CMR INSTITUTE OF TECHNOLOGY

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Internal Assesment Test –2

Sub:Mechanical Measuremnts & Metorlogy				Code: 15ME46B
Date: 08/05/2017	Duration: 90 mins	Max Marks: 50	Sem: IV	Branch (sections):ME (A & B)

Answer any FIVE FULL questions. Good luck!

	Question paper with scheme & Solution	Marks	OBE CO	OBE RBT
1	What are comparators? Explain sigma comparator with neat sketch.	[10]		
Solu.	**Definition** – 2 Marks **Sigma comparator** sketch – 4 marks Explanation - 2 Marks Magnification formulae - 2 Marks		CO3	L2
2	Explain how to measure width & depth of gear tooth using gear tooth vernier caliper.	[10]		
Solu.	Sketch – 2 marks Measurement of width (w) – 4 Marks Measurement of depth (d) – 4 Marks		CO4	L2
3	Explain LVDT & list the advantages & disadvantages of LVDT.	[10]		
Solu.	Sketch – 3 Marks Cases 1, 2 & 3 – 2 Marks each Output graph – 1 Mark		CO3	L1
4	Explain measurement of effective diameter using 2 wire method.	[10]		
Solu.	Sketch – 2 Marks Derivation for constant P – 4 Marks For Withworth thread – 2 Marks For Metric thread -2 Marks		CO4	L2
5	Sketch and explain the following comparators: a) Zeiss Optimeter & b) Solex Comparators	[10]		
Solu.	a) Zeiss ultra optimeter Sketch – 3 Marks Explanation – 2 Marks b) Solex Comparators Sketch – 3 Marks Explanation – 2 Marks		CO3	L3

6	What are Coordinate measuring machines? Explain any two types of CMM.		[10]		
Solu.	Definition	– 2 marks			
	Types –			CO4	L2
	Sketch	– 2 marks each			
	Explanation	– 2 Marks each			
7	Explain i) alignment of gear tooth and ii) Parkinson gear tester with neat sketch.		[10]		
Solu.	i) alignment of gear tooth 2 types Analytical method – 2 Marks Functional method – 2 Marks			CO4	L2
	ii) Parkinson gear tester with neat sketch. Sketch – 3 Marks Explanation – 3 Marks				

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Mechanical Measurements and metrology Date:- 10/5/17.

IAT-2 Question paper Solution. Sub code: 15ME46B

Q.1. What are comparators? Explain sigma comparator with neat sketch.

Sol:- A comparator is an instrument used for the measurements of diameters or lengths on gauges and components, using some standards.

The general principle of all these comparators is to indicate differences in size between the standard and the work being measured.

Sigma comparator:

Sigma comparator is an example of mechanical comparator with magnification in the range of 300 to 5000.

