EXPERIMENT NO-1
ANGLE MEASUREMENT USING BEVEL PROTACTOR & SINE BAR

AIM:

To measure the angle of the given wedge using Sine bar & Bevel Protractor

INSTRUMENTS USED:

1. Sine bar 2. Work piece 3. Dial Gauge 4. Slip gauges 5. BevelProtractor.

SINE BAR:

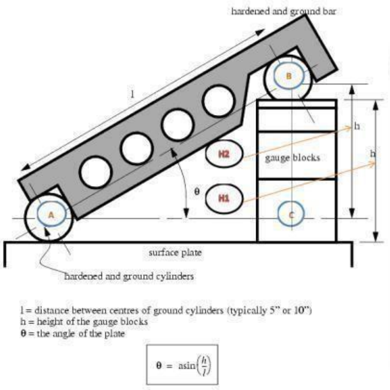
THEORY:

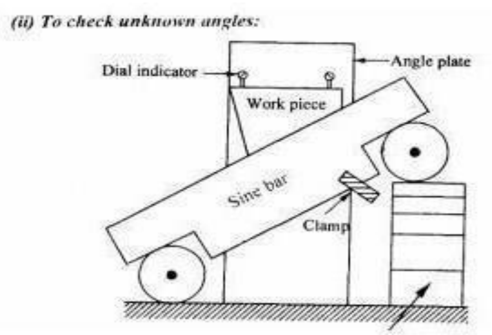
The sine principle uses the ratio of the length of two sides of a right triangle in deriving a given angle. The accuracy with which the sine principle can be put to use is dependent in practice, on some form of linear measurement. The sine bar in itself is not a complete measuring instrument. Sine bars in conjunction with slip gauges constitute a very good device for the precise measurement of angles. The arrangement is based on the fact that for any particular angle θ the sides of a right angled triangle will have precise ratio, i.e,

$$\mathbf{Sin\theta = h/l}$$

If **h** and **l** could be measured accurately, θ can be obtained accurately. The value of h isbuilt-up by slip gauges and value _l' isconstant for a given sine bar.

Sine bars are used either to measure angles very accurately or for locating any work to a given angle within very close limits. Sine bars are made from high carbon, high chromium, corrosion resistant steel, hardened, ground and stabilized. Two cylinders of equal diameter are attached at the ends. The axes of these two cylinders are mutually parallel to each other and also parallel to and at equal distance from the upper surface of the sine bar. The distance between the axes of the two cylinders is exactly 100, 200and





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PROCEDURE:

1. Place the work piece/wedge above the sine bar and make it horizontal with thebase.
2. The dial gauge is then set at one end of the work moved along the upper surface of the component.
3. If there is any variation in parallelism of the upper surface of the component andthe surface plate, it is indicated by the dialgauge.
4. The combination of the slip gauges is so adjusted that the upper surface is truly parallel with the surfaceplate.
5. Note down the values of the slipgauges.
6. Calculate the angle using the formula.

$$\theta = \sin^{-1}(h/l)$$

7. Repeat the procedure 3 or 4 times and take theaverage.

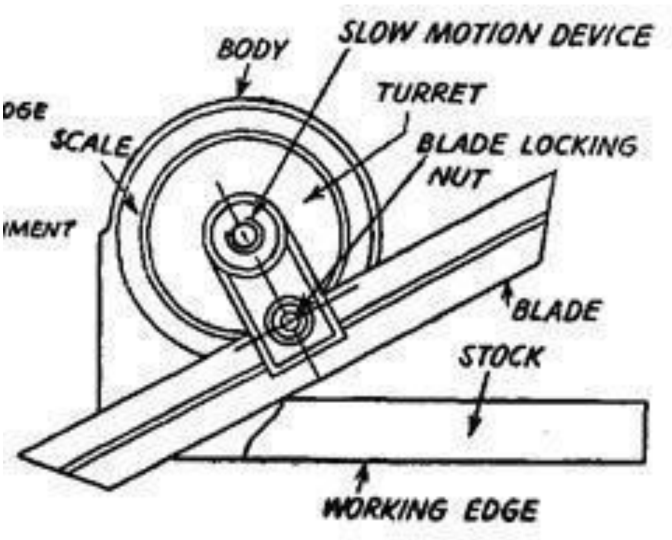
OBSERVATIONS:

S.No.	HEIGHT(h)	LENGTH(l)	ANGLE

BEVEL PROTRACTOR:

A universal bevel protractor is used to measure angles between two planes. This consists of stem, which is rigidly attached to main scale and a blade, which is attached to the Vernier scale and can be rotated to read angles. To improve the accessibility, the blade can also slide.

The least count is calculated by knowing the value of the smallest division on the main scale and number of division on the Vernier scale. It should be noted that the divisions on the main scale is in degrees and that the fractional divisions of degrees are minutes (i.e. with 60 minutes/degree, denoted). To measure angle between two planes, rest the stem on one of the planes (reference plane). Rotate the blade such that blade is flush with second plane. Readings are taken after ensuring that the stem and blade are in flush with the two planes. Lock the protractor at this point and note sown thereadings.



