Subject:-

MOS-2

Submitted By:

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Sec = A

Submitted To

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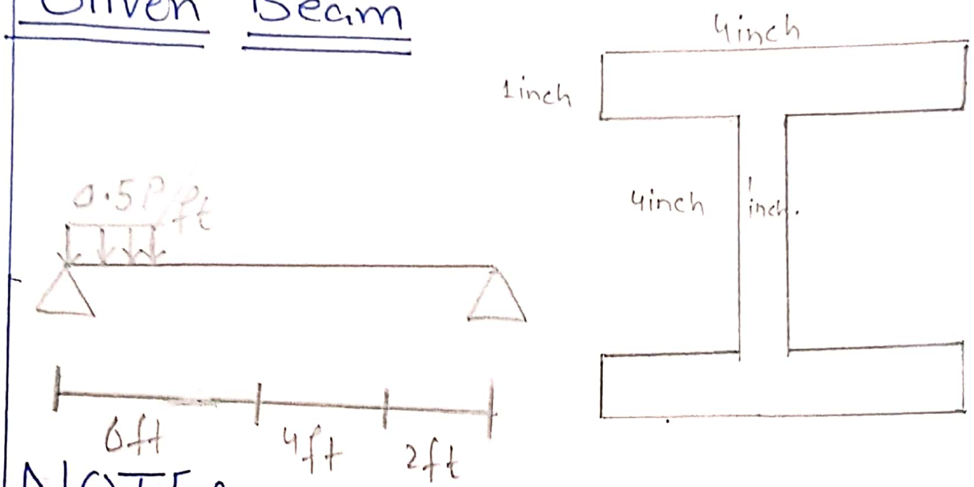
Question No – 1

Ans:-

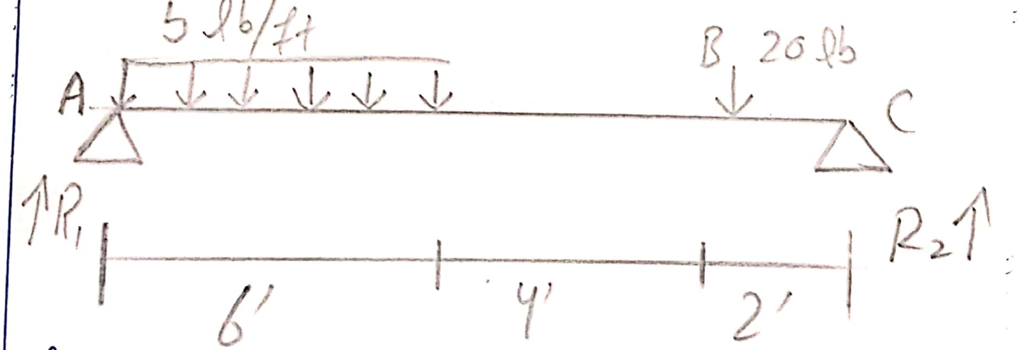
Given Beam



NOTE:-

→ Put the value of $P = 10$

So we have



first to find unknown reaction at the support applying equilibrium equation

$\Sigma f_x = 0$ i.e $R_3 = 0$

$\Sigma f_y = 0$

$(+)\uparrow$

$R_1 + R_2 = (5 \times 6)\, lb + 20\, lb$

$R_1 + R_2 = 30 + 20$

$R_1 + R_2 = 50\, lb$

Next :-

$\Sigma M_A = 0$ (+ ↻ , − ↺)