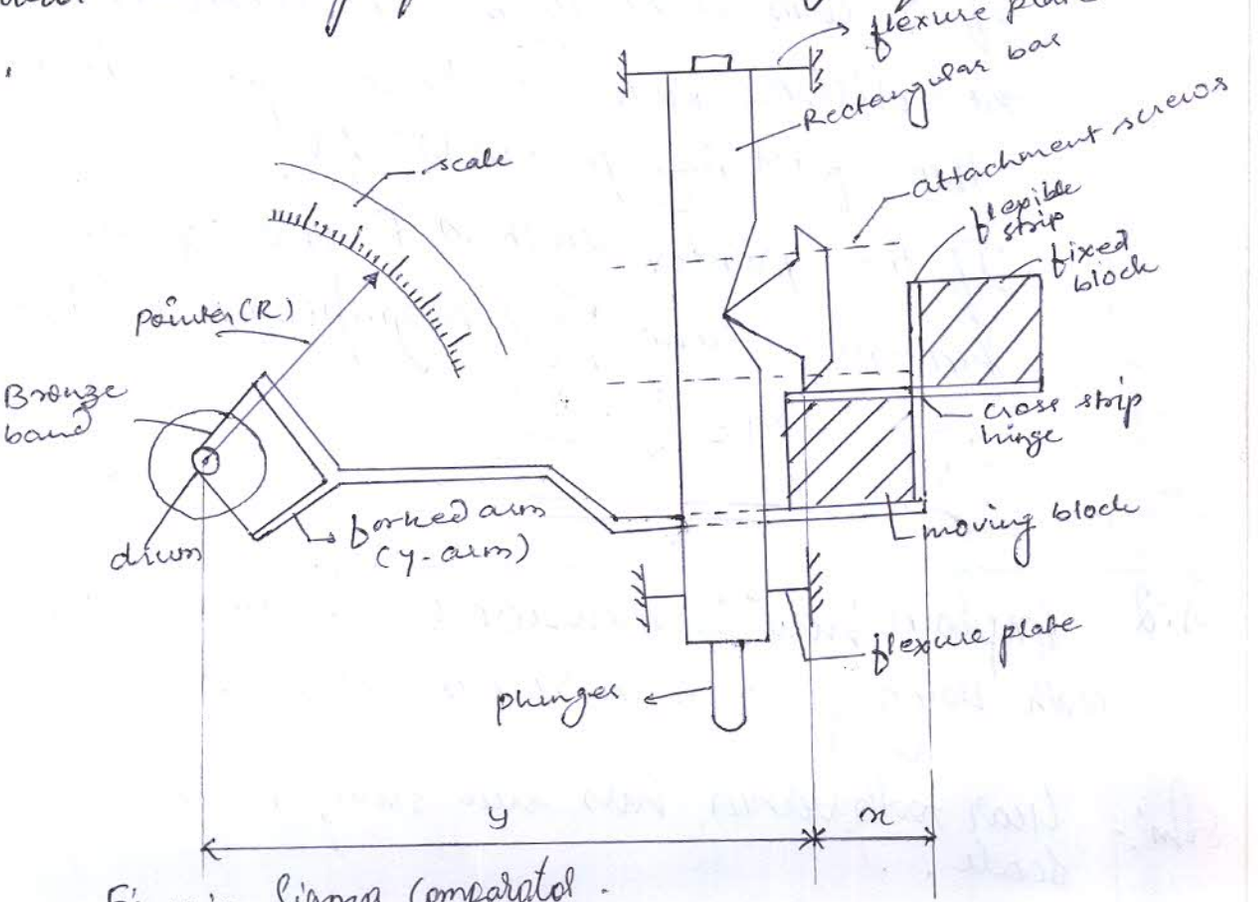


Figure:- Sigma comparator.

The plunger is attached to a rectangular bar which is supported at its upper and lower ends by flexure plates. A knife edge is fixed to the side of the rectangular bar which is bears on a moving block. The moving block and the fixed block are connected by flexible strips at right angles to each other. If the external force is applied to the moving block, it would pivot about the line of intersection of the strip. This hinge is suitably pretensioned to allow it to ~~reduce~~ rotate with in the range of the instrument scale. A fork arm or Y-arm attached to the moving block transmits rotary motion to the indicator driving drum through a bronze band wrapped around the drum.

magnification :-

If Y- arm is the length of the forked arm and 'X' is the distance from the knife edge to the hinge, then first magnification is Y/X.

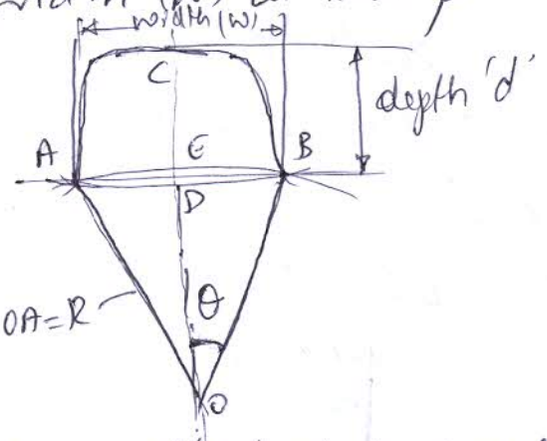
If the pointer length is 'R' and radius of the drum is 'r' then the second stage magnification is R/r.

$$\therefore \quad M = \frac{Y}{X} \times \frac{R}{r}.$$

Q.2 Explain how to measure width and depth of gear tooth using gear tooth vernier calliper.

