

Screw threads

Objectives

Measure the major Diameter

Measure the effective diameter

Measure the minor diameter

Learn how to use the pitch gauge

To learn new important terms such as fiducial pointer, Vee prisms, and fiducial indicator

APPARATUS:

1. Floating carriage diameter measuring machine
2. Thread cylinders
3. Plain cylindrical standards
4. Vee prisms
5. Metric parallel screw thread plug gauge specimen

Theory

Thread Form

There are many different thread forms in use today. The forms most widely used for power transmission screw threads are illustrated in Figure 1. An optical comparator is the easiest method of determining thread form Profile gages, if available, and visual methods can also be used. Great care must be taken as many forms are almost identical. The Acme form (29 degree included angle) is only 1 degree different from the ISO Metric Trapezoidal form (30 degree included angle). Many thread forms such as Unified, Metric ISO and Acme are subject to published standards while others, including Ball screw and Worm threads, are not defined in detail by any standards organizations.

Thread Pitch

The thread pitch is the axial distance from one thread groove to the next its can be measured with a steel rule, as illustrated in figure below or a caliper or comparator can be used. By laying a steel rule down the axis of a screw and counting the number of thread ac in a given length, the pitch can be determined by dividing the count into the length. Example: in the figure shown below, there are 5 pitches in lin. so the thread pitch is.2001 Note that the dumber of threads per inch is the reciprocal of the thread pitch. A common nustan is to count the number of threads starting with "one". This will lead to a one pitch error. Ma you start with zero for the first thread. To double check your pitch determination, check you pitch determined by count against your actual pitch measurement

Hand of the thread

The hand of the thread can be easily determined by visual inspection. Simply compare your screw threads with the right hand and left hand threads illustrated in figure below. Most threads are right hand and right hand is assumed if no left hand designation is specified. Left hand threads are common on manual drives where clockwise handle rotation raises, tightens, extends, or creates motion away from the operator. On fine threads, it may be necessary to lay a small wire in the thread grooves to determine hand. Matching the angle of lic of the wire with the illustrations will indicate the hand of thread.

The pitch diameter (often called the effective diameter) The pitch diameter is the diameter at which the thread tooth and the thread space are equal

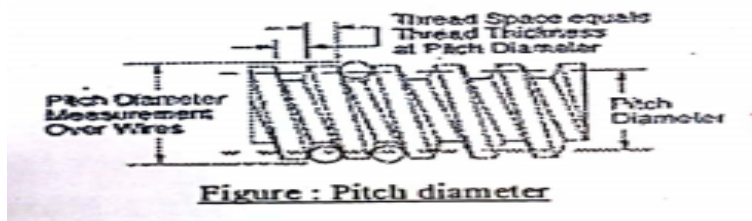


Figure : Pitch diameter

The major diameter : can be measured with a micrometer, caliper or steel rule

Care must be taken to measure the major diameter on a section of the screw thread that is not worn. A worn portion will measure smaller (or larger if burts have been rolled up) than the original major diameter. Therefore, it is good practice to measure the major diameter over the least used section of the Screw.

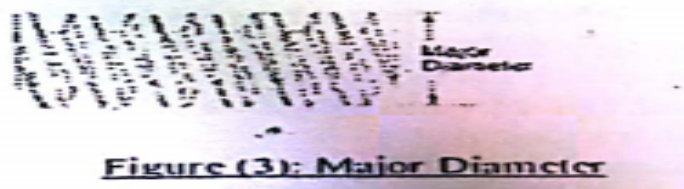
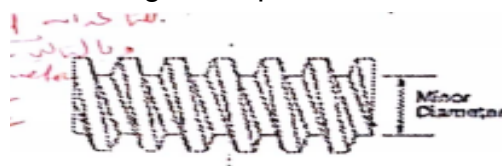


Figure (3): Major Diameter

The minor diameter is the diameter of the cylinder that just touches the to internal thread.

The minor diameter can be determined by measuring the depth of the th with a depth micrometer and subtracting twice the measured depth of the thread from the major diameter. When using a comparator to measure the minor diameter



The crest of a thread : is the prominent part of a thread, whether internal or external

The root : is the bottom of the groove between the two flanking surfaces of the thread whether internal or external.

The flanks of a thread: are the straight sides that connect the crest and the root.

The angle of a thread : is the angle between the flanks, measured in an axial plane
Section

Measurement of major diameter:

Select the appropriate cylindrical standard and mount it between the two micrometer centers. Take the reading R of the micrometer when the fiducial pointer is in the null position. The standard is then replaced by the workpiece; the specimen provided and a second reading R_s is taken. If the micrometer reading over cylindrical standard = R mm \rightarrow the micrometer reading over specimen = R_s mm, the diameter of the cylindrical standard = D mm \rightarrow Then **major diameter** = $D + (R_s - R)$

Measurement of mean effective diameter:

1. We selected per correct thread measuring cylinders (wires) from the tables

Again we mounted the plan cylindrical standard between the two micrometer centers. We hanged the thread measuring cylindrical vertically. freely from the hook We took the micrometer reading say R_x

2. The standard is then replaced by the specimen with the thread measuring cylinders located in the thread form. A second reading R_g of the micrometer is taken.