$R_2 \times 12 - 10 \times 20 - (5 \times 6) \times 3 = 0$

$12 R_2 = 200 + 90$

$\frac{12 R_2}{12} = 290/12$

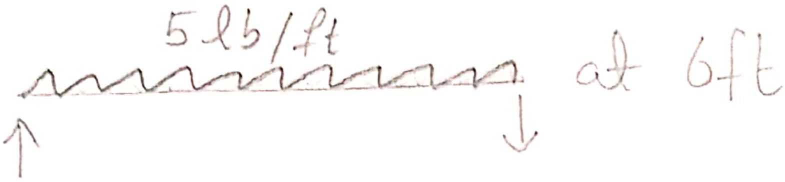
$R_2 = 24.16$

(1) $R_1 + R_2 = 50$

$R_1 = 50 - 24.16 = 25.84$

③

Now shear force at change Point of Beam



Shear force at 6ft from support

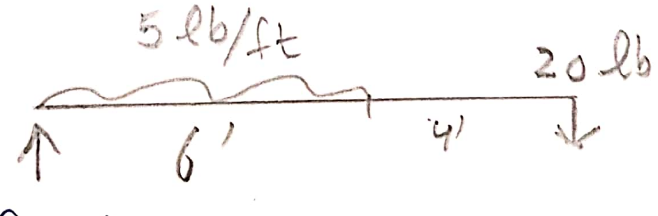
$\Sigma f_y = 0$ ⊕↑ ↓⊖

$25.84 - 5 \times 6 - V_{6ft} = 0$

$\Rightarrow V_{6ft} = + 25.84 - 30 = -4.16$

Now shear force at 10ft

$\Sigma f_y =$ ⊕↑ ↓⊖



$25.84 - (5 \times 6) - 20 - V_{10ft} = 0$

$V_{10}ft = 25.84 - 30 - 20 = -24.16$

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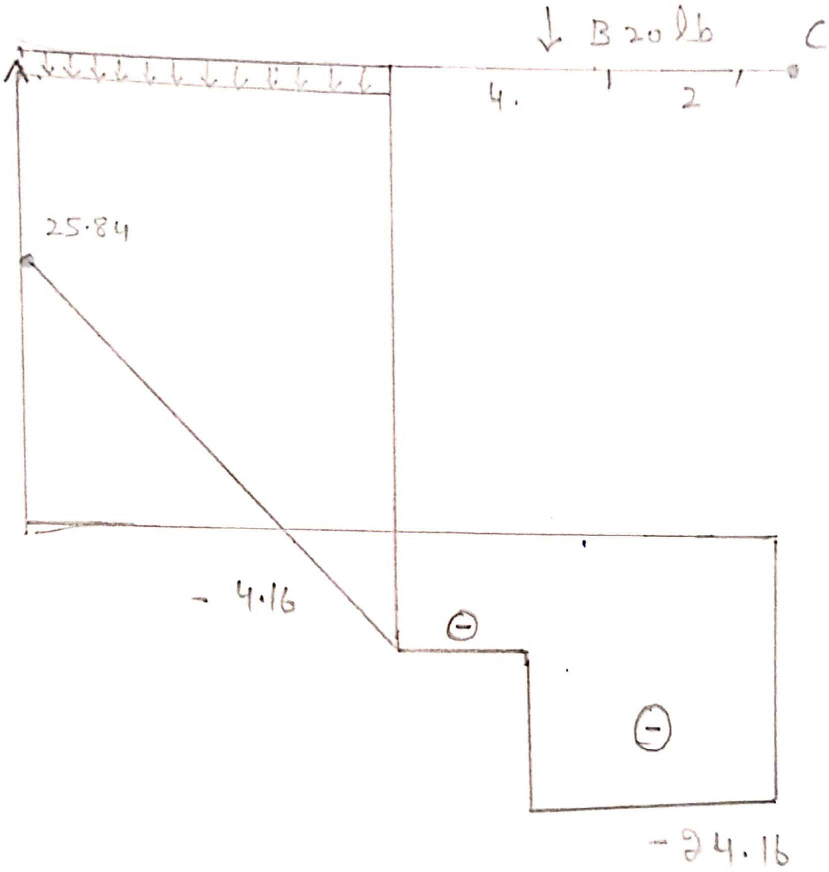
(4)

