University Of Jordan
Faculty of Engineering and Technology
Industrial Engineering Department

Measurement Lab.

EXPERIMENT 2 :

BLOCK GAUGES

9/10

Student Name :
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GROUP (8)

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- grade 1: suitable for inspection rooms. for precise measurements.
- grade 2: for general measurement (lowest accuracy)

* the main difference is in accuracy and tolerance, with higher grades offering finer tolerances suitable for calibration & precision applications.

Q3 the accuracy of block can vary depending on their grade. High grade calibration blocks can have accuracies up to ±0.00005 mm, while workshop-grade blocks may have tolerances around ±0.005 mm
- this information is typically provided by the manufacturer

Q4 Choosing the minimum number of blocks in a combination reduces the cumulative error that could arise from stacking multiple blocks. it also makes the setup more stable, reducing misalignment and increase overall accuracy.

Q5 we care about how gauge blocks are attached because:
1. Accuracy proper wringing ensures precise measurements
2. improper handling can alter the effective length of the stack
3. accurate attachment is important (calibration)

4. Proper attachment protects blocks from damage, maintaining their condition for future use.

DOMS

DETERMINATION OF STRAIGHTNESS ERROR USING AUTOCOLLIMATOR

Prepared: 30 Jan 2006

Principle: An autocollimator is an instrument which can measure small angles. They incorporate a collimating lens which is designed to transmit a parallel beam of light radiating from a source at its principal focus. A plane reflector placed in the path of the beam and normal to the geometric axis of the lens will reflect the light along the transmitted path to be refocused at the source (Fig.1). If the reflector is inclined at a small angle $\delta\theta$ to the normal, the beam is reflected at an angle equal to $2\delta\theta$ from its transmission path (Fig. 2). Any portion of the reflected beam passing through the lens will be refocused at the focal plane at a distance d from the principal focus. Consider that reflected ray which so happens to pass through the geometric centre of the lens. From the triangle made with this ray and the focal length f, $d=2f\delta\theta$. Thus the point at which the reflected beam is focused is independent of the distance of the reflector from the lens. However, as the angle increases, the amount of light that falls back onto the lens decreases and hence there is a limit to the distance that the reflector can be placed.

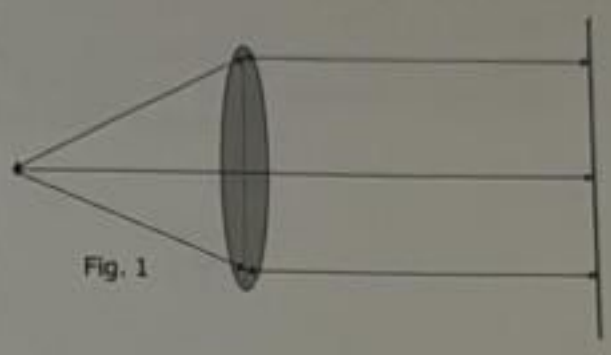


Fig. 1

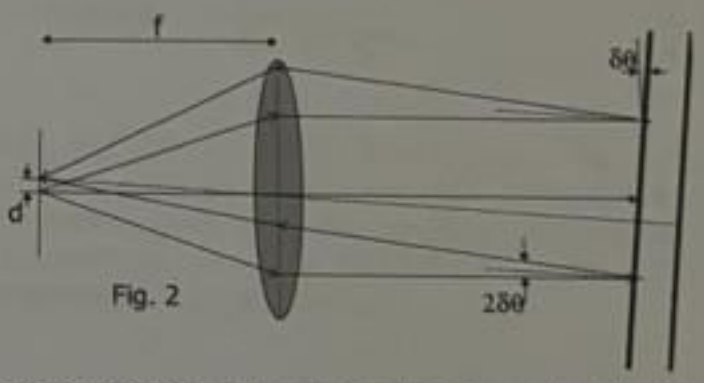


Fig. 2

An autocollimator is essentially a telescope permanently focused at infinity and fitted with means for illuminating an internal target graticule. There is also a micrometer eyepiece viewing system for measuring the displacement d of the image. A schematic diagram of the Microptic Visual Autocollimator is shown in Figure 3. The illuminated

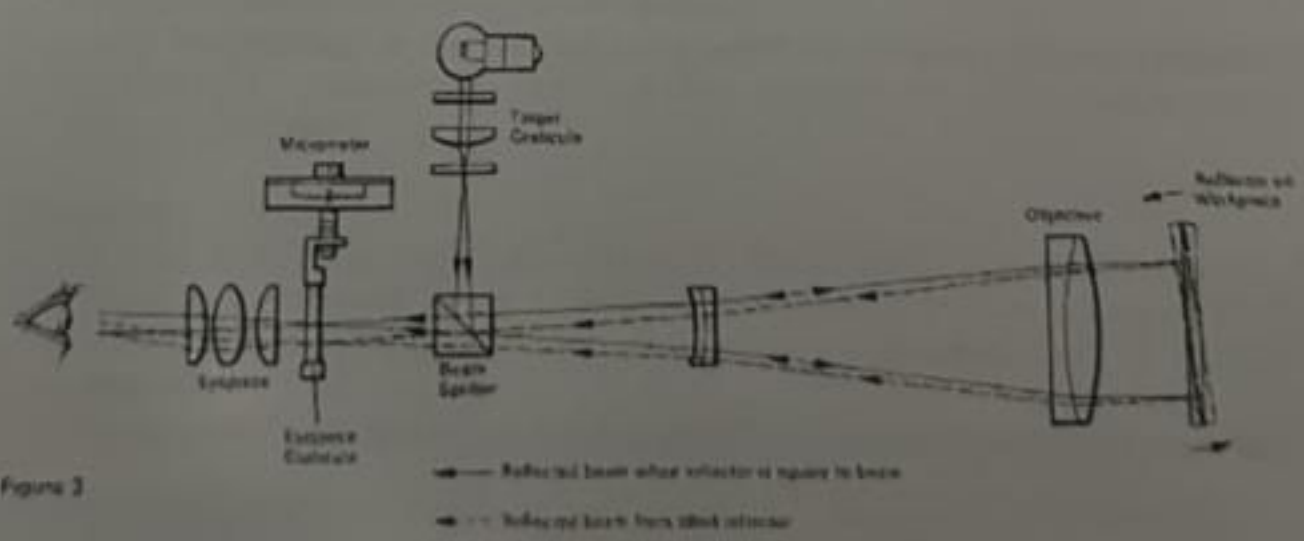


Figure 3

target graticule is situated in the principal focal plane of the objective and the emergent beam is directed along the axis of the telescope by a beam splitter. The reflected beam,

cloth. Then be wiped with clean soft chamois leather. Slip gauges they should be held across one another at right angles and wiring them with a rotary motion; this 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 satisfactory. Unless a very firm wring is obtained there is always the possibility that the wringing film maybe a micrometer thick.

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

1. Remove the gauge blocks required from the protective case
2. Clean of 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 moister.
-Avoid magnetization.
-Handle lapped faces as little 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 it after use. If gauges are not in frequent use they should be coated to prevent corrosion.
-Do not handle gauges above open box, they mat cause damage to other gauges if dropped.

It was mentioned earlier that we have to build the desired length of the blocks; the following example explains the procedure:

-Build a 30.967 mm using the minimum number of blocks.

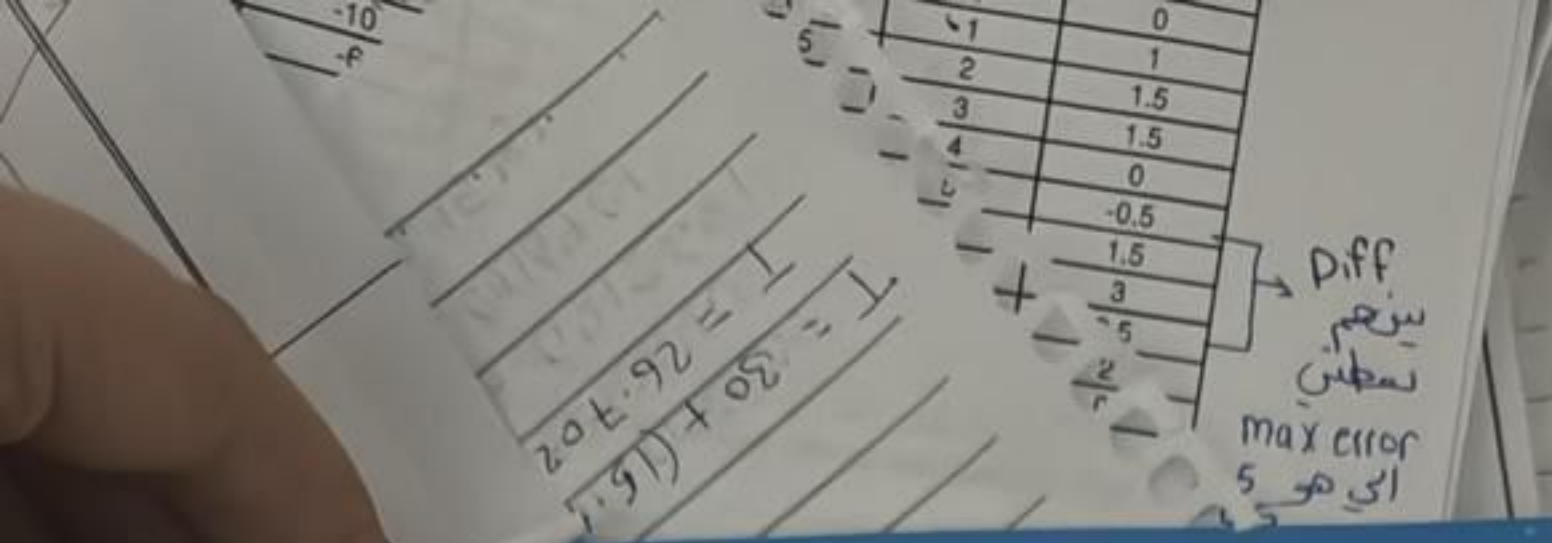
30.967
- 1.007
29.960
-1.090
28.870
-1.370
27.500
-7.500
20.000

= 2

So we 5 blocks are used to build the desired length.

APPARATUS:

- Set of block gauges
- Granite surface plate



accuracy is based on the precision of Screw thread, there could be inaccure measurments because of the movemet of Specimen.

6 - * least count micrometer
* accuracy of Screw thread
* ability to read scale

7 - * parallex error
* wear on spindle

8 - yes, roatating, it can cause friction on the surface of the object & introduce Smallerror.

Question 1: (15 points)
Select the best answer for each of the following paragraph

1. The linear block gauges is considered as an example of ——— measuring devices.

   A. line standard
   B. end standard
   C. both A and B are correct
   D. none of the above is correct

2. The depth of the thread = $\frac{major\ diameter - minor\ diameter}{2}$

   A. True
   B. False

3. if the vernier bevel protractor is used to measure obtuse angle then the reading of the device will equal to the required angle plus 90.

   A. True
   B. False

4. which of the following devices follows Abbes' principle

   A. the vernier caliper
   B. the dial caliper
   C. the micrometer
   D. two points inside micrometer
   E. both c and d are correct
   F. all of the above are correct
   G. none of the above is correct

5. if the smallest division of the main scale of the vernier caliper is 0.5 mm, and its vernier scale is divided into 50 divisions, then the accuracy of the device is ———— mm

   A. 0.01 mm
   B. 0.02 mm
   C. 0.05 mm
   D. None of the above is correct

6. in the vernier caliper , the accuracy of the device always equals to the difference between the size of division on the main scale and the size of division on the vernier scale

   A. True
   B. False

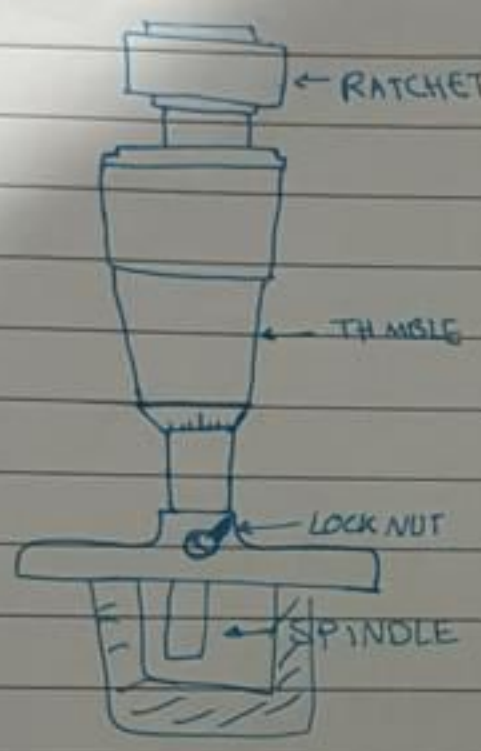
7. the mechanical comparator can be used to calibrate the linear measuring devices

   A. True
   B. False

Position x mm	Autocollimator Mean Reading seconds	Difference from first reading seconds	Rise or fall over 50mm baselength μm	Cumulative Rise or Fall μm
0				
0-50	20	0	0	
50-100	18	-2	0	
100-150	16	-4	-0.5	
150-200	10	-10		
200-250	14	-6		
250-300	24	4		
300-350	22			
350-400	18			
400-450	10			
450-500				

Micrometer

1.



2- 2 threads

3- Yes, the axis of the spindle is aligned with the axis of the screw thread that controls measurement

4- 0.5 mm

5- over tightening can cause:
- damage to the spindle or anvil
- inaccurate readings
- damage to the measuring object
- wear on internal components

4- Yes, micrometer can be used as comparitor

passing straight through the beam splitter, is brought to a focus on the eyepiece graticule and both the graticule and the image are viewed simultaneously through the eyepiece. The eyepiece graticule lines can be moved across the field of view by means of the micrometer, until they coincide with the reflected target image, thus enabling its displacement to be measured. The micrometer is graduated in angular units corresponding to the angular displacement of the reflector.

Measurement of straightness:
See the annexure for definition of straightness error. The principle employed for measurement is illustrated in Figure 4. The reflector is mounted on a carriage which is moved step by step from its initial position AB at one end of the slideway to successive positions BC, CD etc. along the surface. The distances between adjacent points A, B, C, D ... are equal to the nominal span of the carriage (50 mm). Any lack of straightness of the slideway will cause the carriage to tilt slightly. The angles of tilt are measured by the autocollimator and the difference in height of the two feet of the carriage can then be calculated for each position.

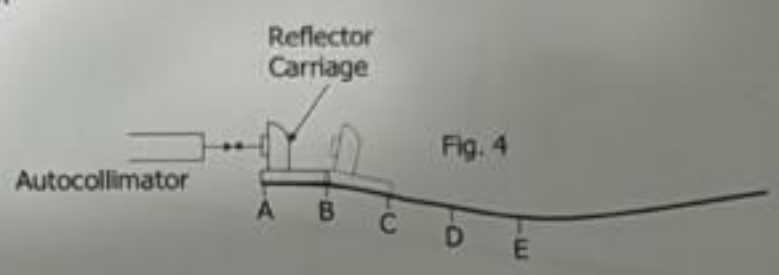


Fig. 4

Procedure:
1. Position the micrometer of the autocollimator to measure displacements in the vertical plane. Place the carriage at the nearest position AB and adjust the autocollimator base until the reflected image of the target crosslines is near the centre of the field of view.
2. Move the carriage to the other end of the bed and check that the reflected image is still within the range of measurement. If it is not, make fine levelling or rotational adjustments to the autocollimator.
3. Return the reflector carriage to position AB. Take an autocollimator reading and record it
4. Move the carriage along to its second position (BC) and take another reading. Continue thus until the carriage is at the end.
5. Repeat the readings as the carriage is moved in the reverse direction, towards the autocollimator. Take the average of the readings at each position as the measurement result.

Calculation:
1. See table next page. The "difference from first reading" column is obtained by subtracting the reading at AB (=20 in this example) from the readings at other positions. This is the variation in tilt of the reflector compared with its attitude at position AB.
2. The "rise or fall" column is the angular deviation in previous column converted into linear displacement. $1\ \text{second} = \frac{1}{3600} * \frac{\pi}{180} radians = \frac{1}{3600} * \frac{\pi}{180} * 50{,}000 \mu m$ $\equiv 0.25 \mu m$. Add a zero at the top of the column to represent the height of point A (regarded as the datum).

Position	Autocollimator Mean Reading	Difference from first reading	Rise or fall over 50mm baselength	Cumulative Rise or Fall	Adjustment required	Error
mm	seconds	seconds	μm	μm	μm	μm
0			0	0	0	0
0-50	20	0	0	0	1	1
50-100	18	-2	-0.5	-0.5	2	1.5
100-150	16	-4	-1	-1.5	3	1.5
150-200	10	-10	-2.5	-4	4	0
200-250	14	-6	-1.5	-5.5	5	-0.5
250-300	24	4	1	-4.5	6	1.5
300-350	22	2	0.5	-4	7	3
350-400	18	-2	-0.5	-4.5	8	3.5
400-450	10	-10	-2.5	-7	9	2
450-500	8	-12	-3	-10	10	0

3. The cumulative rise or fall column, gives the amount by which the end of each segment is displaced from zero datum line AB. When these values are plotted, the graph obtained is shown in Figure 5.

