Scheme of Evaluation
Internal Assessment Test II– April.2019

Sub:	Mechanical Measurements & Metrology							**Code:**	17ME46B
Date**:**	15/04/2019	Duration:	90mins	Max Marks:	50	**Sem:**	IV	**Branch:**	ME

Note: Answer Any Five Full Questions.

Question #		**Description**	**Marks Distribution**		**Max Marks**
1	a)	What are comparators? Explain any one type of mechanical comparator with neat sketch.			
	Solu.	Definition of Comparator • Mechanical Comparator – Sigma comparator or Dial Indicator or Johansson Mikrokator - Sketch - Explanation	2M 4 M 4 M	10 M	10 M
2	a)	Design a plug and ring gauge to control the production of 90mm shaft and hole part of H_8e_9. Data given a) $i= 0.45\sqrt[3]{D} +0.001D$. b) The upper deviations for 'e' shaft $=-11D^{0.41}$ c) The value for standard tolerance grade IT8=25i and IT9=40i and d) 90mm lies in the diameter step of 80mm and 100mm.			
	Solu.	• Finding, D = 89.44 mm i(μ) = 2.102 μ • Hole dimensions are : Upper limit = 90.0525 mm Lower limit = 90 mm • Shaft dimensions are: Upper limit = 89.9305 mm Lower limit = 89.847 mm • Design of Plug gauge Limits of Go gauge	1 M 1 M 2 M 2 M	10 M	10 M

		Upper limit of Go = 90.00577 mm Lower limit of Go = 90.000525 mm Upper limit of No go = 90. 0577 mm Lower limit of NO go = 90.0525 mm • Design of Ring gauge Upper limit of Go = 89.927 mm Lower limit of Go = 89.921 mm Upper limit of No go = 89. 847 mm Lower limit of NO go = 89.838 mm	2 M 2 M		
3	a) Solu.	Write a short notes on: (i)Interchangeability, (ii) selective assembly and (iii)Indian standards (IS 919-1963) systems of limits and fits. • Interchangeability – (2 M each) a) Local Interchangeability b) Universal Interchangeability • selective assembly • Indian standards – (2 Marks each) a) Fundamental Tolerance b) Fundamental Deviation	 4 M 2 M 4 M	10M	10 M
4	a) Solu.	Explain measurement of effective diameter using 2 wire method. • Sketch • P = p/2 cot (theta/2) – d cosec(theta/2 -1) • P for Metric thread, P = 0.866p - d • P for Whitworth tread, P = 0.96 p – 1.165d	 2 M 4 M 2 M 2 M	10 M	10 M
5	a) Solu.	Sketch and explain the following comparators: a) Zeiss Optimeter • Sketch • Explanation	 2 M 3 M	5 M	10 M
	b) Solu.	b) Solex Comparators • Sketch • Explanation	 2 M 3 M	5 M	
6	a)	With a neat sketch explain the principle of LVDT.			

	Solu.	• Sketch • Explanation • Cases (2 mark each) a) When there is no plunger movement b) When plunger moves up c) when plunger moves down	2 M 2 M 6 M	10 M	10 M
7	a) Solu.	Illustrate the principle of GO and NOGO gauges. How the Taylor's principle is used in designing them? • Sketch (2 Marks each) a) Plug gauge b) Ring/ snap gauge • Explanation : a) Go gauge b) No go gauge • Example	 4 M 4 M 2 M	10M	10 M

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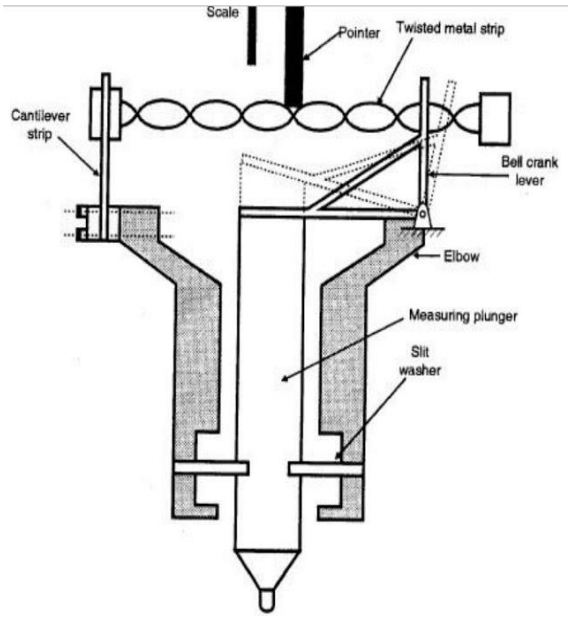
Internal Assesment Test –2

