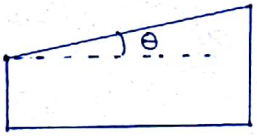
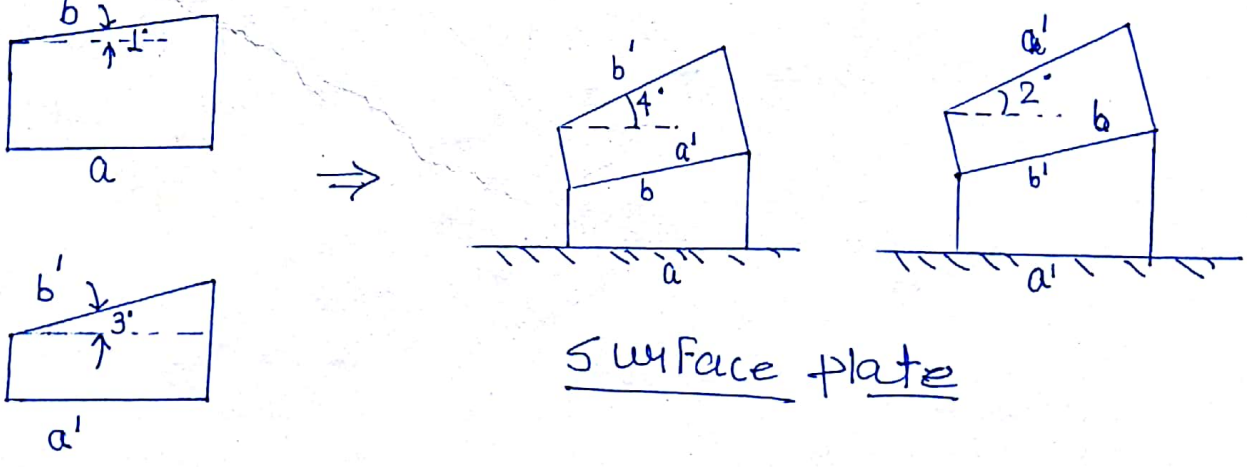
Angle Block :-



Deg's	1	3	9	27	41
Mins	1	3	9	27	
fraction of min	0.05	0.1	0.3	0.5	

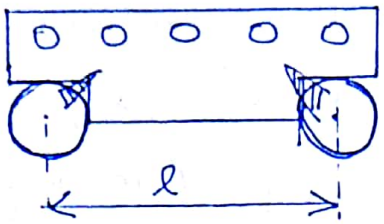
eg.

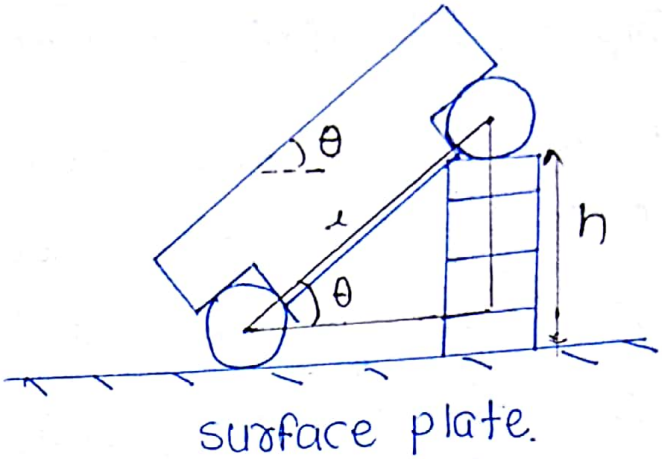


Surface plate

* To add up the angles one plate surface and one inclined surface are wring together.
* To subtract angles both inclined surface shoulal be wringed togbether.

Sine bar





Two rollers of exact size are fixed to the body of sine bar through Allen screw. size of sine bar is define by the centre to centre distance between the rolles. Hole are made in the body of sine bar to make the assembly eight.

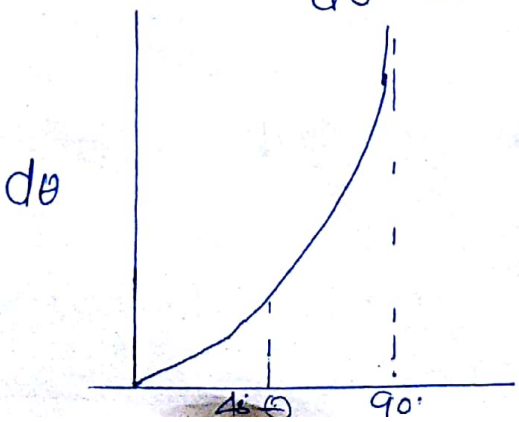
$$\sin\theta = \frac{h}{l}$$

$$\cos\theta \, d\theta = \frac{l\,dh - h\,dl}{l^2}$$

$dh \to 0$
Slip Gauge are very accurate

$$\cos\theta \, d\theta = -\frac{h}{l} \cdot \frac{dl}{l}$$

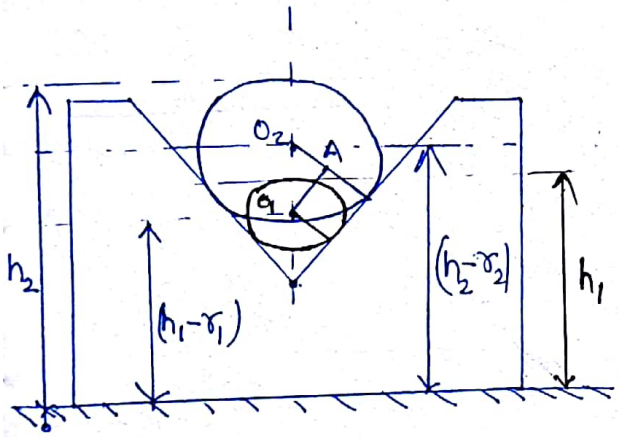
$$d\theta = -\tan\theta \cdot \frac{dl}{l}$$

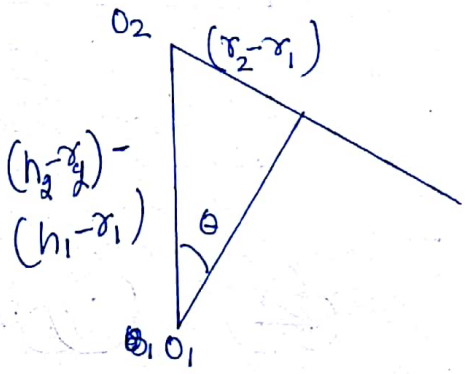


dh = tolerance sink of slip gauge
dl = error b/w centre to centre dist b/w rollers
$d\theta$ = error between angle measurment.