The value P is the difference between the effective diameter (E) and the diameter under the cylinder (T) as below. (i.e. $P = E - T$). the value of P is usually calculated from the following expression: $P = \frac{6}{2} \cot \theta - (\csc \theta - 1) d$

If $\theta = 30$ then $P = 0.86602 \times \text{Pitch-diameter of thread measuring cylinders (wires)}$. Now the reading for an effective diameter equal the **standard diameter** = $R_s - P$ value

If **E is the actual effective diameter** of the specimen, then **$E = D + (R_s - P \text{ value}) - R_g$** mm .

Measurement of the minor diameter:

To determine the minor diameter of a thread, measurements are taken over prisms. We selected the appropriate size prisms from the table. The first reading is taken over a cylindrical standard and selected Vee prisms, and we measured R_s .

Having taken the reading, the standard is replaced by the specimen with prisms located in the thread root. A second reading " R_g " of the micrometer is taken.

If Reading over standard and prisms = R_s , Reading over work piece and prisms = R_g

Diameter of the standard = D

Then the minor diameter $C = D \pm (R_s - R_g)$

1. To find the major diameter of the external thread
 D_c : diameter of cylinder (known)
 R_c : reading of micrometer over the cylinder (measured value)
 D_{th} : diameter of the thread (unknown)
 R_{th} : reading of micrometer over the thread (measured value)

$(R_{th} - D_{th} = R_c - D_c)$ or $(R_{th} - R_c = D_{th} - D_c)$
 After rearrange the formula
 $\therefore \text{major } D_{th} = D_c + (R_{th} - R_c)$

2. To find the Minor diameter of an external thread
 $\therefore \text{minor } D_{th} = D_c + (R_{th(\text{prism})} - R_{c(\text{prism})})$

3. To find the effective diameter E_d of the external thread (using the three wires method)
 For the distance T
 $T = D_c + (R_{th(\text{wire})} - R_{c(\text{wire})})$
 $E_d = T + 2x$
Where
 $(d$: diameter of the wire)

From the Fig-14 $E_d = T + 2x$

From the Fig-14, $E_d = T + 2x$
 In the $\triangle ABC$, $AB = BC \cot \theta$
 But, $BC = \frac{1}{2} \text{pitch} = \frac{1}{2} P$
 Therefore, $AB = \frac{1}{4} P \cot \theta$
 In the $\triangle ADE$, $AE = DE \cos ec \theta = \frac{d}{2} \cos ec \theta$

Now, $x = AB - AF$ and $AF = AE - EF = AE - d/2$
 $\therefore AF = \frac{d}{2} (\cos ec \theta - 1)$
 Therefore, $x = \frac{P}{4} \cot \theta - \frac{d}{2} (\cos ec \theta - 1)$

where,
 $P =$ Nominal Pitch
 $d =$ Wire Diameter
 $\theta =$ Nominal Flank Angle or semi angle of thread

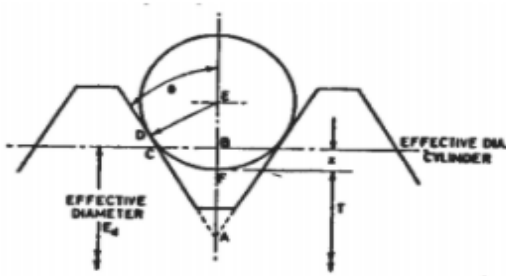


Fig-14 Calculation of simple effective diameter.⁴

The proof for $(E_d = T + 2x)$ is

A bench micrometer was used to measure the dimensions for an external thread; the readings are given as:

- The reading over the thread = 16.3320 mm
- The reading over the cylinder = 16.4216 mm
- The reading over the thread (with prisms) = 18.6356 mm
- The reading over the cylinder (with prisms) = 22.2464 mm
- The reading over the thread (with wires) = 16.7766 mm
- The reading over the cylinder (with wires) = 19.9838mm

And you know that the diameter of the standard cylinder is equal to 40.0000 mm ,the flank angle of the thread $(\theta) = 30^\circ$, the diameter of the wire $(d) = 2.0207 \text{ mm}$, and the pitch size of the thread $(p) = 3.5 \text{ mm}$

The effective diameter equation is
 $D_{eff} = T + \frac{p}{2} \cot \theta - (\text{cosec } \theta - 1) * d$
where T is the dimension under the wire

Calculate the major diameter, the minor diameter, and the effective diameter of the thread. (Show your calculations)

R_{th}: Reading of micrometer over the thread

R_c: Reading of micrometer over the cylinder

R_{(th(prism))}: Reading over the thread (with prisms)

R_{(c(prism))}: Reading over the cylinder (with prisms)

R_{th(wire)} : Reading over the thread (with wires)

R_{(c(wire))} : Reading over the cylinder (with wires)