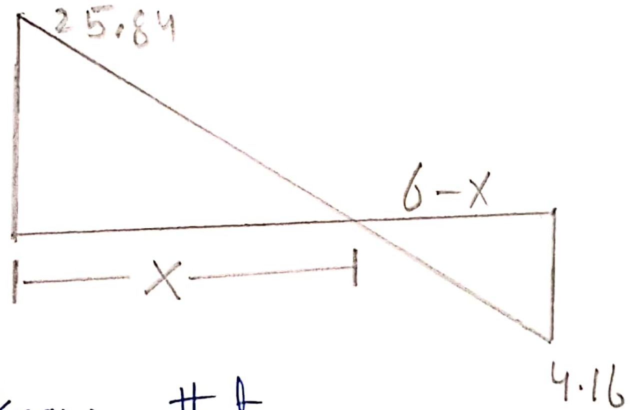
Now draw shear force and bending moment diagram we have:



⇒ Point of Maximum Bending Moment:- (5)

As we Know that the point where Shear force is minimum the bending is minimum so from point of zero Shear corresponding point will have maximum Bending moment.

From shear force diagram we have



we know that

$$\frac{25.84}{x} = \frac{4.16}{6-x}$$

$$\Rightarrow (6-x)(25.84) = 4.16x$$

$$\Rightarrow 155.04 - 25.84x = 4.16x$$

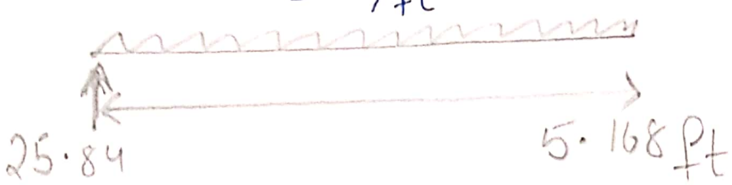
$$\Rightarrow 155.04 = 25.84x + 4.16x$$

$$\Rightarrow 155.04 = 30x$$

$$x = 5.168 \text{ ft}$$

(6)

Now determine the value of moment at 5.168 ft



$$M_{5.168} - R_1 \times 5.168\,ft + (5 \times 5.168) \times \left(\frac{5.168}{2}\right) = 0$$

$$M_{5.168} - 25.84 \times 5.168 + (5 \times 5.168) \times \left(\frac{5.168}{2}\right) = 0$$

$$M_{5.168} - 133.54 + 25.84 \times 2.584 = 0$$

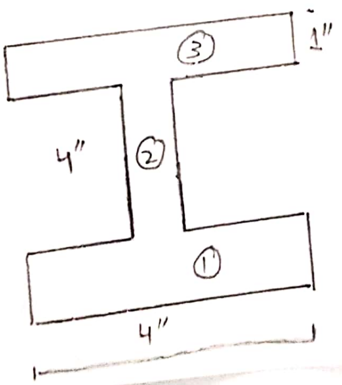
$$M_{5.168} - 133.54 + 66.77 = 0$$

$$M_{5.168} = 66.77\ lb\,ft$$

For shear stress we have:

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

So first we determine moment of inertia I of the given section of Beam



As the given figure is symmetrical along Both the axis (7)

So $\bar{x} = 4/2 = 2$ inch

$\bar{y} = 6/2 = 3$ inch

i.e $(\bar{x}, \bar{y}) = (2,3)$

(Centre of gravity)

extreme left and Bottom

Area of point ① = $4 \times 1 = 4 \text{ inch}^2$

Area of point ② = $4 \times 1 = 4 \text{ inch}^2$

Area of point (3) = $4 \times 1 = 4 \text{ inch}^2$

Moment of inertia about X-axis ((Centroid) I_{xx}

Detemine Distance b/w C.G of the whole section and corresponding parts

Let

G_1, G_2, G_3 be in the centre of gravity of point ① ② and ③ and k_1, k_2, k_3 be the distance b/w $\bar{y}$ and y_1, y_2, y_3 respectively.

