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SECTION : "B"

DEPARTMENT: BE Civil

SUBJECT: MOS - II

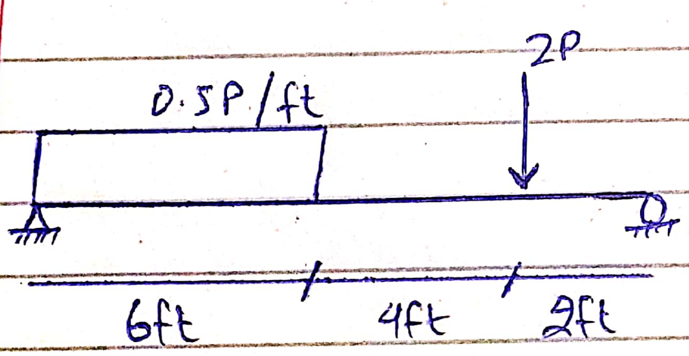
IQRA NATIONAL UNI

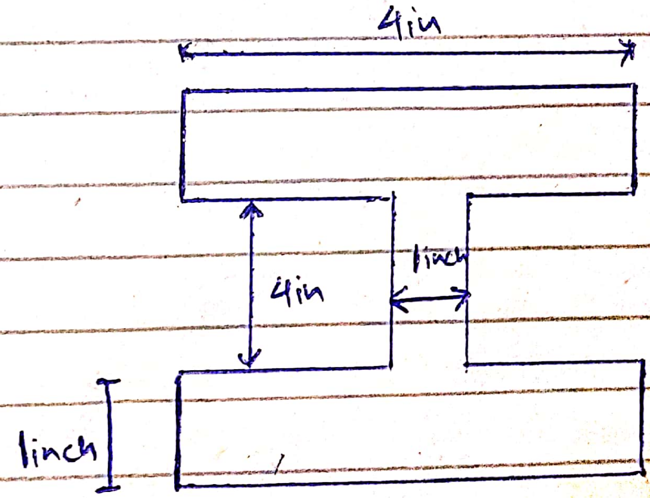
QUESTION:

⇒ Construct the Mohr's circle diagram and find the principle stress and maximum in plane shear stress for the stress .... Compute / Compare the results obtained from the Mohr's circle with the stress transformation equations.

Hint:- ⇒ To calculate the stress in the beam cross section the moment of inertia must be known.

⇒ where P is the last two digits of your class registration number in pounds.





$\Sigma F_y = 0 \uparrow +$

$= R_A + R_B - 31.5 \times 6 - 126\ lb = 0$

$\Rightarrow R_A + R_B = 315\ lb \longrightarrow (1)$

$\circlearrowleft^{+} \Sigma M_A = 0$

$-(31.5 \times 6 \times 3) - (126 \times 10) + (R_B \times 12) = 0$

$12 R_B = 1827$

$\boxed{R_B = 152.25\ lb.}$

putting value of RB in eq (1)

$R_A = 315 - 152.25$

$\boxed{R_A = 162.75\ lb.}$

At 6 ft.