Sub:Mechanical Measuremnts & Metorlogy				Code: 17ME46B
Date: 15/04/2019	Duration: 90 mins	Max Marks: 50	Sem: IV	Branch (sections):ME (A & B)

Answer any FIVE FULL questions. Good luck!

	Scheme and Solution	Marks	OBE CO	OBE RBT
1	What are comparators? Explain any one type of mechanical comparator with neat sketch.	[10]		
Solu.	Comparator is an instrument used for comparing the dimensions of a component with a standard of length.	2 Marks		
	 Figure: Johansson Mikrokator	4 Marks	CO3	L2
	A very thin metal strip at the center carries a light pointer made up of glass. ➢ One end of the strip is connected to the adjustable cantilever strip and the other end is to the spring elbow, in turn connected to the plunger. ➢ The slight movement of the plunger will make the bell crank lever to rotate. ➢ This rotation will create tension in the strip and causes the strip to rotate there by the strip start to twist & untwist resulting in the movement of the point. ➢ The spring ensures that the plunger returns when the contact is removed.	4 Marks		

2	Design a plug and ring gauge to control the production of 90mm shaft and hole part of H_8e_9. Data given a) $i= 0.45\sqrt[3]{D} +0.001D$. b) The upper deviations for 'e' shaft $=-11D^{0.41}$ c) The value for standard tolerance grade IT8=25i and IT9=40i and d) 90mm lies in the diameter step of 80mm and 100mm.	[10]		

Solu.

Given 90mm dia. lies b/w 80 & 100 mm.

$\therefore D = \sqrt{80 \times 100} = 89.44$ mm — 1Mark

$i = 0.45\sqrt[3]{D} + 0.001(D) = 0.45\sqrt[3]{89.44} + 0.001(89.44)$

$= 2.102\mu$ — 1 Mark

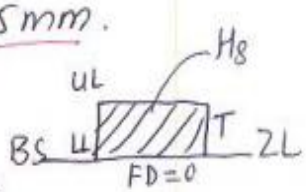
$\therefore i = 0.002102$ mm.

Dimensions / limits of hole are:

F.T for hole H_8 ie. $IT8 = 25i$

$= 25(0.00210) = 0.0525$mm.

F.D for $H = 0$.



2 Marks

∴ limits are: UL = 90 + 0.0525mm

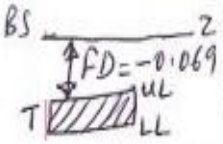
UL = 90.0525mm.

LL = 90 mm.

Dimensions / limits of shaft are:

F.T for eg ie. $IT9 = 40i = 40(0.00210)$

$F.T = 0.08408$ mm.



F.D for 'e' $= -11(D)^{0.41} = -11(89.44)^{0.41}$

$= -69.426\mu = 0.0695$mm. — 2 Marks

limits are:-

UL = 90 − 0.0695 = 89.9305 mm

LL = 90 − (0.0695 − 0.08408) = 89.8747mm

CO2 L3

Design for hole (plug gauge)

Gauge Tolerance GT = 10% of work tolerance of hole

GT = 0.01 × 0.0525 = 0.000525 mm.

Wear allowance = 10% of GT

= 0.1 × 0.00525 = 0.000525 mm.

limits of go gauge are:

UL = 90 + 0.00525 + 0.000525 = 90.005775 mm

LL = 90 + 0.000525 = 90.000525 mm. 1 Mark

limits of No go gauge are:

UL = 90 + 0.0525 + 0.00525 = 90.0578 mm

LL = 90 + 0.05255 = 90.0525 mm. 1 Mark

Design for shaft (Snap gauge)

GT = 10% of WT = 0.01 × 0.08408 = 0.000840 mm.

WA = 10% of GT = 0.01 × 0.00840 = 0.0000840 mm

limits of Go gauge are: 1 mark

UL = 89.9305 − 0.00084 = 89.927 mm.

