- The instrument is held by the handle and placed within the bore.
- One of the surfaces is kept in contact with the internal feature while the thimble is rotated so as to extent the second contact surface as the thimble is rotated the instrument is moved sideward so as to ensure that it is the diameter being measured.
- The instrument is then withdrawn from the hole. Sleeve reading and thimble coincidence are noted.
- The procedure is repeated and a couple of readings are noted. The average of these is taken as the measured value of the dimensions as to reduce error.

FORMULAE:

Total value = sleeve reading + (TC×LC)

TABULAR COLUMN:

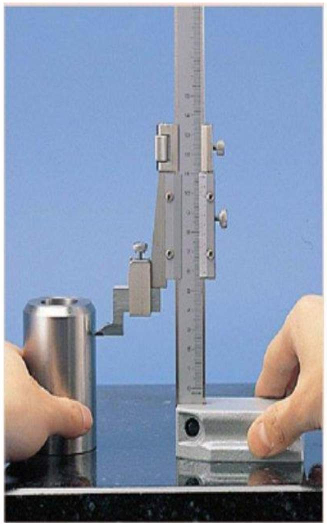
Section	S.no	Sleeve reading	Thimble coincidence	TC×LC	Total reading	Average value

RESULT:

Latest Applications: (By the Student)

EXP.NO: 2 **VERNIER HEIGHT GAUGE** **DATE:**

AIM: To measure the height of the given specimen at various sections.



SPECIMEN SKETCH:

INSTRUMENT USED: Vernier Height Gauge

SPECIFICATONS: Least Count = 0.02 mm
Range =0-300 mm

PRINICIPLE: The principle of a vernier height gauge is the same as that for vernier caliper. When two scales of slightly different sizes are used, the difference between them can be utilized to enhance the accuracy of the measurement.

DESCRIPTION:

- The main parts of Vernier Height Gauge are the base, the main scale, vernier scale, the beans and the scriber.
- The vernier gauge is placed on a surface plate and used so as to avoid any error due to irregularity of the surface.
- The base provides rigidity and support to the base. It is ground and lapped to an accuracy of 0.005 mm.
- Unlike the caliper the main scale on the Vernier Height Gauge is adjustable. It is mounted on the beam and can be adjusted using the adjustment screws. This is used to eliminate any zero error.
- The vernier scale is mounted on a slider which moves over the beam.
- A scriber can be fixed on the slider with the help of locking screw and thus the instrument cam also be used for marking.

PROCEDURE:

- The given specimen is thoroughly cleaned.
- The measuring jaw is adjusted so as to make the surfaces of the scriber and surface plate built. The instrument is then checked for any zero error. If zero error is present, it is eliminated by adjusting the position of the main scale in the beam by fine and coarse adjustment screws.
- The specimen is placed on the surface plate and the slider is adjusted so as to position the scriber on the surface whose height relative to the datum, is to be measured.
- The main scale reading (MSR) and corresponding vernier coincidence are noted.
- The total reading is estimated using TOTAL READING= MSR + (VC * LC).
- The measurement is repeated a few more times and the average reading is noted so as to reduce error.
- Readings are taken for different surfaces of the specimen and the data is tabulated.

FORMULA: TOTAL READING= MSR + (VC * LC).
Least Count = 0.02 mm

TABULAR COLUMN:

SECTION – I					
SL NO	**MSR**	**VC**	**VC * LC**	**TOTAL VALUE**	**AVERAGE(mm)**
SECTION – II					

RESULT:

Specimen 1 : Average height of h_1 (mm) =

Average height of h_2 (mm) =

Average height of h_3 (mm) =

Specimen 2 : Average height of h_1 (mm) =

Average height of h_2 (mm) =

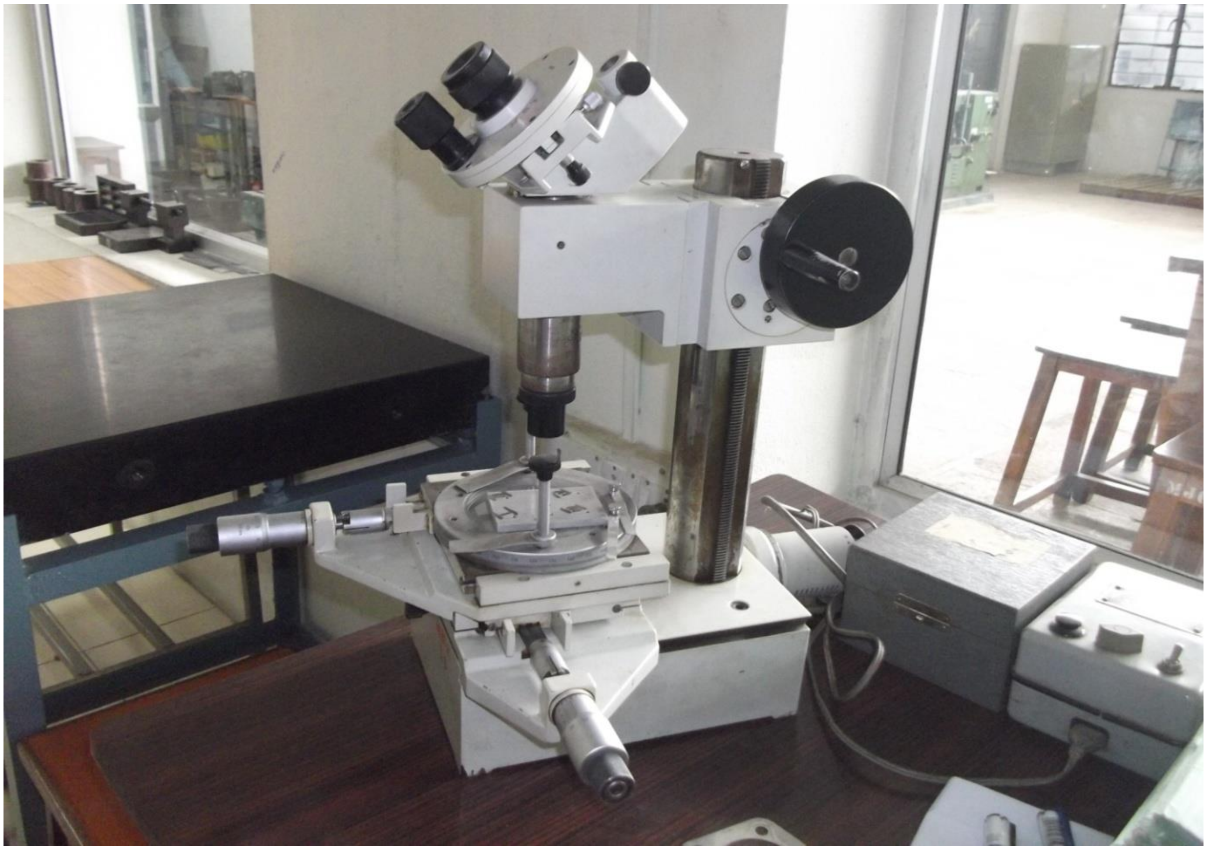
Average height of h_3 (mm) =

Latest Applications: (By the Student)

Exp. No: 3 TOOL MAKER’S MICROSCOPE Date:

AIM: To study the gear tooth nomenclature, rake angle**.**

APPARATUS: - Tool maker’s microscope, gear wheel cutting tool.