Soln:- Gear tooth vernier has two scale, horizontal and vertical scale.

The vertical vernier is used to set the depth 'd' along the pitch circle and horizontal vernier is used to measure width (W) at that point.

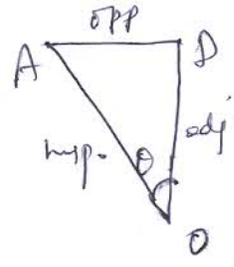


From sketch, width 'W' is therefore called chordal thickness and 'd' is called chordal addendum.

$\therefore \quad W = AB = 2AD.$

We know that $\theta = \frac{360^\circ}{4N}$

where N is the no. of teeth.



In the Δ^{le} ADO, $\sin\theta = \frac{AD}{AO}$

$AD = OA\sin\theta \Rightarrow W = 2AD = 2 \times AO \sin\theta$

$= 2R \sin\frac{360}{4N}$ ($\because$ R = pitch circle radius).

$\text{module } m = \frac{\text{pitch circle dia}}{\text{No. of teeth}} = \frac{2R}{N}$

$\therefore R = \frac{Nm}{2}$

$\therefore W = 2 \cdot \frac{Nm}{2} \cdot \sin\left(\frac{90}{N}\right)$

$$\boxed{W = Nm \sin\left(\frac{90}{N}\right)}$$

Also from the figure

$$d = \alpha - OD.$$

Addendum is the radial distance from the pitch circle to the tip of the tooth, its value is equal to one module.

$$\therefore \quad OC = OE + \text{Addendum} = R + m.$$

$$= \frac{Nm}{2} + m.$$

From Δ^{le} ADO, $OD = R\cos\theta$

$$= \frac{Nm}{2}\cos\left(\frac{90}{N}\right)$$

$\cos\theta = \frac{OD}{OA}$ (hyp., adj)

$$\therefore d = \frac{Nm}{2} + m - \frac{Nm}{2}\cos\left(\frac{90}{N}\right)$$

$$\boxed{d = \frac{Nm}{2}\left[1 + \frac{2}{N} - \cos\left(\frac{90}{N}\right)\right]}$$

Q.3. Explain LVDT & list the advantages and disadvantages of LVDT.

Ans:-

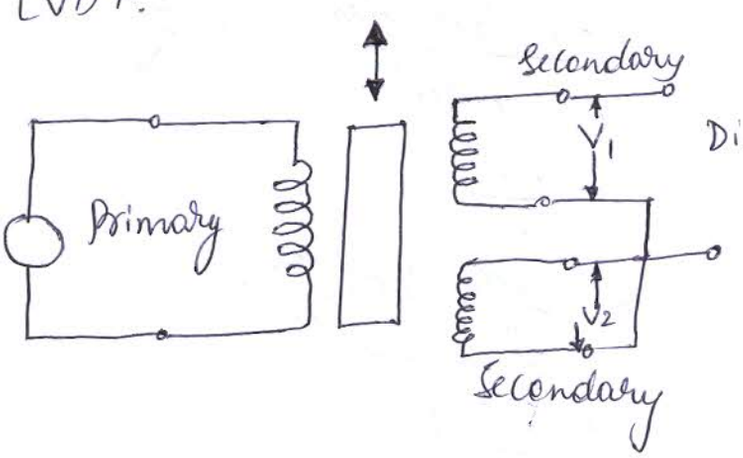


Figure :- LVDT

It is a electro-mechanical device used to convert mechanical displacement into electrical signal.
It is a transformer consisting of 3 symmetrical spaced coils wound on an insulated column.
It works on the principle of mutual inductance and consits 1 primary coil and 2 secondary coil.

Case 1: When the core is at null position, so for no displacement, the value of output e_0 is zero as e_1 and e_2 both are equal.

ie. $E_{sec1} - E_{sec2} = 0$.

Case 2: When an external force is applied and if the steel core tends to move in the left hand direction (upwards) then the emf voltage induced in the secondary coil 1 is greater than secondary coil 2. So positive.

$\therefore E_{sec1} - E_{sec2}$ o/p.