* Since slip gauge are very accurate, dh will very significant compared to dl.
* Since the error is perportional to ~~dθ~~ tan θ when the Angle that has to be measured is more than 45°, the error will approch towards infinity. So Sine bar is not measure beyond 45°.

Precision ball Measurement :-



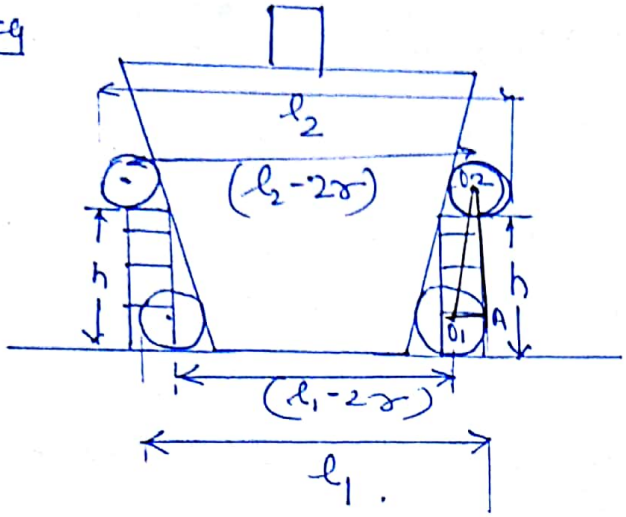


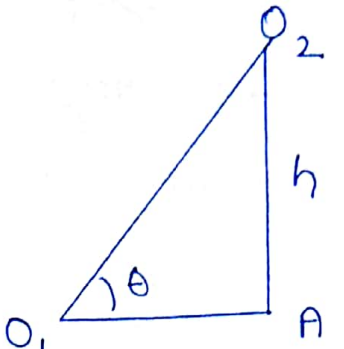
$$\text{Cosec}\,\theta = \frac{(h_2-r_2)-(h_1-r_1)}{r_2-r_1}$$

$$\text{Cosec}\,\theta = \frac{(h_2-h_1)}{r_2-r_1} - 1$$

$$\boxed{\text{Cosec}\,\theta = \frac{h_2-h_1}{r_2-r_1} - 1}$$

Eg



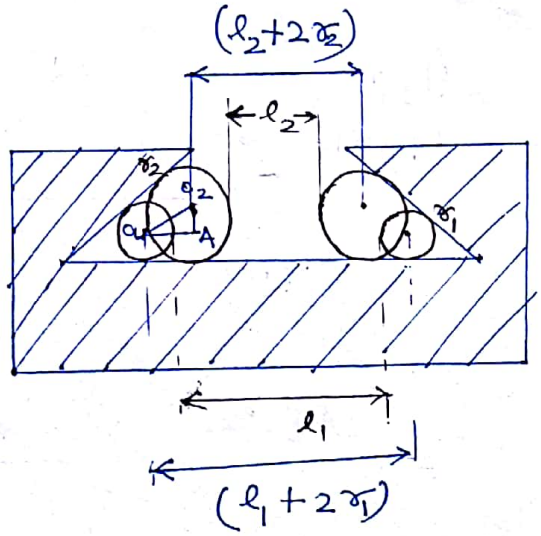


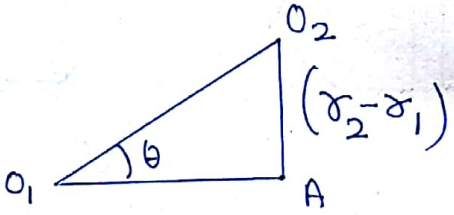
$$\frac{(l_2-2r)-(l_1-2r)}{2}$$

$$= \frac{l_2-l_1}{2}$$

$$\boxed{\tan\theta = \frac{2h}{l_2-l_1}}$$

Eg



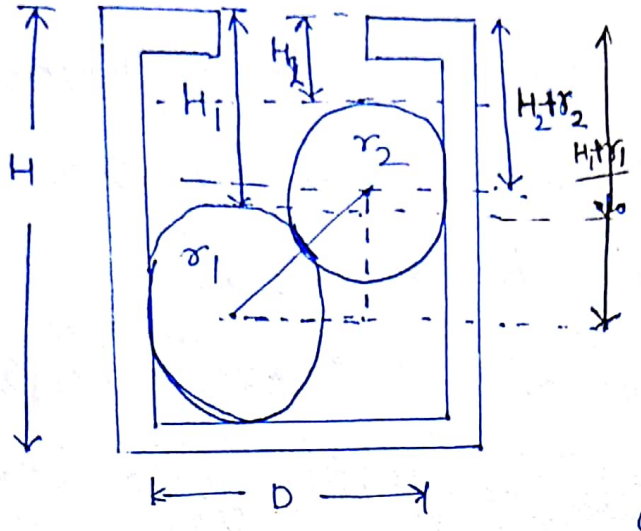


$$\frac{(l_1+2r_1)-(l_2+2r_2)}{2}$$

$$\cot\theta = \frac{\left(\frac{l_1-l_2}{2}\right)+(r_1-r_2)}{(r_2-r_1)}$$

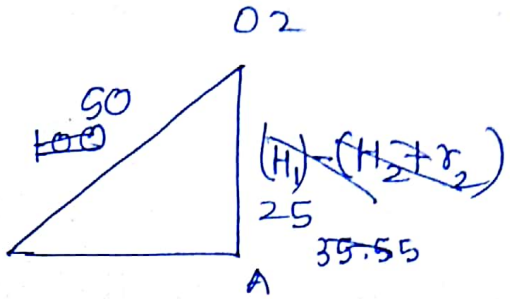
$$\boxed{\cot\theta = \frac{(l_1-l_2)}{2(r_2-r_1)} - 1}$$