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So,

$k_1 = \bar{y} - y_1 \Rightarrow 3 - 0.5 \Rightarrow 2.5 \text{ inch}$ (8)

$k_2 = \bar{y} - y_2 \Rightarrow 3 - 3 \Rightarrow 0 \text{ inch}$

$k_3 = \bar{y} - y_3 \Rightarrow 3 - 0.5 \Rightarrow 2.5 \text{ inch}$

So

$$I_{xx} = \frac{b_1 h_1^3}{12} + a_1 k_1^2 + \frac{b_2 h_2^3}{12} + a_2 k_2^2 + \frac{b_3 h_3^3}{12} + a_3 k_3^2$$

$$I_{xx} = \frac{(4)(1)^3}{12} + 4(2.5)^2 + \frac{(1)(4)^3}{12} + a_2(0) + \frac{4(1)^3}{12} + 4(2.5)$$

$$I_{xx} = 4/12 + 25 + 64/12 + 4/12 + 25$$

$$I_{xx} = \frac{4 + 12(25) + 64 + 4 + 12(25)}{12}$$

$$I_{xx} = 56 \text{ inch}^4$$

Now

$$I_{yy} = \frac{b_1^3 h_1}{12} + \frac{b_2^3 h_2}{12} + \frac{b_3^2 h}{12}$$

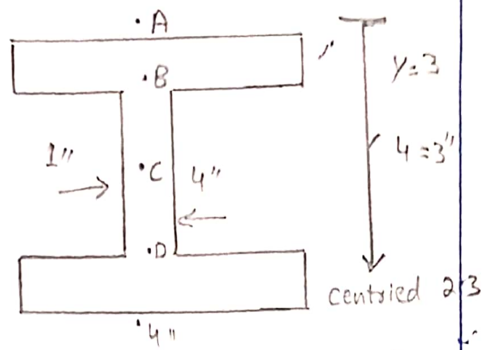
$$I_{yy} = \frac{(4)^3(1)}{12} + \frac{(1)^3(4)}{12} + \frac{(4)^3(1)}{12}$$

$$I_{yy} = \frac{64 + 4 + 64}{12} = \underline{11} \text{ inch}^4$$

(9)

Next find the shear stresses at various point we have:-

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



(i) Shear stress at point "A" i.e at the top fiber

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

$V_{max} = 24.16$ lb

$I = 67 in^4$

$\therefore Q = A\bar{y}$

So $\tau = \frac{24.16(0)}{67(4)}$

$\tau = 0$

Here A=0 Beam no area of the section exist above point A

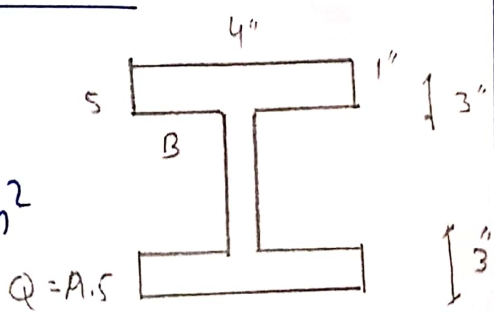
i.e $Q = A\bar{y} \Rightarrow (0)(\bar{y}) = 0$

(ii) Shear stress at point "B"

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

$$\tau = \frac{24.16 \times (4\times1)(3-0.5)}{67\times4}$$

$$\tau = 0.9015\ lb/in^2$$

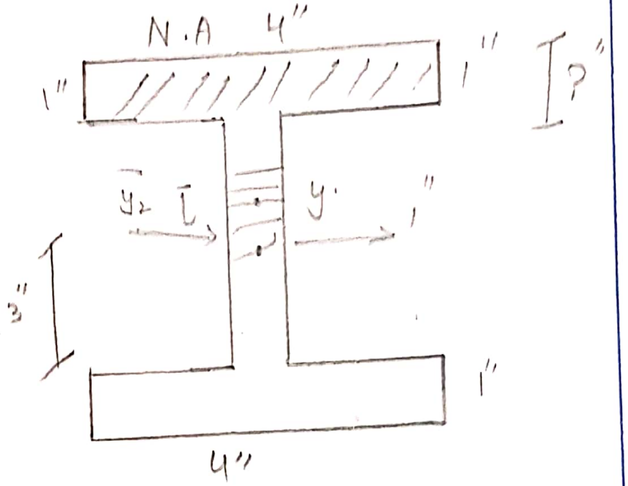


Shear stress at point "c" i.e at NA

(10)