Case 3: When an external force is applied and if the steel core moves in the Right direction (downward) then the emf induced in the secondary coil 2 is greater compared to secondary coil 1.

$\therefore$ output voltage will be $E_{sec2} - E_{sec1}$

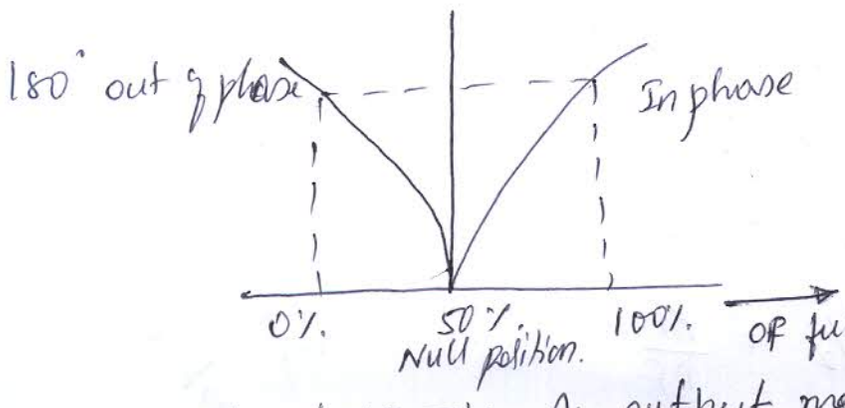


Fig: LVDT's

Q. 4. Explain measurement of effective diameter using 2 wire method.

Sol:-

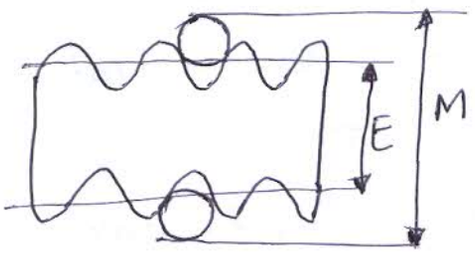


Figure (i)

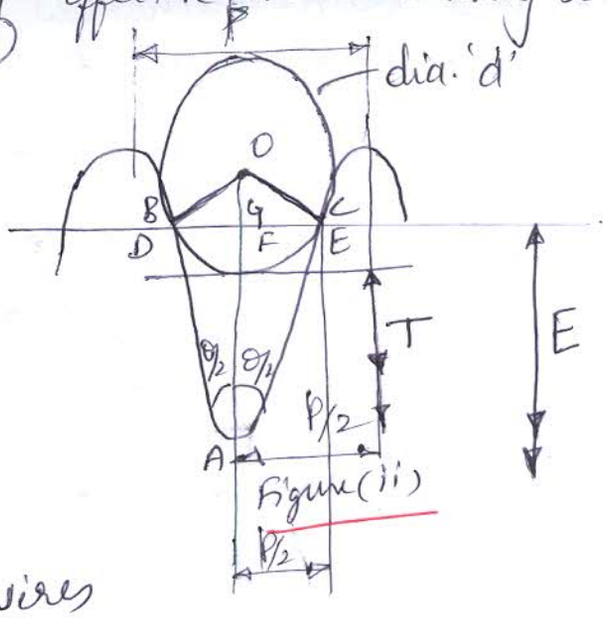


Figure (ii)

where E - Effective dia.
M - Dimension over the wires
T - Dimension under the wires.

Two wire method only two wires of required diameter will be placed on the screw thread to measure effective diameter.

Two wire method is used to determine the ~~dia~~ constant 'P'

T - dimension under the wire M - 2d from fig (i).

$P = 2 \cdot FG$ by considering wire on both the sides.

$FG = E - T$ from figure (ii).

From Δ^{le} OAB

$\sin \theta/2 = \frac{OB}{OA}$

$OA = \frac{OB}{\sin \theta/2} \Rightarrow OB \operatorname{cosec} \theta/2$

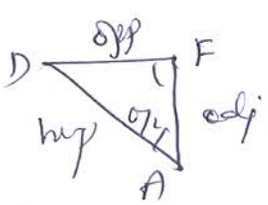
$\therefore AG = OA - OG$ from figure (ii)

$= OB \operatorname{cosec} \theta/2 - r$. ($\because OG = OB = r$)

$= r \operatorname{cosec} \theta/2 - r = d/2 \operatorname{cosec} \theta/2 - d/2$.