Description of Apparatus:

Tool maker’s microscope consists of optical head which can be adjusted vertically along the ways of a supporting column. The optical head can be clamped in any position by a screw. The working table is inserted on a heavy hollow base. The table has a compound slide by means of which the measured part can have longitudinal and lateral movements. These movements are controlled by accurate micrometer screws having thimble scales and vernier. At the back of the base is arranged a light source which provides a horizontal beam of light which is reflected from a mirror but go upwards towards the table. A shadow image of the outline of contour of the part passes through the objective of optical head and is projected by a system of three prisms. Cross lines are engraved on the ground glass screen which can be rotated through 360° and the measurements are made by these cross lines.

Procedure:

1. The illuminating lamps are switched on the required intensity.
2. The following length of the microscope is adjusted to get a clear view of the tool under the observation.
3. Through the micrometers adjustment / the depth and thickness of gear are calculated by keeping the line of the eyepiece parallel to the edge of the shank.
4. The angle of cutting tool is measured through the adjustment of inclined lines with the edges of the tool bit and subsequent measurement through the circular scales provided, either at the eyepieces or at the work table.
5. Thus the measurements are completed using the tool maker's microscope.

Observations:

Sino	Description	Initial reading R1 mm	Final reading R2 mm	Actual reading $R_1 \sim R_2$
1				
2				
3				
4				

Sino	Description	Angle in degrees		Actual angle
		Initial	Final	
1	clearance angle of tool bit			
2				
3				

Precautions:

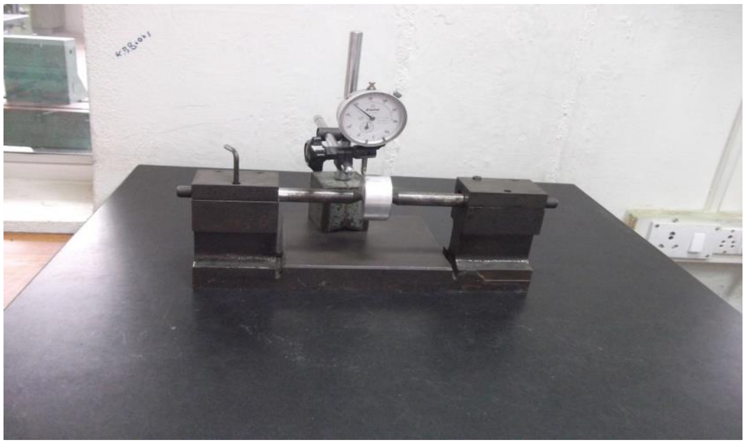
1 The microscope should not be disturbed with the experiment has been completed. 2 Readings should be taken without parallax error.

Result:-

Latest Applications: (By the Student

Exp No:4 **Dial gauge** & Bore Gauge **Date:**

Aim: To find ovality of cylindrical bore of a given component using dial bore gauge.



Instruments: Inside micrometer, Dial test indicator, bore gauge, vernier caliper.

Specification:

a) Inside micrometer: Range 5-50 mm, Least count= 0.01 mm.
b) Dial bore indicator: Range 18-34 mm, Least count =0.01 mm.
c) Dial indicator: Range 0-10 mm, Least count =0.01 mm.

Description:

Dial bore indicator consists of dial test indicator, bore gauge and set of measuring heads and space washers. Determination of ovality means to decide that the given hollow circular specimen is perfectly round or not. This is usually measured by dial bore gauge.

Dial test indicator:

It is a small indicating device used for linear measurements. It uses mechanical means such as gears and pinions or levers for magnification. It is a simplest type of mechanical comparator. It measures the displacement of its plunger or a stylus on a circular dial by means of a rotating pointer. By mounting the dial test indicator on bore gauge it can be used for determining errors in geometrical forms like ovality, taper etc.

Dial indicator converts linear displacement into a radial movement to measure over a small range of movement for the plunger. The radial arm magnification principle is used here. These indicators are prone to errors caused by errors that are magnified through the gear train. Springs can be used to take up any play/backlash in the rack and pinion to reduce these errors. The gears are small, but friction can result in sticking, thus reducing accuracy. A spring is used on the rack to return the plunger after depression. The problems mentioned earlier will result in errors in these instruments. If the dial indicator is used to approach a dimension from two different sides, it will experience a form of mechanical hysteresis that will bias the readings. An example of this effect is given below.

In the graph shown, as the dial indicator is raised in height (taking care not to change direction), the errors are traced by the top curve. As the height of the dial indicator is decreased, the bottom curve is traced. This can be observed using gauge blocks as the known heights to compare the readings against. The causes of this hysteresis are bending strain, inertia, friction, and play in the instrument.

Applications include,

- Centering work pieces to machine tool spindles.
- Offsetting lathe tail stocks.
- Aligning a vise on a milling machine.
- Checking dimensions.

These indicators can be somewhat crude for accurate measurements; comparators have a higher degree of sensitivity.

Bore gauge:

It consists of one fixed measuring head and one movable measuring head. The horizontal movement of measuring head is transmitted to dial indicator by push rod through a spring actuated hinged member. Different lengths of measuring heads are provided to check different sizes of bores.

The reading that is obtained from the gauge is indicated by dial indicator. The reading in dial indicator is multiplied with its least count to get actual deviation with respect to the nominal diameter of the bore. The actual size of the bore can be calculated by subtracting the deviation from the nominal diameter. To check circularity of bore of given specimen, it is required to take at least four readings at four different places of the bore.

Principle: Dial bore indicator is works on comparator principle.

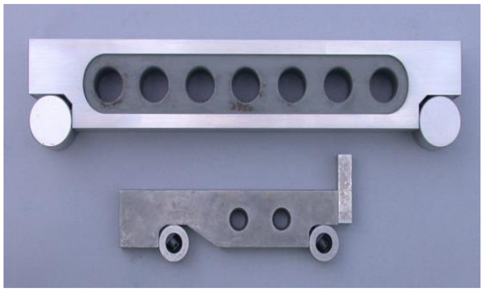
Procedure:

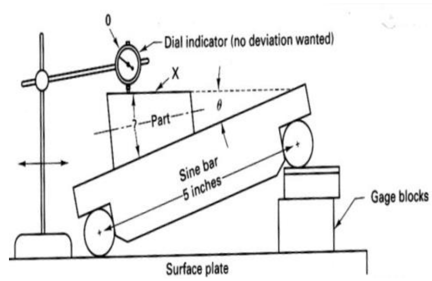
1) Mount the dial indicator on the bore gauge.
2) Measure the approximate diameter of the hole of the given specimen using vernier caliper.
3) Select the appropriate measuring head available from the set based on the reading obtained from the vernier caliper.
4) Fix the selected measuring head in the instrument.
5) Now divide the given circular specimens bore into no. of equal parts.
6) Measure the diameters of the hole by dial bore gauge at different divisions and note down the reading of the dial indicator.
7) Subtract the dial indicator readings from the nominal diameter of the bore to get the actual size.
8) All the readings obtained by above step are plotted on the graph for checking ovality.
9) The deviations obtained between nominal diameter and actual diameters are considered as ovality of the given specimen.