LL = 89.9305 − (0.00084 + 0.00840) = 89.921 mm

limits of NoGo are: UL = 89.847 mm 1 Mark

LL = 89.847 − 0.0084 = 89.838 mm.

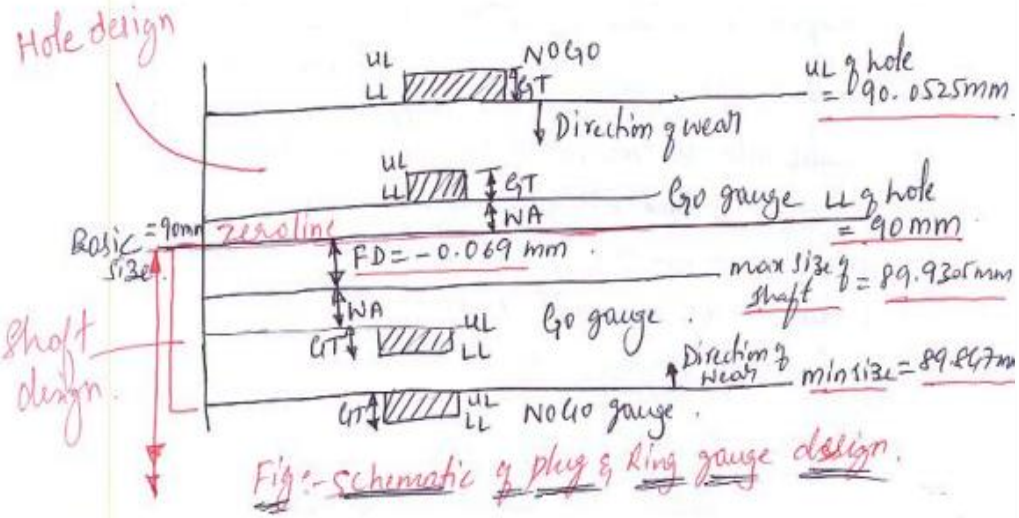


Fig:- Schematic of plug & Ring gauge design.

3	Write a short notes on: (i)Interchangeability, (ii) selective assembly and (iii) Indian standards (IS 919-1963) systems of limits and fits.	[10]		

Solu..

Interchangeability:

Interchangeability occurs when one part in an assembly can be substituted for a similar part which has been made to the same drawing.

For an example:- Suppose there are 100 parts each with a hole, and 100 shafts which have a fit into any of the holes. If there is interchangeability then any one of the 100 shafts should fit into any of the holes and the required kind of fit can be obtained.

Interchangeability is possible only when certain standards are strictly followed. 4 Marks

In universal interchangeability the mating parts are drawn from any two different manufacturing sources. "International Standard".

When all the parts to be assembled are made in the same manufac-turing unit, then local standard may be followed which is known as Local interchangeability.

Selective Assembly:

In selective assembly the parts are graded according to the size and only matched grades of mating parts are assembled. 2 Marks

This technique is most suitable where close fit of two component assemblies are required.

Selective assembly is often followed in aircraft, automobile and other industries where the tolerances are very narrow.

CO2 L2

Indian standard (IS 919-1963)

The Indian standard system of limits and fits comprises suitable combination of 18 grades of fundamental tolerances or grades of accuracy of manufacture, and 25 types of fundamental deviations represented by letter symbols for both holes and a shafts

Capital letters A to ZC for holes and

Lower case letters a to zc for shafts.

"A, B, C, D, E, F, G, H, JS, J, K, M, N, P, R, S, T, U, V, X, Y, Z

ZA, ZB and ZC".

4 Marks

4	Explain measurement of effective diameter using 2 wire method.	[10]	CO4	L4

Solu..

Effective diameter can be measured with the help of floating carriage micrometer. Here in FCM, there are two methods to find effective dia. 2-wire and 3-wire method

Two-Wire method.