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

From Δ^{le} ADF, $\cot \theta/2 = \frac{AF}{DF}$



$$AF = DF \cot \theta/2 .$$

$$AF = \frac{P}{4} \cot \theta/2 \qquad DF = P/4 \text{ from fig(ii)}$$

Considering wires on both the sides.

$$E - T = FG$$

$$P = 2 \times FG = 2 \times (AF - AG)$$

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

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

For Withworth thread, $\theta = 55^\circ$.

$$P = \frac{P}{2} \cot(55/2) - d\left[\operatorname{cosec}(55/2) - 1\right]$$

$$\boxed{P = 0.961P - 1.165d .}$$

For metric thread,

$$\theta = 60^\circ$$

$$P = \frac{P}{2} \cot(60/2) - d\left[\operatorname{cosec}(60/2) - 1\right]$$

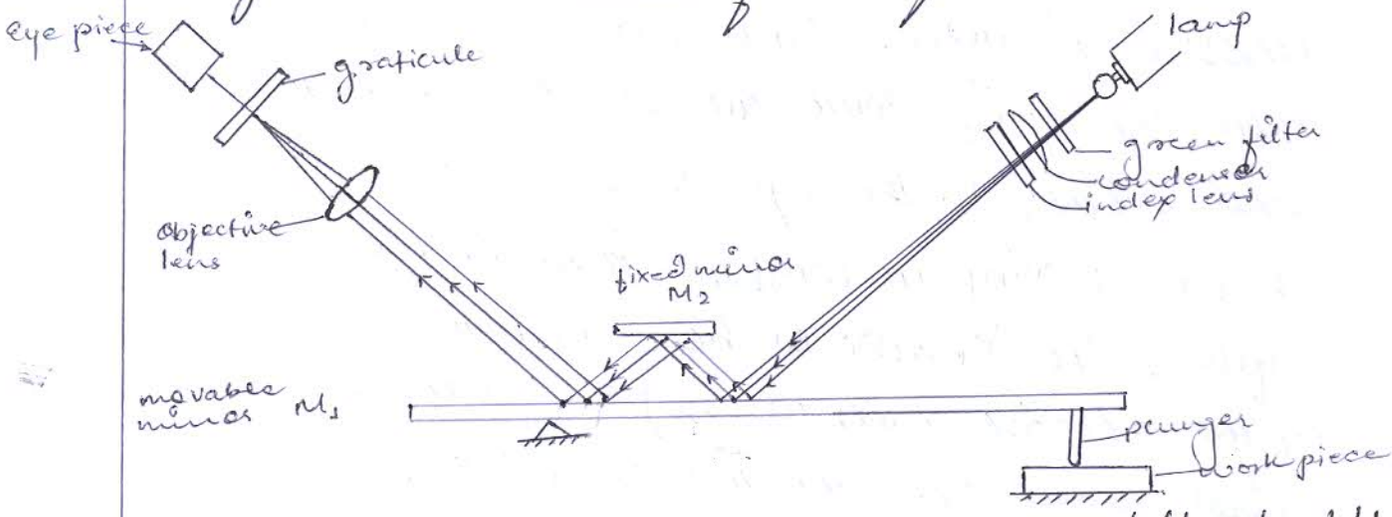
$$\therefore \boxed{P = 0.866P - d.}$$

Q.5. Sketch and explain the following comparators.
a) Zeiss optimeter and b) Solex comparator.

Sol:- (a) Zeiss ultra-optimeter:

This is the optical system involves double reflection of light and thus gives higher degree of magnification.

Figure shows the details of Zeiss optimeter.