Latest Applications: (By the Student)

EXP. NO: 5 A **SINE BAR** **DATE:**

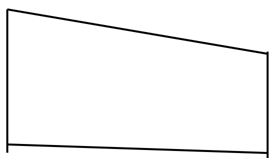
AIM: To measure the angle of the given specimen.





Sine Bar Slip Gauges Working Sketch.

Specimen Sketch:



Instrument Used: Sine Bar, Slip gauges

Specification: The distance between two rollers . (sizes available 100mm,200mm and 300 mm).

Principle: Sine bar as the name suggests work on the sine principle. That is the sine value of a given angle in a right angled triangle is the ratio of the side opposite the angle to the hypotenuse. Thus if the length of these sides are known, the angle can be estimated.

DESCRIPTION: Sine bar essentially is used to measure a length and indirectly estimate the required angle. Sine bars are made of high carbon, high chromium resistant steel which is hardened and stabilized. It consists of main body and two rollers. The rollers are of the same dia and their areas are mutually parallel as well as to the upper surface. Relief holes are provided on the sine bar for producing of weight. The upper ground surface is lapped to a high degree of flatness. Depending on the accuracy of the center distance the sine bar cannot be used by itself and requires a datum such as a surface plate and other equipment such as the dial indicator and slip gauge.

PROCEDURE:

- The work piece is placed on the sine bar and using the dial indicator the difference in height from one end of the work piece to the other is estimated. The sine bar is placed on a surface plate throughout the experiment.
- Suitable slip gauges are selected and wrung together. They are placed below the roller of the sine bar.
- Using the dial indicator, the top face is again checked for difference in level and if there is a difference a corresponding set of slip gauges are added.

- The process is repeated until dial indicator shows zero deflection over the entire length of the work piece.
- The angle is then estimated using sin =h/l

h = height of slip gauge
l = center distance between the two rollers
= angle of sine bar

TABULAR COLUMN:

Length of sine bar = 100 mm

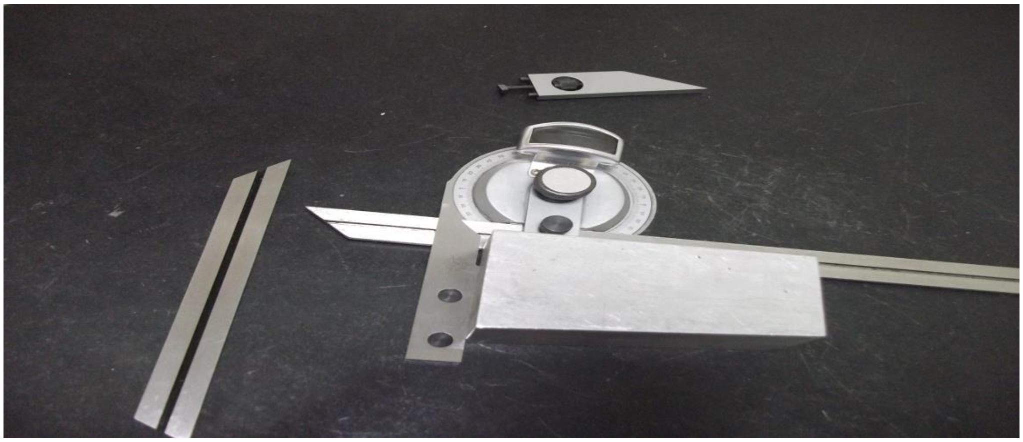
SL NO.	SINE BAR LENGTH (mm)	SLIP GUAGE USED (mm)	ANGLE (degrees)

RESULT: The angle of inclination of several specimens were measured using the sine bar add the readings are tabulated.

Latest Applications: (By the Student)

EX NO: 5B **VERNIER BEVEL PROTRACTOR** **DATE:**

AIM: To measure the angle of the given specimen.



Specimen Sketch:

Instrument Used: VERNIER BEVEL PROTRACTOR

Specification: Least Count = 1/12= 5^o

Principle: The vernier bevel protractor works on the principle similar to that of vernier calipers . That is, it uses two circular scales with different size of units and utilizes the smallest difference to decrease the smallest measurement. It thus achieves a lower least count.

L.C.= 2 MSD-1 VSD
2^o-$23/12^o$ = $1/12^o$ => $1/12^o$ * 60' = 5' .

DESCRIPTION:

- The vernier bevel protractor consists of a main body which houses the main circular scale.
- A stock is fixed to the main body and an adjustable blade is attached to a circular plate containing the vernier scale.
- The adjustable blade is free to rotate about the center of the main circular scale and can be locked in any position.
- An acute angle attachment is provided to facilitate the measurement of acute angle.
- The vernier scale has 24 divisions and it coincides with the 23^{rd} division on the main scale. This results in a least count of 5'.

FORMULA:

Total Reading = Main Scale Reading + (Vernier Coincidence * LC)
Least Count = 2MSD-1VSD = 2^o-$23/12^o$ = $1/12^o$ => $1/12^o$ * 60' = 5'

PROCEDURE:

- The given specimen is thoroughly cleaned.
- The instrument is checked for any error and it's least count is determined.
- The given specimen is placed on a smooth surface and the blade and stock of the protractor are aligned against the edges of the specimen.
- After fixing the stock and the blade, the main scale reading is noted.
- The vernier coincidence is noted and is multiplied with the L.C.
- The total reading is obtained by the MSR and the VSR.

TABULAR COLUMN:

SL NO.	SECTION	MSR	VC	VC * LC	TOTAL= MSR+(VC * LC)

RESULT:

The angle between the faces of the various specimens have been measured and tabulated.

Latest Applications: (By the Student)

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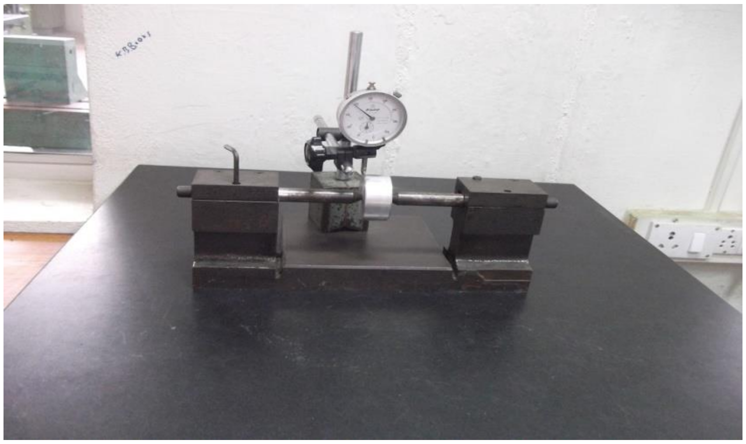
Exp.No : 6 **Roundness Errors with Bench centers** **Date:**

Aim: Measurement of Roundness error with Bench centers.

Theory:



Introduction: The concept of Roundness or Circularity, In an assembly of circular parts only the dimensional tolerances on diameter will not fulfill the requirements but it is geometrical accuracy that is must frequently needed. If cylindrical parts are measured by means of a device such as micrometer the parts though may be found to be within the dimensional tolerances and still may be perfectly circular. Such type of work is often produced in centre-less grinding and this condition is known as lobing.