$\Sigma F_y = 0 \uparrow +$

$-V_{6ft} + 162.75 - 31.5 \times 6 = 0$

$\boxed{V_{6ft} = -26.25}$

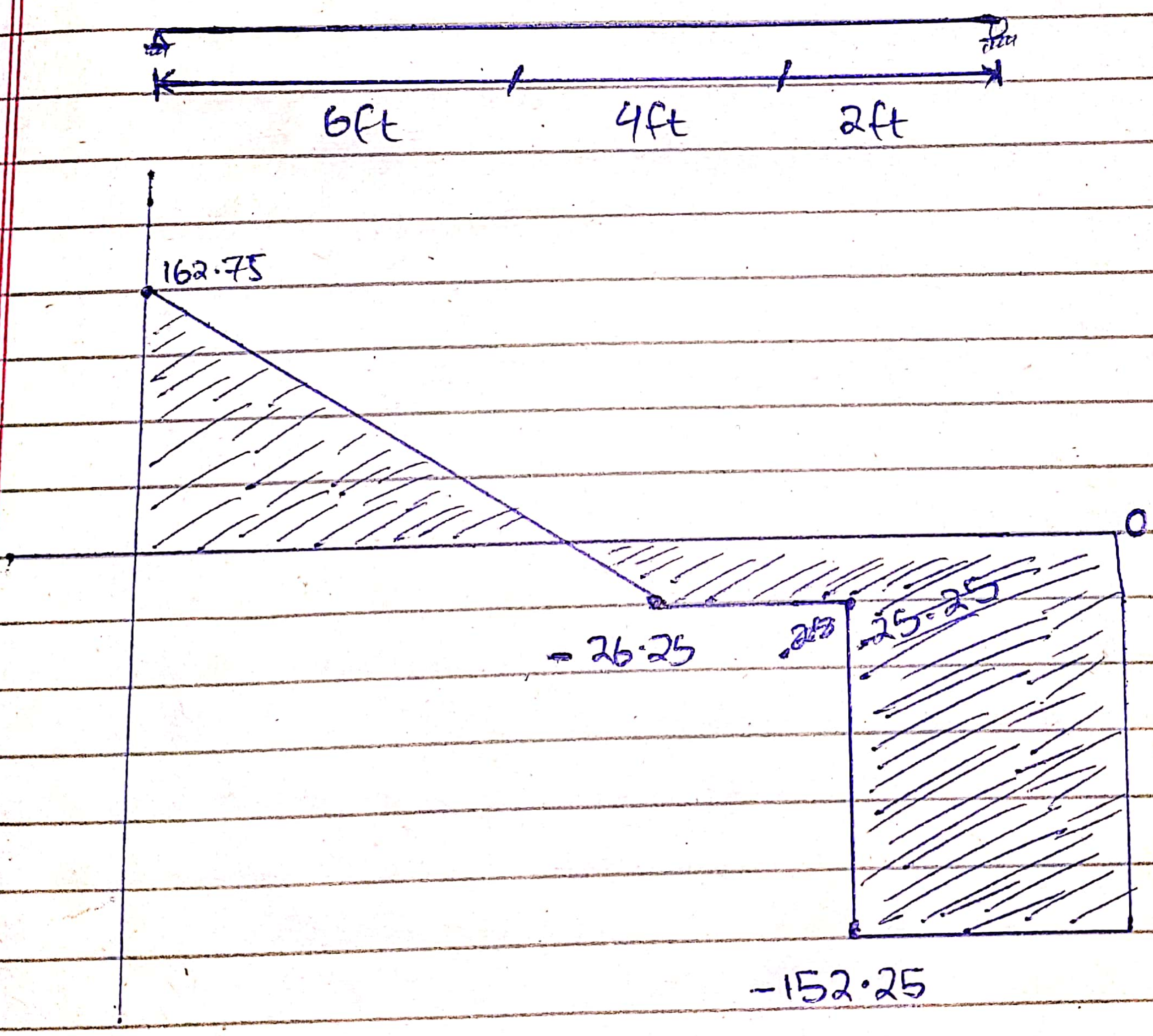
At 10 ft.

$\Sigma F_y = 0 \uparrow +$

$162.75 - 31.5 \times 6 - 126 - V_{10ft} = 0$

$\boxed{V_{10ft} = -152.25 \text{ lb.}}$

Shear force diagram:

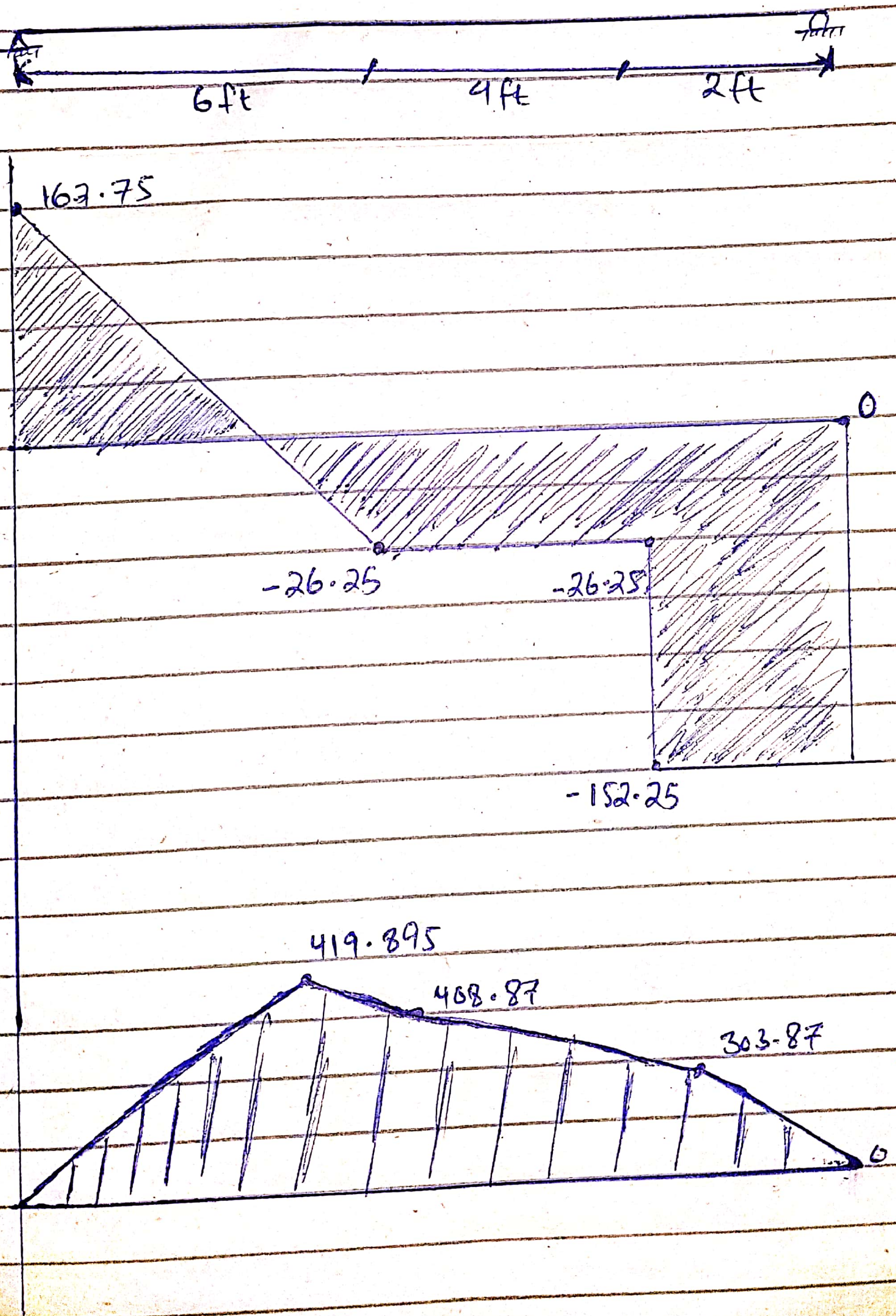


$$\frac{162.75}{x} = \frac{26.25}{6-x}$$

$$(162.75)(6-x) = 26.25x$$

$$x = 5.16$$

S.F and B.M diagram:-



Moment at 3ft which is C point

$\Sigma M_{3ft} = 0$ ↺+

$M_{3ft} - (162.75 \times 3) + (31.5 \times 3 \times 1.5) = 0$

$M_{3ft} = 346.5$ Psi

$\Sigma F_y = 0$ ↑+

$162.75 - 31.5 \times 3 - V_{3ft} = 0$

$V_{3ft} = 68.25$ Psi

⇒ **Shear stress:-**

⇒ To find shear stress at c point occurs

$\tau = \frac{VQ}{Ib}$

which lies in 68.25.