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

$$\tau = \frac{24.16 \times [4 \times 1 \times (3-0.5) + (1 \times 2)(2-1)]}{67 \times 1}$$



$\tau = 4.327 \; lb/in^2$

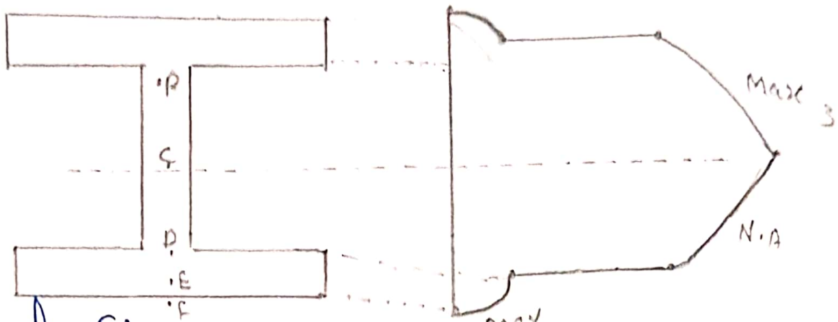
(iv) Shear stress at point D and E will be the same because of the symmetry.

2,297.

Note:-

The maximum shear stress value occur at the Neutral axis and minimum value at the top of the section.

Shear Stress Diagram:- (11)



flexural Stress Determination

$$\delta = \frac{My}{I}$$

(i) flexural stress at the top fibre Point A

$$\delta = \frac{My}{I}$$

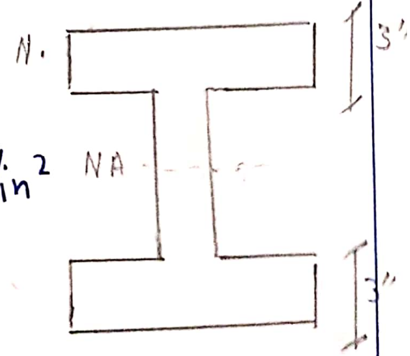
M= 66.77
I=67

$$\delta = \frac{66.77 \times 3}{67} = 2.99 \text{ lb/in}^2$$

(ii) flexural Stress at point "B"

$$\delta = \frac{My}{I}$$

$$\delta = \frac{66.77 \times (3-0.5)}{67} = 2.49 \text{ lb/in}^2$$

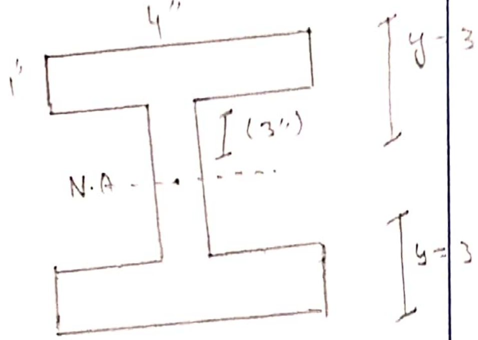


(iii) Flexural Stress at point "C"

$S = \frac{My}{I}$

$S = \frac{66.77 \times (3-1)}{67}$

$S = 1.99\ lb/in^2$

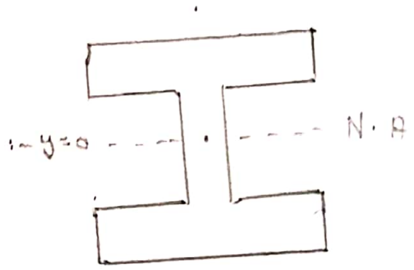


(iv) flexural Stress at Neutral axis (N.A)