Roundness/ circularity testing: Roundness or circularity is defined as the radial uniformity of work surface measured from the centre line of work piece. The error of circularity or out of roundness is defined ad the radial distance between the minimum inscribing circle and maximum inscribing circle , which contain the profile of the surface at a section perpendicular to the axis of rotation.

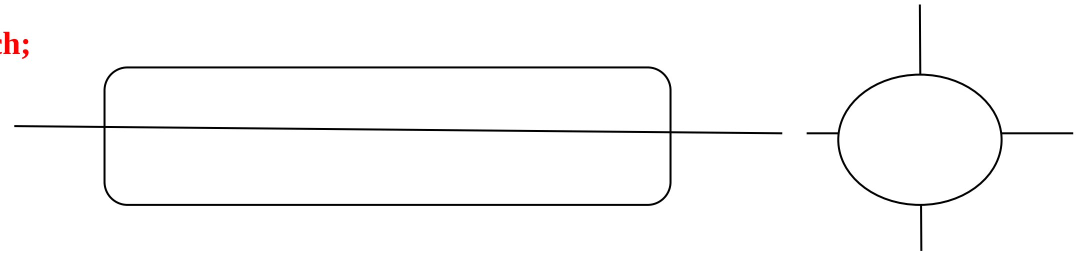
Causes of out-of-roundness: the various sources of out-of roundness may be clamping distortion, Erratic cutting action, spindle run out, In adequate lubrication, vibrations and poor bearing in spindle etc.

Methods for measurement of roundness:

1) Using V block and Dial gauge
2) Roundness measuring machine
3) **Bench center method.**

In this method Bench centers and a precision mechanical (Dial Gauge), air or Electrical indicator may be used to measure out of roundness of a work piece on radial basis. The accuracy of the results is however effected by shape and angle of centers and the center holes, lubrication of center etc. in the part under test.

Component Sketch;



Procedure:

Arrangement of the work piece and dial gauge stand and bench centers are shown in the figure.

- Clean the component before checking.
- Fix the work piece between bench centers
- Tight screw of the bench centers with Allen key
- Set the initial reading with Zero of the dial gauge.
- Select 3 or 4 areas to be measure of the Work pice.
- Name them as A, B, C …….
- Take the readings while rotate manually the work piece in the clock wise direction.
- Tabulate the reading and give the average value.

Tabular form:

Sl.no	A	B	C	Average Value in microns

Result: The Average Value of the given

Latest Applications: (By the Student)

Exp.No:7 ALIGNMENT TESTS FOR LATHE Date:

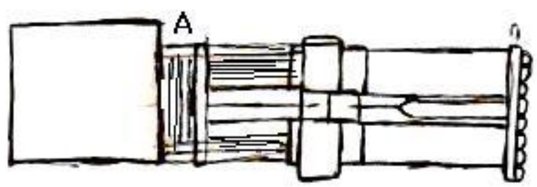
1. Test for level of installation.

(a) In a longitudinal b) In transverse direction

Measuring instruments. Spirit level, gauge block to suit the guide ways of the lathe bed.

Procedure: - The gauge block with the spirit level is placed on the bed ways on the front position, back position and in the cross wise direction. The position of the bubble in the spirit level is checked and the readings are taken.

Permissible error : Front guide ways. 0.02 mm/meter convex only. Rear guide ways, 0.01 to 0.02 convexity. Bed level in cross-wise direction □ 0.02/meters. Straightness of slide ways (for machines more than 3 mm turning length only, measurement taken by measuring tight wire and microscope or long straight edge). Tailstock guide ways parallel with movement of carriage 0.02 mm/m. No twist is permitted.

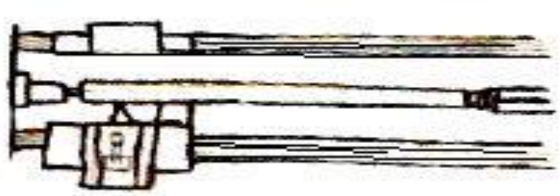


The error in level may be corrected by setting wedges at suitable points under the support feel or pads of the machine.

2. Straightness of saddle in horizontal plane:-

Measuring instruments: Cylindrical test mandrel (600mm long), dial indicator.

Procedure: - The mandrel is held between centers. The dial indicator is mounted on the saddle. The spindle of the dial indicator is allowed to touch the mandrel. The saddle is then moved longitudinally along the length of the mandrel. Readings are taken at different places. Permissible error 0.02 mm over length of mandrel.

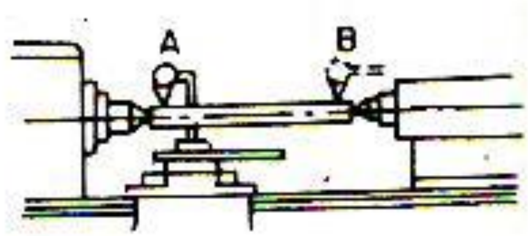


3.Alignment of both the centers in the vertical plane:

Measuring instruments: Cylindrical mandrel 600 mm long, dial gauge.

Procedure: The test mandrel is held between centers. The dial indicator is mounted on the saddle in vertical plane as shown in figure. Then the saddle along with the dial gauge is traveled longitudinally along the bed ways, over the entire length of the mandrel and the readings are taken at different places.

Permissible error: 0.02 mm over 600 mm length of mandrel (Tail stock centre is to lie higher only).

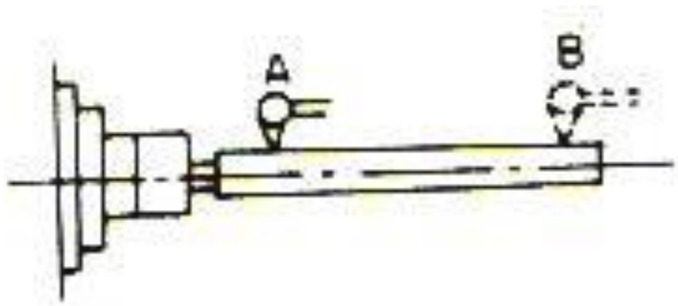


4. True running of taper socket in main spindle

Instruments required: Test mandrel with taper shank and 300 mm long cylindrical measuring part, dial gauge.

Procedure: The test mandrel is held with its taper shank in a head stock spindle socket. The dial gauge is mounted on the saddle. The dial gauge spindle is made to touch with the mandrel. The saddle is then traveled longitudinally along the bed ways and readings are taken at the points A and B as shown in figure.

Permissible error: Position A 0.01 mm, position B 0.02 mm.



5. Parallelism of main spindle to movement:

(a) In a vertical plane (b) In a horizontal plane

Measuring instruments: Test mandrel with taper shank and 300 mm long cylindrical measuring part, dial gauge.

Procedure: The dial gauge is mounted on the saddle. The dial gauge spindle is made to touch the mandrel and the saddle is moved to and fro. It is checked in vertical as well as in horizontal plane.

Permissible error: (a) 0.02/300 mm mandrel rising towards free end only.