eg #



$d_2 = 60 \quad d_1 = 40$

$H_1 = 35.55 \quad H_2 = 20.55$



$O_1A = \sqrt{80^2 - 25^2}$

$O_1A = 43.30$

$AO_2 = (H_1+r_1)-(H_2+r_2)$

$(35.55+30)-(20.55+20)$

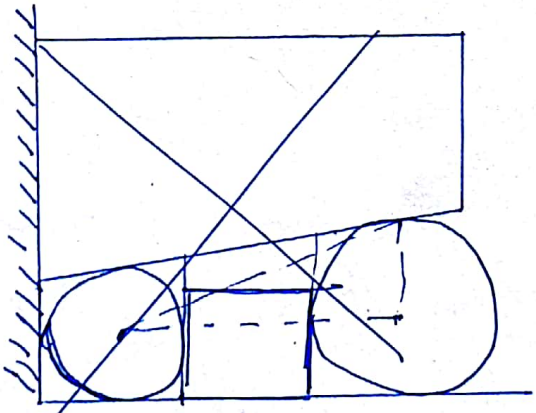
$= 25$

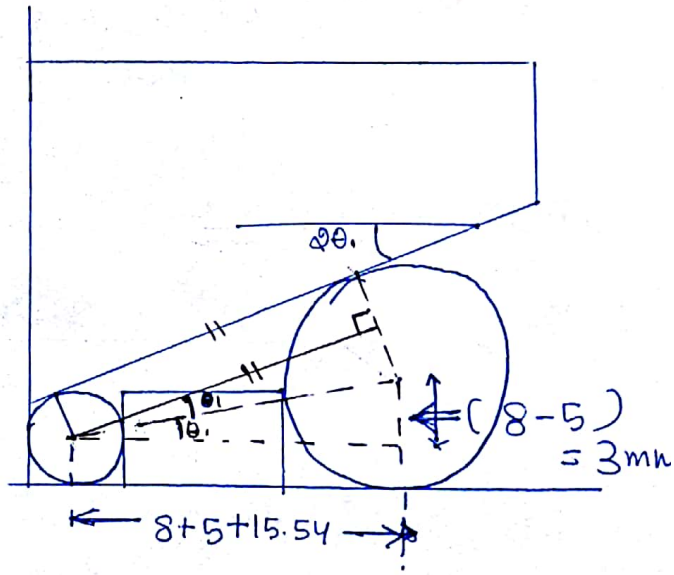
$D = r_1 + r_2 + O_1A$

$D = 30 + 20 + 43.30$

$D = 93.30 \text{ mm}$

Q.49





$\tan\theta = \dfrac{(r_2 - r_1)}{(r_1 + r_2 + h)}$

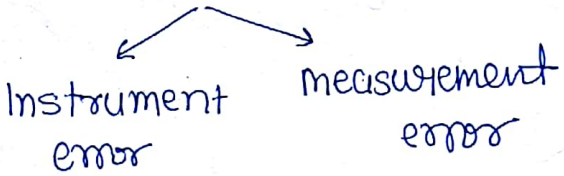
$\tan\theta = \dfrac{3}{28.54} \Rightarrow \theta = 6^\circ$

$2\theta = 12^\circ$ Ans

Vernier Caliper V/s Micrometer

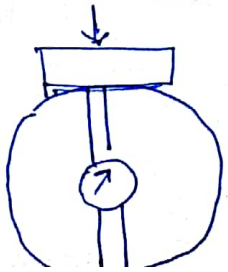
* For any metrological equipment it is important that the plane of measurment doesn't change.
* In vernier caliper since vernier scale moving over the main scale so it an area contact so refrence plane keep on shifting. so it is an not accurate instrument.
* In case of micrometer refrenance plane is well define with the help of balls. So it is ~~most~~ more accurate.

Types of errors:-

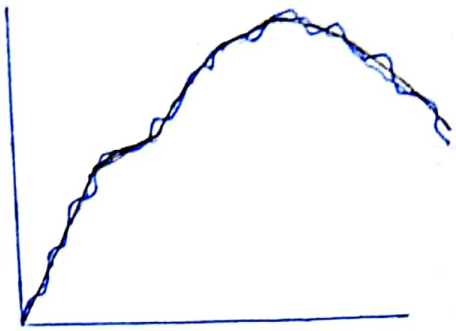


Instrument error:-

① System/Systematic error:- Since no two product are same so output of different instrument will also very called system error. This error can eliminated by celebrating the equipment.



② short period error :-



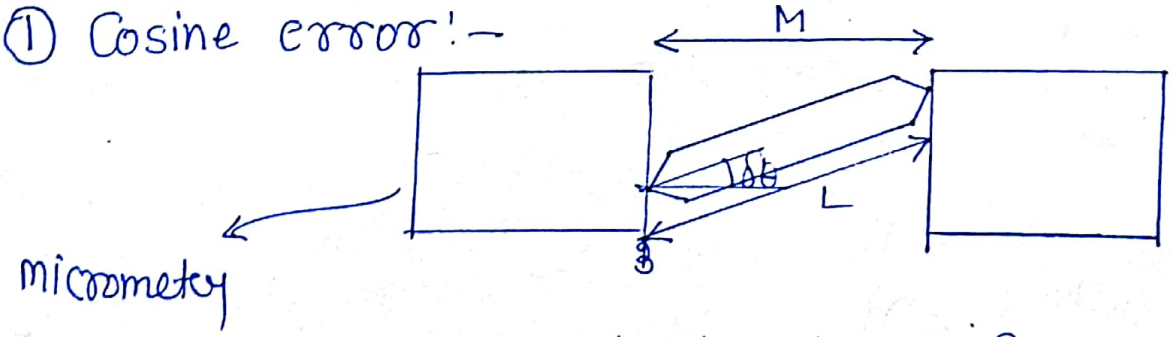
UTM बनाने वाली
ITW ← Company
Instron BISS

This type or error appear due to change in envoirmental Condition. like unexpected increase in temp of load cell, etc. These error can be taking care of by neglecting the data.