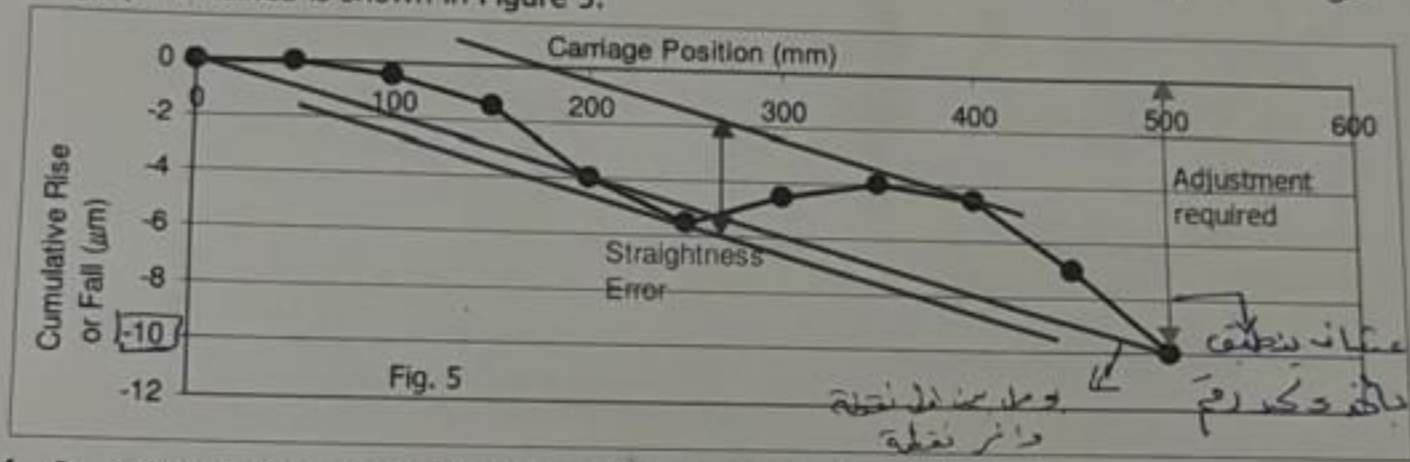


Fig. 5

4. In order to determine the errors with respect to the end-point line, we need to rotate the right end so that the error there becomes zero. Thus, the adjustment required at the last point is negative of the cumulative rise or fall at that point. This total adjustment has to be reduced proportionate to the distance from the first point to get the required adjustments at the intermediate points. The adjustment at the first point will be zero.
5. Add the adjustment required at each point to the cumulative rise or fall. The straightness error along the line is the maximum error – minimum error= (3.5--0.5)=4.0 in this case. See Fig. 5.

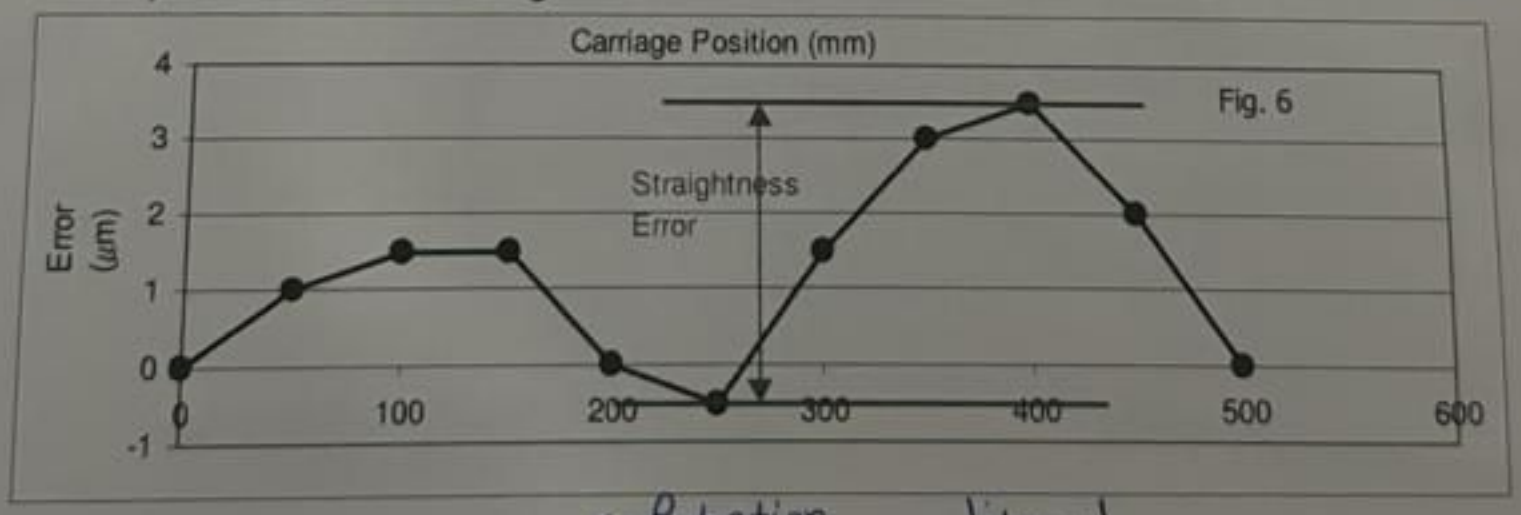


Fig. 6

Position	Autocollimator Reading	Difference from first reading	Rise or fall over 50mm baselength	Cumulative Rise or Fall	Adjustment required	Error
mm		μm	μm	μm	μm	μm
0		0	0			
0·5						
50·1						

Micrometer

Group [8]

Experiment one linear measurments

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8/10

Questions: Vernier Caliper

Q① No Vernier Caliper doesn't Confirm to Abbes principle Because Abbes Principle states that measurement must be directly in line with axis measured to minimize errors in this Case, error may be substional.

Q2 Error of a Vernier Caliper $\frac{1}{20} = 0.05$

Q3 function of Sliding blade (movable Jaw), we can use it to measure outer and inner diameter and also measuring depth

Q4 direct Reading have arrow sliding blade attached to Sliding Jaw
yes it applies Cause Caliper also have sliding Blades, depth

Q5 Sources of error in Caliper parallax error (not Reading with aligment), Surface error, user error, bias error, Random error, systematic error

Q6 if locking screw isn't used The reading might shift Slightly during measurment which will Result in error in Reading

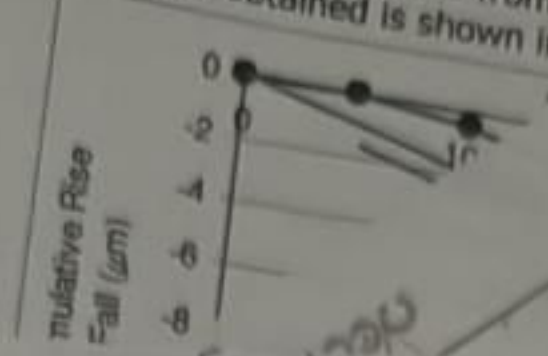
Q7 yes we can Consider it as final Reading but we Can Consider Compartor

Q8 its Considered line standard Cause reading is taken directly from line

Q9 measure internal and external and depth and Larger measuring Range, easier to use

350-400	22	4	-1.5
400-450	18	2	1
450-500	10	-2	0.5
	8	-10	-0.5
		-12	

3. The cumulative rise or fall column, g
segment is displaced from zero d
graph obtained is shown in Flo



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Group (8)

Subject _____ Day _____ Date _____

Q. Discussion:

* to know how to use the measuring tool & take reading & it requires accuracy & precision

* Any unknown projections will cause to enduce errors in the angle measured

~~For the building of the slip~~

~~* yes, for~~ * The overall time required for the measurment would depend on the complexity of the component.

* ~~I~~ I will use the Sine bar for measuring setting up (4)

* one component, because ~~the~~ the Sine bar take time.

	angle 3	angle 1	angle 2
plate protractor	50°	autocollimator	83°
Vernier protractor	51° 5'	32° 10'	83° 20'
Clinometer	—	32° 41'	—

Measuring instrument	D_1	D_2	D_3	D_4	D_a	D_b	D_c	D_d	H_1	H_2	H_3	H_4	H_5
Vernier Caliper	18.30	24.00	31.00	46.50	9.80	unfound	21.50	29.70	—	—	—	10.75	71.10
Outside micrometer	18.32	25.97	30.84	46.30	—	—	—	—	—	—	—	—	—

all in (mm)

OBJECTIVES:

-To familiarize students with types and applications of block gauges.
- To be able to calibrate linear measurements tools.
- Learn the correct ways of using them in measurements.
- Learn how to maintain them in the correct shape

INTRODUCTION:

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

Block gauges are practical length standards of 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 tenth 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 are highly accurate
-End standard have a built in datum because there measuring faces are flat and parallel
-The accuracy of end and line standard 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: each tow surfaces or two lines are parallel to a very high degree.

But there is four types of block gauges differ by the degree of there accuracy, quality and roughness.

Grades of gauge blocks:

1. 00
2. Calibration: this grade provides the highest level of accuracy required in normal engineering practice and is intended for calibrating other blocks in conjunction with suitably accurate comparators. They are used where tolerance are 2 micrometer or less and are not inténded for generally gauge inspection.
3. 0
4. I
5. II

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

USING THE BLOCK GAUGES:

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),

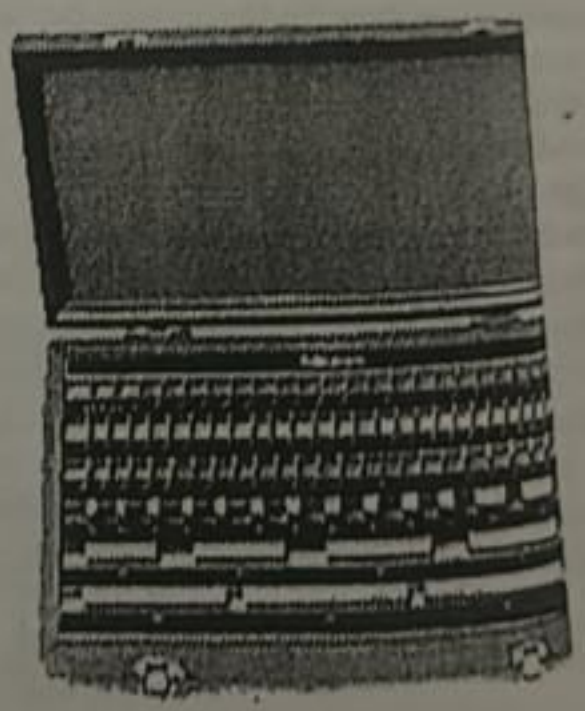
1.30-1.39 (by 0.001 steps),

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.

As can be seen from the figure 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 by noticing that they shine the most of the six faces. The length is taken between these tow surfaces which 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 tetrachloride or other DE-greasing agents and wiped dry on a clean

1. Difference between End standard & Line standard:

- End standard measures the distance between the ends of the gauge block, often designed with flat & parallel surfaces to enhance accuracy.

- Line standard: Measures the distance between two lines, like these on an Engraved ruler.

-reasons for end standard accuracy:

1- requires direct contact, which reduces parallex errors.
2- has a built-in datum surface, to ensure that the measuring faces are flat & parallel, increasing pricision.
3- Made from high-quality materials (like hardened steel), with highly precise processes to ensure maximum accuracy.

2. Difference between the different grades of gauge blocks:

- grade 00: provides the highest level of accuracy intended for calibration ~~but slightly less accurate~~ labs that require extremely fine tolerance, typically ±/2 micrometers or less.

- grade 0: Used for calibration but slightly less accurate than grade 00, used in standerd room only.

Position x mm	Autocollimator Mean Reading seconds	Difference from first reading seconds	Rise or fall over 50mm baselength μm	Cum Rise
0	20	0	0	
0-50	18	-2	0	
50-100	16	-4	-0.5	
100-150	10	-10	-1.5	
150-200	14	-6	-4	
200-250	24	4	-5.5	
250-300	22	2	-4.5	
300-350	18		-4	
350-400	10		-4.5	
400-450			-7	
450-500			-10	

3. The cumu... ser...

Subject _____ Day _____ Date _____

$P = 3.5$

$\theta = 30^\circ$

$\theta = 30^\circ$

$d = 2.0207$

$D_{cy} = 30\,mm.$

$D_{minor} = 30 + (19.6028 + 18.1534)$

$= 26.4494\ mm$

$D_{Major} = 14.5912 - 14.6930 = D_{th} - 30$

$0.1018 = D_{th} - 30$

$D_{th} = 30.1018\ mm$

$D_{eff} = T + 2x$ $\qquad 2x = \frac{P}{2}$

$2x = \frac{3.5}{2}\cot(30) - 2.0207 \times (\operatorname{cosec}(30) - 1)$

$T = 30 + (15.4179 - 18.7164)$

$T = 26.7028$ $\qquad 2x = 1.01039$

$D_{eff} = 27.713$

which the e... se values ar...

400

we need t... adjustment... point. This ... first point ... t at the ...

$\frac{-y}{n} =$

$=$

0.01 mm

$\frac{1}{1000}$ → كل خط بالتعريف رقم ورقم

EXPERIMENTAL PROCERUDE:

After being familiar with the blocks and the available rang of lengths complete the following procedure.

1-Use minimum number of block gauges to build the following size length and complete table1.

Table 1:

# of gauges	59.876 mm	41.389 mm	9.999 mm
1st piece	1.006	1.009	1.009
2nd piece	1.370	1.38	1.09
3rd piece	7.50	9.00	1.4
4th piece	50.0	30.0	6.5
5th piece			
6th piece			

4Blocks all of Them

2-Complete the following table and Plot your results & determine the maximum error

Table 2:

Standard block gauge mm	Standard block gauge with error mm	Reading of micrometer
0.000	0+ 0.0005 0-0.0005	29 + 0.16 / 0.007 ⇒ 29.167
3.000	3+ 0.0005 3-0.0005	
5.000	5+ 0.0005 5-0.0005	
10.000	10+ 0.0005 10-0.0005	
15.000	15+ 0.0005 15-0.0005	
20.000	20+0.0005 20-0.0005	

3-Take the piece which you want to measure its length and take its length by using vernier caliber (to take approximate length to easy the comparison)then we put it in a mechanical comparator and calibrate it to get error less than 0.01 mm. Now remove the piece and put block gauges until we reach the desire value. Then we take the reading of blocks.

40

40.19
- 1.19
39
- 9
30
- 30

So we need 3 Blocks

30
9
1.13

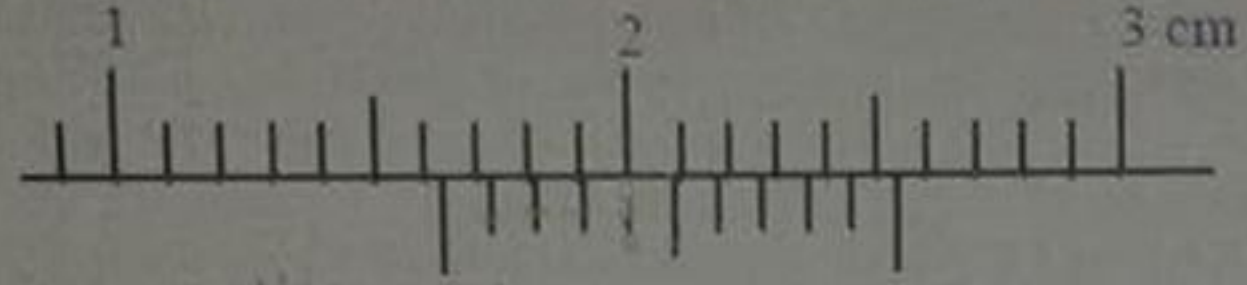
Question 1:

A. What size is the gauge block build-up used with a 5 inches sine bar to set the workpiece at an angle of 4° 30'? show your calculations (3 points) **10 points**

$\theta = 4.5^\circ$ $\quad$ $L = 5 \text{ inche} = 12.7 \text{ cm}$

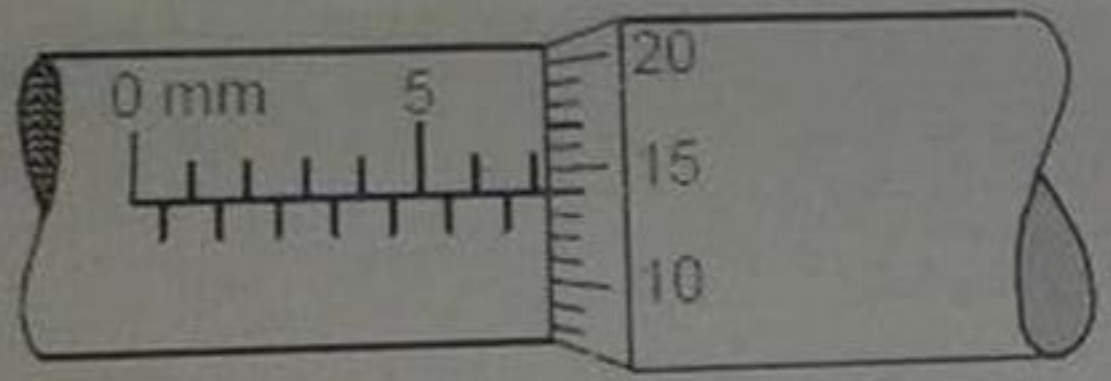
$\sin\theta = \frac{h}{L} \Rightarrow h = \sin 4.5^\circ * 12.7 = 0.9996 \text{ cm} =$ .393 inch

B. A student used a vernier caliper to measure the diameter of a cylinder. The diagram shows an enlargement of the caliper scales. What reading was recorded? (2 points)



11 mm + 0.1 × 4 = 11.4 mm

C. What is the reading of the following micrometer? (2 points)



7 mm + 0.14 mm =

7.14 mm

D. Using the following set of gauge blocks, what is the minimum number of blocks to be wrung together to produce an overall dimension of 47.765 mm

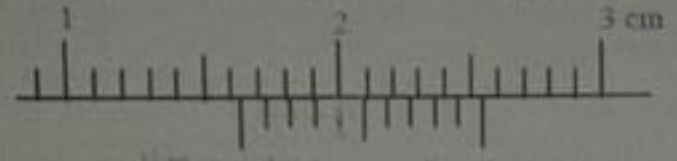
Question 1: **10 points**

A. What size is the gauge block build-up used with a 5 inches sine bar to set the workpiece at an angle of 4° 30'? show your calculations (3 points)

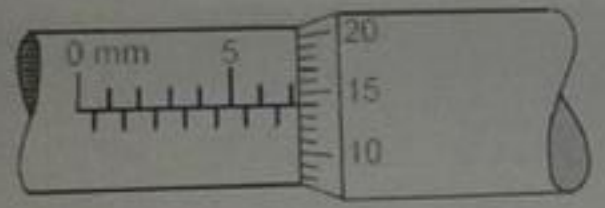
θ = 4.5° L = 5 inche = 12.7 cm

$\sin\theta = \frac{h}{L}$ = $h = \sin 4.5° \times 12.7 = 0.9996$ cm

B. A student used a vernier caliper to measure the diameter of a cylinder. The diagram shows an enlargement of the caliper scales. What reading was recorded? (2 points)



C. What is the reading of the following micrometer? (2 points)



7 mm + 0.14 mm =

7.14 mm

D. Using the following set of gauge blocks, what is the minimum number of blocks to be wrung together to produce an overall dimension of 47.765 mm

Show your calculations (3 points)

Metric 103 pieces	
	Increment
1 piece (1.005) mm	
49 pieces (1.01-1.49) mm	0.01 mm
49 pieces (0.5- 24.5) mm	0.5 mm
4 pieces (25-100) mm	25 mm

we need 5 block gauge

47.765
- 1.005
46.760
- 1.26
45.50
- 0.5
45.0
- 25.00
20.00
- 20.00
0.00

Question 2:

Describe the working principle of the Clinometer **6 points** 6

clinometer , is a device using for angular measurment . how to face aligned from each other ; put the clinometer on one face check the reading of Bubbles equel zero if not you have to move knope and reverse until the Bubbles give zero reading . clinometer consist of two scale main scale in degree , veineer scale in minute you can get the reading in seconed by reverse work piece after that add all reading to get the amount of actual measure of angle

Question 3: **14 points**

A surface was tested for straightness using an autocollimator and a reflector; the readings are shown in the following table, if one second of arc increase in angle observed corresponds to a rise of 0.25 micron of the front end of the reflector relative to its rear end.