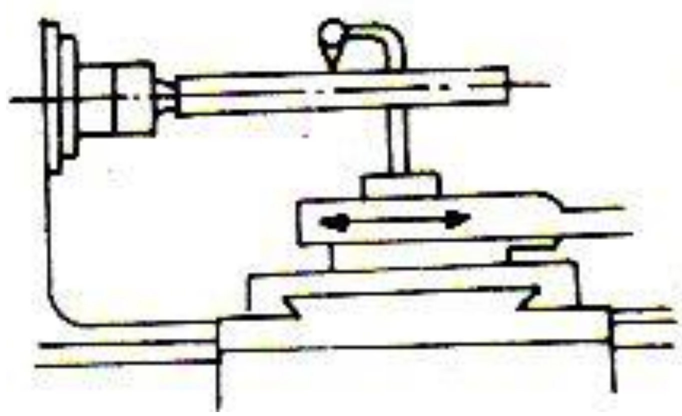
(b) 0.02/300 mm mandrel inclined at free end towards tool pressure only

6. Movement of upper slide parallel with main spindle in vertical plane:

Measuring instruments: Test mandrel with taper shank and 300 mm long cylindrical measuring part, dial gauge.

Procedure: The test mandrel is fitted into the spindle and a dial gauge clamped to the upper slide. The slide is transverse along with the dial gauge plunger on the top of the stationary mandrel.

Permissible error: 0.02 mm over the total movement of the slide.

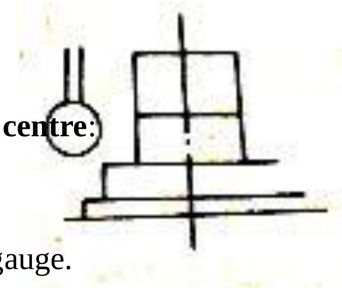


7. True running of locating cylinder of main spindle:

Measuring instrument: Dial gauge.

Procedure: The dial gauge is mounted on the bed, touching at a point on main spindle. The main spindle is rotated by hand and readings of dial gauge are taken.

Permissible error: 0.01 mm.

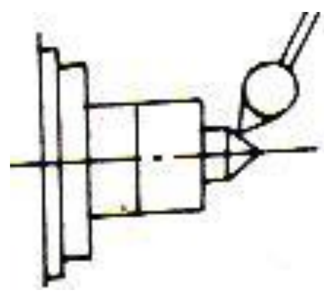


8. True running of head stock centre:

Measuring instruments: Dial gauge.

Procedure: The live centre is held in the tail stock spindle and it is rotated. Its trueness is checked by means of a dial gauge.

Permissible error: 0.01 mm.



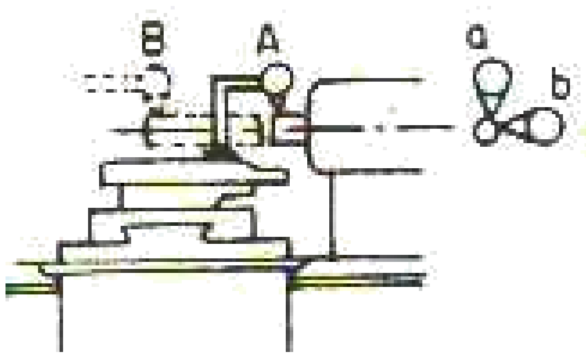
9. Parallelism of tailstock sleeve to saddle movement:

Measuring instruments: Dial indicator

Procedure: Tailstock sleeve is fed towards. The dial gauge is mounted on the saddle. Its spindle is touched to the sleeve at one end and the saddle is moved to and fro, it is checked in H.P. and V.P. also.

Permissible error: (a) 0.0 1/100 mm (Tailstock sleeve inclined towards

tool pressure only). (b) 0.0 1/100 mm (Tailstock sleeve rising towards free end only).



10.Paralle1ism of tail stock sleeve taper socket to saddle movement

(a) in V.P.
(b) in H.P.

Measuring instruments: - The mandrel with taper shank and a cylindrical measuring part of 300 mm length, dial gauge.

Procedure: - Test mandrel is held with its taper shank in tail-stock sleeve taper socket. The dial gauge is mounted on spindle. The dial gauge spindle is made to touch with the mandrel. The saddle is then transverse longitudinally along the bed way and readings are taken.

Permissible error:-

(a) 0.03/300 mm (mandrel rising towards free end only)
(b) 0.03/300 mm (Mandrel inclined towards tool pressure only).

Latest Applications: (By the Student)

Exp.No:8 FLATNESS OF SURFACE PLATE BY USING SPIRIT LEVEL Date:

AIM: To determine the flatness of surface plate by using spirit level.

Apparatus Required: surface plate, spirit level

Theory:

The spirit of level consists of a sealed glass tube mounted on a base. The inside surface of the tube is ground to a convex barrel shape having large radius. The precision of the level depends on the accuracy of this radius of the tube. A scale is engraved on the top of the glass tube. The tube is nearly filled with either ether or alcohol, except a small air or vapor in the form of a bubble.

The bubble always tries to remain at the highest point of the tube. If the base of the spirit level is horizontal, the centre point is the highest point of the tube. So, that when the level is placed on a horizontal surface, the bubble rests at the centre of the scale. If the base of the level is fitted through a small angle, the bubble will more relative to the tube a distance along its radius corresponding to the angle.

Surface Plate

spirit level

The figure shows two positions of the base of the level(OA_1 and OA_2) and corresponding positions of the bubble (Bl,B2). When the base OA_1 is horizontal, the bubble occupies position B_1. Let ‘ □ ‘ be the small angle through which the base is fitted. The bubble now occupies the position B2.Let L be the distance travelled by bubble along the tube and ‘h’ the difference in heights between the ends of the base. Then L= R□ and h =. L□

Therefore □ = $\frac{l}{R} \;\square\; \frac{h}{L}$

$\square\; h = \frac{L \square l}{R}$

Where R = radius of curvature of the tube

L = length of base

Finally h = $\frac{L}{R}$

Procedure:

1. Place the spirit level on the surface plate for which we have to find out the flatness
2. Find the base length of the spirit level
3. Note the radius of curvature of the spirit level tube
4. Find the tilt in the bubble
5. Finally find out the difference in heights between the ends of the base.

Observations:

S.NO.	Distance traveled by the bubble	Difference in height between Ends	Angle □
1			
2			
3			
4			
5			

Precautions:

1 .Clean the surface plate and ensure there is no dust particles

2. Take the bubble reading without any parallax error

Latest Applications: (By the Student)

Exp. No: 9 **PROFILE PROJECTOR** **Date:**

AIM: To measure the distance between points, angles between adjacent edges and diameter of the hole of the given specimen.

INSTRUMENT USED: optical projector with digital readout.

SPECIFICATIONS:

Image: inverted

Field of view: 10*36

Screen dia: 360mm

Magnification: standard 10 x

Optional 25 x and 50x

Accuracy: +0.1%

Profile illumination: +0.15%

Working area: 180mmx 130mm

DESCRIPTION:

The profile projector is a non-contact measurement device which works on the optical principle works on the optical principles of image proportion. Light from an illuminating source is collimated by condenser and passed from beneath a grass stage plate on which the specimen is placed. This results in the shadow image of the specimen's profile which ,after passing through prisms and reflected of mirrors ,is focused on a screen .the screen is usually made of glass with the surface facing the operator ground to a very fine grain. The location of the ground surface is of critical importance for accurate focusing and magnification of the image. For this reason the thickness of the glass must be held to close limits. The screen is provided with a rotary scale for coarse angular measurement (angular L.C) but accurate measurements are made by utilizing the DRO which yields a linear loc of 0.001mm.