D_c: Diameter of cylinder

d: diameter of the wire

Θ: angle of the thread

p :pitch size of the thread

To find major diameter

$$[\text{majorD}]_{\text{th}} = D_c + R_{\text{th}} - R_c$$

To find minor diameter

$$[\text{minorD}]_{\text{th}} = D_c + (R_{\text{th}(\text{prism})}) - R_{\text{c}(\text{prism})}$$

To find effective diameter E_d

$$E_d = T + 2x$$

$$T = D_c + (R_{\text{th}(\text{wire})}) - R_{\text{c}(\text{wire})}$$

$$2x = P/2 \cot\theta - d(\operatorname{cosec}\theta - 1)$$

Angular measurement

THEORY:

Bevel Protractor: When two surfaces are at any angle other than 90° , the angle between them must be tested with some form of protractor. Instruments for this purpose may have a scale of degrees, enabling the angle to be read off, or they may consist of gauge which must be set to the angle before use. And the Bevel Protractor fig. (1) is an example of this second variety of gauges, and must be set to the correct angle before use.

The Plain Bevel Protractor:

Consists mainly from main scale, movable arm and fixed nut, see fig(2) scale is divided into 180 division, each division equals 1 degree , thus accuracy= ± 0.5 degree and 'total revolution can be measured = 180°

Vernier Protractor:

The main scale of this device is divided up into degrees from 0 to 90° each way. The vernier scale is divided up to that 12 of its division occupying the same space as 23° on the main scale, thus 1 vernier division = $23/12 = 1.92$ degree on main scale. The instrument therefore allows settings to 5 min of angle to be obtained, so we use it to get accurate readings. This device has a movable arm, plate blade, fixed nut and vernier scale

Reading the vernier protractor:

- 1- Read directly from the scale the number of whole degrees between 0 on the main scale and 0 on the vernier scale.
- 2- Count in the same direction the number of divisions from the 0 on the vernier scale to the first line on it that is level with a line on the main scale. As each division on the vernier scale represents 5, the number of these divisions multiplied by 5 will be the number of minutes to be added to the whole number of degrees. Actually the multiplication is not necessary, as it has been done on the scale. In fig. (4) notice that the number of the whole degrees is 85 degrees, and the mark on the vernier representing 30 minutes is level. The reading is therefore $85^\circ 30'$.

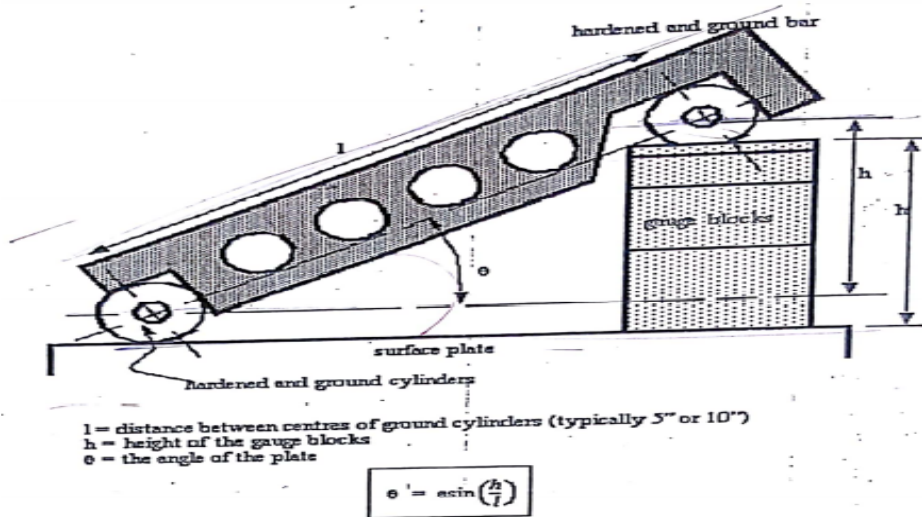
The Clinometer:

The clinometer is a special case of the application of the spirit level. In this instance the level is mounted in a rotatable body carried in a housing, one face of which forms the base of the instrument. A main use of the instrument is the measurement of the included angle of two adjacent faces of a workpiece. Thus, in use, the instrument base

is placed on one face and rot table body is adjusted until a zero reading of the bubble is obtained. The angle of rotation necessary to bring this about is then shown on an angular scale moving against an index. A second-reading is taken in a similar manner on the second face of the workpiece, the included angle between the faces being the difference the first and the second readings. Depending upon the type of instrument used, reading direct to 1 min are obtained and up to **range of movement** of 90°

Main Scale = 360

Vernier scale: full revolution = 1° = 60 min, so each division on vernier scale = 1 min.



Gauge blocks can provide lengths only in small steps and it may not possible to build a gauge pile to the exact height required for a given angle and we use a dial indicator to make sure that we are at the exact height. The error is small but its magnitude depends on the step change of gauge block set. To insure that the compound angle error is not introduced, the axis of the work must always be parallel to the axis of the sine bar.