OBSERVATIONS:

S.NO.	ANGLE MEASURED

PRECAUTIONS:

1. The sine bar should not be used for angle greater than 60^0 in because any possible error construction is accentuated at thislimit.

2. A compound angle should not be formed by mis-aligning of work piece with the sine bar. This can be avoided by attaching the sine bar and work against an angleplate.
3. As far as possible longer sine bar should be used since using longer sine bars reduces manyerrors.

RESULT:

1. The angle of the given specimen measured with the sine baris
2. The angle of the given specimen measured with the Bevel Protractoris

ADVANTAGES:

- The bevel protractor is used to establish and test angles to very close tolerances. It reads to 5 minutes or $1/20^{o}$ and can be used completely through 360^{o} .
- For checking a Vblock
- For measuring Acuteangle..

APPLICATIONS:

- The hypotenuse is a constant dimension—(100 mm or 10 inches in the examples shown).
- The height is obtained from the dimension between the bottom of one roller and the table's surface.
- The angle is calculated by using the sine rule. Some engineering and metalworking reference books contain tables showing the dimension required to obtain an angle from 0-90 degrees, incremented by 1 minute intervals.
- The two rollers must have equal diameter and be true cylinders.
- For checking inside face of bevel face of ground face.
- Measure angles very accurately.

Experiment No.02

AIM: To measure the thickness and height of gear teeth at the pitch line or chordal thickness of teeth and the distance from the top of a tooth the chord using gear tooth caliper.

EQUIPMENT REQUIRED:

1. Gear tooth Verniercaliper
2. Gear of knownmodule
3. Surfaceplate

THEORY:

Tooth thickness is the arc distance measured along the pitch circle from its intercept with one flank to its intercept with the other flank of the tooth.

p d N d 1

Module, m =(d/N) = (1/dp)

Where d = Pitch Circle Diameter(pcd)

N = Number of teeth on given gear dp

= Diametral Pitch

Diametral Pitch, d_p = (N/d) = (N+2)/D

Where D = Outside Diameter of Gear

Theoretical Thickness, Wt = N m sin (90/N)

Chordal Height or depth, h = N m

% Error = (W_t– W_m)/W_tx 100

Addendum is the radial distance from the tip of a tooth to the pitch circle.

In the most of the cases, it is sufficient to measure the chordal thickness i.e. the chord joining the intersection of the tooth profile with the pitch circle because it is difficult to measure length of the arc directly.

Tooth thickness caliper consists of a slide which moves vertically with the help of knob. The jaw moves horizontally with the help of know there by varying the gap between them. An adjustable tongue, each of which is adjusted independently by adjusting screw on graduated bars, measures the thickness of a tooth at pitch line and the addendum.

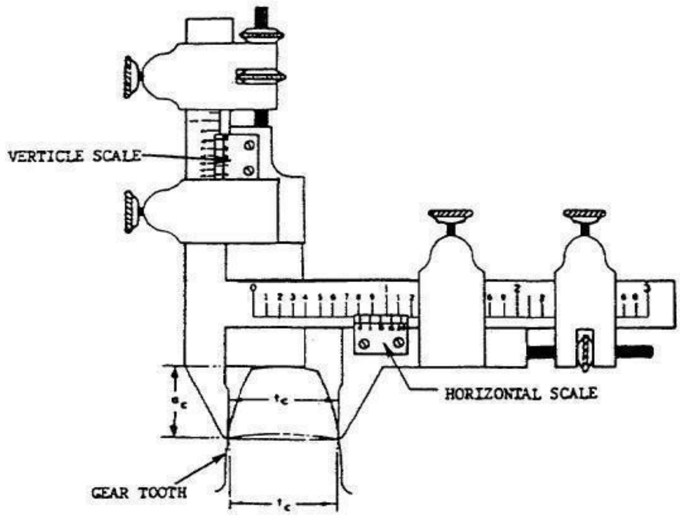
PROCEDURE:

1. The given gear caliper is held over the gear and the slide is moved down so that it touches the top of the geartooth.
2. The jaws are made to have contact with the tooth on either side by adjusting the knob.
3. The reading on vertical scale i.e. height is noteddown.
4. The reading on horizontal scale i.e. tooth thickness is noteddown.
5. The above procedure is repeated for five times and readings arenoted.

Least count of given caliper:

TOOTH THICKNESS

S.No.	M.S.R	V.S.R	TOTAL = MSR +(VSR x L.C.)



HEIGHT:

S.No.	M.S.R	V.S.R	TOTAL = MSR +(VSR X L.C)

TOOL MAKER'S MICROSCOPE

Experiment No.03

AIM: To measure the pitch & angle of the screw thread.

APPARATUS: Tool makers microscope, screw thread specimen

THEORY:

Tool makers microscope is based on the Principle of optics. The microscope consists of a heavy-duty hallow-duty hallow base, which accommodates the illuminating unit underneath, and above this on the top surface of the base, the work table carriage is supported on ball and controlled by micrometer screws. Projecting up from the rear of the base is a column, which carries the microscope unit and various interchangeable eyepieces. The chief applications of the tool room microscope are as follows

1. The determination of relative position of various points onwork.
2. Measurement of angle by using a protractoreyepiece.
3. Comparison of thread forms with master profiles engraved in theeyepiece, measurement of pitch and effectivediameter.