A. Construct a profile graph of the surface relative to the initial points (0- 50). (4 points)

B. Calculate the maximum deviation of the profile from the straight line using the least square method. (10 points)

Position	Autocollimator reading	Difference from first reading	Rise of fall over 50 mm	Cumulative rise or fall						
Mm	Sec	sec	micron	micron						
0	0	0	0	0	0		-250	-3.7	925	-0.37
0 -50	22	0	0	0	1	1	-200	-3.7	740	-1.22
50-100	20	-2	-0.5	-0.5	2	1.5	-150	-4.2	630	-2.07
100-150	18	-4	-1	-1.5	3	1.5	-100	-5.2	520	-2.92
						0	-50	-7.7	385	-3.77

A surface was tested for straightness using an autocollimator and a reflector, the readings are shown in the following table, if one second of arc increase in angle observed corresponds to a rise of 0.25 micron of the front end of the reflector relative to its rear end

A. Construct a profile graph of the surface relative to the initial points (0- 50). (4 points)
B. Calculate the maximum deviation of the profile from the straight line using the least square method. (10 points)

	Position	Autocollimator reading	Difference from first reading	Rise of fall over 50 mm	Cumulative rise or fall			x_m $(x-\bar{x})$	y_m $(y-\bar{y})$	$x_m x_m$	$y_m x_m$
	Mm	Sec	sec	micron	micron						
	0	0	0	0	0	0		-250	-3.7	925	-0.37
1	0 -50	22	0	0	0	1	1	-200	-3.7	740	-1.22
2	50-100	20	-2	-0.5	-0.5	2	1.5	-150	-4.2	630	-2.07
3	100-150	18	-4	-1	-1.5	3	1.5	-100	-5.2	520	-2.92
4	150-200	12	-10	-2.5	-4	4	0	-50	-7.7	385	-3.77
5	200-250	16	-6	-1.5	-5.5	5	-0.5	0	-9.2	0	-4.62
6	250-300	26	4	1	-4.5	6	1.5	50	-8.2	-410	-5.47
7	300-350	24	2	0.5	-4	7	-3	100	-7.7	-770	-6.32
8	350-400	20	-2	-0.5	-4.5	18	3.5	150	-8.2	-1230	-7.17
9	400-450	12	-10	-2.5	-7	9	-2	200	-10.7	-2140	-8.2
10	450-500	10	-12	-3	-10	10	0	250	-12.7	-3425	
	250										

graphical method → $\bar{y}$ (-3.77)

$$m = \frac{\sum y_m x_m}{x_m^2} = \frac{-4975}{275000} = -0.017$$

$$y = -0.017x + 1.48$$

$$c = \bar{y} - m\bar{x}$$

$$-3.77 - (-0.017 * 250)$$

error →
4.18
-4.07
-2.98
-3.13
-4.78
-5.93
-3.58
-2.23
-1.88
-1.8

of called measure of angle

1 3/4 1

Question 3: (4 points)

Describe the working principle of the clinometer

Question 4: (6 points)

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

The reading over the thread = 10.6270 mm

The reading over the cylinder = 10.7166 mm

The reading over the thread (with wires) = 11.0716 mm

The reading over the cylinder (with wires) = 14.2788 mm

The reading over the thread (with prisms) = 12.9306 mm

The reading over the cylinder (with prisms) = 16.5414 mm

And you know that the diameter of the standard cylinder is equal to 10.0000 mm ,the flank angle of the thread (θ) = 30° ,the diameter of the wire (d) = 2.0207 mm , and the pitch size of the thread (p) = 2.5 mm

The effective diameter equation is

$E_{pt} = T - \frac{3}{2}(\cot\frac{\theta}{2} - \frac{1}{2}\csc\frac{\theta}{2})\cdot d$

where T is the dimension under the wires

Calculate the major diameter, the minor diameter, and the effective diameter of the thread.

(Show your calculations)

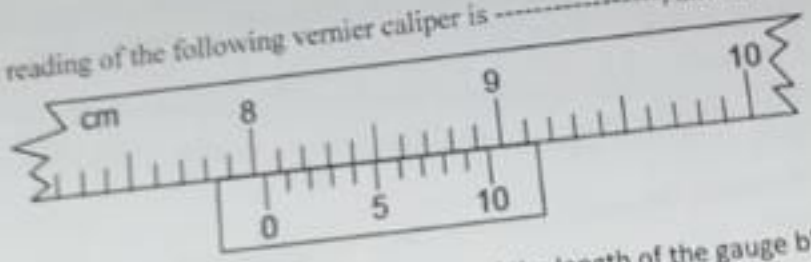
15. Which of the following statements is true

A. The micrometer conforms to Abbe's principle of alignment, while the vernier caliper doesn't conform.
B. The vernier caliper conforms to Abbe's principle of alignment, while the micrometer doesn't conform.
C. Both the vernier caliper and the micrometer conform to Abbe's principle
D. none of the above is correct

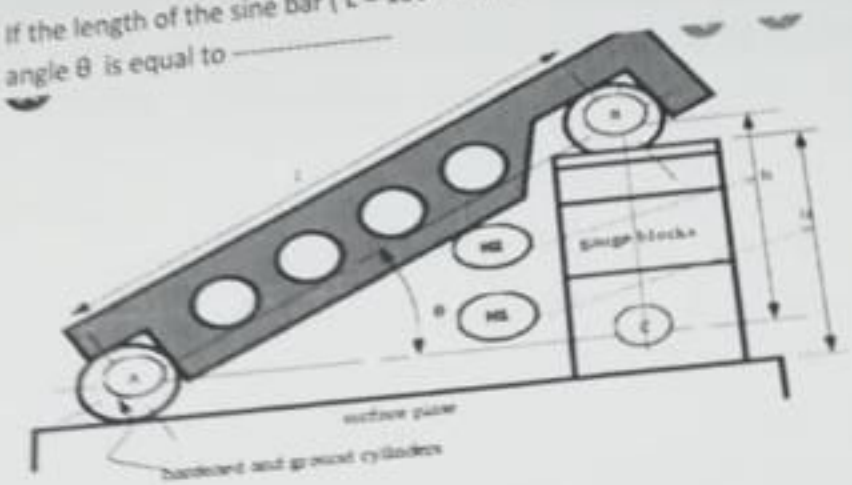
Question 2: (5 points)

A. The reading of the following vernier bevel protractor is ----------, and the accuracy is ----------

B. The reading of the following vernier caliper is ----------, and the accuracy is ----------



C. If the length of the sine bar (L = 100 mm), and the length of the gauge blocks (h=50 mm), then the angle θ is equal to ----------



8. ——— is the diameter at which the thread tooth and the thread space are equal.

A. the major diameter
B. the minor diameter
C. the effective diameter
D. the pitch diameter
E. the pitch size
F. both C and D are correct
G. none of the above is correct

9. we can use the bench micrometer to find different dimensions (major , minor , and effective diameters) for an internal threads.

A. True
B. False

10. in any thread, (external or internal), the major diameter is the distance between the crest and this distance should be perpendicular to the axis of the thread

A. True
B. False

11. while using the sine bar to measure an angle, it is feasible to use the angular blocks with the sine bar instead of the linear blocks.

A. True
B. False

12. the outside firm joint caliper is considered as ---------- measuring device.

A. a direct and a contact
B. a direct and a contactless
C. an indirect and contact
D. an indirect and contactless

13. the pitch gauge can be used to measure ----------

A. the pitch diameter of the thread
B. the effective diameter of the thread
C. the pitch size of the thread
D. both A and B are correct
E. all of the above are correct
F. none of the above is correct

14. which of the following is considered from the characteristics of the **linear block gauges :**

A. straightness
B. flatness
C. parallelism
D. all of the above are correct
E. none of the above is correct

9. ——— is the diameter at which the thread tooth and the thread space are equal.

A. the major diameter
B. the minor diameter
C. the effective diameter
D. the pitch diameter
E. the pitch size
F. both C and D are correct
G. none of the above is correct

F

10. we can use the bench micrometer to find different dimensions (major , minor , and effective diameters) for an internal threads.

A. True
B. False

B

11. in any thread, (external or internal), the major diameter is the distance between the crest and this distance should be perpendicular to the axis of the thread

A. True
B. False

A

12. while using the sine bar to measure an angle, it is feasible to use the angular blocks with the sine bar instead of the linear blocks.

A. True
B. False

B

12. the outside firm joint caliper is considered as ---------- measuring device.

A. a direct and a contact
B. a direct and a contactless
C. an indirect and contact
D. an indirect and contactless

C

13. the pitch gauge can be used to measure ----------

A. the pitch diameter of the thread
B. the effective diameter of the thread
C. the pitch size of the thread
D. both A and B are correct
E. all of the above are correct
F. none of the above is correct

14. which of the following is considered from the characteristics of the **linear block gauges :**

A. straightness
B. flatness
C. parallelism
D. all of the above are correct
E. none of the above is correct

D

15. Which

- a. Wire-wound RTD
- b. thin-film RTD
- c. Both A and B are correct

Clear my choice

4

Both the vernier caliper and the inside micrometer can be used to measure the depth of a specimen

Select one:

- a. True
- b. False

Clear my choice

5

The external micrometer is one of the indirect measuring instruments

Select one:

- a. True

Clear my choice

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.

Select one:

- a. True
- b. False

Clear my choice

The spring joint caliper is one of the direct measuring devices

Select one:

- a. True
- b. False

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n 22

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out of

n

Thermistors have either a negative temperature coefficient (NTC) or a positive temperature coefficient (PTC). The second (PTC) is more common.

Select one:

- True
- False

n 23

It is required to know the major diameter of the thread in order to determine the wires with the best size that will be used with the bench micrometer to measure the effective diameter of the external thread.

Select one:

- True
- False

n 24

Thermistors are more sensitive than the RTDs

Select one:

- True

to search

...stion 3: 5 Points

Using the root mean squared (RMS) method of surface roughness calculate the value of the surface roughness for the following ordinates obtained from testing a work piece of a length equal to 0.5 mm, where **h** are the ordinates of surfaces from mean line, and the vertical magnification factor is equal to 200000 times.

ordinates	h(mm)
1	0.45
2	- 0.55
3	0.65
4	0.20
5	-0.35
6	0.12
7	0.06
8	-0.12
9	-0.17
10	0.12

4/5

$$Ra = \frac{h_{max} - h_{min}}{\text{Magnification}}$$

$$= \frac{0.65 - (-0.55)}{200000} = 6 \times 10^{-6}$$

$$\frac{(1.54) - (1.25)}{5 \times 200000} = 2.9 \times 10^{-7}$$

$$\sqrt{\frac{\sum h^2}{n}} \times \frac{1}{m} = \sqrt{\frac{1.1657}{10}} \times \frac{1}{200000} = 1.707 \times 10^{-7}$$

$$\frac{0.65 + (-0.55)}{L} = \frac{0.65 - 0.55}{0.5} = 0.2$$

Question 4: 6 Points

Define the following terminology from the (thread measurement experiment)

1. major diameter $d_{major} = D(R_{th} - R_c)$

   The outside main diameter

2. minor diameter $d_{minor} = D(R_{th} - R_c)$

   the inside diameter

3. crest

   the tooth of

4/6

---------- can be used to measure the pitch size of an external thread.

- a. the micrometer
- b. the vernier caliper
- c. the three wires
- d. the pitch gauge

Question 3

Not yet answered

Marked out of 2.00

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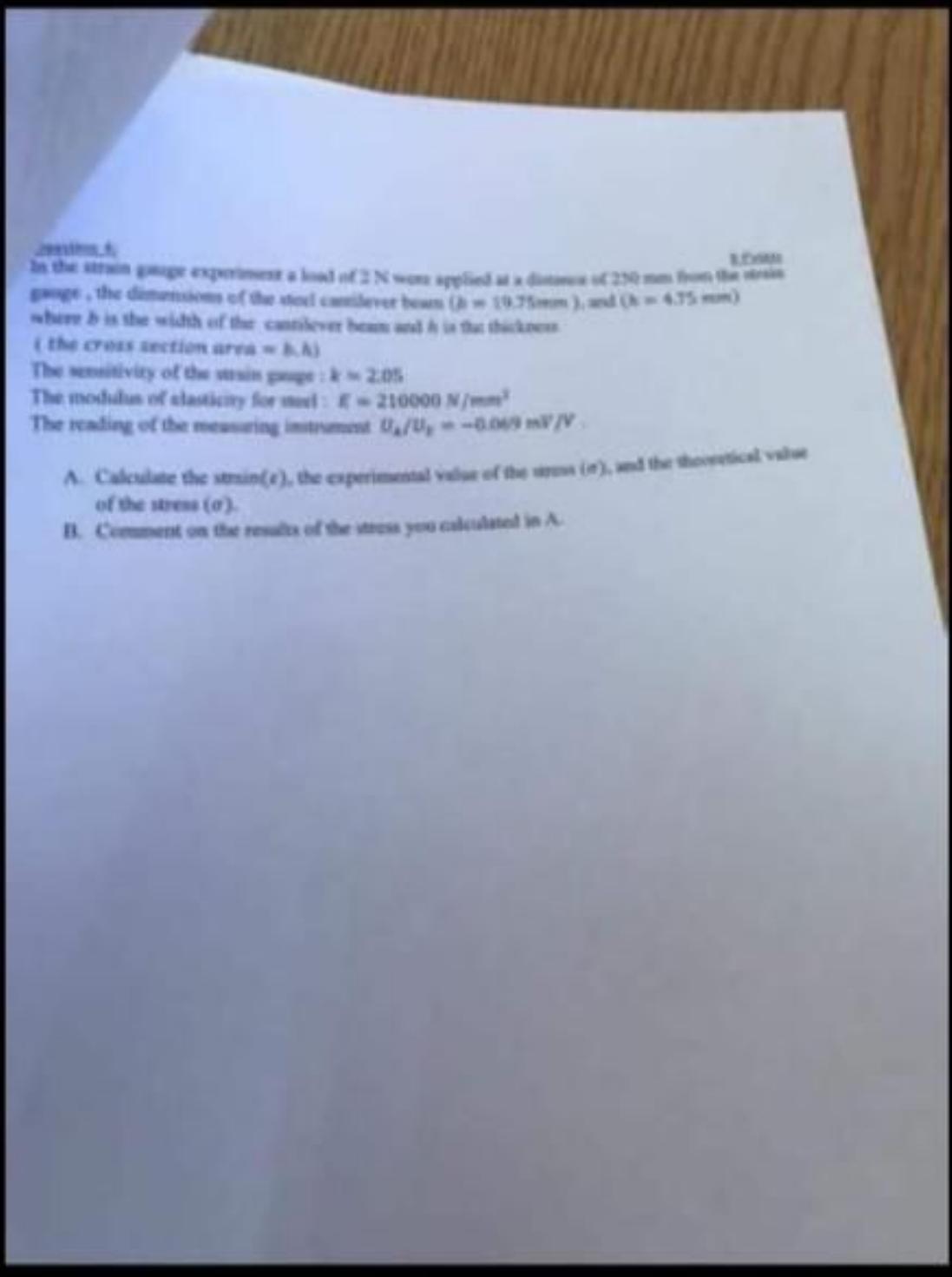
60%



In the strain gauge experiment a load of 2 N were applied at a distance of 250 mm from the strain gauge , the dimensions of the steel cantilever beam ($b = 19.75mm$), and ($h = 4.75\ mm$)
where b is the width of the cantilever beam and h is the thickness
(*the cross section area* $= b.h$)
The sensitivity of the strain gauge : $k = 2.05$
The modulus of elasticity for steel : $E = 210000\ N/mm^2$
The reading of the measuring instrument $U_A/U_E = -0.069\ mV/V$.

A. Calculate the strain(ε), the experimental value of the stress (σ), and the theoretical value of the stress (σ).
B. Comment on the results of the stress you calculated in A.

More

Edit

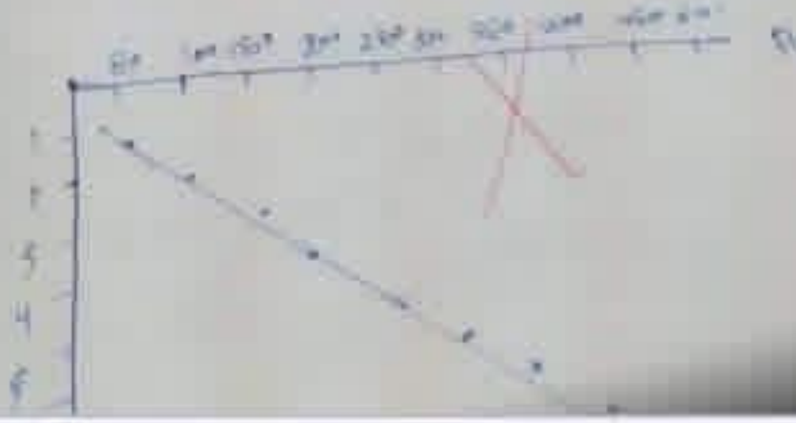
udent name: Student number: section

uestion 1: (8 points)

surface was tested for straightness using an autocollimator and reflector. the readings are hown in the following table, if one second of arc increase in angle observed corresponds to a se of 0.25 micron of the front end of the reflector relative to its rear end.