Experiment 1 Linear measurements

Calipers →

→ an instrument consisting essentially of two curved hinged legs used to measure thickness and distance. Often used in the plural.

→ a large instrument having a fixed and a movable arm on a graduated stock, used for measuring the diameters of logs and similia objects.

→ a vernier caliper.

Specifications and functions of the caliper

- All stainless steel construction
- Used to measure inside dimensions
- Used to measure outside dimensions
- Used to measure step dimensions
- Convenient thumbscrew to lock a measurement in place.

- Accuracy equation of caliper $Accuracy = \frac{1 \text{ division main scale}}{\text{no. of divisions on vernier scale}}$

Two types of calipers

1) The vernier caliper

Is a precision instrument that can be used to measure internal and external distances extremely accurately.

Description :

- A vernier caliper has two scales, the main scale, and a vernier scale.
- These two scales move past each other, usually on a slide.
- When the measurements are taken, the zero points of the vernier scale lies at the true datum of the measurement.
- The main scale (on the larger, fixed portion of the caliper) gives the most significant digits of your readings.
- The vernier scale (on the smaller moving portion of the caliper) gives the least significant digits reading and subdivides a mark on the main scale into 10, 20, 50 subdivisions.
- Notice that ten thick marks on the sliding scale are the same width as nine tick marks on the fixed scale.
- The smallest division on a scale is the least count of it. On the fixed scale (main scale) the least count is 1 mm, while on the sliding scale (vernier) the least count is 0.02 mm (50 divisions to represent 1 cm)

- Most direct reading calipers have an arrow sliding blade attached to the sliding jaw. It permits the dial caliper to be used as an efficient and accurate depth gauge.

How to use and read a vernier caliper:

To start

- Place the object between the jaws of the caliper
- Close the jaws gently on the part to be measured.
- When you are measuring round cross-sectional parts make sure that the axis of this object is perpendicular to the caliper. To ensure measuring the full diameter
- Lock the final locking screw and remove the object

Then

- Read the cm mark on the fixed scale to the left of the 0-mark on the vernier scale
- Find mm mark on the fixed scale that is just to the left of the 0 marks on the vernier scale.
- Look along with the ten marks on the vernier scale and the millimeter marks on the adjacent scale until you find the two that most nearly line up.
- To get the correct reading simply add this found digit to your previous reading.
- If two adjacent tick marks on the sliding scale look equally aligned with their counterparts on the fixed scale then the reading is halfway between two marks
- If the reading is a nice number such as (2, 6, 9) don't forget to place the zero decimal after the reading plus the error

Reading error of vernier caliper is $(1 / 20) \text{ mm} = 0.05 \text{ mm}$

- For reading the inside readings, the thickness of the jaws must be added to the scale reading,

2) Dial caliper

A modified vernier caliper with gauges allows us to have a direct reading. It can also be provided with a digital indicator. because it is easier to read the direct reading dial caliper is gradually replacing the standard caliper

Description :

- Manufactured in inch and or metric standards and are available with digital readouts.
- A dial indicator the hand of which is attached to a pinon is mounted on the sliding jaw.
- For a metric dial caliper one revolution of the hand represents 2mm of travel, depending on the manufacater therefore each dial graduation represents 0.2mm maximum discrimination. Another type with 5mm move/ rev and a maximum of 0.05 mm
- Most direct reading calipers have an arrow sliding blade attached to the sliding jaw (and dail) it permits the dial caliper to be used as an efficient and accurate depth gauge as introduced later.
- The beam scale on the dial caliper is graduated only into 5mm and 10mm increment
- The caliper dial is graduated into 100 dimensions

How to use and read dial caliper

- Place the object between the jaws of the caliper
- Close the jaws
- When measuring round cross-sectional parts make sure the axis of the object is perpendicular to the caliper to ensure the full diameter.
- Get the most significant digit from the main scale then look at the dial gauge to take the least significant digits (one division on the dial indicator equals 0.02 mm)
- Add the most and least significant and take into considerations units

How to care for the caliper

- 1) Wash your hands before use.
- 2) Wipe the caliper components
- 3) Do not drop or otherwise mishandle the caliper

3) alignment principle

Abbes principle → the max accuracy may obtain when the standard scale and the workpiece being measured are aligned on the same line measurements

When contact points of a micrometer are away from the axis of graduation --. Measurements of error will become significant.

4) Micrometers

Widely used device in mechanical engineering for precisely measuring thickness of blocks outer and inner diameters of shafts and depths of slots.