③ Erratic error: These error occur during the maintenance of equipment. Some part of it are not properly fixed or tight correctly.

Measurment error :-

① Cosine error :-

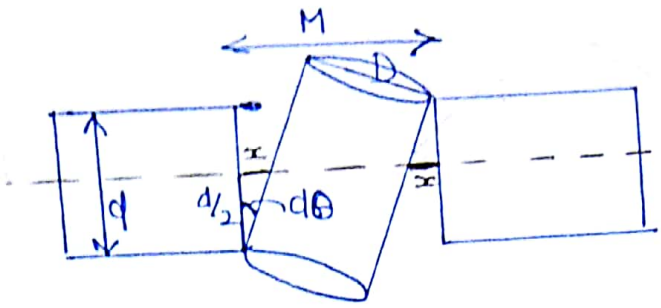


$$\text{error} = L - M = L - L\cos\delta\theta$$

$$\delta\theta \to 0 \quad \simeq 0$$

this error can be neglected.

② Sine error :-



$$\text{error} = M - D \cong 2x$$

$$\frac{x}{d/2} = \tan\delta\theta = \delta\theta$$

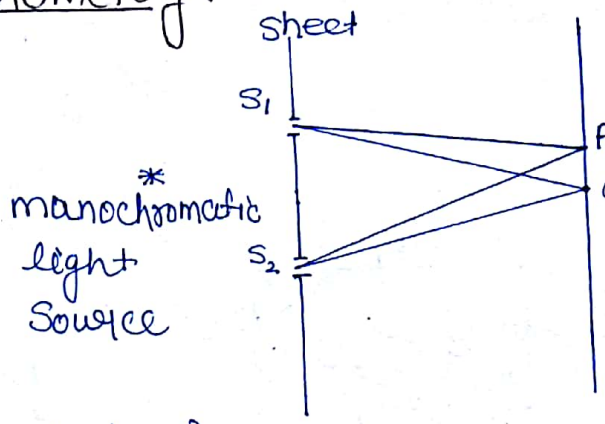
$$x = \frac{d}{2} \times \delta\theta$$

So error $= 2x$

$$\boxed{\text{Error} = d\delta\theta}$$

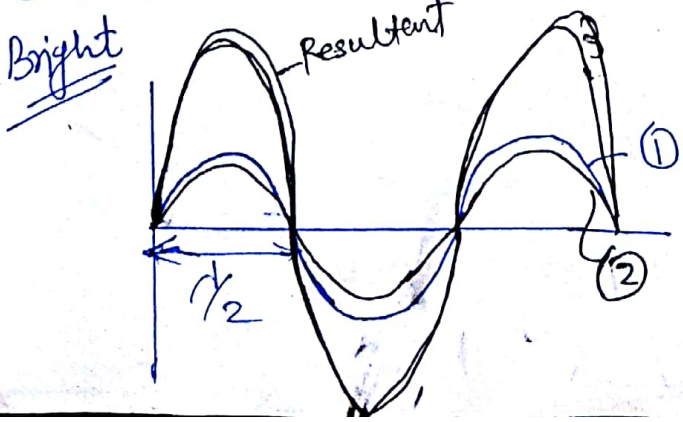
Can't be neglected d-dia. of micrometer.

Interferometry :-



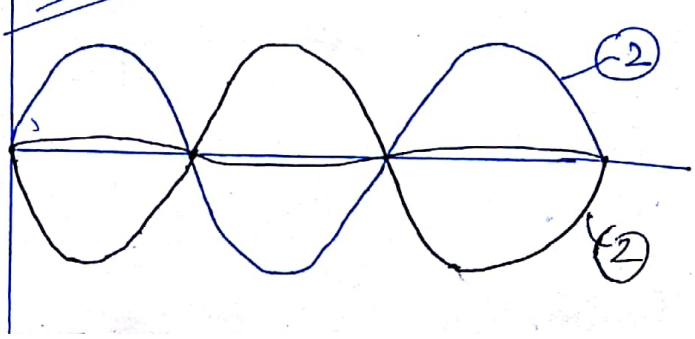
Constructive Interference

Bright



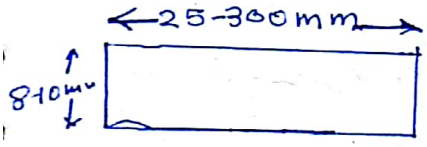
* Distructive Interference

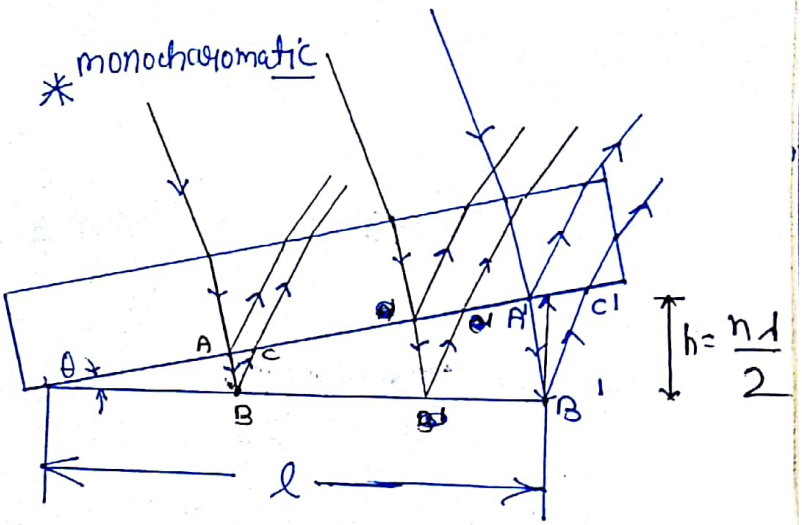
Dark



* Every odd integer of $\lambda/2$ path difference leads to Distructive interfarence and it produces a dark band on screen.
* Every even integer of $\lambda/2$ path difference leads to constructive interfarence and it produces a bright finge on screen. (white finge)