⇒ **Moment of inertia:-**

$I_{xx} = I_{xx_1} + I_{xx_2} + I_{xx_3}$ ——— (i)

$I_{xx_1} = 1/2\,(4)\,(1)^3 + 4(2.5)^2 = 25.33$ inch

$I_{xx_2} = 1/2\,(4)^3\,(1) + 4\,(0) = 5.33$ inch

$I_{xx_3} = 1/12\,(1)^3\,(4) + 4\,(3-5.5)^2 = 25.33$ inch putting values in eq (i) i.e:-

$I_{x.x} = I_{xx_1} + I_{xx_2} + I_{xx_3}.$

$I_{xx} = 25.33 + 5.33 + 25.33.$

$I_{xx} = 56$ inch.

=> for shear stress:-

$$I = \frac{VQ}{Ib}$$

$A = 1 \times 4 = 4 in^2$

$Q = 1 \times 4 + 2.5 = 10$ in

$$\tau = \frac{63.25 \times 10}{56 \times 4.}$$

$\tau = 3.04$ Psi

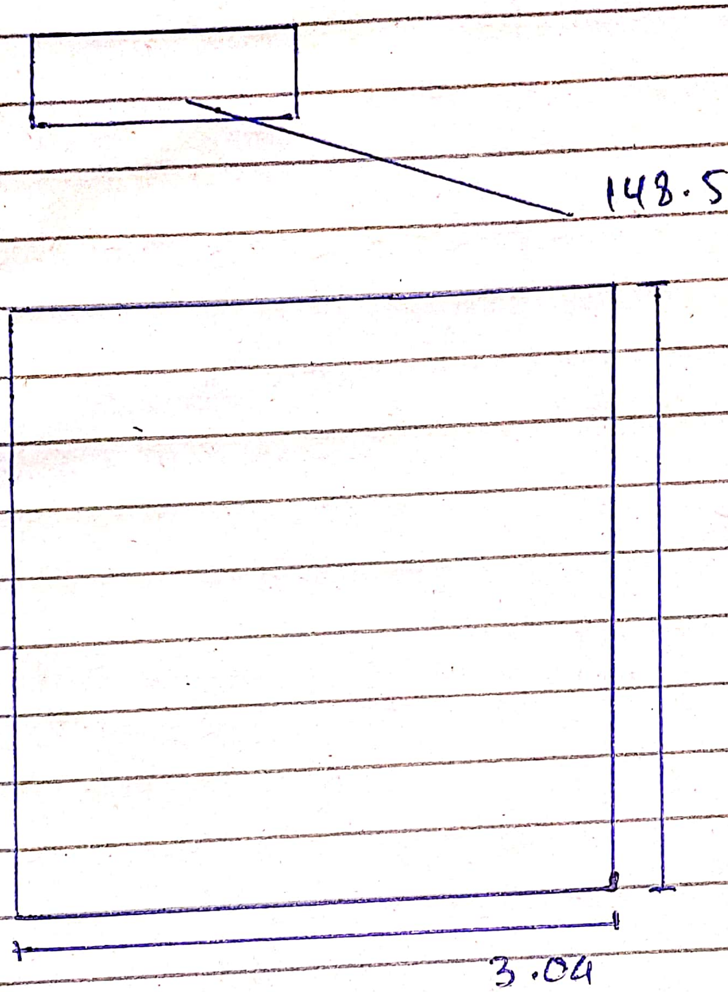
Flexure Stress:-

The moment at C point is 346.5 Psi

Flexure stress = $\delta = \frac{MY}{I}$

$$\delta x = \frac{346.5 \times 12 \times 2}{56}$$

$\delta x = 148.5$ Psi



$\sigma x = 148.5$ Psi

Stress state condition:-

Assumed angle is 20° clockwise orientiation.