Advantages of micrometer :

- It measures greater precision than a caliper, but smaller ranges of lengths
- More accurate than vernier caliper because :
 - It's difficult to obtain a correct feel due to its size and weight
 - The scales are difficult to read even with the aid of a magnifying glass

Description::

- The tick marks along the fixed barrel of the micrometer represent halves of the millimeters.
- One revolution of the knob exposes another tick marks on the barrel consequently the jaws will open another half mm
- The moving barrel of the micrometer has 50 tick marks wrapped around each tick mark represents 0,01 mm
- Pitch is the distance from a point on one thread to a corresponding point on the next thread
- Lead is the distance to a thread advances axially in one complete revolution to turn

$$\text{accuracy} = \text{pitch} \times \frac{\text{no.of divs. On vernier scale}}{\text{no.of divs. On thimble scale}}$$

Accuracy verification of a micrometer

- Zero checking
 - One way to determine the accuracy
 - Checking the condition where the display of a zero to one inch (2.54 cm) micrometer should be zero.
- Steps of zero
 - Turn the thimble of the micrometer until the spindle is snug against the anvil.
 - fine-tune the contact between the spindle and anvil with the ratchet stop until it clicks
 - Check reading
 - Must be zero
- Calibration
 - To ensure the accuracy of gages. Involves a gauge block and micrometer. a gage block is a block made from steel that is cut to size within a millionth of an (inch/cm) gage blocks come in various sizes and are used to check the accuracy of measuring devices such as micrometer.
 - If the reading you get from the micrometer is the sage block's dimension, you may begin using the micrometer for measuring. The micrometer may also be checked for calibration using other gauge blocks within its range.
 - Using other blocks that fall within the range of the gage will test the gage's accuracy from one end of the spindle to the other. This may cover problems and explain why the gauge is losing accuracy. If the display and the gage block - dimension do not correspond, you will need to re-calibrate the micrometer,
 - Tyles of micrometers
 - Calendar
 - *There are three types of micrometers based on their application:*
 - • External micrometer • Internal micrometer • Depth micrometer
 - An external micrometer is typically used to measure wires, spheres, shafts, and blocks
 - An internal micrometer is used to measure the opening of holes, and a depth micrometer typically measures the depths of slots and steps.
 - How to use & read a Micrometer
 - **To start: • Use the ratchet Knob (cap) to close the jaws gently on the object to be**
 - measured. When the ratchet clicks the jaws are closed sufficiently Then: To read the distance between the jaws of a micrometer:
 - • Get the reading from the fixed barrel while(1 div. - 5 mm), divisions • Get the reading of the moving barrel while (1 div. - .01 mm) • To get the final reading: simply add the two reading, and take into
 - consideration the units

How to care the micrometers:

- Before work makes sure that the object to be measured is fixed stationary (not moving)
- Avoid over-tightening the micrometer. Such abuse to the micrometer will only do damage to the micrometer, or any other gage you may be using Great care must be taken in using the micrometer caliper, A ratchet knob is provided for closing the caliper on the object being measured without exerting too much force. While you are using a micrometer, it would be most recommended to hold **the frame with one hand and turning the knurled sleeve with the other hand,**
- **Damage can be caused to a micrometer if it is dropped. So it is recommended**

to make sure that the micrometer is in a safe place when it is not being used. • Before you store a micrometer back the spindle away from the anvil wipe all

exterior surfaces with a clean glove.

(2.1)THE DEPTH GAUGE MICROMETER:

Definition:

The depth gauge micrometer is a precision measuring instrument, used by engineers to measure depths of holes, slots, and recesses, the distance of stepped faces from each other, and similar applications.

Description:

-

Each revolution of the ratchet moves the spindle face 0.5mm towards the bottom of the blind hole. Fig (2.1.1) below shows how the depth gauge is used. The ratchet is turned clockwise until the spindle face touches the bottom of the blind hole The scales are read in the same way as the scales of a normal micrometer.

(22) two-point inside micrometers this micrometer is used for measuring the internal dimensions and graduated in 100' of this micrometer is available in two designs. fig(2.2.1) 1. Obe with jeans similar to vernier caliper and with a scale reading backward. 2. The second is a straight bar with a micrometer barrel this type can b obtained with several interchangeable rods which allow a wide range of measurements.

Figure (2.2.1): 2-point inside micrometer

Description:

- • •

This type of micrometer is used for measuring inside diameters. The same principle

applies to another micrometer. The reading of the two-point inside micrometer is taken similarly is that of the depth micrometer. The reading increase as the thimble is screwed.

Exp2

INTRODUCTION:

In industrial applications, maximum accuracy must be met to produce reliable products. What is the most accurate way to measure a 5mm distance? Using a steel rule, caliber, or micrometer? When maximum accuracy is needed the use of ordinary measuring tools is not a good approach, there for some other ways are introduced to give more accuracy such as block gauges.

Block gauges are practical length standards of the industry. A modern end standard consists fundamentally of a block (slip) or bar of steel or cemented carbide-generally hardened- whose end faces are lapped flat and parallel within a few tenths of a micrometer.

There are two types of length standards:

1. Line standard or Engraved scale: In which the unit length is defined as being the distance suitably engraved lines Like the ruler you can measure 1cm or 1.5 cm that is the whole distance is divided into sub measurements units.
2. End standard: In which the unit of length is defined as being the distance between the end faces of the standard, these take the form of either slip, so the whole piece can measure 5mm for example but not 4.5 mm.