1. Construct a profile graph of the surface relative to the initial point (0.50 mm) (5 points)
2. Using the end points method to calculate the max deviation of the profile from the straight line. (3 points)

position	Autocollimator reading	Difference from first reading	Rise or fall over 50 mm	Cumulative rise or fall	Adjustment required	error
mm	Sec	Sec	micrometer	micrometer		
0		0	0			
0-50	40	0	0			
50-100	36	-4	-1.0			
100-150	32	-8	-2.0			
150-200	28	-12	-3.0			
200-250	25	-15	-3.75			
250-300	48	+8	+2.0			
300-350	44	-4	-1.0			
350-400	36	-12	-3.0			
400-450	20	-16	-4.0			
450-500	16	-4	-1.0			



Tareen Almasri 0194582
Haya Hamarsheh 0192249

2. Calculate stress and strain.
3. Name two types of strain gauge. Quarter-bridge, Full-bridge strain gauge.
4. Find the slope of the graph and compare the value with calculated one.

Example:

The stress is now to be determined for a load of 6.5 N where the reading was $-0.227 \cdot 10^{-3}$. The following results for the strain

$$\varepsilon = \frac{1}{k}\left(\frac{U_A}{U_E}\right)$$

$$= \frac{1}{2,05} \cdot (-0.227 \cdot 10^{-3})$$

$$= -0.0001107.$$

The modulus of elasticity for steel of 210000 N/mm2 gives the following stress:

$$\sigma = \varepsilon \cdot E$$

$$= -0.0001107 \cdot 210000 = -23.25 \text{ N/mm}^2.$$

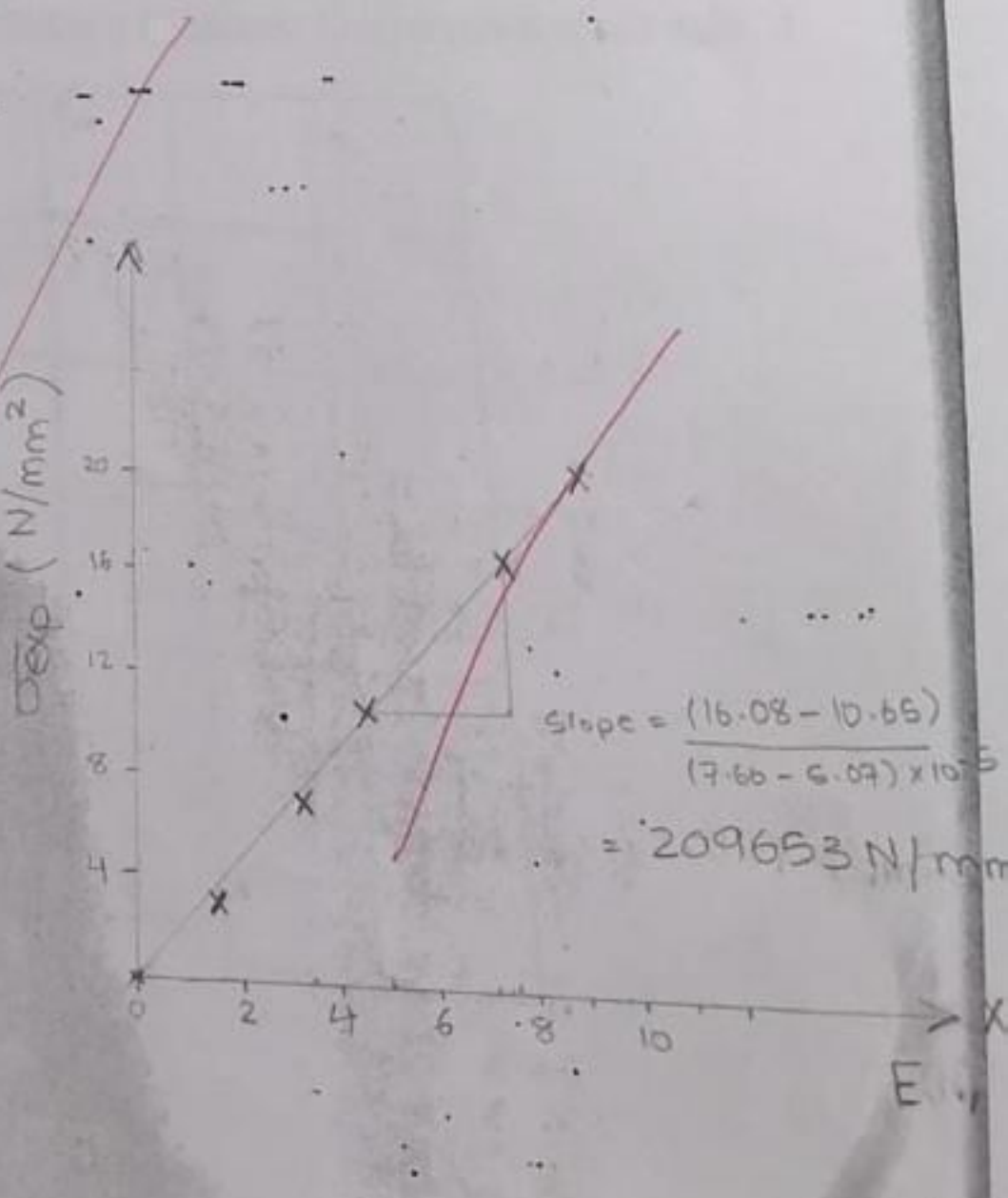
The measured stress is to be compared to the theoretical result in the following.
The section modulus for the rectangular cross section is $W_y = 74.26 \text{ mm}^3$.

The calculation produces the following stress

$$\sigma = \frac{Mb}{Wy}$$

$$= -6.5 \cdot 250/74.26 = -21.88 \text{N/mm}^2.$$

F	$\frac{U_A}{U_E}$ $\frac{\Delta V}{V}$	ϵ	σ_{exp}	$\sigma_{th} = \frac{N}{W}$
0	0	0	0	0
1	-0.034	1.66×10^{-5}	3.48	3.366
2	-0.069	3.37×10^{-5}	7.07	6.732
3	-0.104	5.07×10^{-5}	10.65	10.099
4.5	-0.157	7.66×10^{-5}	16.08	15.148
5.5	-0.192	9.37×10^{-5}	19.67	18.514



C. The reading of the following

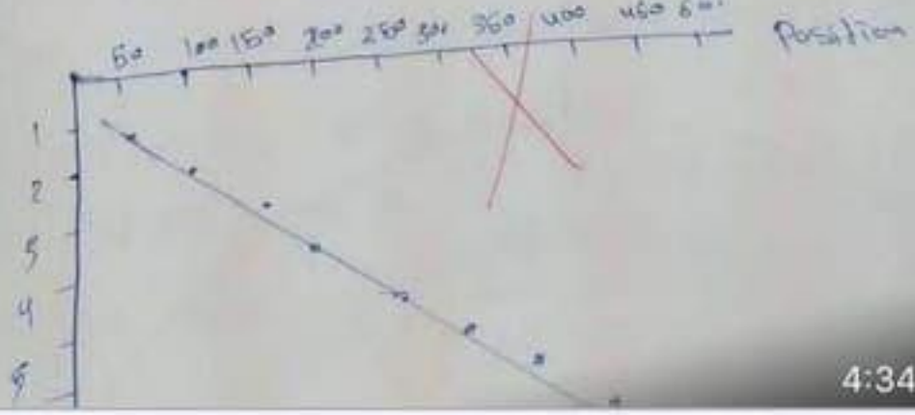
udent name: اسامة عبدالقادر النجيدي Student number: 0123380 section 5 ع/ا

uestion 1: (8 points)

surface was tested for straightness using an autocollimator and reflector; the readings are hown in the following table, if one second of arc increase in angle observed corresponds to a ise of 0.25 micron of the front end of the reflector relative to its rear end.

1. Construct a profile graph of the surface relative to the initial points (0-50 mm). (5 points)
2. Using the end points method to calculate the max deviation of the profile from the straight line. (3 points)

position	Autocollimator reading	Difference from first reading	Rise or fall over 50 mm	Cumulative rise or fall	Adjustment required	error
mm	Sec	Sec	micrometer	micrometer		
0		0	0			
0 -50	40	40	2.0			
50-100	36	-4	-2.0			
100-150	32	-4	-2.0			
150-200	20	-12	-6.0			
200-250	28	8	4.0			
250-300	48	20	1.0			
300-350	44	-4	-2.0			
350-400	36	-8	-4.0			
400-450	20	-16	-8.0			
450-500	16	-4	-2.0			



uestion 2

8 po

surface was tested for straightness using an autocollimator and reflector; the readings are hown in the following table, if one second of arc increase in angle observed corresponds to a ise of 0.25 micron of the front end of the reflector relative to its rear end.

1. Construct a profile graph of the surface relative to the initial points (0-50 mm). (5 points)
2. Using the end points method to calculate the max deviation of the profile from the straight line. (3 points)

Position	Autocollimator reading	Difference from first reading	Rise or fall over 100 mm	Cumulative rise or fall	Adjustment required	error
mm	Sec	sec	micrometer	micrometer		
0		0	0	0	0	
0 -50	8	0	0	0	1	
50-100	10	2	0.5	0.5	2	
100-150	18	10	2.5	3	3	
150-200	22	14	3.5	6.5	4	
200-250	24	16	4	10.5	5	
250-300	14	6	1.5	12	6	
300-350	10	2	0.5	12.5	7	
350-400	16	8	2	14.5	8	
400-450	18	10	2.5	17	9	
450-500	20	12	3	20	10	

$m = \frac{\sum xy}{\sum x^2} = 12.2$ $\bar{s} = 1.8181$

$C = \bar{s} - m\bar{x}$

$= 1.8181 - 24 \times 12.2$

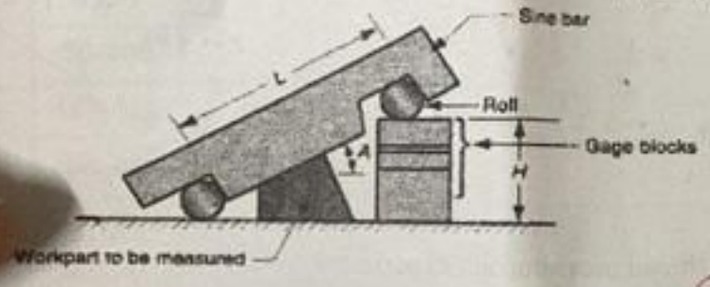
$= -3.1731817$

Question 5: 8 Points

A. Describe the working principle of the clinometer.

the clinometer is special case of the application of sipirt level in this instance level is mounted in rotatable body carried in housing are face of which forms the base of an instrument

B. A sine bar was used to measure the angle (A) of a certain specimen as shown in the following figure , the center-to-center distance between the cylinders on the sine bar (L) is equal to 100 mm. and the height of the block gauges (H) was equal to 49.535mm. Calculate the angle A.



$L = 100\,mm$

$H = 49.535$

$\sin\theta = \frac{H}{L}$

$= \frac{49.535}{100}$

$= \sin^{-1}(0.49535)$

$A = 29.6928$

Question 6: 7 Points

A. Write three reasons why the thermocouple has been popular choice over the years.

1. cost
2. ~~It's very accurate~~ availability
3. It's very accurate

B. Compare between the RTD and the thermistor, include the following in your answer: (resistance response to temperature change, and sensitivity)

	RTD	thermistor
resistance response	~~high~~ low	high
temep	~~lea~~ leanir ~~sub~~	leanir sub
sensitivity	~~height~~ stable	high

lainar

Question 3: 5 Points

Using the root mean squared (RMS) method of surface roughness calculate the value of the surface roughness for the following ordinates obtained from testing a work piece of a length equal to 0.5 mm, where **h** are the ordinates of surfaces from mean line, and the vertical magnification factor is equal to 200000 times.

ordinates	h(mm)
1	0.45
2	- 0.55
3	0.65
4	0.20
5	-0.35
6	0.12
7	0.06
8	-0.12
9	-0.17
10	0.12

4/5

$Ra = \frac{h_{max} - h_{mb}}{\text{Magnification}}$

$= \frac{0.65 - (-0.55)}{200000} = 6 \times 10^{-6}$

$\frac{(1.54) - (1.25)}{5 \times 200000} = 2.9 \times 10^{-7}$

$\sqrt{\frac{\Sigma h^2}{n}} \times \frac{1}{m} = \sqrt{\frac{1.165^2}{10}} \times \frac{1}{200000} = 1.707 \times 10^{-7}$

$\frac{0.65 + (-0.55)}{L} = \frac{0.65 - 0.55}{0.5} = 0.2$

Question 4: 6 Points

Define the following terminology from the (thread measurement experiment)

1. major diameter $d_{major} = D(R_{ts} - R_c)$

   The outside main diameter

2. minor diameter $d_{minor} = D(R_{rs} - R_c)$

   the inside diameter

3. crest

   the tooth of

4/6

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the bottom of the groove between the two flanking surfaces of the thread, whether external or internal, is called ----------

- a. the root of the thread
- b. the crest of the thread
- c. the flank of the thread
- d. the angle of the thread

Clear my choice

Thermistors exhibit a fast response rate, they 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.

Select one:

- True
- False

Next page

Finish attempt ...

Question 3)

8 Points

In the strain gauge experiment a load of 2 N were applied at a distance of 250 mm from the strain gauge , the dimensions of the steel cantilever beam ($b = 19.75mm$), and ($h = 4.75$ mm) where b is the width of the cantilever beam and h is the thickness

($the\ cross\ section\ area = b.h$)

The sensitivity of the strain gauge : $k = 2.05$

The modulus of elasticity for steel : $E = 210000\ N/mm^2$

The reading of the measuring instrument $U_A/U_E = -0.069\ mV/V$

A. Calculate the strain(ε), the experimental value of the stress (σ), and the theoretical value of the stress (σ).

B. Comment on the results of the stress you calculated in A.

8

d

out of

question

if the smallest division of the main scale of the vernier caliper is 1 mm, and its vernier scale is divided into 10 divisions, then the accuracy of the device is

Select one:

- a. 0.01 mm
- b. 0.1 mm
- c. 0.05 mm
- d. 1 mm

Clear my choice

stion 1
t yet
swered
arked out of
00
Flag question

A bench micrometer was used to measure the major diameter of an external thread, given that the diameter of the standard cylinder is 20.0000 mm. the micrometer reading over the standard cylinder was 20.9344, the micrometer reading over the thread was 21.1342 mm, then the major diameter of the thread is equal to ------- -----

Select one:

- a. 19.8002 mm
- b. 20.1998 mm
- c. 22.0686 mm
- d. None of the above is correct

Clear my choice

Question 2
Not yet

The bottom of the groove between the two flanking surfaces of the thread whether internal or external

Quiz

1
10
19

Finish att

Time left

Type here to search

Clear my choice

stion 21

yet

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0

Flag question

The accuracy of the vernier bevel protractor is

Select one:

- a. 1 min
- b. 2.5 min
- c. 5 min
- d. 1 degree

Clear my choice

The reading of the vernier bevel protractor is

- a. 28 degrees and 34 minutes
- b. 28 degrees and 15 minutes
- c. 34 degrees and 15 minutes
- d. 15 degrees and 34 minutes

B

In an extemal thread, the distance between two consecutive crests parallel to the axis of the thread is called ----------

- a. the pitch size
- b. the lead of the thread
- c. the height of the thread
- d. the major diameter of the thread

A

if 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 veriner scale is 10 divisions then the accuracy of the device is equal to ----------

- a. 0.01 mm
- b. 0.02 mm
- c. 0.001 mm
- d. 0.002 mm

C?

Next page

---------- can be used to measure the pitch size of an external thread.

- a. the micrometer
- b. the vernier caliper
- c. the three wires
- d. the pitch gauge

Clear my choice

B

b. the vernier caliper

c. the three wires

d. the pitch gauge

Clear my choice

In the strain gauge experiment , we found that the experimental value of the stress and the theoretical one are equal.

Select one:

True

False

Next page

tivity

Jump to...