Optical flat





$AB + BC$ = Band Gap

if 'n' no. of finge are there

$$A'B' + B'C' = n\lambda$$

θ is very small $\Rightarrow$ $A'B' \simeq B'C' \simeq \frac{n\lambda}{2}$

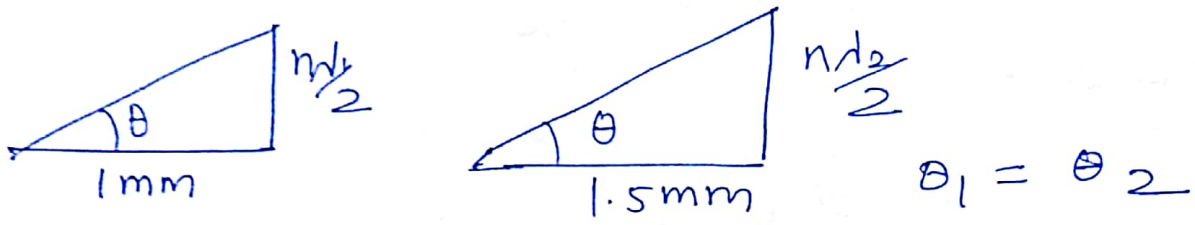
$$\tan\theta = \frac{A'B'}{l} = \frac{n\lambda}{2L}$$

$$\boxed{\theta \simeq \frac{n\lambda}{2L}}$$

Problem

Fringe shace $\ell_1 = 1mm$, $\lambda_1 = 450nm$

$\ell_2 = 1.5mm$ $\lambda_2 = ?$



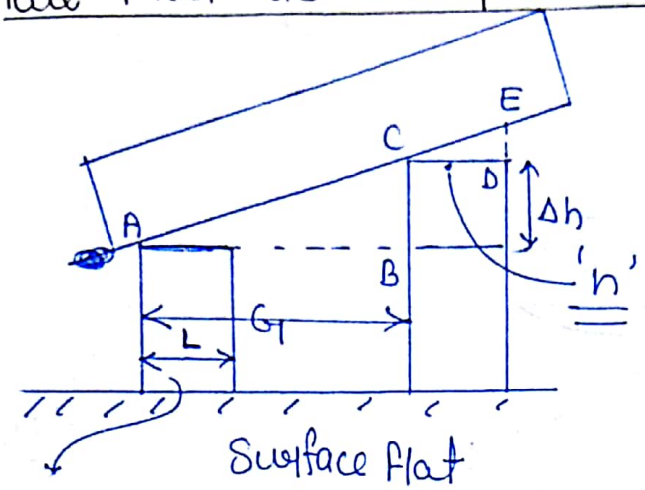
$\theta_1 = \theta_2$

$$\frac{n\lambda_1}{2\ell_1} = \frac{n\lambda_2}{2\ell_2}$$

$$\frac{450}{1} = \frac{\lambda_2}{1.5} \Rightarrow \lambda_2 = 675\ nm$$

* Upon increasing the angle b/w surface and optical flat since the ~~ph~~ path diff. is quickly multiple by $\lambda/2$. So fringe become thinner thiney so more no. of fringe will be accomodated in the same are.
when the angle increase beyond a certain value, fringle are very thin that we are not able to recognize so fringe will disappear.

Optical Flat as comparatey.



ΔCDE & ΔABC

$$\frac{ED}{CB} = \frac{CD}{AB}$$

$$\frac{\left(\frac{n\lambda}{2}\right)}{\Delta h} = \frac{L}{G_1}$$

$$\boxed{\Delta h = \left(\frac{n\lambda}{2}\right)\left(\frac{G_1}{L}\right)}$$

Q.39

$L = G_1 =$ 10

$(L = G_1)$

$$\Delta h = \frac{n\lambda}{2}\left(\frac{G_1}{L}\right)$$

$$\Delta h = \frac{n\lambda}{2}$$

$$n = \frac{2\,\Delta h}{\lambda}$$

$$n = \frac{2 \times 0.002}{0.00058928}$$

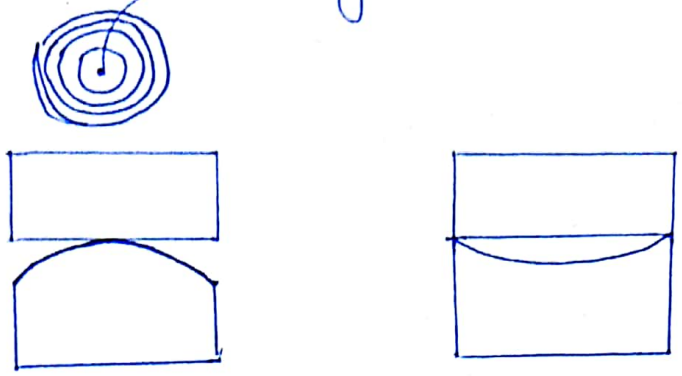
$$n = 6.78$$

So total $= 2n = 2 \times 6.78$

$= 13.8$

$\simeq 13 \simeq$

* bull's eye



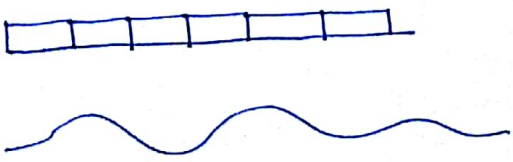
* when optical flat kept over a convex surface center fringe will be dark called Bull's eye The angle between the optical flat and surface keeps on increasing in outward direction so centre fringes will be broad and fringe thickness keeps on decreasing in outward direction. Upon pressing the optical flat if it is a convex surface centeral fringe will always be dark and since angle b/w optical flat and surface keeps on decrease & fringe thickness keep on increase.