SPECIFICATION:

MAGNIFICATION : 30X (Standard)
OBJECTIVE :2X
EYEPIECE : W.F.15X with crossrectile
FIELD OFVIEW : 8mm. (approx)
WORKINGDISTANCE :80mm
OBSERVATIONTUBE : monocular inclined at 30degree
STAND :largeandheavybaseprovideextraoverallrigiditytothe instrument

MEASUREMENT STAGE : 150X150.
Size travel up to 50mm in each direction, least count 6 minutes.

CONSTRUCITON OF MICROSCOPE

BASE:

The study base rest on three support two of which are adjustable for leveling the instrument. The base has built in all electrical transformers and their control panel and transmitted illuminator with green filter.

ARM:

The arm has a groove guide on which the microscope tube is vertically adjusted by rack and pinion system.

FOCUSSING MECHANISM:

The course focusing movement provided in the microscope tube separately. The coarse motion is knurled knob on both side of the tube and ha as the total travel of 200mm. Itsalso lock any position by lever, this movement is characterized by its exceptionally smooth and accurate precision. The vertical travel or measurement up to 10mm, thickness can be read by the depth dial gauge. The thickness is being measured with the difference of two different focusing of object. The least count of gauge is0.01.

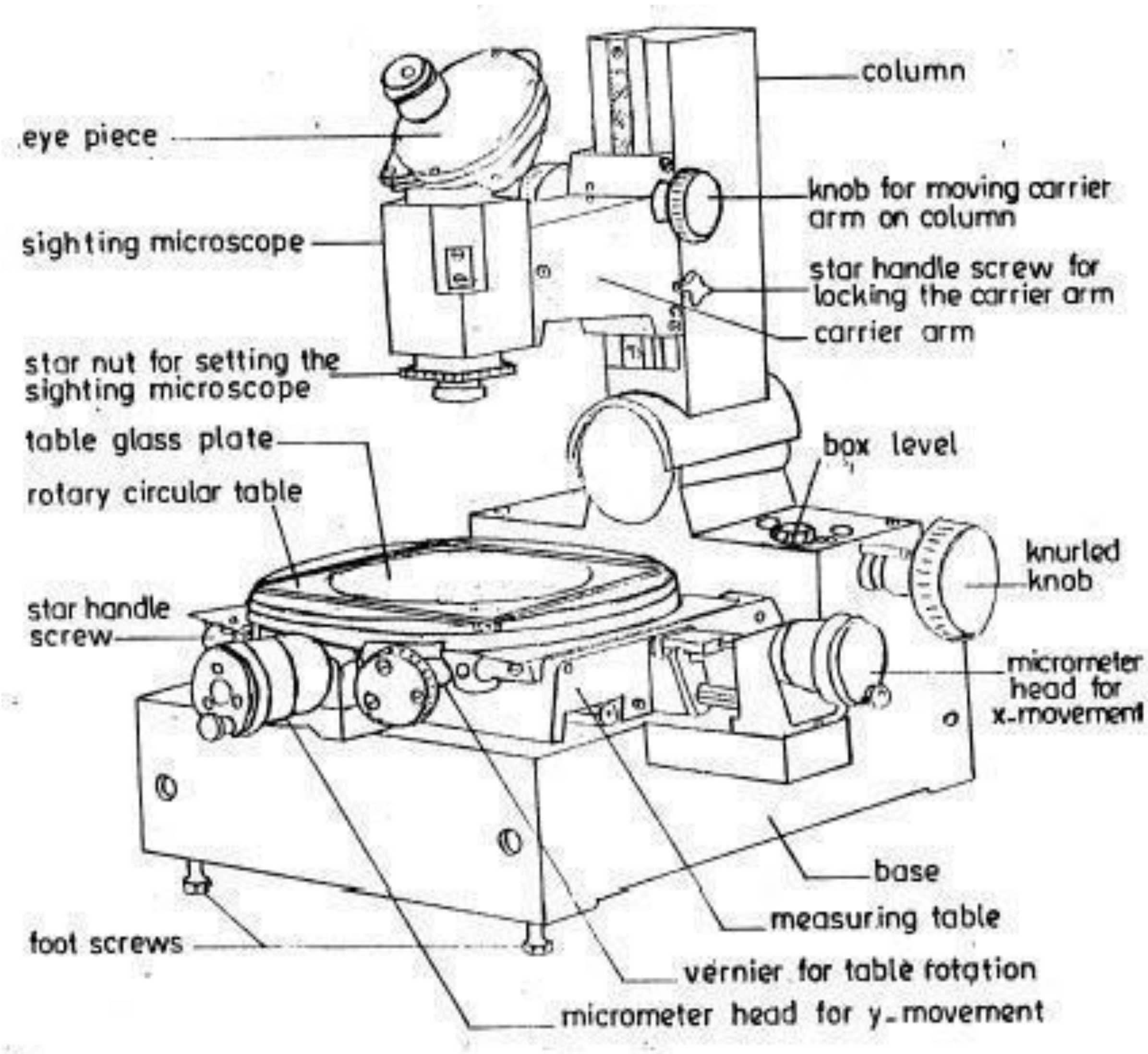


Fig. 1 Tool Makers Microscope

EYEPIECE PROTRACTOR

This unique protractor head graduated 0 to 360 degree with adjustable vernier reading to 6 minutes cross line incorporated in the protractor head rotating in the optical axis of the microscope the cross linegraticule is replaceable with many other measuringgraticules.