In order to calculate the error of straightness using Autocollimator

- a. we can use the least square method
- b. we can use the end points method
- c. both a and b are correct
- d. none of the above is correct

C

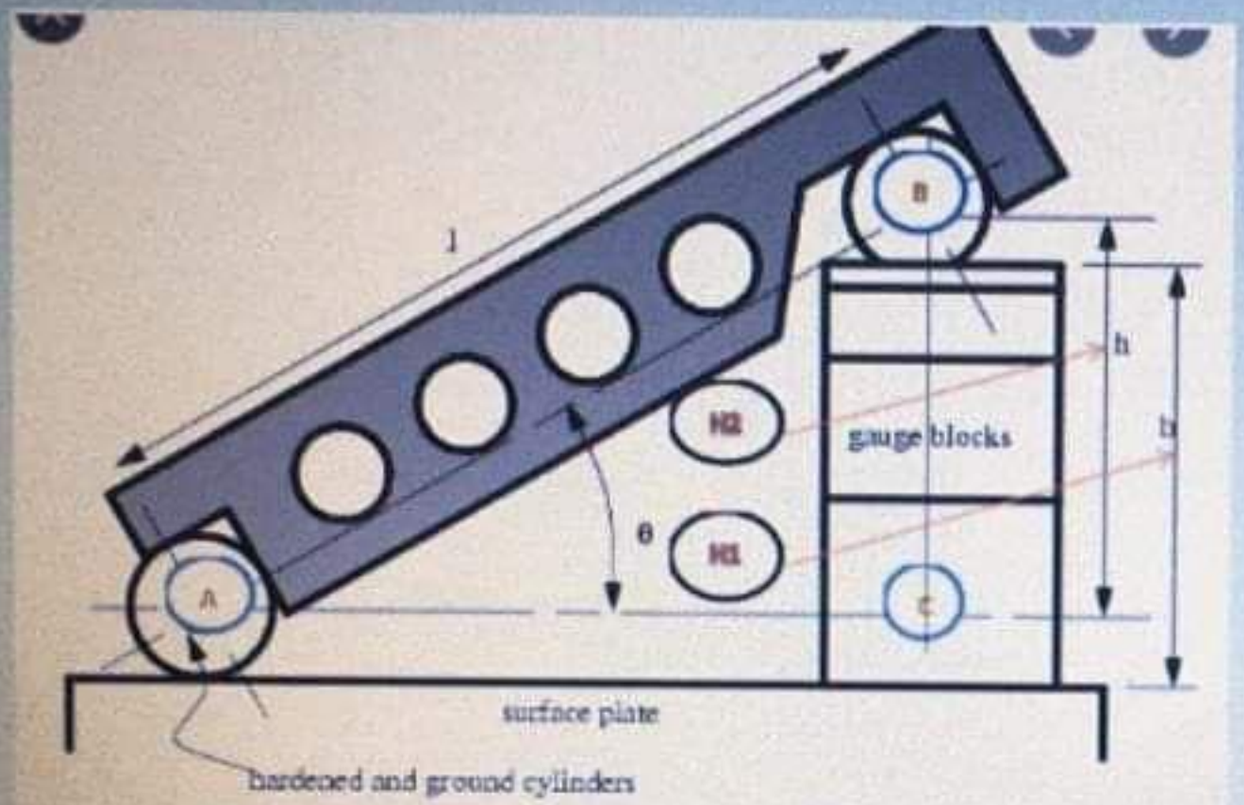
Next page

ous activity

od/quiz/attempt.php?attempt=307566&cmid=278524#

search

If the length of the sine bar (L = 100 mm), and the height of the gauge blocks (h=50 mm), then the angle theta is equal to ----------



- a. 30 degree
- b. 45 degree
- c. 60 degree
- d. none of the above is correct

30

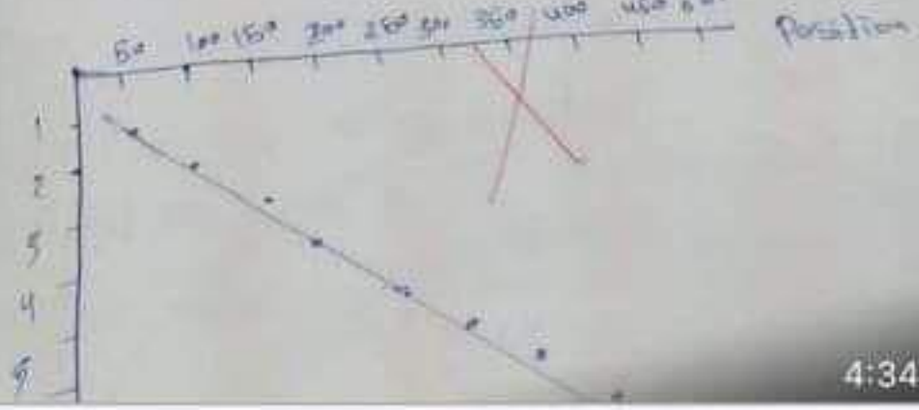
udent name: Student number: 0123880 section

uestion 1: (8 points)

surface was tested for straightness using an autocollimator and reflector; the readings are hown in the following table, if one second of arc increase in angle observed corresponds to a ise of 0.25 micron of the front end of the reflector relative to its rear end.

1. Construct a profile graph of the surface relative to the initial points (0-50 mm). (5 points)
2. Using the end points method to calculate the max deviation of the profile from the straight line. (3 points)

position	Autocollimator reading	Difference from first reading	Rise or fall over 50 mm	Cumulative rise or fall	Adjustment required	error
mm	Sec	Sec	micrometer	micrometer		
0		0	0			
0 -50	40	40	20			
50-100	36	-4	-2.0			
100-150	32	-4	-2.0			
150-200	20	-12	-6.0			
200-250	28	8	4.0			
250-300	48	20	1.0			
300-350	44	-4	-2.0			
350-400	36	-8	-4.0			
400-450	20	-16	-8.0			
450-500	16	-4	-2.0			



In the strain gauge experiment a load of 2 N were applied at a distance of 250 mm from the strain gauge, the dimensions of the steel cantilever beam ($b = 19.75mm$), and ($h = 4.75\ mm$) where b is the width of the cantilever beam and h is the thickness
($the\ cross\ section\ area = b.h$)
The sensitivity of the strain gauge : $k = 2.05$
The modulus of elasticity for steel : $E = 210000\ N/mm^2$
The reading of the measuring instrument $U_A/U_E = -0.069\ mV/V$.

Calculate the strain

- a. $7068.293\ N/mm^2$
- b. $7.068293\ N/mm^2$
- c. 0.033659
- d. $3.3659 * 10^{-5}$

C

4:39 4G

Big G

13 Photos

Select

4:34 PM

Question 2:

Describe the working principle of the Clinometer 6 points

[illegible handwritten answer]

Question 3: 14 points

A surface was tested for straightness using an autocollimator and a reflector, the readings are shown in the following table, if one second of arc increase in angle observed corresponds to a rise of 0.25 micron of the front end of the reflector relative to its rear end.

A. Construct a profile graph of the surface relative to the initial point (0-50). (4 points)

B. Calculate the maximum deviation of the profile from the straight line using the least square method. (10 points)

Position	Autocollimator reading	Difference from first reading	Rise of fall over 50 mm	Cumulative rise or fall
Mm	Sec	sec	micron	micron
0	0			
0-50	22			
50-100	20			
100-150	18			
150-200	12			
200-250	16			
250-300	24			
300-350	24			
350-400	20			
400-450	12			
450-500	18			

4:34 PM

Question 2: (12 points)

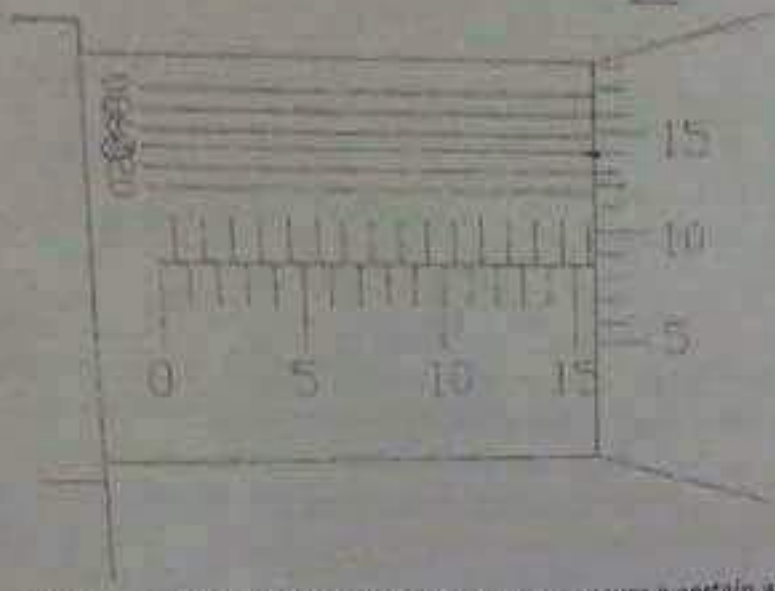
Fill in the space:

A. The reading of the following vernier caliper is [redacted] and the accuracy is 0.05 mm

16 Points

A student used a vernier micrometer to measure a certain dimension. The diagram shows an enlargement of the micrometer scales. What reading was recorded?

Note; the dimensions on the sleeve are in mm.



16.34 mm = 163.9 mm

4

15.50 +
0.80
0.04
16.34

B. A student used a vernier bevel protractor to measure a certain angle. The diagram below shows the reading of the angle. What reading was recorded?

28° 15'

The reading of the angle is

4

Final exam
Measurement lab (0906442)

Eng. Lamees Al-Dorghom
may, 8,2018

Student name: _____ Student no: _____ Section: _____

Question 1: 15 Points

Select the best answer for each of the following paragraph:

1. What device is similar to an RTD but has a negative temperature coefficient?
A. Strain gauge
B. Thermistor
C. Negative-type RTD
D. Thermocouple

2. Temperature sensing can be achieved by the use of
A. Thermocouples
B. RTDs
C. Thermistors
D. All of the above

3. The output voltage of a typical thermocouple is
A. less than 100 mV
B. greater than 1 V
C. Thermocouples vary resistance, not voltage
D. None of the above

4. The connections to a thermocouple:
A. can produce an unwanted thermocouple effect, which must be compensated for
B. produce an extra desirable thermocouple effect
C. must be protected, since high voltages are present
D. both B and C are correct

5. The purpose of compensation for a thermocouple is:
A. to cancel unwanted voltage output of a thermocouple
B. to decrease temperature sensitivity
C. to increase voltage output
D. used for high-temperature circuits

6. The strain gauge resistance varies with:
A. Vibration
B. Heat
C. Weight
D. Bending

7. RTD stands for
A. Relative Thermal Devices
B. Radioactive Thermonuclear Dipoles
C. Resistance Temperature Detectors
D. Resistive Temperature Devices

8. The decrease of resistance with the temperature increase is a property of:
A. Thermocouple
B. bimetallic thermometer
C. Thermistor
D. RTD

Question 3:

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

8 Points

The reading over the thread =	9.6329 mm
The reading over the cylinder =	9.7216 mm
The reading over the thread (with wires) =	10.0766 mm
The reading over the cylinder (with wires) =	13.2838mm
The reading over the thread (with prisms) =	11.9356 mm
The reading over the cylinder (with prisms) =	15.5464 mm

And you know that the diameter of the standard cylinder is equal to 30.0000 mm , the flank angle of the thread $(\theta) = 30^{\circ}$, the diameter of the wire $(d) = 2.0207$ mm , and the pitch size of the thread $(p) = 3.5$ mm

The effective diameter equation is

$D_{eff} = T + \frac{p}{2}\cot\theta - (cosec\,\theta - 1) * d$

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)

Question 3: 8 Points

In the strain gauge experiment a load of 2 N were applied at a distance of 250 mm from the strain gauge , the dimensions of the steel cantilever beam ($b = 19.75mm$), and ($h = 4.75$ mm) where b is the width of the cantilever beam and h is the thickness

($the\ cross\ section\ area = b.h$)

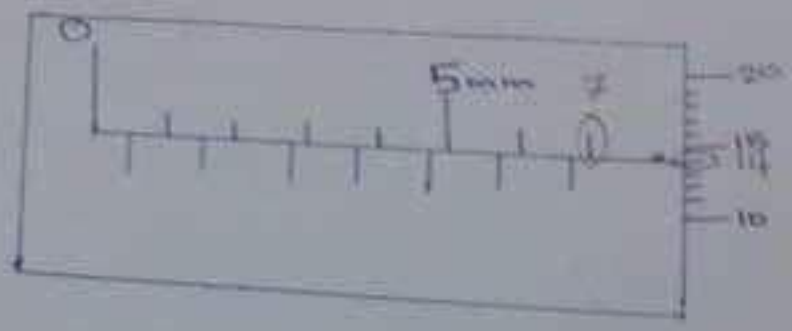
The sensitivity of the strain gauge : $k = 2.05$

The modulus of elasticity for steel : $E = 210000\ N/mm^2$

The reading of the measuring instrument $U_A/U_E = -0.069\ mV/V$

A. Calculate the strain(ε), the experimental value of the stress (σ), and the theoretical value of the stress (σ).

B. Comment on the results of the stress you calculated in A.



$\Longrightarrow$ 7.14 mm

What size is the gauge block build-up used with a 10 inches sine bar to set the work piece at an angle of $4^{\circ}30'$? Show your calculations

$\sin\theta = \frac{h}{L} \Rightarrow \boxed{h = \sin\theta * L}$

Describe the working principle of the Auto collimator?

The Auto Collimator is an optical device used to measure small angles with very high sensitivity. The Auto collimator projects a beam of collimated light. An external reflector reflects all or part of the beam back into the instrument where the beam is focused and detected by a photodetector

3

the Auto Collimator measures the deviation between the

Q2

(A) is a component of surface texture.

(B) measurment of the more widely spaced component of surface texture

(C)

9. In the RTD experiment , the relationship between the Resistance and temperature is linear.
A. True
B. False

10. Thermi stors are
A. Less sensitive than RTDs
B. More sensitive than RTDs

11. With all co mmon types of RTD, the resistance increases as Temperature increases.
A. True
B. False

12. RTDs t ypically have much higher nominal resistance values than thermistors.
A. True
B. False

13. - _____ refers to the predominant direction of the surface texture.
A. Form
B. Lay
C. Profile
D. Center line

14. The inside micrometer is one of the indirect measuring instruments
A. True
B. False

Question 2:
Define the following Terminology from the Surface Texture Experiment. 9 Points

A. Roughness

B. Waviness

C. Lay

D. Profile

E. Center line

F. Form

Q1)

1) B
2) D
3) A
4) A
5) A
6) C
7) C
8) B
9) A
10) A
11) A
12) B
13) A
14) B

9) True
10) A

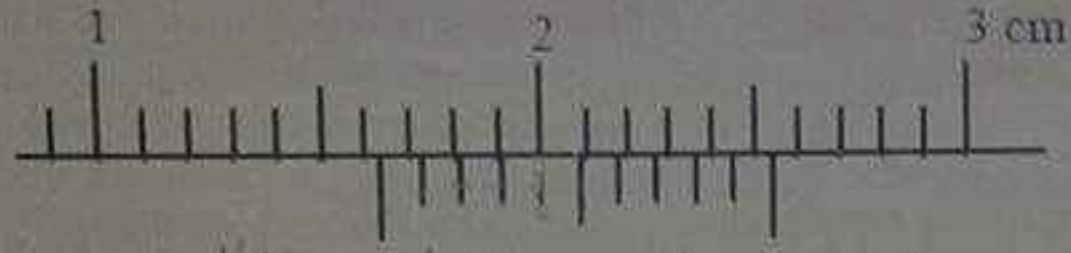
Question 1: **10 points**

A. What size is the gauge block build-up used with a 5 inches sine bar to set the workpiece at an angle of 4° 30'? show your calculations (3 points)

$\theta = 4.5°$ $\quad$ L = 5 inche = 12.7 cm

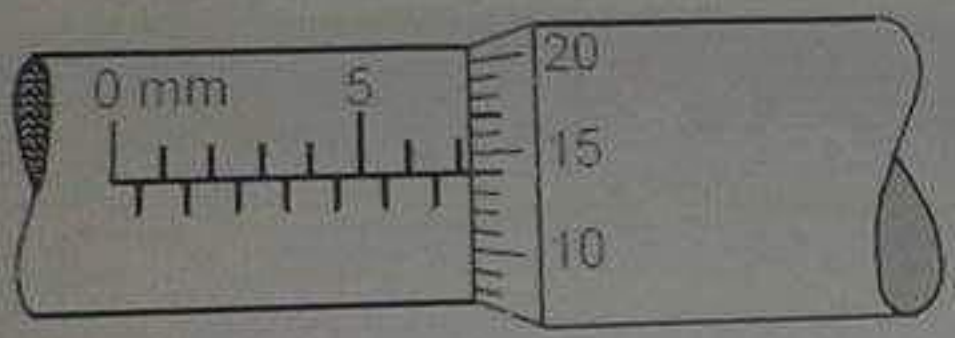
$\sin\theta = \frac{h}{L} \Rightarrow h = \sin 4.5° * 12.7 = 0.9996$ cm =

B. A student used a vernier caliper to measure the diameter of a cylinder. The diagram shows an enlargement of the caliper scales. What reading was recorded? (2 points)



11 mm + 0.1 x 4 = 11.4 mm

C. What is the reading of the following micrometer? (2 points)



7 mm + 0.14 mm =

7.14 mm

D. Using the following set of gauge blocks, what is the minimum number of blocks to be wrung together to produce an overall dimension of 47.765 mm

Show your calculations (3 points)

Metric 103 pieces	
	Increment
1 piece (1.005) mm	
49 pieces (1.01-1.49) mm	0.01 mm
49 pieces (0.5- 24.5) mm	0.5 mm
4 pieces (25-100) mm	25 mm

25 we need 5 block gauge.