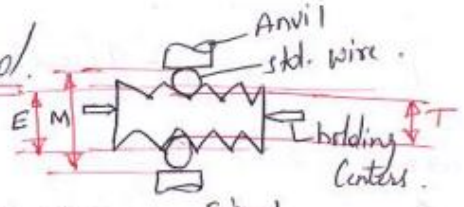


Fig-1

Where E - Effective dia

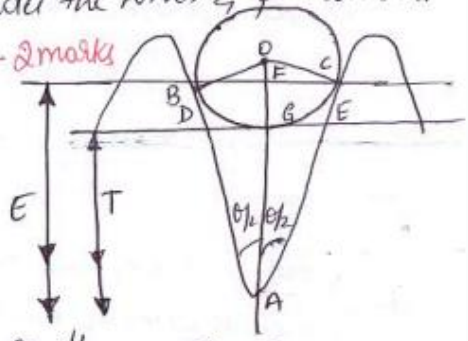
M - dimension over the wires

T - dimension under the wires.

W.K.T using FCM ⇒ Effective dia $E = T + P$

where T is dimension under the wires & P - constant

$\therefore P = E - T$ — (i) — 2 marks

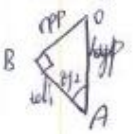


From fig-2, $E - T = FG$

$FG = AF - AG$ — — — (ii)

2 Marks

From Δ^{le} OAB



$\sin\theta/2 = \frac{OB}{OA}$ (W.K - $OB = r = d/2$ from fig-2)

$OA = d/2 \operatorname{cosec}\theta/2$ ($\because 1/\sin\theta/2 = \operatorname{cosec}\theta/2$)

Fig - 2

$AG = OA - OG$

$\therefore AG = d/2 \operatorname{cosec}\theta/2 - d/2 \quad (\because OG = \theta_1 = d/2)$

$AG = d/2(\operatorname{cosec}\theta/2 - 1)$

From Δ^{le} ADF

$\cot\theta/2 = \frac{AF}{DF} \Rightarrow AF = DF\cot\theta/2$

$AF = P/4 \cot\theta/2 \quad (\because DF = P/4$ from fig-2)

Sub. AF and AG in eq (2)

$FG = P/4 \cot\theta/2 - d/2(\operatorname{cosec}\theta/2 - 1)$

By considering wire on both the ends of the thread $\quad P = 2 \times FG$

$\therefore P = 2[P/4 \cot\theta/2 - d/2(\operatorname{cosec}\theta/2 - 1)]$

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

4 Marks

For metric thread. $\theta = 60°$

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

$P = 0.866p - d$.