The profile projector can be set for angular linear measurement by using the provided button .The projector can be used in any of the following measuring techniques

(1) measurement by comparison (2) measurement by movement (3) measurement by revelation over the specimen . For measurement by comparison, clips are provided around the screen for fixing charts. The chart gauges are provided with a reference line along the contour to be checked and the tolerance limits.

PROCEDURE:-

- The given specimen is thoroughly cleaned.
- The main power supply the DRO and the illuminating source are switched on.
- The specimen is then placed in a suitable position on the glass stage so that the required portions image can be observed on the screen.
- The required operation from the options on the control panel, such as angle ,radius of circle , distance between points etc. the x and y coordinates displayed can be set to zero by pressing the corresponding buttons.
- Using the ball screws on the table, the table is moved so as to position the cross wire at desired positions based on the measurement being taken. At each position, to input the coordinates enter is pressed.
- Once the required number of points has been input, the FINISH button is pressed to obtain the desired measurement. To continue on to measure other feature quit is pressed and the above procedure is repeated.

RESULT:-

The various dimensions of the parameters of the given specimen obtained by using profile projector are

(1) 0D =
(2) 0C =
(3) LA =
(4) LB = **Latest Applications: (By the Student)**

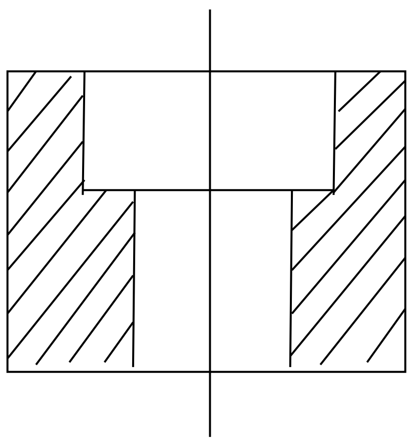
Exp.No: 10 A **INSPECTION WITH Plug GAUGE** **Date**:

Aim: To Check Internal and thickness of given Work pieces with Plug Gauge .

PLUG Gauges

Principle of works on the Taylor's Limiting Gauge Principle which states that the 'Go' gauge Checks Maximum material condition of as many as dimensions possible. Where as in 'NO GO" gauge should inspect the minimum material condition of one dimension only at a time. According to this principle GO plug gauge

Component Sketch:



Specification: Range: 19-25 mm

Description: Plug Gauges are used for measuring or checking external dimensions shafts are mainly checked by plug gauge In these gauges, the gauging anvils are adjustable endwise in the hard steel frame . This type of gauge is set by means of slip gauges to any particular limit required. It is possible to set well made gauge to within about 0.002 mm of desired size and thus this use enables advantage to be taken of the manufacturing tolerances on the work than when solid gauges with in appreciable manufacturing tolerance of their own are employed.

Procedure:

- Wipe the dust from the anvils of the Plug Gauge.
- Adjust the adjustable nut of the snap gauge with a screw driver.
- Take the required number of slip gauges from the slip gauge box.
- Properly wipe the slips on a leather sheet.
- Proper wringing should be done so as to present slip from falling down.
- Adjust the slips in the fixed anvil of snap gauge and locking the screw by screw driver.
- Similarly adjust for No Go dimensions and check the component dimensions.

Precautions:

- In any case force should not be applied on the instrument.
- Carefully handle slip gauge box, because very and precision slips miss it is difficult to get back.
- Do not handle the gauge hardly
- Keep everything clean before and after the component inspection.
- Take care with the set up.

Tabular Form

Sino	Max. limit	Min. Limit	Accepted	Rejected	Rework	Remarks
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Result: The given component is Accepted / Rejected / Rework.--------------------------------.

Latest applications :

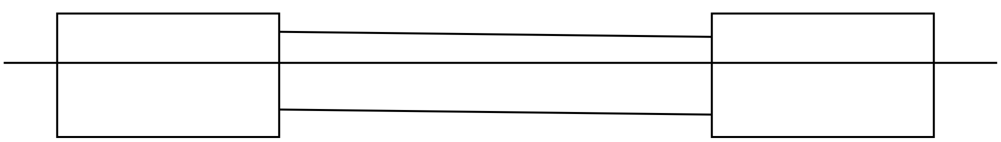
Exp.No: 10 B **INSPECTION WITH Plug GAUGE and SNAP GAUGE** **Date**:

Aim: To Check Internal and thickness of given Work pieces with Plug Gauge and **Snap gauge**.

Adjustable Snap Gauges

Principle of works on the Taylor's Limiting Gauge Principle which states that the 'Go' gauge Checks Maximum material condition of as many as dimensions possible. Where as in 'NO GO" gauge should inspect the minimum material condition of one dimension only at a time. According to this principle GO plug gauge

Component Sketch:



Specification: Range: 19-25 mm

Description Snap Gauges are used for measuring or checking external dimensions shafts are mainly checked by snap gauge In these gauges, the gauging anvils are adjustable endwise in the hard steel frame . This type of gauge is set by means of slip gauges to any particular limit required. It is possible to set well made gauge to within about 0.002 mm of desired size and thus this use enables advantage to be taken of the manufacturing tolerances on the work than when solid gauges with in appreciable manufacturing tolerance of their own are employed.

Procedure:

- Wipe the dust from the anvils of the Snap Gauge.
- Adjust the adjustable nut of the snap gauge with a screw driver.
- Take the required number of slip gauges from the slip gauge box.
- Properly wipe the slips on a leather sheet.
- Proper wringing should be done so as to present slip from falling down.
- Adjust the slips in the fixed anvil of snap gauge and locking the screw by screw driver.
- Similarly adjust for No Go dimensions and check the component dimensions.

Precautions:

- In any case force should not be applied on the instrument.
- Carefully handle slip gauge box, because very and precision slips miss it is difficult to get back.
- Do not handle the gauge hardly
- Keep everything clean before and after the component inspection.
- Take care with the set up.

Tabular Form

Sino	Max. limit	Min. Limit	Accepted	Rejected	Rework	Remarks
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

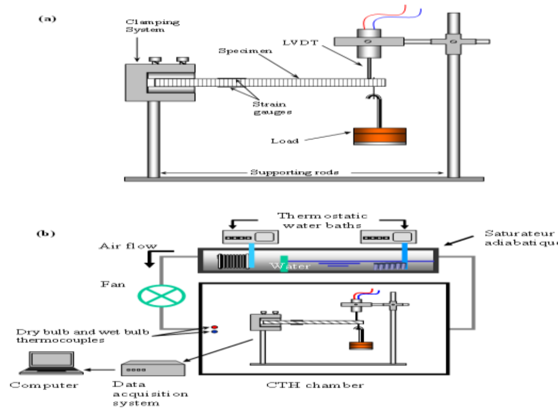
Result: The given component is Accepted / Rejected / Rework.-------------------------------.