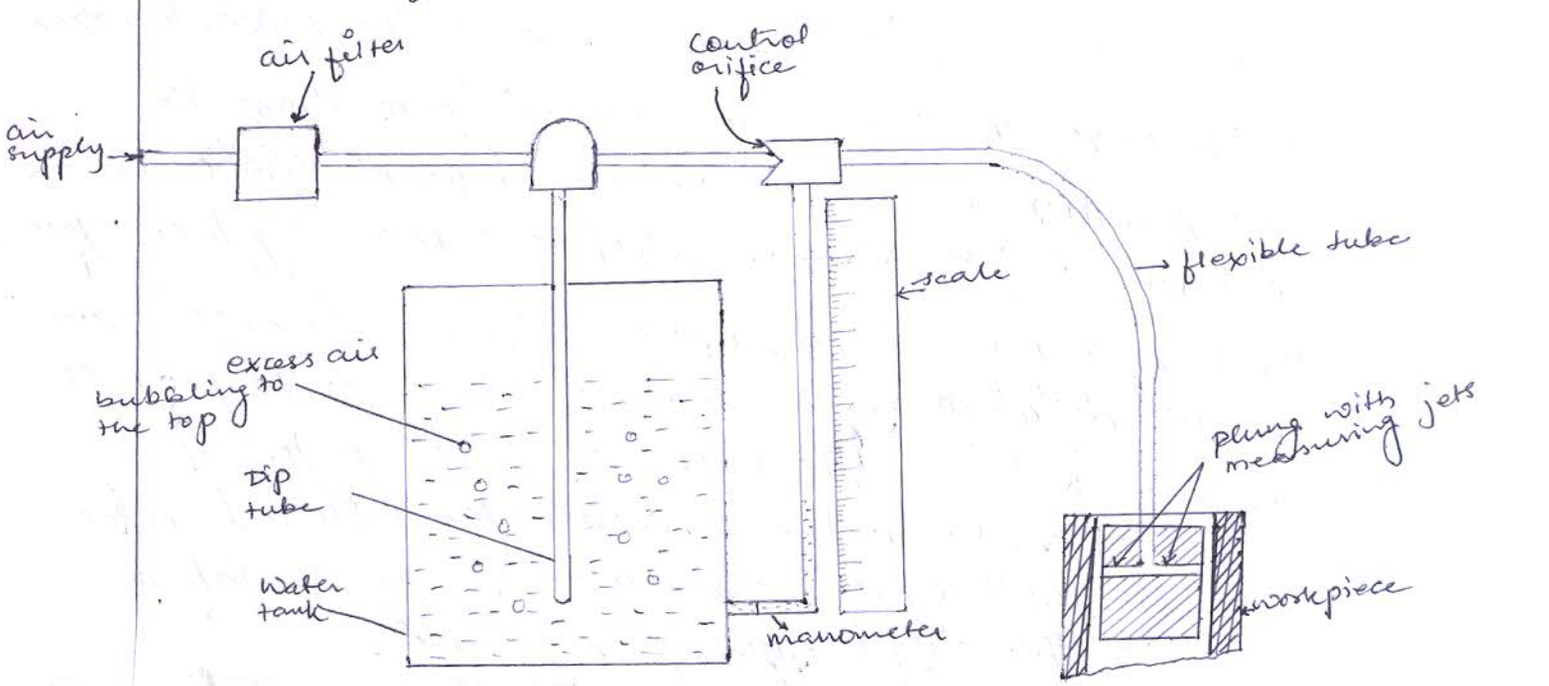
A lamp sends light rays through green filter to filter all rays except green light, which causes less fatigue to eye. The green light then passes through a condenser which makes light rays parallel and pass through via index mark which projects to a movable mirror M_1. It is then reflected to another fixed mirror M_2 and back again to the movable mirror The objective lens brings the reflected beam from the movable mirror to a focus at a transparent graticule containing a precise scale which is viewed by the eyepiece. The plunger rests on the surface which has to be measured if any deflection on the surface, it moves the plunger vertically will tilt the mirror to some angle. This causes a shift in the position of the reflected index line on the eyepiece graticule scale, which infers measure the displacement of the plunger.

(5) Solex pneumatic gauge :

Solex uses a water manometer for the indication of back pressure.

It consits of water tank in which water is filled upto a certain level and a dip tube is immersed into it upto a depth corresponding to the air pressure required. Since air is sent at high pressure than required, some air will escape from the dip tube and bubbles to the top of the water tank. Thus the air will moving in constant pressure through control orifice. The pressure in the manometer is regulated by the relative rates to escape of air through the control orifice and the measuring jets.