Gauge blocks are good examples of end standards. The name end standards indicate that these consist of sets of standard blocks or bars, and to have the desired measurement we have to build a required length from the blocks. And they have the following characteristics:

-End standard is highly accurate

-End standard has a built-in datum because their measuring faces are flat and parallel

The accuracy of end and line standards is affected by the temperature they are calibrated at 20 °C. -They are made in high-grade cast steel.

As motioned earlier, block gauges are standard bars made of hardened steel, which is heat-treated. Its accuracy is 0.0005 mm. Its calibrated conditions: 20°C, 1 atm, and 60% relative humidity, they are specially machined and therefore they have the following characteristics:

- 1) Straightness

2) Flatness: the surfaces are made by a very accurate process named lapping therefore they are flat to a very high degree

3) Parallelism every two surfaces or two lines are parallel to a very high degree. But there are four types of block gauges that differ by the degree of their quality and roughness

Grades of gauge blocks: 1.00

2. Calibration: this grade provides the highest level of accuracy required in engineering practice and is intended for calibrating other blocks in conjunction with suitably accurate comparators. They are used where tolerance is 2 micrometer and are not intended for generally gauge inspection

3.0

4.1

5. II

When the grades get larger the tolerance gets larger and the price cheaper, the and most expensive of all is grade 00.

USING THE BLOCK GAUGES:

The number of pieces in gauge blocks set can be

1 .48 pieces in gauge block set

2 .87 pieces in gauge block set

The sizes found in 87 pieces gauge block set Grade II, which we use it in this experiment are:

0.5, 1.0, 1.001-1.009 (by 0,001 steps),

1.10-1.19 (by 0.001 steps),

1.20-1.29 (by 0,001 steps),

1.30-1.39 (by 0.001 steps),

1.40-1.49 (by 0.001 steps),

1.50, 2.0, 2.5,3.0, 3.5, 4.0,

4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5,

8.0, 8.5, 9.0, 9.5, 10.0, 20.0,

30.0, 40.0,50.0,60.0, 70.0, 80.0, 90.0 and 100.0mm. the block gauges are fitted in a wooden box, for each of the blocks there is a special place with the length written on it.

Each block has two surfaces that have high lapping you can distinguish them noticing

that they shine the most of the six faces. The length is taken between two surfaces that are parallel.

- Instructions for wringing together two slip gauges;
 - 1) Surfaces must be clean and free from burrs, they should be washed in petrol benzene carbon ___ chloride or other DE- greasing agents and wiped dry on a clean cloth.

Then be wiped with clean soft chamois leather. Slip gauges should be held across one another at right angles and wringing them with a rotary motion; reduces the amount of surface rubbing necessary.

- 2) A minute amount of grease or moisture must be present between the surfaces for them to wring satisfactorily. Unless a very firm wring is obtained there is always the possibility that the wringing film may be a micrometer thick.

• **Another way to assemble a gauge block:**

- 1. Remove the gauge blocks required from the protective case**
- 2. Clean the oil that they have been coated in using a special cleaner. It is acceptable to handle the blocks; in fact, the oil from your hands will help them stick together.**
- 3. One at a time, hold the blocks so that the faces just overlap, push the blocks together, and slide them until the faces overlap together. This will create a vacuum between the blocks that makes them stick together (this process is known as wringing)**
- 4. Make required measurements with the gauge blocks, being careful not to damage the faces**
- 5. Take the blocks apart, and apply the protective coating oil, and return them to their box.**

In order to protect the blocks take the following points into consideration:

- Protect from dust, dirt, and moisture.**
- Avoid magnetization.**
- Handle lapped faces as little as possible to prevent etching from finger acid; wipe all finger marks with chamois leather.**
- Always wipe faces immediately before use even when it continuous.**
- Always replace clean gauges in their box and close them after use. If**

gauges are not in frequent use they should be coated to prevent corrosion.

-Do not handle gauges above the open box, they may cause damage to other gauges if dropped.

Past papers

The external micrometer is one of the indirect measuring instruments → FALSE

The firm joint calipers are an example of → indirect

In order to measure the effective diameter of the external thread using a bench micrometer it is required to measure the major diameter and the minor diameter of the thread → false

The accuracy of the vernier bevel protractor is → 5 minutes

The steel rule is an example on a high resolution line measuring device → false

In the vernier caliper the size of a division on the main scale is always greater than the size of a division of a vernier on the vernier scale and the difference between the two values equal size of division on main scale divided by the number of divisions on the vernier scale → ???

The inside micrometer follows abbes principle → true or false =)

Calliper → direct → false

Micrometer → direct → true

The angular measurements experiment we found the plate protractor to be more accurate than the vernier bevel protractor → false

We can use vernier depth scale and vernier height scale for the same purpose → false ??