Straightness:- It is departure of any surface from ideal state line. after Floting the surface characteristic state line d is drawn by joining the first and last point. The maximum deviation of surface from this refence line is called straightness.

① Straight Edge:- straight edge is a piece of block one surface of which is straight. By keeping the straight edge over surface under examination if lasser intensity of light is coming from the interface it means surface is straight.

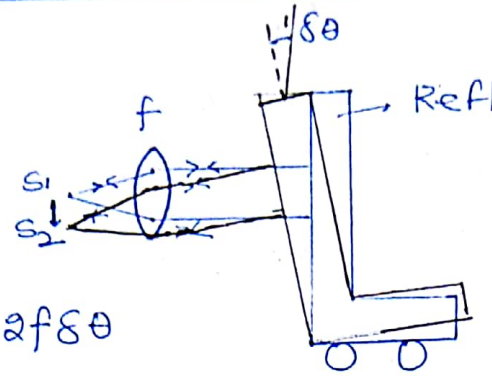
② spirit level:- surface under examination is devided into sigments with sigment size is equal to the spirit level. By keeping the spirit level from sigment to sigment position of it's bubble is noteded down and surface charactor can be plotted.

③



Surface Charater

③ Autocollimeter :-

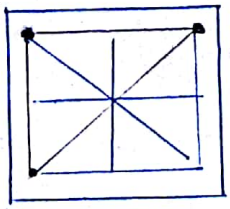


it is an expansive equipment

$\Delta S = 2f\delta\theta$

The reflector of Autocollimeter is moved over surface under examination and deviation of surface are recorded in terms of ΔS values and hence surface characteristic can be platted on the paper

Flatness :- It is departure of any surface from a refrence plane and when the surface is straight along infinite no. of line it is called flat. An Autocollimeter is moved in three direction to identify three points. By these three point a refrenance plane defined in auto collimeter is know moved in all possible direction and departure of surface from this refrenance plane is noted down is called flatness.



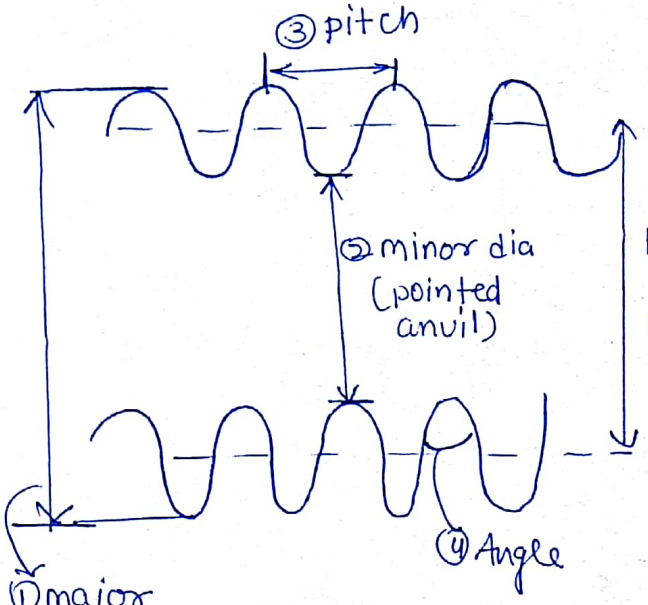
Q.30

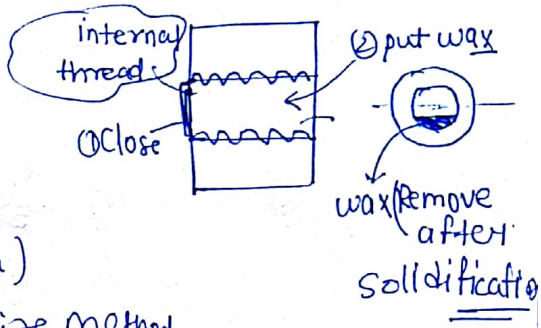
$$\frac{0.5}{50} = 0.01 \text{ mm}$$

$$5 \times 0.5 + 12 \times 0.01 = 2.62 \text{ MM}$$

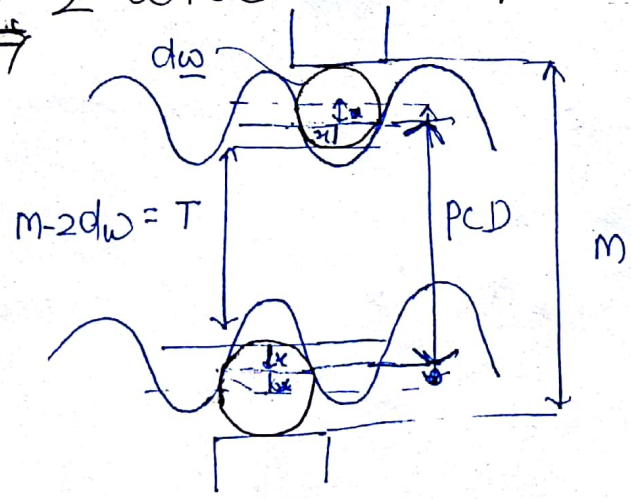
Q.40

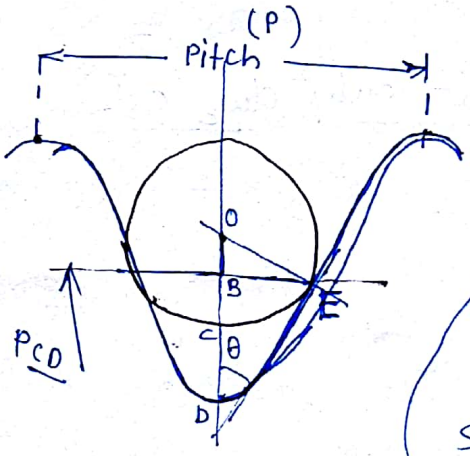
Screw thread metrology :-





⇒ 2-wire method :-





wire is not best size So don't Consider ΔOBE

$$PCD = T + 2x$$

dw - wire diameter

$$x = BC$$

$$x = OC - OB$$

$$x = \frac{dw}{2} - OB$$

Now $OB = OD - BD$

ΔODE

$$\frac{OE}{OD} = \sin\theta \Rightarrow \underline{OD} = \frac{d_w}{2}\operatorname{Cosec}\theta$$