If the measuring jets are completely closed, the manometer level is depressed to the bottom of the tube. The tube is graduated linearly to show changes in the pressures resulting from changes in the internal diameter of the work being measured.



Q.6. What are coordinate measuring machines? Explain any two types CMM.

Soln:- Coordinate measuring machine [CMM]

CMM is a 3D device for measuring the physical geometrical characteristics of an object.
CMM is a specialised form of an industrial robot.
CMM include three main components
- Main structure
- probing system and
- Data collection & reduction system.

Types of CMM. (any two types)

i) Cantilever type :-

A vertical probe moves in the Z axis carried by a cantilevered arm that moves in the Y-axis.
This arm also moves laterally through the X-axis.

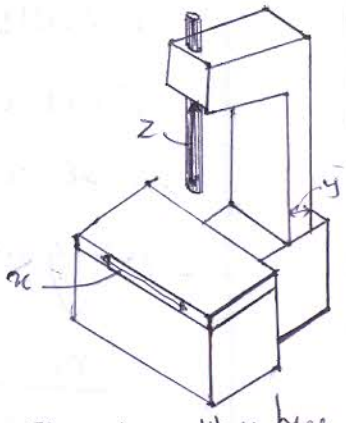


Figure : cantilever type

Advantages:
- Large measuring range
- maximum accessibility.

~~Diso~~

Disadvantages:

- Bending of the cantilever above the measuring area.

Applications:

For checking sheet metal, cast iron and steel parts in the automotive industry, Aircraft & Ship building.

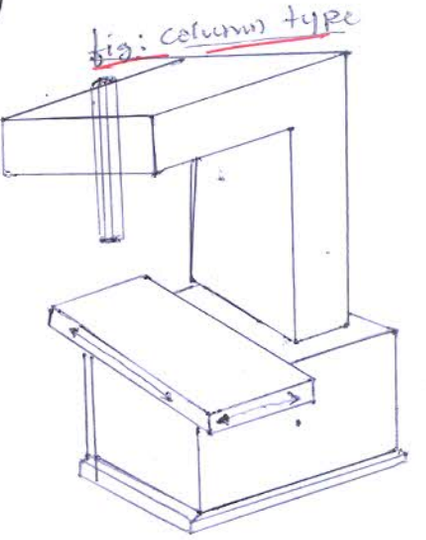
ii) Column type:

often referred to as universal measuring m/c instead of CMM.

The column type cmm construction provides exceptional rigidity and accuracy.

These machines are usually reserved for gauge rooms rather than inspections.

fig: column type



Advantages:

- High accelerations & speed
- low weight & large supporting base

Disadvantages:

- Suitable only for small measuring ranges
- only since the projecting part of the column must have short length due to its rigidity

Applications:-

- In precision measurement on gauges & master parts.

Q.7. Explain i) alignment of gear tooth and
ii) Parkinson gear tester with neat sketch.

Sol:- i) Alignment of gear tooth:

Alignment of each tooth on a gear is very essential otherwise the load will not be distributed evenly over its face.

Tooth alignment can be checked by placing a standard roller in the tooth space and checking for parallelism with a surface plate.

There are two methods to check alignment

i) Analytical method
ii) The functional method.

i) Analytical method:

All the individual elements of the gear teeth are to be checked one by one.

This method is slow and tedious process

The analytical inspection of gears consits of determining the following elements one by one.

i) profile
ii) spacing
iii) pitch
iv) Run out or eccentricity or concentricity
v) Thickness of tooth and
vi) Backlash.

b) Functional method:

carry out the running test of gear with another gear which is more accurate and it is known as control or master gear.

This method of inspection determines composite errors, vibration and noise.

(ii) Parkinson gear tester:

This test is commonly used in mass production of gear wheels. It takes much less time and gives quite accurate results.

The composite errors can be checked by measuring the variations of the centre distance when the gear to be tested is rotated under spring pressure against a master gear. The test is generally performed on a most commonly used machine called parkinson gear tester.