MEASURING STAGE

The stage plate is of 150 X 150 mm having very smooth and precise movements in both axis with special ball racers arrangements. The travel of the stage is 25mm. in both direction with precise imported micrometer head, least count 0.01 or 0.005mm. The stage has two T-slots for mounting accessories like rotary stage, center holding device attachment and V-blocketc.

ROTARY STAGE

A rotating stage is fixed in T-slots of square plate having 360 degree graduations on its periphery with vernier reading to6 minute, and lock screw. All types of horizontal angular measurements can be done with this stage.

ILLUMINATING SYSTEM

Two possible range of illuminating system are provided with standard equipment to meet every application, operated through 6 volts solid state variable light control built in transformer.

1. Sub-stage transmitted light from a bottom source providing collimated green filter halogen light for viewing contours and transparentobjects.
2. Surface incident illuminator for shadow free lighting, for high powerexamination of opaqueobjects.

PROCEDURE:

MEASUREMENT OF SCREW THREAD PITCH

1. The image of the thread profile is set so that some of the profile coincides with the cross hair as seen on the ground-glass screen.
2. The reading on thimble of the longitudinal micrometer screw is noteddown.
3. Then the part is traversed by the micrometer screw until a corresponding point on the profile of the next thread coincides with the crosshairs.
4. The reading on thimble is again noted and the difference in two readings gives the actual pitch of thescrew.

MEASUREMENT OF ANGLE OF THREAD

1. It is determined by rotating the screen until a line on the screen coincides with one flank of the threadprofile
2. The angle of screen rotation is noted and then the screen is further rotated till the same line coincides with the other flank of thread. The difference in two angular readings gives the actual angel of thread on thescrew.

PITCH OF THE THREAD

S. No.	Initial micrometer readings on thread pitch A(mm)	Final micrometer readings on thread pitch B(mm)	Pitch of the thread B-A (mm)

FLANK ANGLE OF THE THREAD:

S. No.	Intial flank angle A (Deg)	Final flank angle B (Deg)	Flank angle = B-A (Deg)

PRECAUTIONS:

1. The coincidence on the component & cross hairs must be carefullymatched.
2. Eyepieces are to be handledcarefully.
3. Don‘t expose eyes directly to the lightsource.

RESULT:

The pitch and flank angle of the given object is measured with toolmakers microscope are tabulated.

As compared to the optical comparators, a tool maker‘s microscope is preferred whenthe z-axis height information is required.

- The stage can be equipped with linearscales.
- They can easily adapt to both cameras CCTV's for photo documentationrequirements.

- The toolmakers microscope offers a variety of optical techniques Moreover, it canuseoptics, which offer higher magnification resolution for better measuring accuracy.
- It is ideal for measurements of hardness test indentations.

APPLICATIONS:

- Determining relativepositions

Here, the microscope is used elative positions of different points by simply measuring the travel that is necessary for bringing a second point to the position that was formerly occupied by the first and so forth.

- **Measuring angles**

Using this microscope, it is possible to measure the angles by using the protractor eyepiece. This allows for the angles of the object to be viewed and determined. This is where the microscope is used to do comparison of the thread forms, measuring of the pitch and diameter. Here, the microscope achieves this using the master profiles engravings in the eyepiece.

- **Comparing with a scale**

This is where the images of the object are compared with the scale in the projection screen.

VIVA-QUESTIONS:

- What are the applications of Toolmakersmicroscope?
- State the principle involved in Toolmakersmicroscope?
- How to change the magnification in Toolmakersmicroscope?

Experiment No.04

AIM: To measure the surface roughness of a given specimen

APPARATUS: SURF TEST301

Introduction:

Surface Roughness is like a fingerprint left behind by the manufacturing process.

1. The surface irregularities of small wavelength are called primary texture or roughness these are caused by direct action of the cutting elements on the material i.e., cutting tool shape, feed rate or by some other disturbances such as friction, wear orcorrosion.
2. The surface considerable wavelength of a periodic character are called secondary texture or waviness. These irregularities result due to inaccuracies of slides, wear of guides, misalignment of centers, non-linear feed motion, vibrations of any kindetc.

Elements of Surface Texture

Actual Surface: It refers to the surface of apart which is actually obtained after manufacturing process.

Nominal surface: A nominal surface is theoretical, geometrically perfect surface which does not exist in practice, but it is an average of the irregularities that are superimposed on it. **Profile**: It defined as contour of any section through a surface.