The mechanical comparator is an example of a contactless measuring device → true

The accuracy of a clinometer → 1 degree or minute ? (minute 3ala 7ake fara7) =)

The center finder and the right angle aligner are accessories used with steel rule for the same purpose → false

When the thimble of the external micrometer rotates one revolution (clockwise) the spindle moves linear distance equals to the smallest division on the sleeve → true ??

is mechanical comparator an example of contactless measuring device → true

The angular measurement experiment we found the plate protractor is more accurate than the vernier bevel protractor → false

Spindle moves and anvil is fixed

Gauge block thing → 4 blocks

Vernier bevel thing → 28 degrees and 15 minutes

The b working slip gauges are more accurate than the aa master slip gauges → true ??

The three wired method can be used to measure pitch diameter of the thread

Stuff from the ppt

Direct measuring → in which the measured value is determined directly.

indirect → in which the dimension is determined by measuring other values functionally related to the required value example : divider . caliper.

Absolute → here the zero division of the instrument corresponds with the zero value of the measured dimension

Comparative → here only the deviations of the measured dimensions from a master gauge are determined

Contact → here the measuring tip of the instrument actually touches the surface to be measured

Contactless → no contact is required for measurements.

Linear → length measuring instrument

Angular → angle measuring instrument

Most accurate group includes light interference instruments

Second group includes optimeters, dial comparators

Third group includes ; dial indicator, vernier calipers

Measuring instruments can be divided based on their metrological properties such as range of measurements scale, graduation value, scale spacing, sensitivity, and reading accuracy.

Range of measurement

- It indicates the size values between which measurements can be made on the given instrument
- Example ; micrometers are available for the following ranges (0-25, 25-50 , 50-75 ...)

Scale division value

- It is the measured value corresponding to one division of the instrument scale.
- Example : the scale division value of a micrometer is 0.01mm

Sensitivity

- It is also called simplification factor or gearing ratio.
- Its the ratio of scale spacing to the scale division value.
- Example ; on a dial indicator the scale spacing is 1.5mm and the scale division value is 0.01 mm then the sensitivity is 150mm

Types of length standards

- The distance may be expressed as the distance between 2 lines or the distance between two faces
- The instruments used for the direct measurements if the linear dimensions fall into 2 categories
 - Line standards → the measurements is made between 2 parallel lines engraved across the standard
 - End standards → the measurements is made between 2 flare parallel faces

Steel rule

Is a low resolution line measuring instrument, comparing an unknown length to a previously calibrated one

Basic desirable qualities

- 1) clearly engraved lines
- 2) Min thickness
- 3) Good quality spring steel
- 4) Graduations on both sides
- 5) Low coefficient of thermal expansion

Degree of accuracy affected by

- 1) Quality of rule
- 2) Skill of user in estimation the parts of mm

Reliability of measurements when using scale for direct measurements depends on the proper positioning of the scale in relation to workplace

Some accessories of rules → removable hooks and clamping shaft and right angle aligner, center finder

Errors

- Instrument limitations
- Geo,etric errors like flatness and parallelism
- Thickness of the garde line
- Least increment limitation

- Observation error
- Alignment error
- Parallax error - object not well aligned with scale.

Calipers

- Calipers are used to pick up diameters or distance from a work piece
- This setting is then measured with a scale vernier or micrometer
- They are known as transfer measuring instrument

Vernier caliper

- Basic components
 - Beam
 - Fixed jaw
 - Sliding jaw
- Types
 - Vernier depth scale
 - Vernier height scale
- Two variations of the vernier scale
 - Where the main scale is graduated into mm and 0,5mm
 - Where the main scale is graduated in whole mm only
- The relation between the size of the division on main scale and the size of a division on a vernier scale is $C - C_v = C/n$...
 - C = size of a division on main scale
 - C_v = size of a division on a vernier scale
 - n = number of total divisions on the vernier scale
- Advances in vernier calipers
 - Dial caliper
 - Digital caliper

Micrometer

- Accuracy of the micrometer depends on
 - The parallelisms and the flatness of the measuring surfaces
 - The deflection of the frame because of the holding strength
 - The accuracy of the screw thread
 - heat transfer
 - Lack of the alignment with the object
 - The reading error

Slip gauges

Classification : based on their guaranteed accuracy they are classified as

- AA master slip gauge → accuracy of ± 2 microns per meter.
- A reference slip gauge → accuracy of ± 4 microns per meter.
- B working slip gauge → accuracy of ± 8 microns per meter.

Master 56

Master 103

English 81 pieces

88 pieces

Screw thread

Thread is the helical grooves opened to the inner and outer surfaces

External thread screw is a thread on the external surface of a cylinder

Internal thread nut is a thread on the internal surface of the cylinder

Major diameter is the largest diameter of a screw thread

Minor diameter is the smallest diameter of a screw thread

Pitch diameter is the diameter of an imaginary cylinder, the surface of which cuts the thread forms where the width of the thread and groove are equal

Crest is the edge or surface that joins the sides of a thread and is farthest from the cylinder or cone from which the thread projects

Root → the edge or surface that joins the sides of adjacent thread forms and coincides with the cylinder or cone from which the thread projects

Thread depth → the distance between crest and root

Pitch → the distance between corresponding points on adjacent thread forms measured parallel to the axis

Right hand thread --. A thread that when viewed axially winds in a clockwise and reading direction. Threads are RH unless otherwise specified

Left hand thread → winds in a counter-clockwise and reading direction these threads are designated LH

Autocollimator

- 1- Autocollimator works on the principle of light reflection, it concerned with the idea that flat surfaces reflect light at **0-degree** angle.
- 2- The main scale is divided into **20** divisions each reads **0.5** min
- 3- The accuracy of the device is **0.2** seconds
- 4- The alignment between the autocollimator and reflector should be checked at both extremes of the operational distance to **make certain that the target graticule is contained within eyepiece field**

1- are the existence of burrs or dust on the surface plate affect your results?