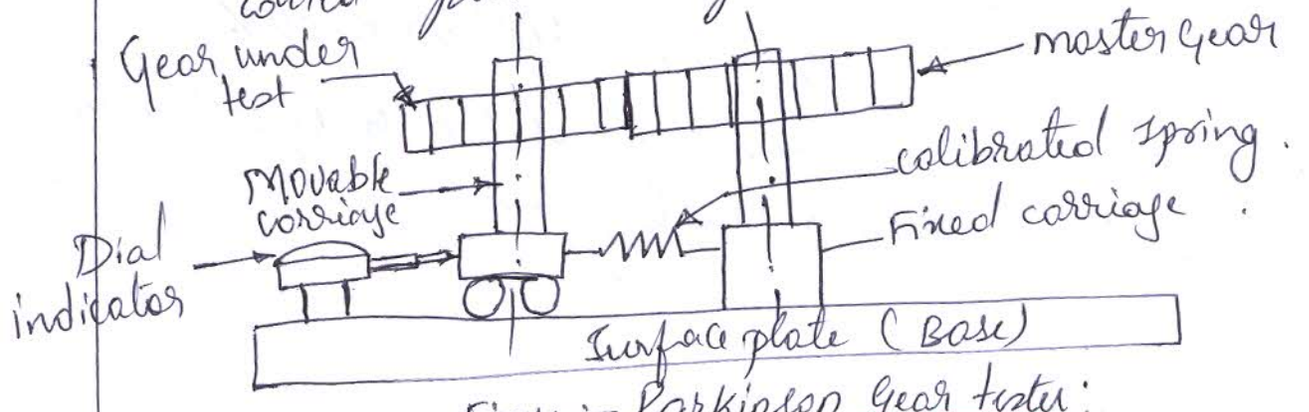
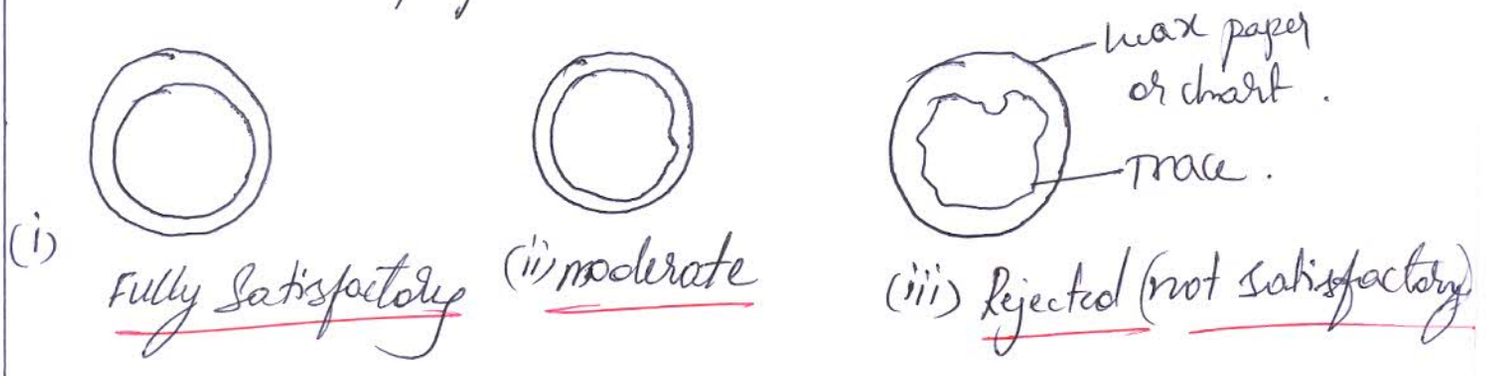


Figure:- Parkinson Gear tester:

If the gear to be tested and master gear rotate manually if their any deviations b/w the gears i.e. variations in the centre distance the calibrated spring helps to move the movable carriage thus that deviation will be noted in the dial indicato

If the gear under test and master gear rotates automatically then there will be a electronic sensor which reads the variation b/w the centre distance and gives the out put on a wax paper like a trace.



(i) Fully Satisfactory (ii) moderate (iii) Rejected (not satisfactory)