Lay: It is the direction of predominant surface pattern produced by the tool marks or scratches, generally surface roughness is measured perpendicular to the lay. **Sampling Length:** It is the length of the profile necessary for the evaluation of the irregularities to be taken in to account

Roughness Height: This is rated as the arithmetical average deviation expressed in micro-meters normal to an imaginary center line, running through the profile **Roughness Width**: Roughness width is the distance parallel to the normal surface between successive peaks or ridges that constitute the predominant pattern of the roughness.

Measuring instruments:

1. Profilograph

This is an optical instrument and is used for direct measure of the surface quality. The principle of operation is shown in fig.1 A finely pointed stylus mounted in the pickup unit, is traversed across the surface either by hand or motor drive. The work to be tested is placed on the table of the instrument. It is traversed by means of a lead screw. The stylus, which is pivoted to a mirror, moves over a tested surface. A light source sends a beam of light through lens and a precision slit to the oscillating mirror. The reflected beam of light is directed to a revolving drum, upon which a sensitized film is arranged. The drum is rotated through 2-bevel gears from the same lead screw. A profilograph will be obtained from the sensitized film, that may be subsequently analyzed to determine the value of the surfaceroughness.

2. Tomlinson surfacemeter

This is purely a mechanical lever operated piece of equipment. The diamond stylus on the recorder is held by spring pressure against the surface of a lapped steel cylinder. The stylus attached to the bodyof the instrument by means of a leaf spring and it has some height adjustment. The lapped cylinder is supported on one side by the stylus and on the other by two fixed rollers as shown in fig.2

The stylus is restrained from all motions except the vertical one by the tension in the coil and leaf spring. The tensile forces in these two springs also keep the lapped cylinder in horizontal positon. Alight arm is attached to the lapped steel cylinder, and it carries at its tip a diamond scriber which leans against a smokedglass.

While traversing across the surface of the job, any vertical movement of the stylus caused by the surface irregularities causes the lapped cylinder to roll. Thus, vertical movement coupled with horizontal movement produces a track on the glass magnifies in vertical direction and there being no horizontal magnification.

3. Taylor-Hobson-Talysurf

Taylor-Hobson-Talysurfis a stylus and skid type of instrument working on carrier modulating principle. Its response is more rapid and accurate as compared to Tomlinson Surface Meter. The measuring head of this instrument consists of sharply pointed diamond stylus of about 0.002mm tip radius and skip or shoe which is drawn across the surface by means of a motorized drivingunit.

In this instrument the stylus is made to race the profile of the surface irregularities, and the oscillatory movement of the stylus is converted in to changes in electric current by the arrangement as shown in fig.3 The arm carrying the stylus forms an armature which pivots about the centrepiece of E-shaped stamping. On two legs of (outer pole pieces) the E-shaped stamping there are coils carrying an a.c current. These two coils with other two resistances form an oscillator. As the armature is pivoted about the central leg, any movement of the stylus causes the air gap to vary and thus the amplitude of the original a.c current flowing in the coils is modulated. The output of the bridge thus consists of modulation only as shown in fig3 this is further demodulated so that the current now is directly proportional to the vertical displacement of the stylus. The demodulated output is caused to operate a pen recorder to produce permanent record and the meter to give numerical assessmentdirectly.

DESCRIPTION OFSURFTEST SJ-301

The surftest SJ-301 is a stylus type surface roughness measuring instrument developed for shop floor use. The SJ-301 is capable of evaluating surface texture with variety of parameters according to various national standards and international standard. The measurement results are displayed digitally/graphically on the touch panel, and output to the built-inprinter.

The stylus of the SJ-301 detector unit traces the minute irregularities of the work piece surface. Surface roughness is determined from the vertical stylus displacement produced during traversing over the surface irregularities. The measurement results are displayed digitally/graphically on the touch panel.

OBSERVATIONS:

Specimen. No.	R_a Microns	R_q Microns	R_z Microns	R_t Microns	Rsk	Rku
1.						
2.						
3.						

Result: The various roughness parameters for different specimens are tabulated.

ADVANTAGES:

- The main advantage of such instruments is that the electrical signal available can be processed to obtain any desired roughness parameter or can be recorded for displayor subsequentanalysis.
- Therefore, the stylus type instruments are widely used for surface texturemeasurements inspite of the followingdisadvantages.

DISADVANGES:

- These instruments are bulky andcomplex.
- They are relativelyfragile.
- Initial cost ishigh.
- Measurements are limited to a section of a surface. (v) Needs skilled operatorsfor measurements.
- Distance between stylus and skid and the shape of the skid introduce errors in measurement for wavysurfaces.

APPLICATIONS:

- Low-coherence profilometersdeliver fast, reliable, and non-contact 3D surface measurements – with precision better than 1 µm. Surfaces are rapidlycharacterized in terms of shape, roughness, flatness, waviness, and other surfacequalities

- High-speed scanning**:** 1,000 to 30,000 points/sec andhigher

- Real-time feedback on manufacturing or coating processes**:** application data is typically forwarded to process controlsoftware

- Easy visual inspection**:** depth profiles, 2D cross-sections (B-scans or C-scans) and3D surfacemaps.