For optical autocollimator it doesn't affect as the light won't touch the surface, on other hand the results will be affected if dust was on the reflector

inserting any type of wire into a thermocouple circuit has no effect on the output as long as both ends of that wire are the same temperature, or isothermal.

Which thermometer has the fastest response time → Thermistor

Which thermometer has the slowest response time → Thermocouple

Which thermometer has the closest reading compared to the glass thermometer reading? → Thermistor

Strain gauge equations →

$\text{strain} = 1/k * \text{reading}$
$k = 2.05$
$\text{stress}(\text{exp}) = E * \text{strain}$
$\text{stress}(\text{theo}) = Mb/Wy$
$Mb = -F * L$
$Wy = (b * h^2) / 6$

two types of strain gauges

1. Full-bridge Strain Gauge
2. Rosette Strain Gauge
3. Shear Strain Gauge

The spring joint caliper is one of the direct measuring devices → false indirect

The firm joint calipers are examples of → indirect measuring devices

Prominent part of the thread → the crest of the thread

Block gauges are examples of end standard → true

RTD are more sensitive than thermistors → false

Thermistors have either a NTC or PTC , NTC more common

We can use External micrometer to measure : wires , spheres , shafts , blocks

The block gauges can be used to check accuracy of micrometer → true

Accuracy of vernier caliper = 0.1

RTD → resistance temp detector

Manufacturing configuration of RTD → wire wound RTD or thin film RTD

Mechanical comparator is not angular but linear

Accuracy of vernier bevel protractor → 5 min

The firm joint caliper → indirect measuring devices

Strain gauge resistance varies with → BENDING

External micrometer is → direct

Both vernier caliper and inside micrometer can measure depth → true

In order to measure effective diameter using bench micrometer you're required to find (minor and major diameter) → false

Spring joint caliper is → indirect

To find accuracy → smallest division / no. of divisions

- 1) both the vernier caliper and the inside micrometer can be used to measure the depth of a specimen: FALSE
- 2) the prominent part of a thread whether internal or external is called: The crest of the thread
- 3) block gauges are example of end standard: TRUE
- 4) Which of the following are true Thermistors have either a NTC or PTC , the first are more common
- 5) a bench micrometer was used to measure the major diameter of an external thread given that the diameter of the standard cylinder is 20 mm the micrometer reading over the cylinder is 20.9344 and the reading over the thread 21.1342 find the major diameter:

$$D_c = 20 \quad R_c = 20.9344 \quad R_{th} = 21.1342$$

$$\text{Major } D = D_c + (R_{th} - R_c)$$

- 6) rtds are more sensitive than thermistors: FALSE
- 7) the block gauges can be used to check the accuracy of the micrometer: TRUE
- 8) we can use to measure wires, spheres, shafts and blocks: EXTERNAL micrometer
- 9) The pitch diameter of the thread is another name for the effective diameter: TRUE
- 10) is the bottom of the groove between the two flanking surfaces of the whether internal or external. : **thread root**
- 11) which of the following is considered manufacturing configuration of RTD: Wire-wound RTDs and thin-film RTD
- 12) RTDS stands for: Resistance Temperature Detector (RTD)
- 13) The pitch diameter of the thread is another name for the effective diameter → true
- 14) In an external thread, the distance between two consecutive crests parallel to the axis of the thread is called → pitch size
- 15) Lay → refers to the predominant direction of the surface texture
- 16) MICROMETER Can be used to measure the pitch size of an external thread
- 17) In the strain gauge experiment we found that the experimnatla value and the theoretical value are equal → FALSE
- 18) According to the Thermocouple Law of Intermediate Metals inserting any type of wire into a thermocouple circuit has no effect on the output as long as both ends of that wire are the same temperature, or isothermal.
- 19) they exhibit a fast response rate, thermistors are limited for use up to the 300 °C temperature range. This, along with their high nominal resistance, helps to provide precise measurements in lower-temperature applications

- 20) In an external thread the distance between two crests perpendicular to the axis of the thread is called → the lead of the thread
- 21) To calculate error of straightness → line joining end points or least square method line
- 22) the smallest division of the sleeve of the micrometer is equal to 0.5 mm and the number of divisions on the thimble scale is equal to 50 divisions and the number of divisions on the vernier scale is 10 divisions then the accuracy of the device is equal to: accuracy = pitch x(no.of divs On vernier - scale / no.of divs. On thimble scale)