: Latest Applications: (By the Student)

Exp No:11 **RESISTANCE WIRE GAUGE** **DATE:**

AIM: To measure elongation or strain due to applied loads.

Strain Gauge Setup



Circuit Diagram of Strain Gauge.

Introduction:

Resistance wire strain gauges are transducers applied to the surface of structural members under test in order to sense the elongation or strain due to applied loads. The wire strain gauges depend upon the fact that when the wire is stretched elastically, its length and diameter are altered. This results in overall change of resistance due to both the dimensional change and resistivity change.

R= RHO X A/L where RHO is the Resistivity of material. In addition to single bonded wire strain gauges we can have metal foil gauges Rosette Gauges and semiconductor strain gauges. Normally strain gauges with nominal values of 120 ohms, 240 ohms and 360 ohms are available. Strain gauge transducers find applications in measurement of such variables as load, force, thrust, pressure, torque Displacement and flow etc. The main problem with the resistance wire strain gauge is the extremely small change in resistance as a result of change in the applied load.

Operating Instructions :

1. Ensure that the instrument is switched off.
2. Connect the flexible the wires proved with the strain gauge cantilever beam between terminals 1-1, 2-2, 3-3 and 4-4. May observe the color code provided for the flexible wires and the color of the binding posts. If terminals 1 and 3 are interchanged or 2 and 4 are interchanged, only the output polarity will be changed.
3. Amp. Gain pot may be kept in the position of 100 (note that 1.00X100 gives a gain of 100).
4. Keep the switch SW2 in the downward position (i.e. four arm operation).
5. Turn on the mains supply. By gently moving the balance pot P1 and P2, obtain initial balance On the meter and wait for 5 minutes to allow the strain gauge temperature to stabilize.

6. Now apply a gentle pressure by hand on the end of cantilever beam, the DPM should indicate some change in readings. This indicates that strain gauge set up is ready for experimentation.

Use of Strain Gauge as load cell

1. Apply a weight of 1 kg on the cantilever and adjust the gain pot so that reading of 1.00 is obtained on the DPM. Now the weight and check for bridge balance. After one or two such adjustments that the least there will be able to get a reading of 1.00 on the DPM. Here we may note count of this arrangement becomes equal to 0.01 kg or 10 gm.
2. You can add weights up to 5 kg and enter results in the following table.
3. Plot a graph of applied load versus the indicated meter readings.
4. For 2 arm operation keep switch SW2 in upward position and remove connection from terminal No.4 . in this case only two strain gauges SG! And SG2 contribute to the output while two internal resistances 350 ohms each from two remaining arms of the bridge. The sensitivity of the two arm operation is 50 % of that of four arm bridge.

Observations

We can see from the graph that the strain gauge response is almost linear with respect to the amount of applied load.

We have $E_{out} = \frac{E_{xc} * \Delta R}{2R}$ (for 2 Arm Bridge)

$$\frac{\Delta R}{R} = \text{Gauge factor} * \text{strain}$$

= 2.00 * strain where gauge factor = 2.00

Strain = $\frac{\text{Stress}}{2X\ 10^6}$ (Modulus of elasticity = $2X\ 10^6$ Kg/cm2)

Stress = f = M/Z M= length * Applied load (in kg)

Z= Moment of cross section = 1/6 Bt^2

B= width and t= thickness of cantilever beam in cm .

Precautions:

1. All the dimensions must be consistent . One may calculate stress and then strain and then E_{out} to verify with the experimental value. Excitation voltage of the bridge can be measured across the terminals 1 and 3 of the bridge.
2. Make the connections to the binding posts and terminals very carefully.
3. Provide a warm up time of about 10 to 15 minutes before taking readings.
4. Ensure that the cantilever arrangement is security fixed to the table.
5. Operate the gain control knob carefully.

TABLE FOR 4 ARM OPERATION

SL.NO	WEIGHT ON THE CANTILEVER	DPM READING
1	5 K.G	
2	4 K.G	
3	3 K.G	
4	2 K.G	
5	1 K.G	
6	0 K.G	

Sample calculation

Do not connect anything to terminal No.4 on the panel. This configuration uses two internal resistances (1-4 and 4-3) and two strain gauges (1-2,2-3) switch SW2 must be in two arm position. Make connections carefully and firmly.

For two arms bridge E out = $\frac{E\,xc * R}{2R}$ (for 2 arm bridge)

Where R = G.F * Strain

And strain = stress (modulus of elasticity = 2 X 10 6 kg/cm 2)

Result:

Latest Applications: (By the Student)

Ex No: 12 **Thermo couple** **DATE:**

Aim : Temperature Measurement with Thermo couple.

Introduction : In many engineering systems temperature constitutes an important physical variable that needs to be monitored and controlled. For example temperature sensors are present in buildings, chemical processing plants, engines, computers, vehicles, etc. Many Physical phenomena (e.g., pressure, volume, electrical resistance, expansion coefficients ,etc.,) can be related to temperature through the fundamental molecular structure. Temperature variations affect these quantities, and hence their changes can be used to indirectly measure temperature.

Thermo couple setup

Temperature measurement devices can be classified as mechanically operative (mercury thermometer and bimetallic strip) or electrically operative (RTD, Thermistar and Thermocouple) . In this lab we will concentrate on electrical based temperature sensors due to their higher accuracy and ease in providing measurements for signal processing and computer acquisition. These sensors are based on the principle that electrical resistance or voltage of some materials changes in a reproducible manner with temperature.

Thermo couple

Thermo couples are utilize the so called See back effect in order to transform a temperature difference to a voltage difference , A thermocouple consists of Two electrical conductors that are made of dissimilar metallic materials and have at least one electrical connection. This electrical connection is referred to as a junction. A thermocouple junction may be welding, soldering, or by any method that provides good electrical contact between the two conductors, such as twisting the wires around one another, a typical Thermo couple circuit with two junctions, To reference and T measured, is shown in figure 1. The output of a Thermo couple circuit is

a voltage which is related to the temperatures of the junctions that make up the circuit. For the circuit of figure 1, the Thermo couples utilize the so-called See back effect in order to transform a temperature difference to a voltage difference, A Thermo couple consists of two electrical conductors that are made of dissimilar metallic materials and have at least one electrical connection. This electrical connection is referred to as a junction.
A Thermo couple output is a voltage which is relate to the temperatures of the junctions that make up the circuit. For the circuit of figure 1, the following relationship for a wide range of temperatures is given by the following linear equation :

$$V = \alpha_1 (T - T_o) + \alpha_2 (T - T_o)^2 + \ldots\ldots.$$

Where the _i is are some positive constant coefficients which are dependent on the thermocouple material. Thermocouples are characterized according to the alloys that are used for their construction. The following four classes are the most popular ones : J-type (iron constantan), K-type (chromelalumel), E-type (chrpmel-constantan), and T-type (copper-constantan).

Experimental Procedure:

1. The water bath SS tank is cleaned and filled with water.
2. The top of the tank is provided with 6 operating with are fitted with 3 thermocouples (J,K and T type) two RTD sensor and one Therm0meter.
3. The plug of the water bath is connected with the mains supply and is switched on.
4. Adjust the thermostat at a particular temperature and wait for a while the water reached a particular temperature.
5. Note down the mV reading from the mV multipoint indicator of the various thermocouples and the reading from the resistance indicator.
6. Also note down the reading from the temperature indicator connected to the master RTD sensor.
7. Now compare the reading to the standard tables provided along with each of this sensors and plot the resistance - temperature mV- temperature curves.
8. Point the IR thermometer at the water bath and note down the reading from the screen.