VIVA –QUESTIONS:

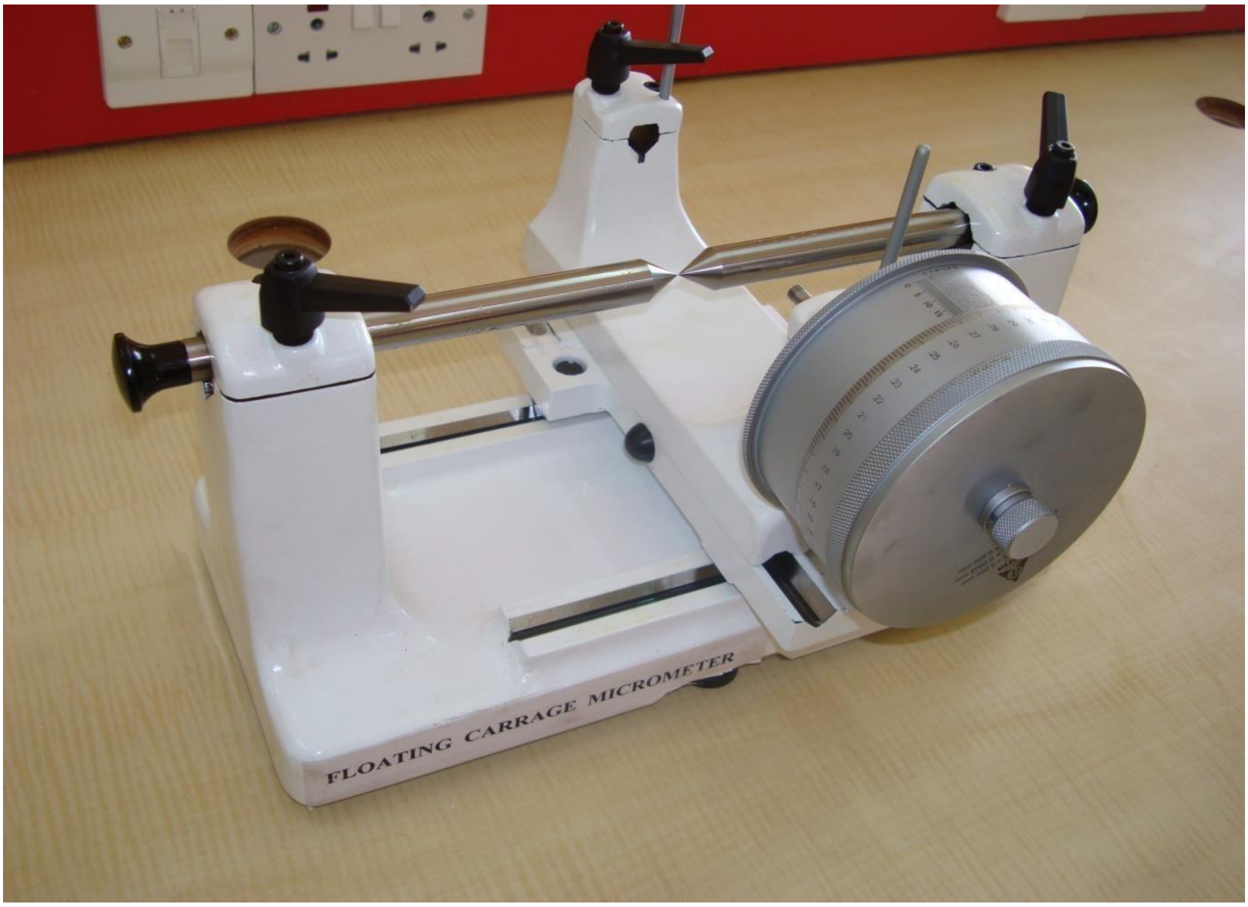
- Define the following terms a) Roughness b) Waviness c) Lay d) SamplingLength
- Explain the terms R_a , R_z ,RMS.
- What are the various methods of measuring surfaceroughness?
- Explain the use of dial boregauge?
- What is the principle involved in spritlevels?
- What is primary texture?
- What is secondary texture?
- What isLay?
- What do you mean by traversing length and sampling length?
- Define Ra, Rq and Ry vi) What is calibration ? and why is it necessary for roughness measurement?