47.765

① 1.005

46.760

② 1.26

45.50

③ 0.5

45.0

④ 25.00

20.00

⑤ 20.00

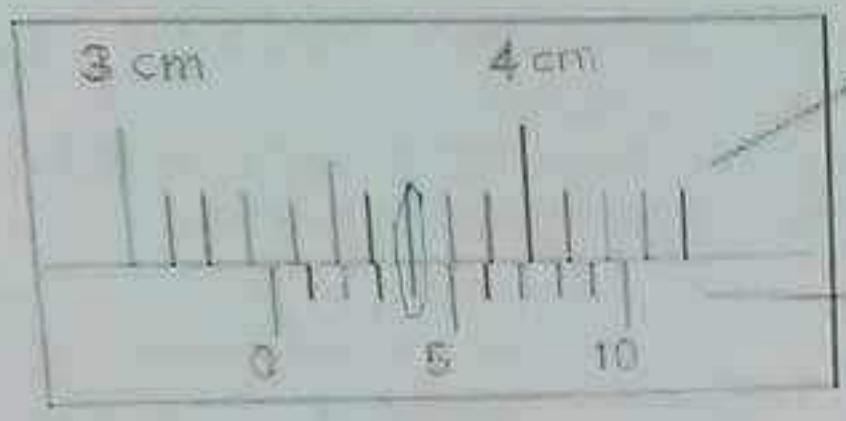
0.00

4/12

Question 2: (12 points)

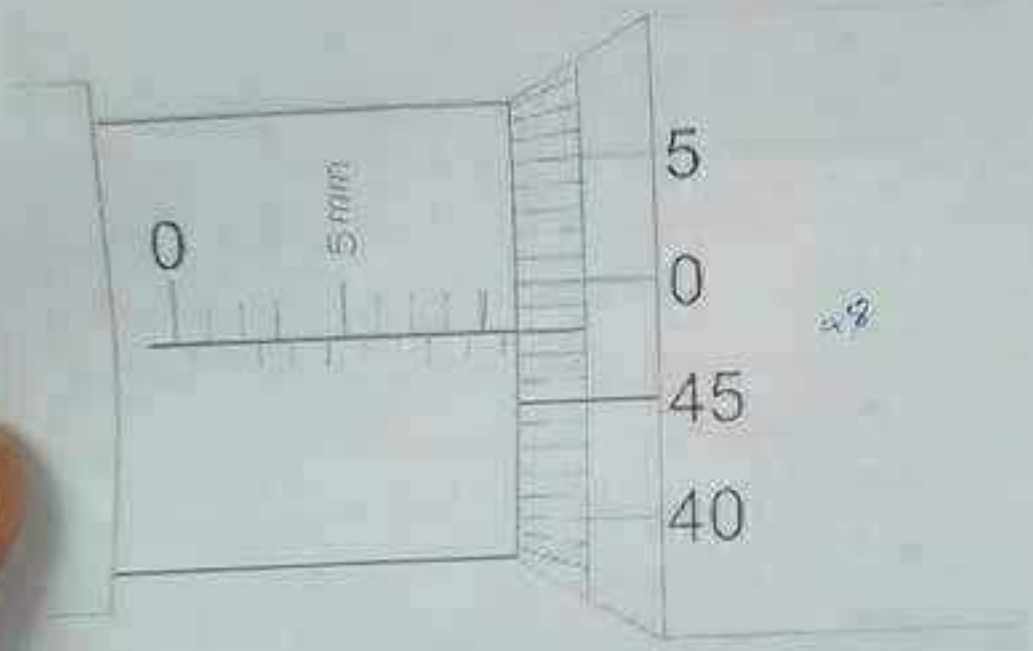
Fill in the space:

A. The reading of the following vernier caliper is 3.34 cm, and the accuracy is 0.05 mm

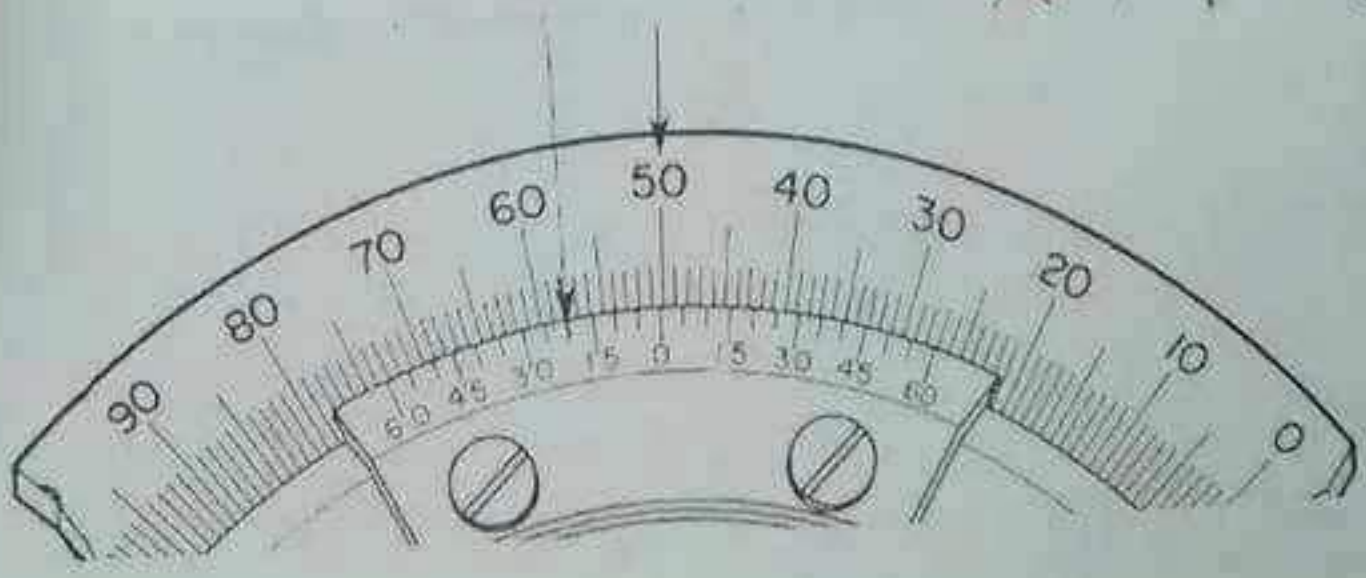


3.3
0.04
3.34

B. The reading of the following micrometer is 9.28 mm and the accuracy is 0.1 mm

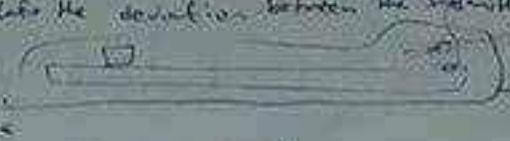


C. The reading of the following vernier bevel protractor is 49° 20', and the accuracy is 0.05



Question 2: (14 points)

A. Describe with a simple sketch the working principle of the autocollimator. (6 points)



B. Describe the working principle of the clinometers (4 points)

C. Does the external micrometer obeys to the Abbe's Principe? Explain (4 points)

Question 3: (4 points)

A. Using the following set of gauge blocks, list the minimum number of blocks to produce an overall dimension of 76.575 mm. (show your calculations)

Metric (103) pieces	
	Increment
1 piece (1.005) mm	
49 pieces (1.01 to 1.49) mm	0.01
49 pieces (0.5 to 24.5) mm	0.5
4 pieces (25- 100) mm	25

B. Write two applications of block gauges.

Question 4: (4 points)

What is the minimum number of blocks that will be used to produce an overall dimension of 18.7775 mm. Show your calculations.

4/4

Note : remember to include the wearing blocks.

5 + 2 wearing blocks = (7)

	Pieces	Increment
One piece	1.0005	
9 pieces	1.001-1.009	0.001
49 pieces	1.01-1.49	0.01
19 pieces	0.5-9.5	0.5
9 pieces	10-90	10
2 pieces (wearing block)	2 mm each one	

18.7775
① ... 1.0005 -
17.777
② ... 1.007 -
16.77
③ ... 1.27 -
15.5
④ ... 1.5 -
14
⑤ ... 2 -
12
⑥ ... 2 -
10
⑦ ... 10 -
00

Question 5: (8 points)

A. Describe **Abbes' principle**, and provide an example for a device that follows Abbes' principle. **(3 points)**

when the measured Peace is aligned with the axial dimension of the device the accuracy becomes higher . Example: [external micrometer]

4/8

B. Compare between line standard and end standard devices. **(2 points)**

line Standards : the distance between two Parallel lines.

end Standards : the distance between two Parallel Surfaces

C. Describe the working principle of the clinometer. (3 points)

it is a special case of Spirit level.

we put the device on the workpiece that has two adjusted ~~surf~~ faces to measure the angle. we adjust to make the ~~water~~ bubble in the middle (to make the reading Zero) then we take our measures.

- main Scale in Degrees
- Vernier in minutes.

Group [8]

Experiment one linear measurments

0217902	رهف الرفاعي
2210640	حور عطيات
0216701	ريانا الحاج
0212681	ليان ابو مارية
0215151	ريم كفاية

8/10

Questions: Vernier Caliper

Q① No Vernier Caliper doesn't Confirm to Abbes principle Because Abbes Principle states that measurment must be directly in dine with axis measured to minimize errors in this Case, error may be substional.

Q2 Error of a Vernier Caliper $\frac{1}{20} = 0.05$

Q3 function of Sliding blade (movable Jaw), we can use it to measure outer and inner diameter and also measuring depth

Q4 direct Reading have arrow sliding blade attached to Sliding Jaw
yes it applies Cause Caliper also have sliding Blades, depth

Q5 Sources of error in Caliper parallax error (not Reading with aligment), Surface error, user error, bias error, Random error, systematic error

Q6 if locking screw isn't used The reading might shift Slightly during measurment which will Result in error in Reading

Q7 yes we can Consider it as final Reading but we Can Consider Compartor

Q8 its Considered line standard Cause reading is taken directly from dine

Q9 measure internal and external and depth and Larger measuring Range, easier to use

Tuesd

Dania ALnsour

CF=0.5

Δθ

y

0

Adj

curacy is based on the precision of Screw thread,
could be inaccure meusurments because of
the movemet of Speciemen.

6 - * least count micrometer
* accuracy of Screw thread
* ability to read scale

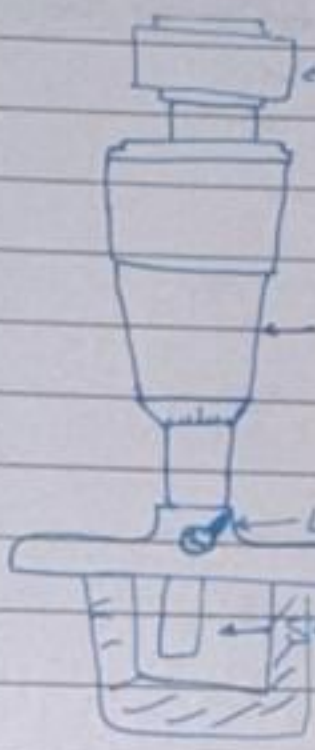
7 - * parallex error
* wear on spindle

8 - yes, rotating, it can cause
friction on the surface of the
object & introduce Smallerror.

...rsity Of Jordan
...ng and Technology
...Department

Micrometer

1.



2- 2 threads

3- Yes, the axis of the spindle is aligned with the axis of the screw thread that controls measurement

4- 0.5 mm

5- over tightening can cause:
- damage to the spindle or anvil
- inaccurate readings
- damage to the measuring object
- wear on internal components

4- Yes, micrometer can be used as comparitor

Measuring instrument	D_1	D_2	D_3	D_4	D_a	D_b	D_c	D_d	H_1	H_2	H_3	H_4	H_5
Vernier Caliper	18.30	24.00	31.00	46.50	9.80	unfound	21.50	29.70	–	–	–	10.75	71.10
Outside micrometer	18.32	25.97	30.84	46.30	–	–	–	–	–	–	–	–	–

all in (mm)

OBJECTIVES:-

-To familiarize students with types and applications of block gauges.
- To be able to calibrate linear measurements tools.
- Learn the correct ways of using them in measurements.
- Learn how to maintain them in the correct shape

INTRODUCTION:

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

Block gauges are practical length standards of 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 tenth 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 are highly accurate
-End standard have a built in datum because there measuring faces are flat and parallel
-The accuracy of end and line standard 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: each tow surfaces or two lines are parallel to a very high degree.

But there is four types of block gauges differ by the degree of there accuracy, quality and roughness.

Grades of gauge blocks:

1. 00
2. Calibration: this grade provides the highest level of accuracy required in normal engineering practice and is intended for calibrating other blocks in conjunction with suitably accurate comparators. They are used where tolerance are 2 micrometer or less and are not intended for generally gauge inspection.
3. 0
4. 1
5. H

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

USING THE BLOCK GAUGES:

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),

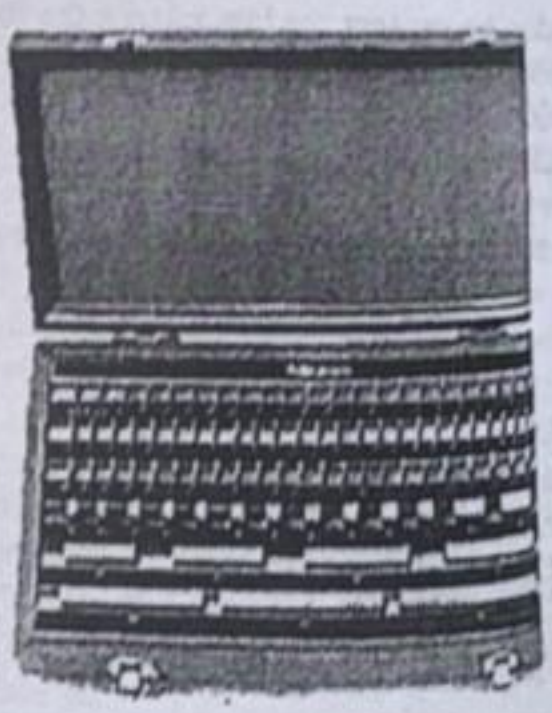
1.30-1.39 (by 0.001 steps),

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.

As can be seen from the figure 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 by noticing that they shine the most of the six faces. The length is taken between these tow surfaces which 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 tetrachloride or other DE-greasing agents and wiped dry on a clean

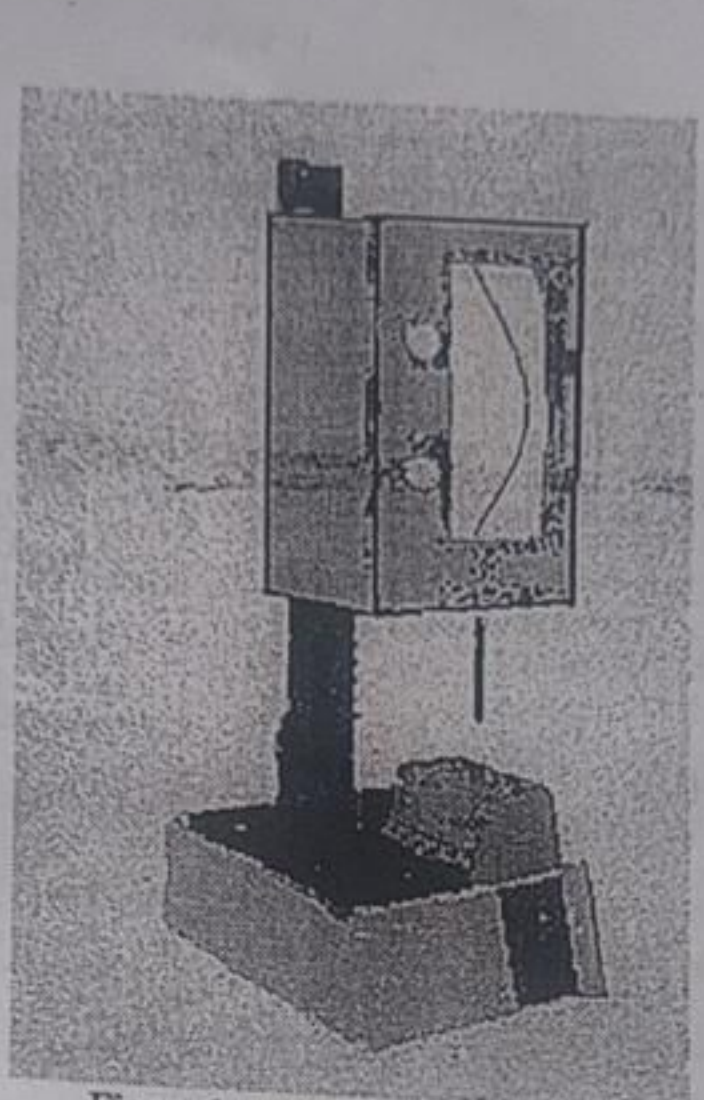


Figure 1 mechanical comparator

As seen in the figure the mechanical comparator is used to detect the correct number of blocks needed to the desired length, and it provides a rang of tolerance within the measurement is acceptable.

DISCUSSION:

1. State the difference between end standard and line standard? And state the reason that make the end standard more accurate?
2. Stat the difference between the different grades of the blocks.
3. What is the accuracy of the block gauges? How did you reach the answer?
4. Why do we always choose the minimum number of blocks combination?
5. Why do we bather ourselves with how the blocks should be attached to each other?
6. Suggest other applications for block gauges?
7. In the comparator measuring method what do we compare with?

University Of Jordan
Faculty of Engineering and Technology
Industrial Engineering Department

Measurement Lab.

EXPERIMENT 2 :

BLOCK GAUGES

Student Name :
Student No. :

GROUP (8)

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Yafa Ahmad 0216701
Noor Atayat 2210640
~~Rancem Kefaya~~.
Rancem Kefaya 0215151

cloth. Then be wiped with clean soft chamois leather. Slip gauges they should be held across one another at right angles and wiring them with a rotary motion; this 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 satisfactory. Unless a very firm wring is obtained there is always the possibility that the wringing film maybe a micrometer thick.

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

1. Remove the gauge blocks required from the protective case
2. Clean of 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 moister.
-Avoid magnetization.
-Handle lapped faces as little 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 it after use. If gauges are not in frequent use they should be coated to prevent corrosion.
-Do not handle gauges above open box, they mat cause damage to other gauges if dropped.

It was mentioned earlier that we have to build the desired length of the blocks; the following example explains the procedure:
-Build a 30.967 mm using the minimum number of blocks.

30.967
- 1.007
29.960
-1.090
28.870
-1.370
27.500
-7.500
20.000

= 2

So we 5 blocks are used to build the desired length.

APPARATUS:

- Set of block gauges
- Granite surface plate

-Rahaf AL Refai 0217902

Hoor atyat 2210640

- Yafa AL Haj 0216701

- Layan Abu sheikha 0212681

Group8

9/10 11

- Ranéem Kefayeh. 0215151

VMF = 2000

1] $Ra = \frac{Peak - Valley}{VMF} = \frac{5.3 - -2.1}{2000} = 3.7 * 10^{-3}$

2) 10 Points Height of irregularities

$R = \frac{(5.4+5+5.2)+3.8+2.6) - (-5.5-5.2-4.5-4.5-3.5)}{5 * 2000} = \frac{22 - -23.2}{5 * 2000} = 4.52 * 10^{-3}$

3) Root mean Square

$RMS = \sqrt{\frac{\Sigma h2}{n}} * \frac{1}{VMF} = \sqrt{\frac{3.1^2 + 1.6^2 + 1.7^2 + .9^2 + 0.5^2}{5}} \frac{1}{2000}$

$= \frac{1.7956}{2000} = 8.978 * 10^{-4}$ cm

4) CLA -

$CLA = \frac{\text{area Above} + \text{area Below}}{L * VMF}$

$= \frac{(1.43 + 3.25 + 4.37 + 3.38 + 0.76 + 2.7 + 1.08 + 3.15 + 0.825 + 4.95 + 2.275 + 4.29 + 1.305 + 4.95}{20 \times 2000} =$

$\Rightarrow 1.075 * 10^{-3}$

DOMS

8 marks

COMMITTED TO SUSTAINABLE PRODUCTIVITY

* رنيم كنانة 0215151 [14]
* ياقا الحاج 0216701
* ليان أبو شدف 0212681
* حور العين دقياق 2210640

Group (8)

Subject _____ Day _____ Date _____

Q. Discussion:

* to know how to use the measuring tool & take reading & it requires accuracy & precision

* Any unknown projections will cause to enduce errors in the angle measured For the building of the slip

* The overall time required for the measurment would depend on the complexity of the component.