ΔBDE

$$\frac{BE}{BD} = \tan\theta \Rightarrow BD = \frac{P}{4}\cot\theta$$

So Now $$OB = \frac{d_w}{2}\operatorname{Cosec}\theta - \frac{P}{4}\cot\theta$$

So $$x = \frac{d_o}{2} - OB$$

$$x = \frac{d_w}{2}(1-\operatorname{Cosec}\theta) + \frac{P}{4}\tan\theta$$

So Pitch Circle diameter $PCD = T + 2x$

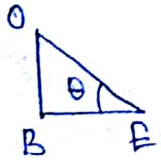
$$PCD = T + d_w(1-\operatorname{Cosec}\theta) + \frac{P}{2}\tan\theta$$

In Ques if only d_{w_b} ask

if it is Best size wire

dia $\Rightarrow d_{w_b}$

So consider ΔOBE right angle



$$\frac{P/4}{d_{w_b}/2} = \cos\theta$$

$$\boxed{d_{w_b} = \frac{P}{2}\sec\theta}$$

best size wire diameter

Q.34 $P = 2\ mm$

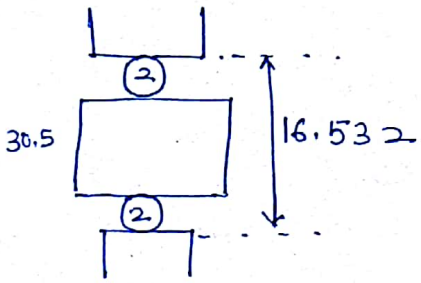
$2\theta = 60^\circ$ $\quad \theta = 30^\circ$

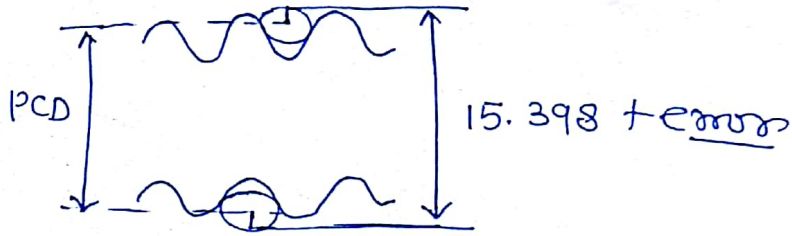
$$d_{w_b} = \frac{P}{2}\sec\theta = \frac{2}{2}\sec 30^\circ$$

$$d_{w_b} = \frac{1}{\cos 30^\circ} = \frac{2}{\sqrt{3}} = 1.154\ mm$$

Q 35 $P = 3.5\ mm$ $\quad d_w = 2\ mm$

$2\theta = 60^\circ \Rightarrow \theta = 30^\circ$





error = $30.5+2+2-16.532$

$= 34.5 - 16.532$

Error = $17.968\ mm$

Now $M = 15.398 + error$

$M = 33.366\ mm$

~~PCD = 33.366~~

$PCD = T + 2x$

$= M - 2d_w + d_w(1 - \text{Cosec}\theta) + \frac{P}{2}\cot\theta$

$= 33.366 - 2(2) + 2\left(1 - \text{Cosec}\,30^\circ\right) + \frac{3.5}{2}\cot 30^\circ$

$= 33.366 - 4 - 2 + 3.031089$

PCD $= 30.397$

Surface Finish :-

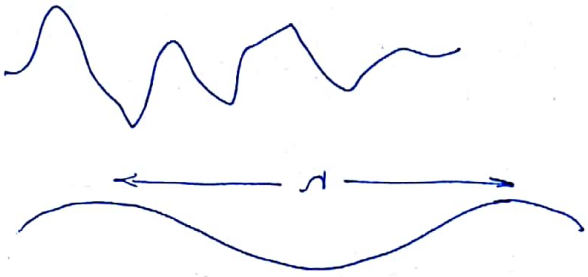
→ Small wavelength deviation of surface are called Roughness

→ Large wavelength deviation called waviness

→ Waviness appear in machiness component due to error in guide ways, machine vibration, chatter.

→ Roughness appear due to improper selection of cutting parameter, improper selection of cutting fluids etc.

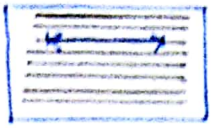
Roughness



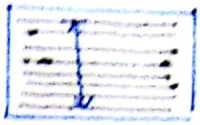
waviness

Flaw :- Flaw is highly localize and it may appear due to sudden change into cutting speed, some operator mistake, some localized impurities within the work.

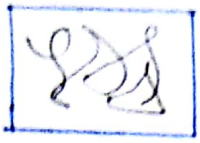
Lay :- It is the predominent surface pattern produce by feed marks



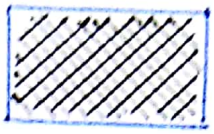
Parallel '=' lay



Perpendicular '⊥' lay

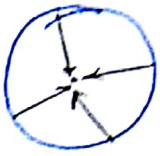


Multidirection 'M' in Grinding there is no predefine direction



Crossed 'X' lay in knurling

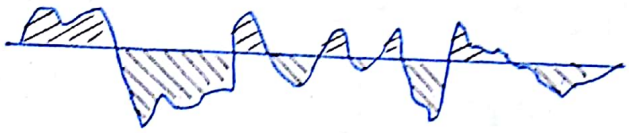
Circular 'C' lay in facing



Radial lay 'R' in sloting.

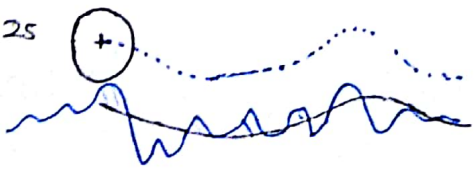
Establishing Datum:-

① M System:-
↳ Mean line



After ploting surface characteristic straight line drawn by joining the ~~fir~~ first point and last point. This line shifted to upward and downward dirⁿ to the plate when area below the line and area above the line are same called mean line.