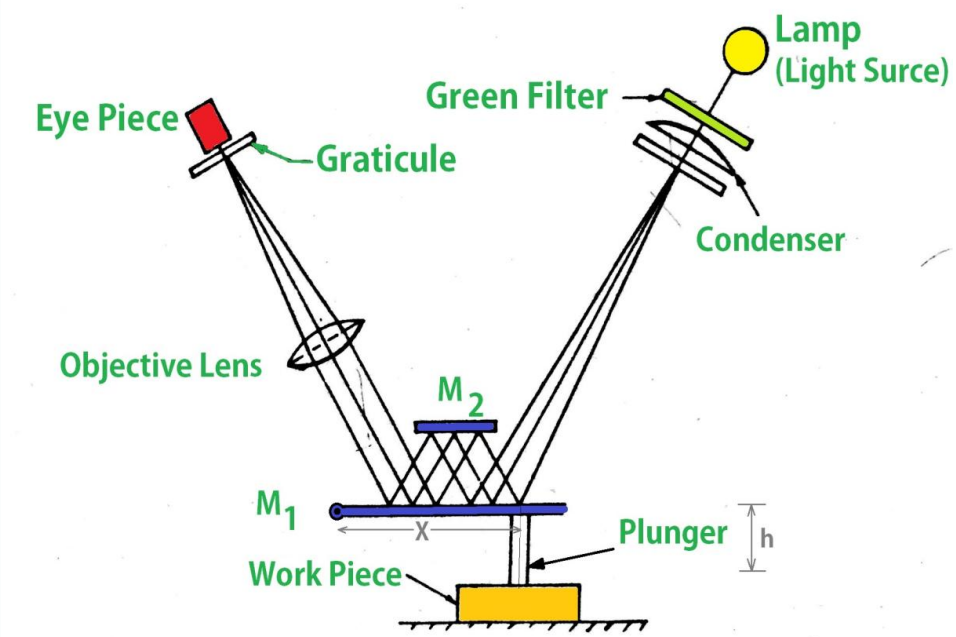
2 Marks

For whitworth thread $\theta = 55°$

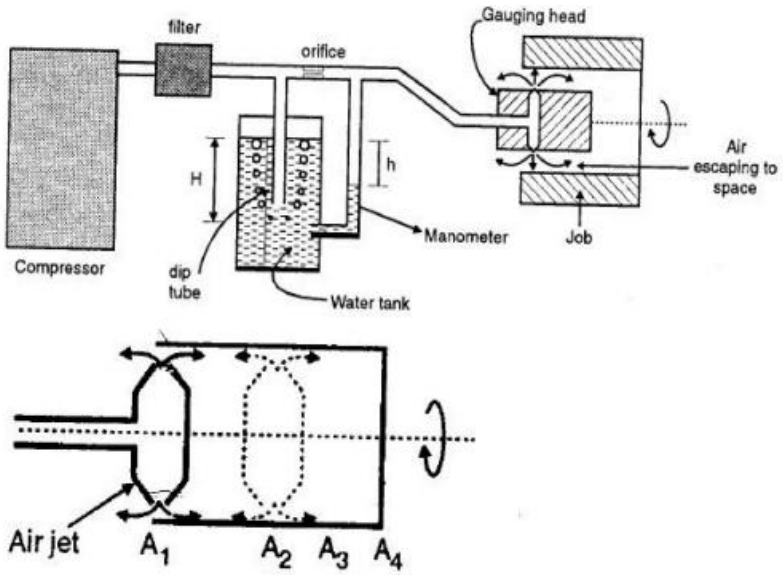
$c = P/2 \cot 55/2 - d(\operatorname{cosec} 55/2 - 1)$

$c = 0.96p - 1.165d$.

2 Marks

5	Sketch and explain the following comparators: a) Zeiss Optimeter	[10]		
Solu.	 Figure: Zeiss optimeter ➢ The Light from the light source passes thru the green filter and condenser as shown in figure. ➢ The function of the Green filter is to allow only the green light and filters the remaining all colors in the light. Which cause less fatigue to eye. ➢ This filtered beam light passes thru the Condenser, the function of the condenser is to collect light & focus the light to the movable mirror (M1). Where the Mirror 1 is a movable mirror which is operated by the Plunger. ➢ The plunger is the measuring tip (Contacts to the workpiece to take the deviation). Mirror 2 (M2) is a fixed mirror. ➢ Once the focused light from the condenser falls on the mirror (M1) and get reflected on to the Mirror 2 (M2) and again reflected back to the Mirror 1 (M1) as shown in figure. ➢ Then the objective lens will collect this image and projects on to the graticule. *(Graticule is a screen is having vertical and Horizontal lines which has a precise scale on it)* ➢ This image on the Graticule is observed by the Eye Piece and the deviation will be noted.	2 Marks 3 Marks	CO3	L3