Observations:

Result:

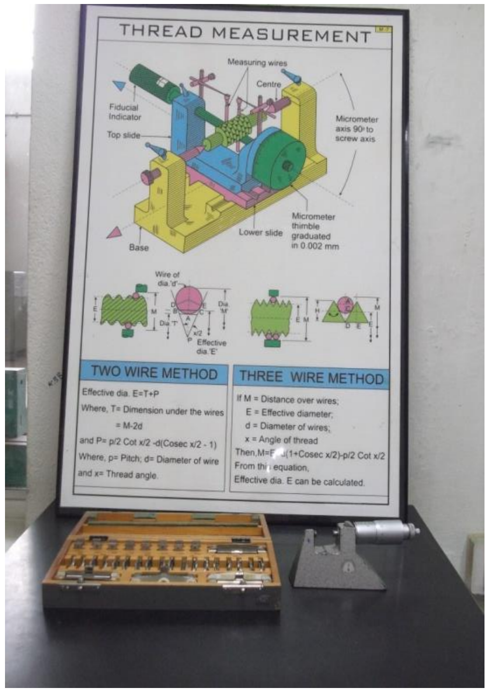
Latest Applications: (By the Student)

Latest Applications: (By the Student

Exp .No: **THREE WIRE METHOD** Date:

AIM: To measure the effective diameter of the thread using 3-wire method.

Instruments Used: Bench micrometer and three wires set.



DESCRIPTION: interchangeable manufacturer demands that all parts to be made to certain standards in order that on assembly they will fit the intended component properly. this is especially important for the threaded components and therefore the measurement and inspection of threads is important.

The 3-wire method of measuring threads is recommended by the bureau of standards as one of the best methods of checking the effective diameter of the thread. Effective diameter of the thread is same as pitch diameter provided the thread is free from errors and is measured by specially designed thread micrometer with two or three small diameter wires is very convenient.

Different sizes and pitches of the thread require different wire size .for greater accuracy, the best wire should be used [best wire is the one that will contact the thread at the pitch diameter]. It is mathematically given as

D=(P/2)sec0/2

PROCEDURE:

1. Three wires of equal diameters are placed in the thread with two wires on one side and on the other side.

2. Measure the distance across the top of the wires (M) by noting down the reading of the micrometer.

Sample CALCULATIONS:

M=E+Q

BUT Q=D (1+cosec0/2) – (P/2 cot0/2)

M=E+D (1+cosec0/2)-p/2cot0/2

OBSERVATIONS:

Calculated D=P/2 sec0/2

P=Pitch of thread

P=1.25mm

D=1.25/2(Sec60/2) =0.675. 2/3 =0.721mm

Best wire selected D=0.725mm

E= m-d (1+cosec0/2 +p/2cot0/2)

M- Micrometer reading =8.18mm

D- 0.725mm (best wire dia)

E- Effective diameter

E = 8.18-0.725(1+cosec30)+1.25/2 cot30

= 8.18-2.175+1.169= 7.174mm

E =M-D (1+cosec0/2) + (p/2 cot0/2)

E – Effective diameter

M- Micrometer reading = 8.18mm

D- Calculated diameter = 0.712mm

E= 8.18-0.721(1+cosec30) + (1.25/2) cot30

= 7.186mm

Error= 7.186-7.174= 0.012mm

RESULT:

The effective diameter of the thread is 7.174mm

MJCET
MECHANICAL ENGG DEPT
BE 4/4 MECHANICAL-B, I SEM (2015-16)
METROLOGY & INSTRUMENTATION LAB
LABORATORY SCHEDULE

Name of the In-charge : **V.SUVARNA KUMAR**
Subject : **METROLOGY & INSTRUMENTATION LAB**
Course code : **ME 432**
Class : **B.E.IV/IV MECHANICAL & Production** Academic year: 2015-2016

S.no.	EXPERIMENT	Planned no. of classes	Batch	Class held on
1	.Measurement of with inside, outside and depth Micrometers.	3	B1	
			B2	
			B3	
2	Measurement with height gauges, height masters, etc.	3	B1	
			B2	
			B3	
3	Measurement of Linear dimensions with tool Makers Microscope-Flat specimens plain, cylindrical with centers and threaded components. gauges,	3	B1	
			B2	
			B3	
4	.Measurement wit Dial Indicator/Electrical Comparator Mechanical comparator/Dial Bore Gauges, etc.	3	B1	
			B2	
			B3	
5	Measurement of angles with Sine bar Bevel protractor and precision level, block level, etc.	3	B1	
			B2	
			B3	
6	Measurement of Roundness errors with bench centers.	3	B1	
			B2	

			B3	
7	. Geometrical test on Lathe Machine.	3	B1	
			B2	
			B3	
8	. Measure of Flatness errors (surface plate) with precision level.	3	B1	
			B2	
			B3	
9	.Measurement optical projector.	3	B1	
			B2	
			B3	
10	Checking machined components with plug adjustable, indicating gauges, etc.	3	B1	
			B2	
			B3	
11	Force measurement with strain gauge type load cell/proving ring, piezoelectric load cell etc.	3	B1	
			B2	
			B3	
12	Temperature measurement with Thermo couples.	3	B1	
			B2	
			B3	

VIVA – QUESTIONS

1. What is the use of angle plates?
2. Name some angle measuring devices?
3. What is the least count of mechanical Bevel Protractor?
4. What is the least count of optical Bevel Protractor?
5. What is a sine bar?
6. What are the limitations of Sine bar?
7. What is the difference between the sine bar and sine center?
8. What is the use of V-block?
9. What is the purpose of adjusting nuts in a micrometer?
10. What is the least count of dial indicator?
11. How do you specify sine bar?
12. How to maintain constant pressure in micrometer?
13. What are the applications of Gear tooth vernier caliper?
14. How do we check the profile of a Gear tooth?
15. Name some angle measuring devices?
16. Why do we use Feeler gauges?
17. What are slip gauges and why do we use them?
18. What are slip gauges and why do we use them?
19. Explain zero error and zero correction in case of micrometers?
20. What is the principle involved in sprit levels?
21. What is the least count of digital vernier caliper?
22. What is the difference between vernier height gauge, vernier depth gauge, and vernier caliper?
23. Explain briefly about the different types of micrometers?
24. What is the least count of a micrometer and how is it determined?
25. What is the range of dial bore gauge?

26. Define the following terms a) Roughness b) Waviness c) Lay d) Sampling Length
27. Explain the terms R_a, R_z, RMS.
28. What type of micrometer is used for measuring longer internal length?
29. What are the applications of Toolmakers microscope?
30. State the principle involved in Toolmakers microscope?
31. How to change the magnification in Toolmakers microscope?
32. What are the various methods of measuring surface roughness?
33. Explain the use of dial bore gauge?
34. What are the precautions to be taken while using slip gauges?
35. What is lobing?
36. Specifications Dial Gauge.