MEASUREMENT OF SCREW THREAD PARAMETERS USING TWO WIRE METHOD BY FLOATING CARRIAGE MICROMETER

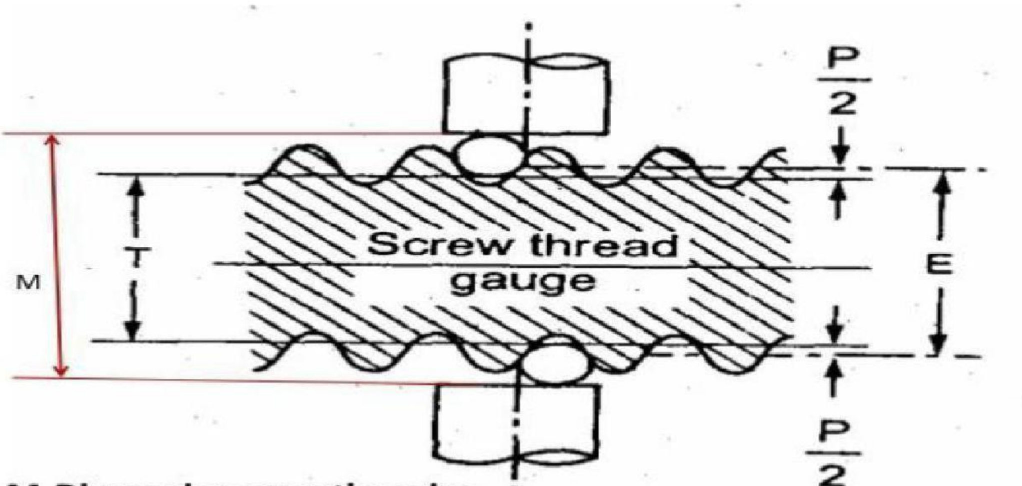
Experiment No.05

Aim: To measure the screw thread parameters using two wire method by Floating carriage micrometer.

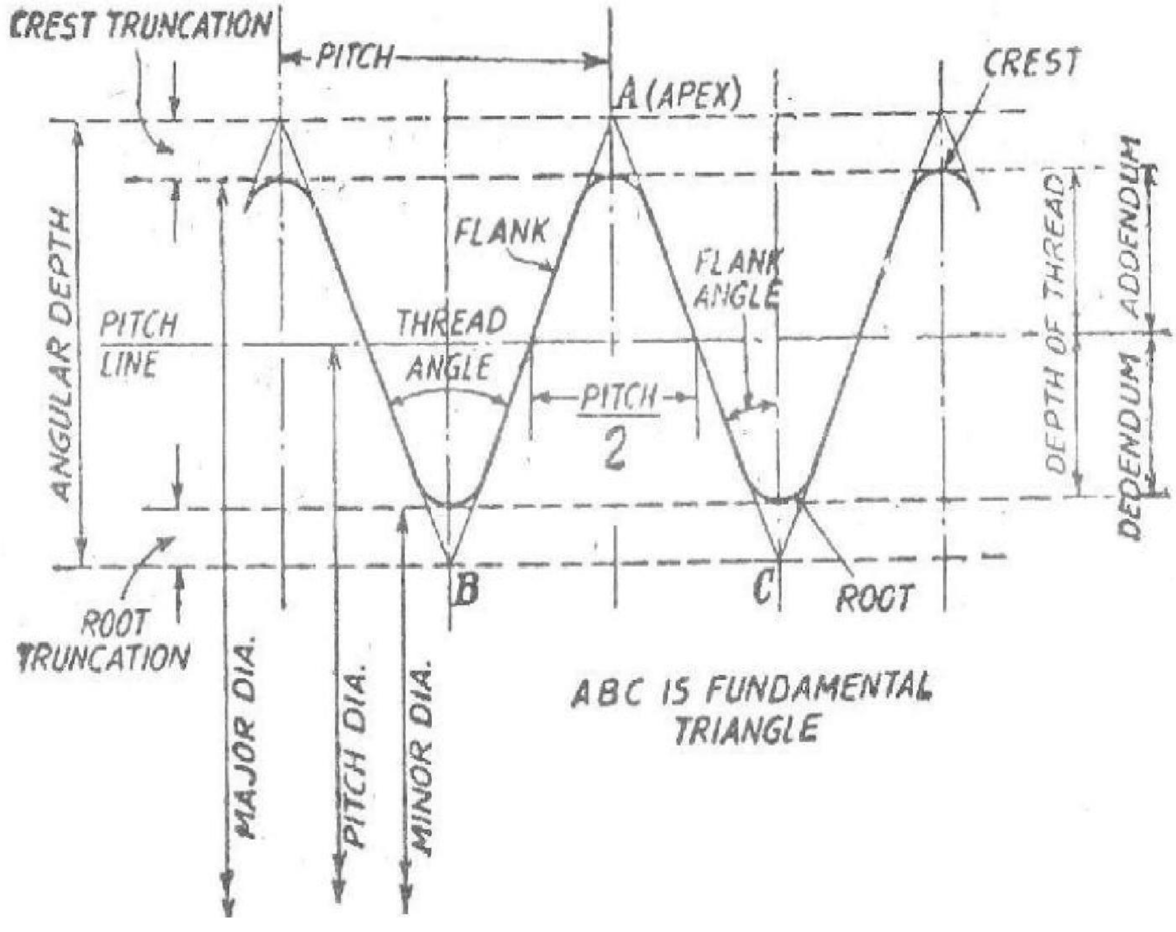
Apparatus: Micrometer, micrometer stand, a set of two wires, pitch gauge and Screw thread specimen.



Two wire method:



M-Dimension over the wire



Screw Threads Terminology:

Screw thread. A screw thread is the helical ridge produced by forming a continuous helical groove of uniform section on the external or internal surface of a cylinder or cone. A screw thread formed on a cylinder is known as straight or parallel screw thread, while the one formed on a cone or frustum of a cone is known as tapered screw thread.