$\theta = -20^\circ$.

Transformation:-

for $\sigma x'$:

$$\sigma x = \frac{\sigma x + \sigma y}{2} + \frac{\sigma x - \sigma y}{2} \cos 2\theta + \tau xy \sin\theta$$

$\cancel{\cos 2\theta + \tau xy \sin\theta}$

$$\delta x' = \frac{-148.5 + 0}{2} + \frac{(-148.5) - 0}{2} \cos 2(-20)$$
$$+ 3.04 \sin 2(-20).$$

$$\delta' x = -133.08$$

for $\delta y'$

$$\delta y' = \frac{\delta x + \delta y}{2} - \frac{\delta x + \delta y}{2} \cos 2\theta + \tau xy \sin 2\theta$$

$$\delta y = \frac{-148.5 + 0}{2} - \frac{(-148.5) - 0}{2} \cos 2(-20) + 3.04 \sin 2(-20)$$

$$\delta y' = -19.32.$$

$$\tau x'y' = - \frac{-\delta x - \delta y}{2} \sin\theta + \tau xy \cos 2\theta$$

$$\tau x'y' = \frac{(-148 - 0)}{2} \sin(-20) + 3.04 \cos 2(-20)$$

$$\tau x'y' = -45.39.$$

=> Find the principle stress:-

Principle stress equation is:-

$$\delta_{1,2} = \frac{\delta x + \delta y}{2} \pm \sqrt{\left(\frac{\delta x - \delta y}{2}\right)^2 + \tau_{xy}^2}$$

$$\delta_{1,2} = \frac{-148.5 + 0}{2} \pm \sqrt{\left(\frac{-148.5 - 0}{2}\right)^2 + (3.04)^2}$$

$$\delta_{1,2} = -74.25 \pm 74.31.$$

$$\delta y = \delta_1 = -74.25 + 74.31 = 0.06 \text{ Psi}$$

$$\delta x = \delta_2 = -74.25 - 74.31 = -148.56 \text{ Psi}$$

To find $\theta P = ?$

$$\tan 2\theta P = \frac{\tau_{xy}}{(\delta x - \delta y)/2}.$$

$$= \frac{3.04}{(-148.5 - 0)/2}.$$

$$\theta P = -2.59.$$

put in general eq.

$$\delta'_{max} = \frac{-148.5 + 0}{2} + \frac{-148.5 - 0}{2} \cos 2(-2.59) + 3.04 \sin 2(-2.59).$$

$$\delta'_{max} = -148.47 \text{ Psi}$$

Max in Plane shear stress:-

$$\tan 2\theta_s = \frac{-(\sigma_x - \sigma_y)/2}{\tau_{xy}}.$$

$$\tan 2\theta_s = -\frac{(-148.5-0)/2}{3.04}.$$

$$\theta_s = 43.82.$$

put in general solution for $\tau_{x'y'}$.

$$\tau_{x'y'} = -\left(\frac{\sigma_x - \sigma_y}{2}\right)\sin 2\theta + \tau_{xy}\cos 2\theta.$$

$$\tau_{x'y'} = -\left(\frac{-148.5-0}{2}\right)\sin 2(43.82) + 3.04\cos 2(43.82)$$

$$\tau_{x'y'} = 74.43.$$

⇒ Mohr's Circle:-

Centre co-ordinate.