b) Solex Comparators



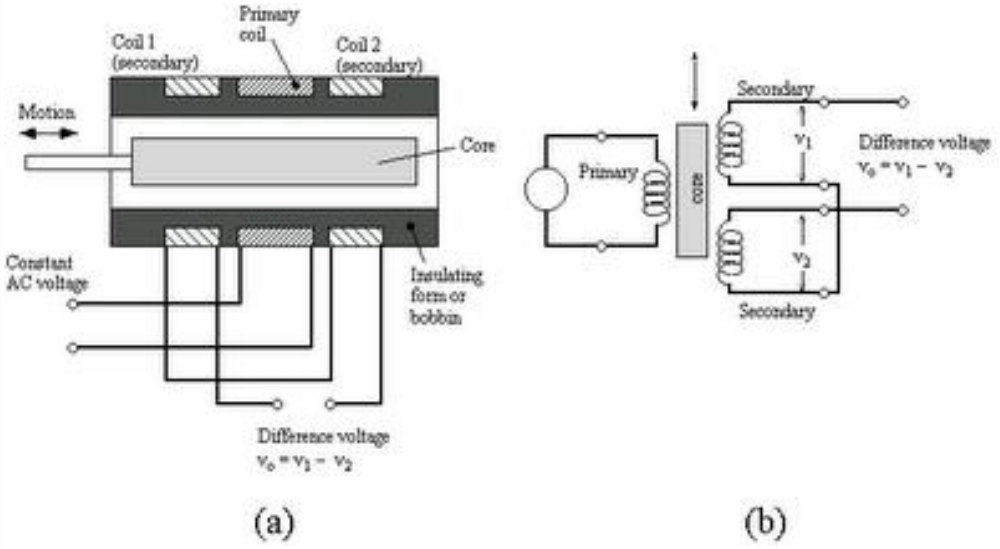
2 Marks

- The air is compressed in the compressor at high pressure which is equal to Water head H.
- The excess air escapes in the form of bubbles.
- Then the metric amount of air is passed through the orifice at the constant pressure.
- Due to restricted area, at A1 position, the back pressure is generated by the head of water displaced in the manometer tube.
- To determine the roundness of the job, the job is rotated along the jet axis, if no variation in the pressure reading is obtained then we can say that the job is perfectly circular at position A1.
- Then the same procedure is repeated at various positions A2, A3, A4, position and variation in the pressure reading is found out.
- Also the diameter is measured at position A1 corresponding to the portion against two jets and diameter is also measured at various position along the length of the bore.

3 Marks

6 With a neat sketch explain the principle of LVDT. [10]

Solu.



2 Marks

The working principle of the **LVDT is** by mutual induction. 2 Marks

Linear variable differential transformer which transfer mechanical displacement into electrical signals.

The working of LVDT circuit diagram can be <u>divided into three cases</u> based on the position of the iron core in the insulated former.

CASE I : (for no displacement)

When the core is at null position then the flux linking with both the secondary windings is equal so the induced emf is equal in both the windings. So for no displacement the value of output e_{out} is zero as $e_1$and e_2 both are equal. 2 Marks

i.e., Esec1-Esec2=0

CASE 2:

When an external force is applied and if the steel iron core tends to move in the left hand side direction (UP Ward) then the emf voltage induced in the secondary coil 1 is greater when compared to the emf induced in the secondary coil 2. **SO POSITIVE.** 2 Marks

Therefore the net output will be Esec1-Esec2

CASE 3:

When an external force is applied and if the steel iron core moves in the right hand side direction (Downward) then the emf induced in the secondary coil 2 is greater when compared to the emf voltage induced in the secondary coil 1**.** 2 Marks

SO NEGATIVE

Therefore the net output voltage will be Esec2-Esec1

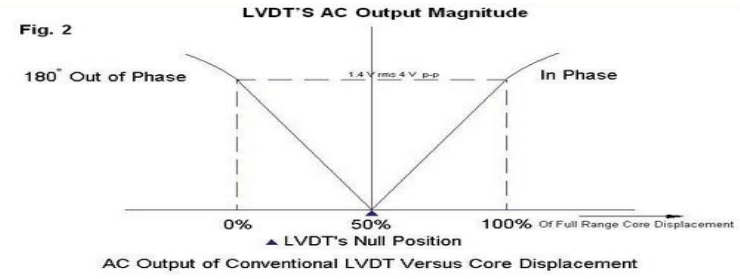


Fig. 2 AC Output of Conventional LVDT Versus Core Displacement

CO3 L2

7	Illustrate the principle of GO and NOGO gauges. How the Taylor's principle is used in designing them?	10 Marks		
Solu.	Taylor's principle of Gauge design: According to Taylor's principle 'Go' and 'no Go' gauges should be designed to check max & min material limits. 'Go' limit – Is applied to that limit of the two sizes which corresponds to the max material limit ie, upper limit of a shaft and lower limit of a hole. 'NO Go limit': is applied to that limit of the two sizes which corresponds to the minimum material limit. ie. the lower limit of the shaft and upper limit of a hole. 'NO Go' gauge should check only one part feature of the component at a time. Tolerance upper limit lower limit Go snap gauge NO Go snap gauge Ring gauge Go plug gauge upper limit NO Go plug gauge lower limit Plug gauge	2Marks 2 Marks 2+2 Marks	CO2	L2
	Example for Taylor's principle The slot is to be checked for height & width. Go gauge. A Go gauge must check the dimensions as well as form A NO Go gauge must check the dimensions of the slot one at a time and hence two separate gauges must be used.	2 Marks		