② E-System:-
↳ Envelope



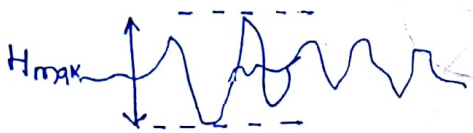
Sphere of ϕ25 mm is rolled over the surface of examination and the locus of its centre is being traced called envelope.

This envelope is lowered such that the area above the envelope and below the envelope are same.

* Envelop eliminates waviness from surface.

Measurement of surface Roughness

① Peak to Valley height :- (H_{max}, R_t, R_{max})

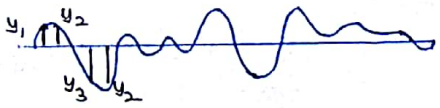


this is may be due to some fusk.

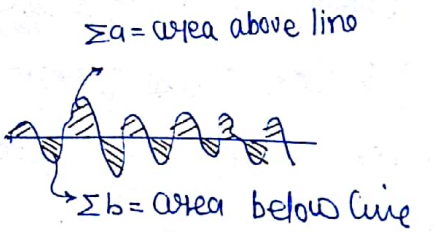
Sometimes it doesn't give Good result

It is the difference between highest peak and deepest vallay. But some time it doesn't represent the surface characteristic properly.

② Centre line avg value (CLA), (Ra)

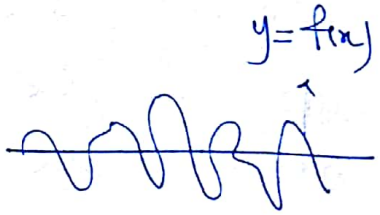


$$Ra = \frac{y_1 + y_2 + y_3 + y_4 + y_n}{n}$$



$$Ra = \frac{\Sigma a + \Sigma b}{L}$$

L = Cutoff length



$$Ra = \frac{1}{L}\int_0^L y\,dx$$

according to Mathematic.

$$H_{max} = \frac{f^2}{8R}$$

$$H_{max} = \frac{f}{\tan\psi + \cot\psi_1}$$

ψ - side cutting edge angle

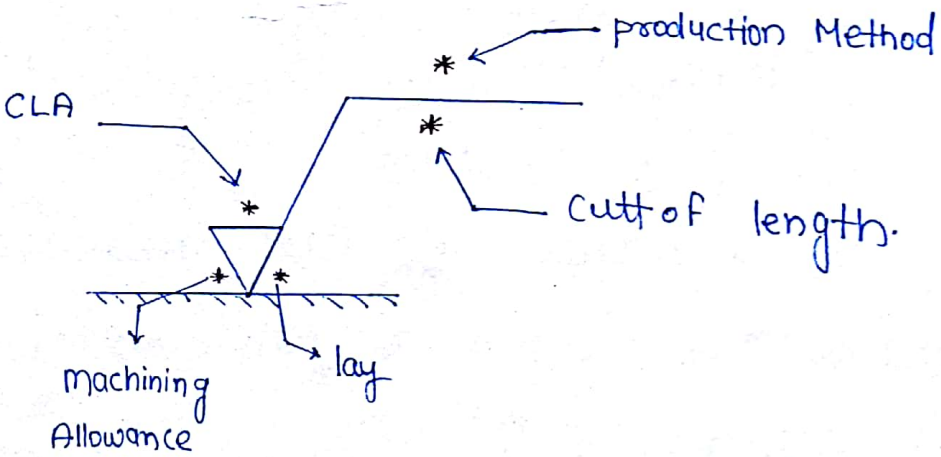
ψ_1 - end. cutting edge angle

③ Root mean square value (RMS) (R_q)

$$R_q = \sqrt{\frac{y_1^2 + y_2^2 + y_3^2 + \dots + y_n^2}{n}}$$

④ 10 point value (R_z) :- It is the average of 5 highest peak and 5 deepest valley's

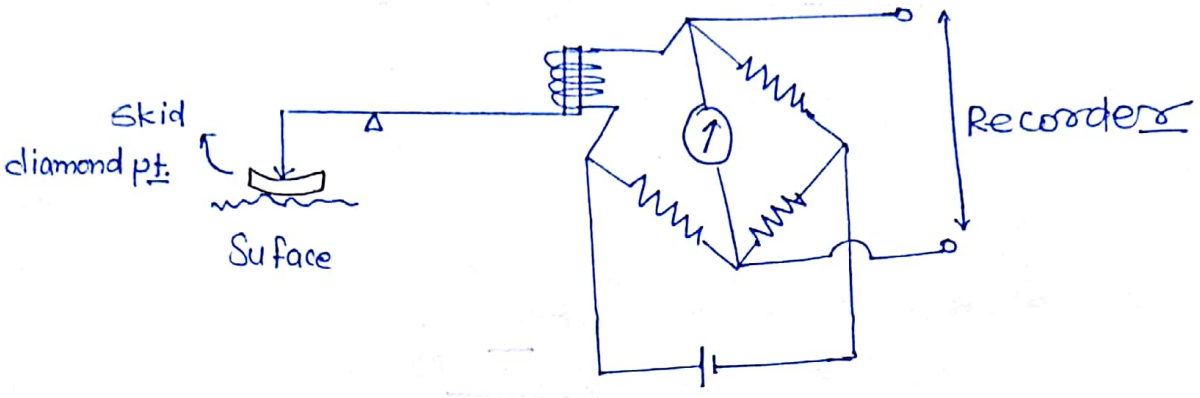
☆ Representation



☆

R_a 8-25 Hs 1.6-8Hs 0.025 - 1.6 Hs < 0.025 μ's

Taly surf :-



A diamont point is placed at one side of lever arm which moves over the hill down the vellay through skid.

$kid. it a soft material ment to protect diamond point. As diamont point moving it changes the position of core in induction coil. This changes the effective resistance. Since induction coil is connected to the 4th arm of wheat stone bridge so change in resistance can be measured in terms of flow of current. Hence Surface charactyistics can be plotted.