$$(h,k) = \left(\frac{-148.5+0}{2}\right)$$

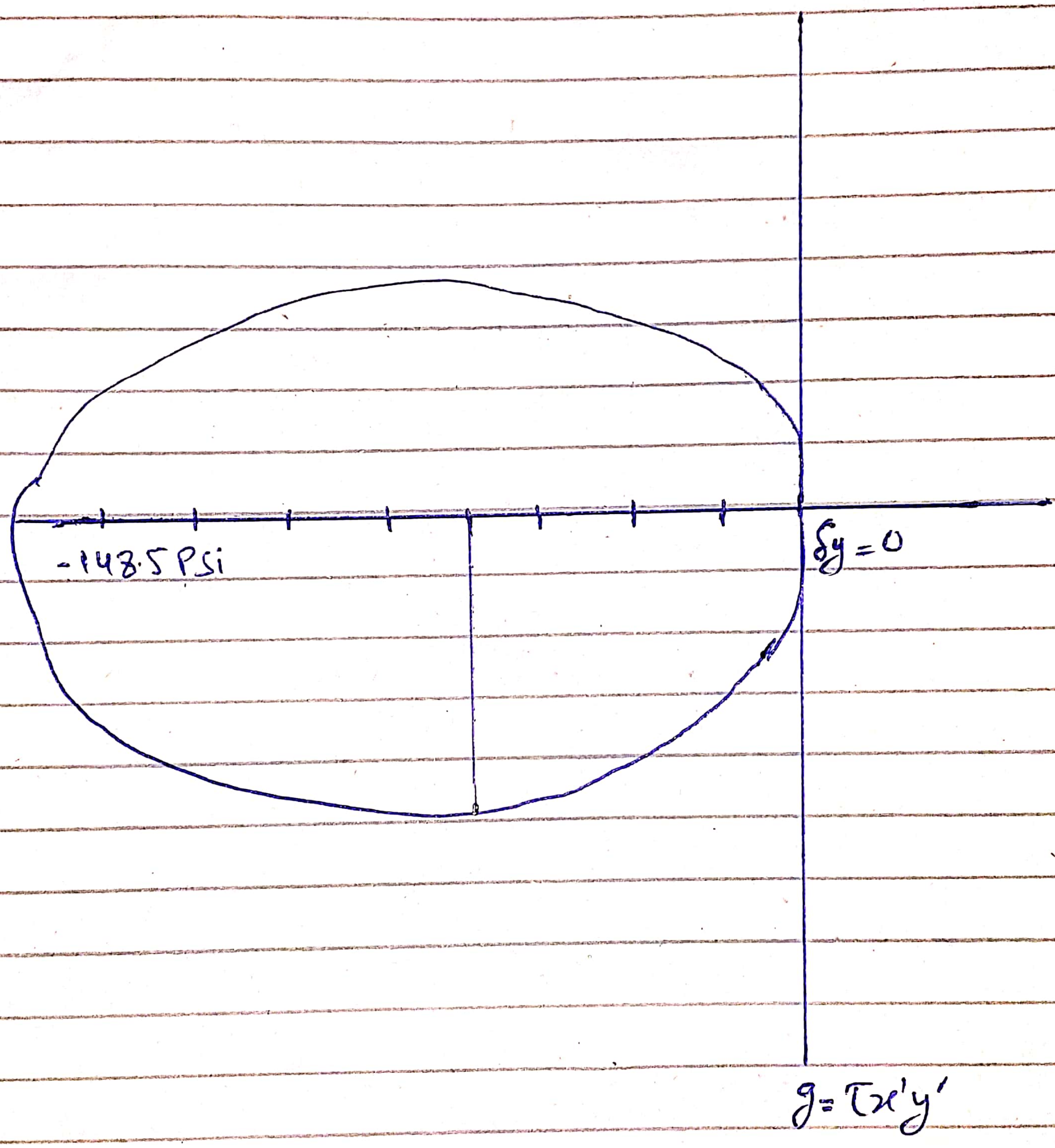
$$= -74.25$$

Radius of Mohr's circle:-

$$r = \sqrt{(\sigma_x - \sigma_y/2) + \tau_{xy}}$$

$$r = \sqrt{\left(\frac{-148.5-0}{2}\right)^2 + (3.04)^2}$$

$$r = -74.25 \text{ Psi}$$


-148.5 Psi
δy = 0
g = τx'y'