* I will use the Sine bar for measuring (4) one component, because setting up the sine bar take time.

	angle 3	angle 1	angle 2
plate protractor	50°	out of range	83°
Vernier protractor	51° 5'	32° 10'	83° 20'
Clinometer	—	32° 41'	—

Group 8

Rahaf Al Refai 0217902

Raneem Kelayeh 0215151

Yafa AL Haj 0216701

Layan Abu Shelkha 0312681

Noor Al-Ja 2210640

Group 8
Tuesday

Rahaf ALRefai 0217902
data Noor ALetyat 2210640
Yafa AL Haj 0216701

dania ALnsour ~~020884~~ 0208819

exp → Straightness Error

Cf = 0.5

Position	θ	Δθ	ΔY = Cf * Δθ (0.5)	y	Adj	error
0-100	45	0	0	0	0	0
100-200	59	14	7	7	10.5	17.5
200-300	63	18	9	16	~~25~~ 21	37
300-400	34	-11	-5.5	10.5	31.5	42
400-500	15	-30	-15	-4.5	42	37.5
500-600	-20	-65	-32.5	-37	52.5	15.5
600-700	-30	-75	-37.5	-74.5	63	-11.5
700-800	17	-28	-14	-88.5	73.5	-15
800-900	20	-25	-12.5	-101	84	-17
900-1000	37	-8	-4	-105	94.5	-10.5

$\left(\frac{-y}{n} = \frac{+105}{10} = 10.5\right)$

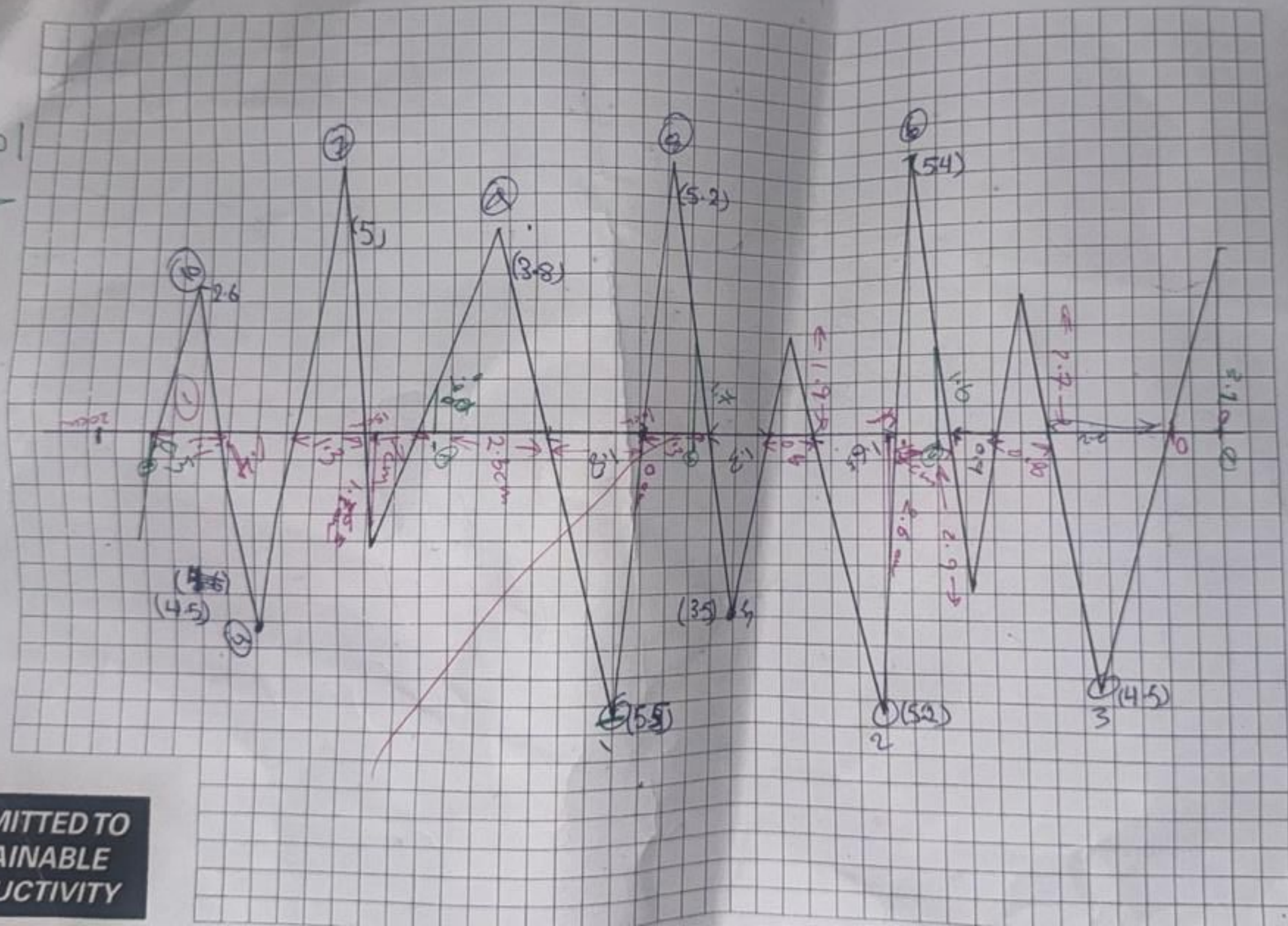
max error

* max Value = 42

min = -17

42 - -17 = 59 = straightness error

Group 8



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CL

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Group 8

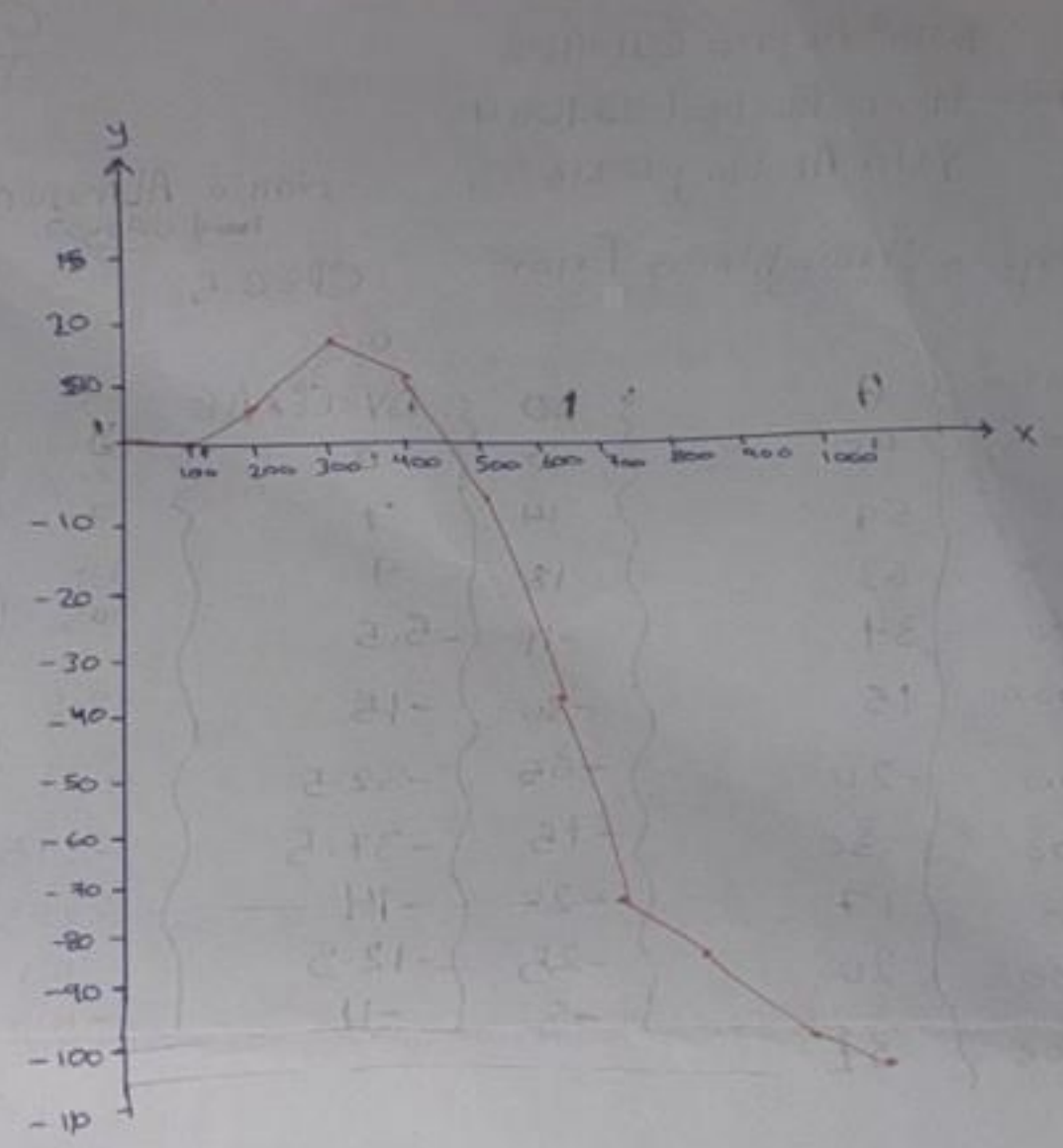
Rahaf Al Refai 0213908

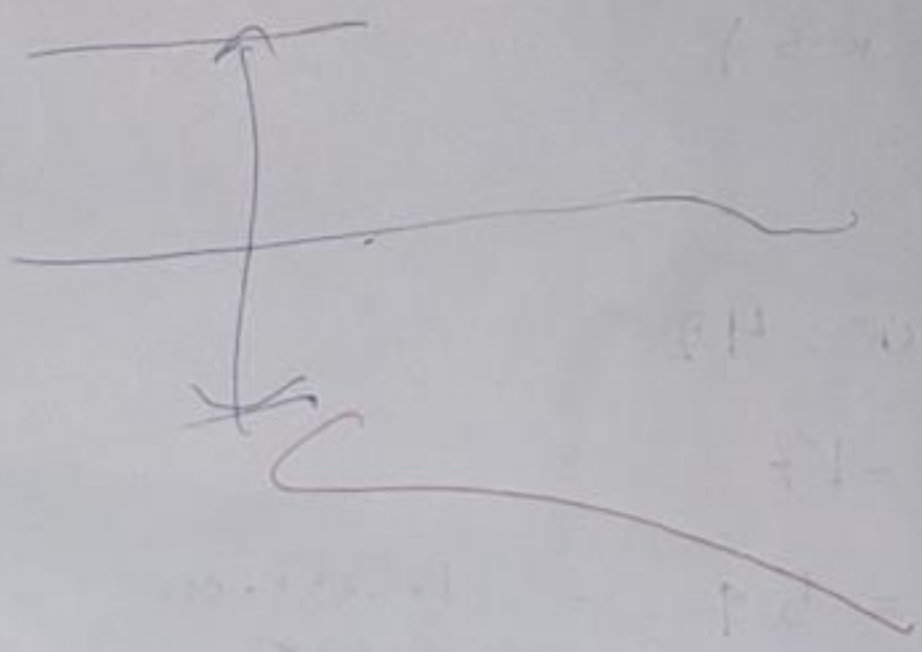
Ramzem Kefayeh 0215151

Yafa AL-hajj 0216701

Iuljan Abu Shelkha 0212451

Noor Al-Ja 0220410





DETERMINATION OF STRAIGHTNESS ERROR USING AUTOCOLLIMATOR

Prepared: 30 Jan 2006

Principle: An autocollimator is an instrument which can measure small angles. They incorporate a collimating lens which is designed to transmit a parallel beam of light radiating from a source at its principal focus. A plane reflector placed in the path of the beam and normal to the geometric axis of the lens will reflect the light along the transmitted path to be refocused at the source (Fig.1). If the reflector is inclined at a small angle $\delta\theta$ to the normal, the beam is reflected at an angle equal to $2\delta\theta$ from its transmission path (Fig. 2). Any portion of the reflected beam passing through the lens will be refocused at the focal plane at a distance d from the principal focus. Consider that reflected ray which so happens to pass through the geometric centre of the lens. From the triangle made with this ray and the focal length f, $d=2f\delta\theta$. Thus the point at which the reflected beam is focused is independent of the distance of the reflector from the lens. However, as the angle increases, the amount of light that falls back onto the lens decreases and hence there is a limit to the distance that the reflector can be placed.

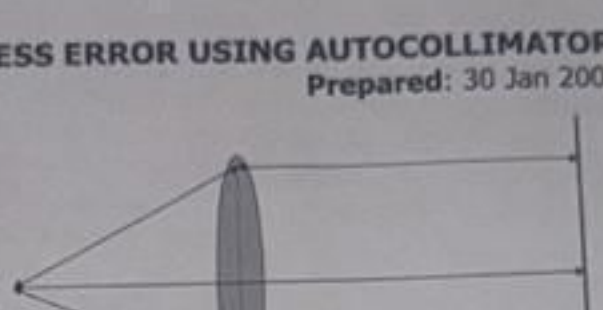


Fig. 1

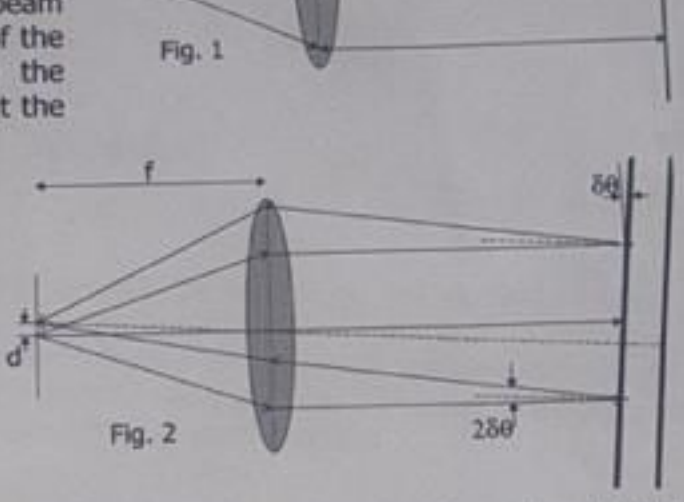


Fig. 2

An autocollimator is essentially a telescope permanently focused at infinity and fitted with means for illuminating an internal target graticule. There is also a micrometer eyepiece viewing system for measuring the displacement d of the image. A schematic diagram of the Microptic Visual Autocollimator is shown in Figure 3. The illuminated

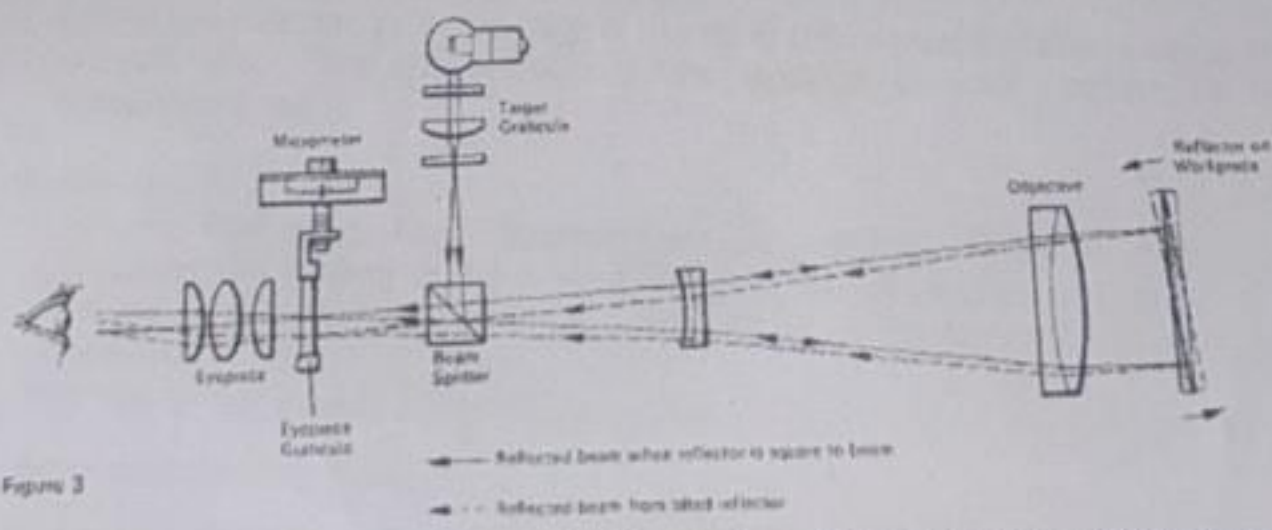


Figure 3

target graticule is situated in the principal focal plane of the objective and the emergent beam is directed along the axis of the telescope by a beam splitter. The reflected beam,

passing straight through the beam splitter, is brought to a focus on the eyepiece graticule and both the graticule and the image are viewed simultaneously through the eyepiece. The eyepiece graticule lines can be moved across the field of view by means of the micrometer, until they coincide with the reflected target image, thus enabling its displacement to be measured. The micrometer is graduated in angular units corresponding to the angular displacement of the reflector.

Measurement of straightness:
See the annexure for definition of straightness error. The principle employed for measurement is illustrated in Figure 4. The reflector is mounted on a carriage which is moved step by step from its initial position AB at one end of the slideway to successive positions BC, CD etc. along the surface. The distances between adjacent points A, B, C, D ... are equal to the nominal span of the carriage (50 mm). Any lack of straightness of the slideway will cause the carriage to tilt slightly. The angles of tilt are measured by the autocollimator and the difference in height of the two feet of the carriage can then be calculated for each position.

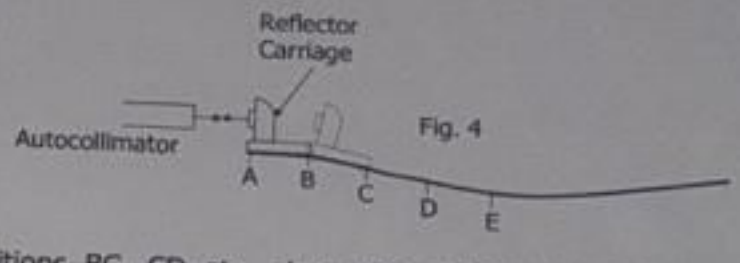


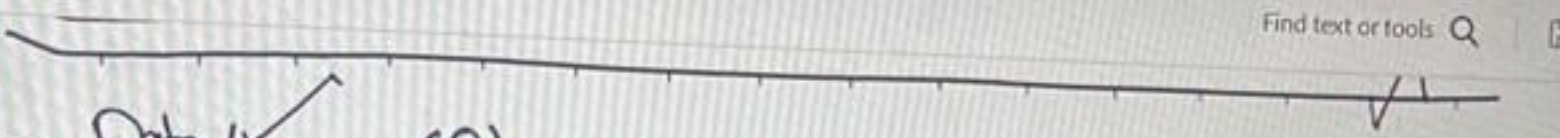
Fig. 4

Procedure:

1. Position the micrometer of the autocollimator to measure displacements in the vertical plane. Place the carriage at the nearest position AB and adjust the autocollimator base until the reflected image of the target crosslines is near the centre of the field of view.
2. Move the carriage to the other end of the bed and check that the reflected image is still within the range of measurement. If it is not, make fine levelling or rotational adjustments to the autocollimator.
3. Return the reflector carriage to position AB. Take an autocollimator reading and record it
4. Move the carriage along to its second position (BC) and take another reading. Continue thus until the carriage is at the end.
5. Repeat the readings as the carriage is moved in the reverse direction, towards the autocollimator. Take the average of the readings at each position as the measurement result.