External thread. A thread formed on the outside of a work piece is called external thread e.g., on bolts or studs etc.

Internal thread. A thread formed on the inside of a work piece is called internal thread e.g. on a nut or female screw gauge.

Multiple-start screw thread. This is produced by forming two or more helical grooves, equally spaced and similarly formed in an axial section on a cylinder. This gives a _quick traverse_ without sacrificing core strength.

Axis of a thread. This is imaginary line running longitudinally through the centre of the screw.

Hand (Right or left hand threads). Suppose a screw is held such that the observer is looking along the axis. If a point moves along the thread in clockwise direction and thus moves away from the observer, the thread is right hand; and if it moves towards the observer, the thread is left hand.

Form, of thread. This is the shape of the contour of one- complete thread as seen in axial section.

Crest of thread. This is defined as the prominent part of thread, whether it is external or internal.

Root of thread. This is defined as the bottom of the groove between the two flanks of the thread, whether it be external or internal.

Flanks of thread. These are straight edges which connect the crest with the root.

Angle of thread {Included angle). This is the angle between the flanks or slope of the thread measured in an axial plane.

Flank angle. The flank angles are the angles between individual flanks and the perpendicular to the axis of the thread which passes through the vertex of the fundamental triangle. The flank angle of a symmetrical thread is commonly termed as the half- angle of thread.

Pitch. The pitch of a thread is the distance, measured parallel to the axis of the thread, between corresponding points on adjacent thread forms in the same axial plane and on the same side of axis. The basic pitch is equal to the lead divided by the number of thread starts. On drawings of thread sections, the pitch is shown as the distance from the centre of one thread crest to the centre of the next, and this representation is correct for single start as well as multi-start threads.

Lead. Lead is the axial distance moved by the threaded part, when it is given one complete revolution about its axis with respect to a fixed mating thread. It is necessary to distinguish between measurements of lead from measurement of pitch, as uniformity of pitch measurement does not assure uniformity of lead. Variations in either lead or pitch cause the functional or virtual diameter of thread to differ from the pitchdiameter.

Procedure:

1. Fix the given screw thread specimen to the arrangement block.
2. Measure the pitch of the given thread using pitch gauges and also note down theangle of the thread based on Metric or With Worth.
3. Measure the maximum diameter of the screw thread using micrometer.
4. Calculate the best wire to be used by using the given equation.
5. Consider the available wires and fix the two wires to one end on micrometer Anvil and one wire towards another anvil.
6. Measure the distance over the wire properly by using micrometer.
7. Calculate the effective diameter of the screwthread.
8. Find out the error in effective diameter of the screwthread.

Observations:

1. Least Count of theMicrometer= mm.
2. Initial error in themicrometer= mm.
3. Pitch of the threadp= mm.
4. Best size of the wire usedd= mm.

Results:

The following parameters are found as follows;

1. MajorDiameter= mm
2. MinorDiameter= mm
3. EffectiveDiameter= mm.

ADVANTAGES:

- Very accurate, assuming correct flank angle Can be used on all external threads Suitable for machine set-up and processcontrol.
- Inspects full thread profile and pitch Can be used with a minimum of trainingAssuming correct use of both GO and NO-GO gauges the component can be judged ‖good‖ or‖bad
- Measures the total thread geometry (diameters andpitch).
- When set up easy to use. Fixtures for both external and internalthreads.
- Suitable for machine set-up and processcontrol

DISADVANTAGES:

- Only suitable for external threads Requires a calculation to find the correct measurement result Measuring wires must be bought to suit the relevant micrometer spindle diameter N.B. there are 3 standard micrometer spindle diameters – Ø8mm (5/16‖), Ø6,5 and Ø6,35 mm (1/4‖) ―Only‖ measures thread pitchdiameter.
- Only reveals if the component is ‖good‖ or ‖bad‖ – not the relationship to the tolerance Time consuming when setting up the machine and performing process control Difficult/expensive to calibrate Manufacturing tolerances and wear on the gauges usually give less tolerance on the actual components to be inspected Can only be used for the specific thread and tolerance stated on the gauge.

MACHINE TOOLS LAB

- Relatively expensive as it can only be used for the designatedthread.
- Requires a reference component for correct setup.
- One wrong dimension on the threaded component can give a false indication i.e. an incorrect pitch will give a false reading as will an incorrect flankangle.

APPLICATIONS:

- Certify set plug gages and working thread pluggages
- Monitor the wear on working thread plug gages
- Monitor and control pitch diameter variation during threadfabrication
- Use in conjunction with Go and No Go ring gages to control thread sizes to the most demandingspecification
- Determine out of roundness and taper that may exist in threadedparts
- Eliminate the cost and time involved in using outside calibrationservices
- Reducemeasurementtimetoafractionoftimenormallytakingusingthetraditional three-wiremethod.

GOVT CO-ED POLYTECHNIC

BYRONBAZARRAIPUR(C.G.)

LAB MANUAL

Branch:Mechanical Engineering

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ENGINEERING METROLOGY LAB (2037465(037))
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