Calculation:

1. See table next page. The "difference from first reading" column is obtained by subtracting the reading at AB (=20 in this example) from the readings at other positions. This is the variation in tilt of the reflector compared with its attitude at position AB.
2. The "rise or fall" column is the angular deviation in previous column converted into linear displacement. $1\ \text{second} = \frac{1}{3600} * \frac{\pi}{180}\ radians = \frac{1}{3600} * \frac{\pi}{180} * 50{,}000\mu m$ $\equiv 0.25\mu m$. Add a zero at the top of the column to represent the height of point A (regarded as the datum).



Data (x) (θ)

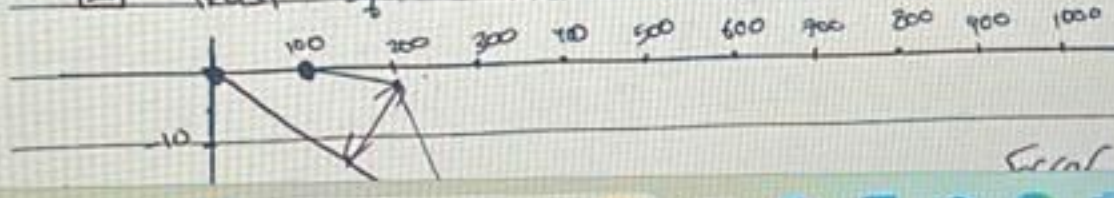
position	Reading	Diff	Raise or fall	cumulative	Adjustment	Error
0-100	27	0	0	0	0	0
100-200	33	-4	-2	-2	9	7
200-300	-17	-54	-27	-29	18	-11
300-400	-22	-59	-29.5	-58.5	27	-31.5
400-500	-11	-48	-24	-82.5	36	-46.5
500-600	15	-22	-11	-93.5	45	-48.5
600-700	17	-20	-10	-103.5	54	-49.5
700-800	54	17	8.5	-95	63	-32
800-900	59	22	11	-81	72	-12
900-1000	43	6	3	-81	81	0

-81 / 10 = -8.1

Calculate the error of straightness using:

[1] End points method:

[2] least square method: (position)



Error = (max - min)

Error = (7 - -49.5)

Final exam
Measurement lab (0906442)

Eng. Lamees Al-Dorghom
may, 8,2018

Student name: _____ Student no: _____ Section: _____

Question 1: 15 Points

Select the best answer for each of the following paragraph:

1. What device is similar to an RTD but has a negative temperature coefficient?
A. Strain gauge
B. Thermistor
C. Negative-type RTD
D. Thermocouple

2. Temperature sensing can be achieved by the use of
A. Thermocouples
B. RTDs
C. Thermistors
D. All of the above

3. The output voltage of a typical thermocouple is
A. less than 100 mV
B. greater than 1 V
C. Thermocouples vary resistance, not voltage
D. None of the above

4. The connections to a thermocouple:
A. can produce an unwanted thermocouple effect, which must be compensated for
B. produce an extra desirable thermocouple effect
C. must be protected, since high voltages are present
D. both B and C are correct

5. The purpose of compensation for a thermocouple is:
A. to cancel unwanted voltage output of a thermocouple
B. to decrease temperature sensitivity
C. to increase voltage output
D. used for high-temperature circuits

6. The strain gauge resistance varies with:
A. Vibration
B. Heat
C. Weight
D. Bending

7. RTD stands for
A. Relative Thermal Devices
B. Radioactive Thermonuclear Dipoles
C. Resistance Temperature Detectors
D. Resistive Temperature Devices

8. The decrease of resistance with the temperature increase is a property of:
A. Thermocouple
B. bimetallic thermometer
C. Thermistor
D. RTD

Tanθ =h/ radius
θ = 1 sec of arc
h=tan 1 sec x Radius
h = 4.848 x 10^{-6} meter
h = 5 micrometer / meter approximately
h = 0.5 micrometer / 10^{-3} mm

$$\tan(\theta) = \frac{h}{l}$$

Assume $\theta = 1\text{sec}$

$\tan(\theta) \approx \theta$ for small values

$$1\text{sec} = (\frac{1}{60\times 60})\frac{\pi}{180} = 4.8\times 10^{-6} rad$$

$$h = 4.8\times 10^{-6} m$$

i.e. each 1 sec indicates a vertical distance of approximately 0.5 micron "since L = 0.1m".

ex:
For θ=3° find the corresponding vertical distance, for L = 0.1m.

$$h = 3\times 60\times 60\times 4.8\times 10^{-7} = 5.18\times 10^{-3} m$$

Principles of operation

The autocollimator projects a beam of collimated light. An external reflector reflects all or part of the beam back into the instrument where the beam is focused and detected by a photodetector. The autocollimator measures the deviation between the emitted beam and the reflected beam. Because the autocollimator uses light to measure angles, it never comes into contact with the test surface.

Visual autocollimators rely on the operator's eye to act as the photodetector. Micro-Radian visual autocollimators project a pinhole image. The operator views the reflected pinhole images through an eyepiece. Because the human eye acts as the photodetector, resolution will vary among operators. Typically, people can resolve from 3 to 5 arc-seconds. Because the human eye is able to discern mutiple images simultaneously, visual autocollimators are suitable for measuring multiple surfaces

simultaneously. This makes them ideal alignment instruments in applications like aligning laser rod ends or checking parallelism among optics. Visual autocollimators can also be equipped with an eyepiece reticle for aid in lining up test optics to a master reference.

Visual Autocollimator Sample Applications

1-Measurement of non-parallelism in windows, laser rod ends,

DETERMINATION OF STRAIGHTNESS ERROR USING AUTOCOLLIMATOR

Prepared: 30 Jan 2006

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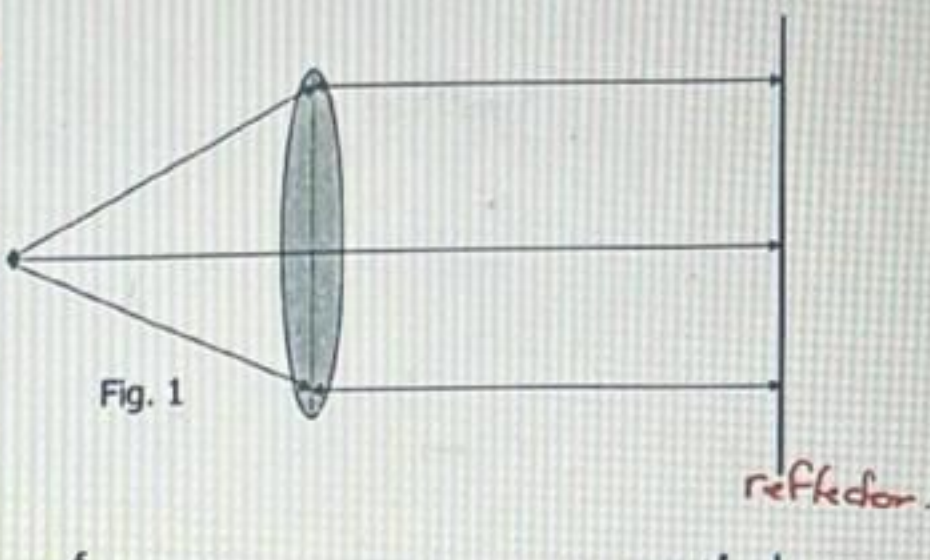


Fig. 1

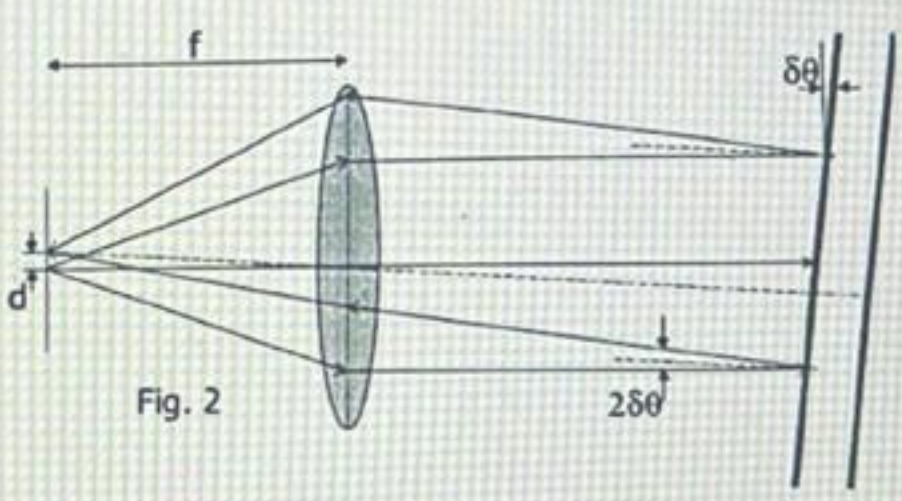


Fig. 2

An autocollimator is essentially a telescope permanently focused at infinity and fitted

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

$\therefore majorD_{th} = D_c + (R_{th} - R_c)$

2. To find the **Minor diameter**of an external thread

$\therefore minorD_{th} = D_c + (R_{th(prism)} - R_{c(prism)})$

3. To find the **effective diameter**E_d of the external thread (using the three wires meth

For the distance T

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

$E_d = T + 2x$

Where $2x = \frac{P}{2}\cot\theta - d(cosec\,\theta - 1)$

$(d: diameter\ of\ the\ wire)$

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

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

Now, $x = AB - AF$ and $AF = AE - EF = AE - d/2$

$\therefore AF = \frac{d}{2}(\cos ec\,\theta - 1)$

Therefore, $x = \frac{P}{4}\cot\theta - \frac{d}{2}(\cos ec\,\theta - 1)$

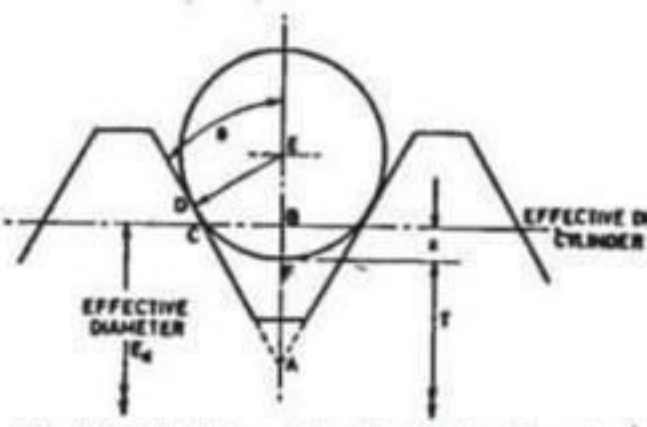
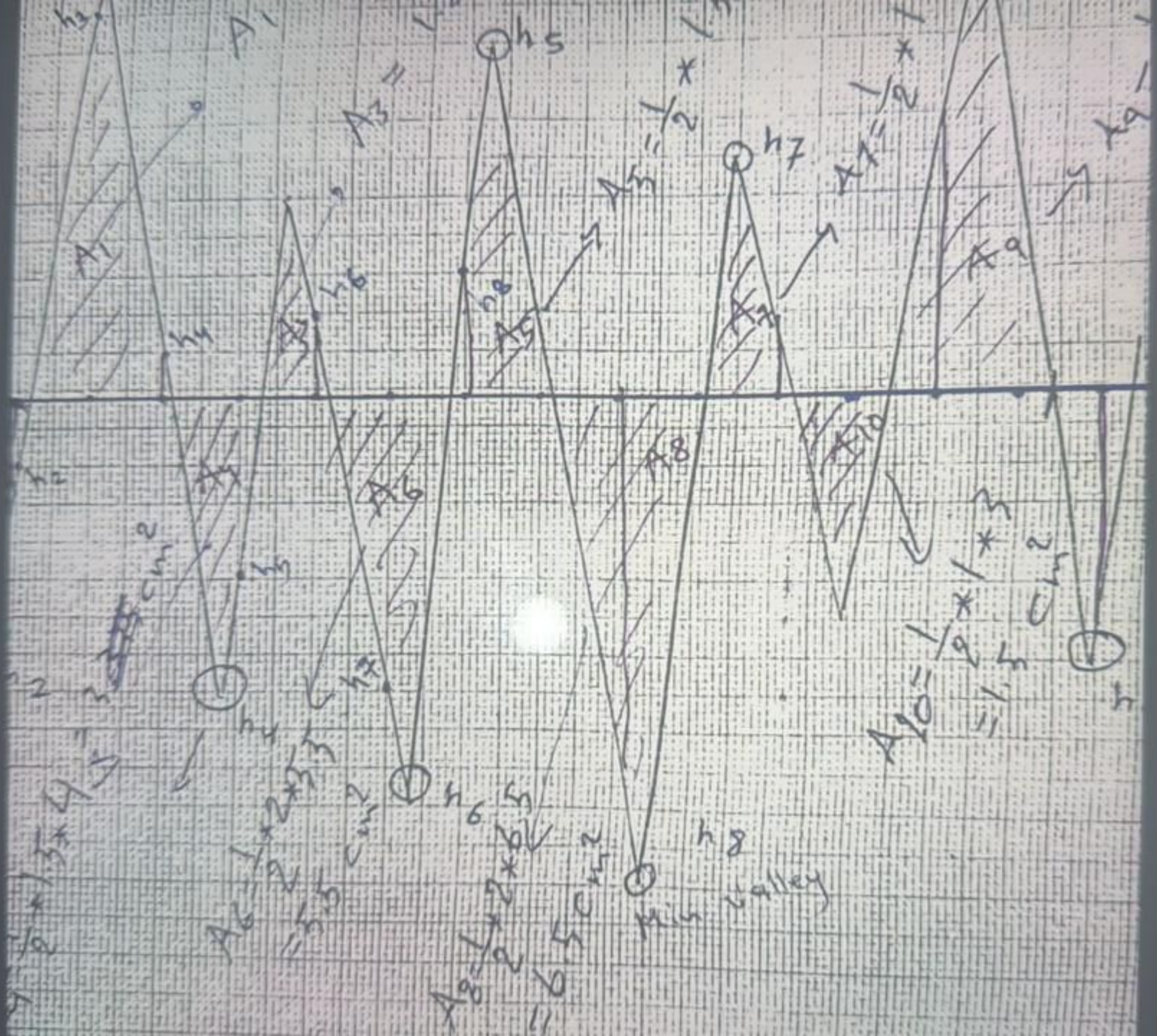


Fig-14 Calculation of simple effective diameter.[4]

where,

P= Nominal Pitch
D=Wire Diameter
θ= Nominal Flank Angle or semi angle of thread


h1
h2
h3
h4
h5
h6
h7
h8
h9
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
main valley

Question 1: (15 points)
Select the best answer for each of the following paragraph

1. The linear block gauges is considered as an example of ——— measuring devices.

   A. line standard
   B. end standard
   C. both A and B are correct
   D. none of the above is correct

2. The depth of the thread = $\frac{major\ diameter - minor\ diameter}{2}$

   A. True
   B. False

3. if the vernier bevel protractor is used to measure obtuse angle then the reading of the device will equal to the required angle plus 90.

   A. True
   B. False

4. which of the following devices follows Abbes' principle

   A. the vernier caliper
   B. the dial caliper
   C. the micrometer
   D. two points inside micrometer
   E. both c and d are correct
   F. all of the above are correct
   G. none of the above is correct

5. if the smallest division of the main scale of the vernier caliper is 0.5 mm, and its vernier scale is divided into 50 divisions, then the accuracy of the device is ——— mm

   A. 0.01 mm
   B. 0.02 mm
   C. 0.05 mm
   D. None of the above is correct

6. in the vernier caliper , the accuracy of the device always equals to the difference between the size of division on the main scale and the size of division on the vernier scale

   A. True
   B. False

7. the mechanical comparator can be used to calibrate the linear measuring devices

   A. True
   B. False

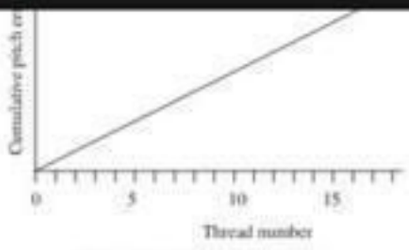


Fig. 8.28 Progressive pitch error

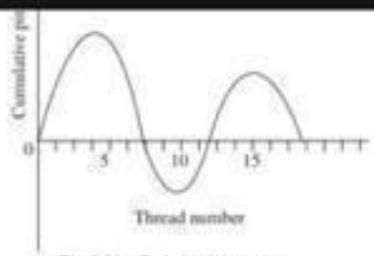


Fig. 8.29 Periodic pitch error

1. To find **the major diameter** of the external thread

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R_c: reading of micrometer over the cylinder	(measured value)
D_{th}: diameter of the thread	(unknown)
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After rearrange the formula

$\therefore major D_{th} = D_c + (R_{th} - R_c)$

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Therefore, $x = \frac{P}{4}\cot\theta - \frac{d}{2}(\cos ec\,\theta - 1)$

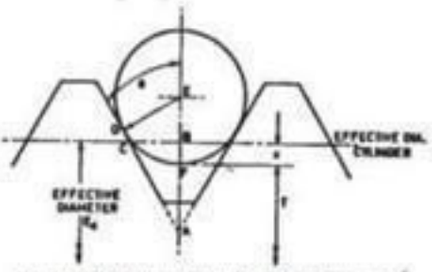

Fig-14 Calculation of simple effective diameter.

where,

P= Nominal Pitch

D=Wire Diameter

θ= Nominal Flank Angle or semi angle of thread