$S = \frac{My}{I}$

$S = \frac{66.77 \times 0}{67}$

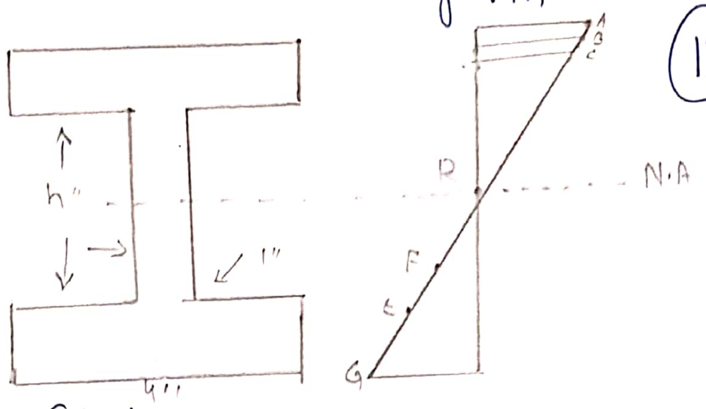
$S = 0\ lb/in^2$



flexural stress value at point E, f and g remain the same because of the same because of symmetry.
The upper portion above the N.A shows Tension and below the N.A Shows compression.

Note:- The flexural stress value is maximum at extreme top and bottom fibre at zero at N.A.

flexural Stress diagram



Stress State:-

find stress state of a point element located 3ft from left support and 1inch below from top fibre

flexural stress at point "C"

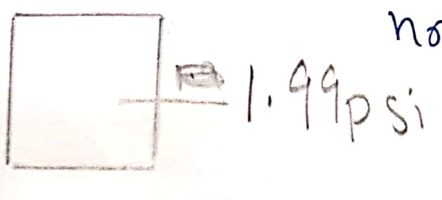
$\sigma = 1.99 \ lb/in^2$ or psi

Shear stress at point "C"

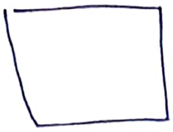
$\tau = 4.327 \ lb/in^2$ or psi

Consider point "C" is a planner element

As the flexural stress is perpendicular to the cross section can be represented normal stress



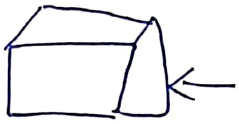
$\tau = 4.327$ psi is comprective
because point "C" lies in compression zone of Beam cross section.



(14)

If point "C" lies below the centroid then stress would be tensile.

$\tau = 4.327$ psi



$\tau = 4.327$ psi

$\sigma_x =$ 1.99 psi

Combine stress on 2nd element

Find it principle stress:-

we have also find

$\sigma_x = 1.99$ psi

$\sigma_y = 0$

$\tau_{x'y} = 4.327$ psi

(15)

Principle Stress equation

$$\sigma_{x,y} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (\tau_{xy})^2}$$

$$\sigma_{x,y} = \frac{-1.99 + 0}{2} \pm \sqrt{\left(\frac{-1.99 - 0}{2}\right)^2 + (4.327)^2}$$

$$\sigma_{x,y} = -0.995 \pm \sqrt{0.99 + 18.72}$$

$$\sigma_{x,y} = -0.995 \pm \sqrt{19.71}$$

$$\sigma_{x,y} = -0.995 \pm 4.44$$

$$\sigma_x = -0.995 - 4.44 = -3.445$$

$$\sigma_y = -0.995 + 4.44 = 5.435$$

or first find $\theta_P = ?$

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

$$\tan 2\theta_P = \frac{4.327}{(-1.99 - 0)/2}$$

$$\tan 2\theta_P = -1.087$$

$$2\theta_P = \tan^{-1}(-1.087)$$

$$\theta_P = -26.351$$

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To Draw Mohr's circle

Centre Co-ordinate

$$(h, k) = \left(\frac{\sigma x + \sigma y}{2}, 0\right)$$

$$\Rightarrow \left(\frac{-1.99 + 0}{2}, 0\right)$$

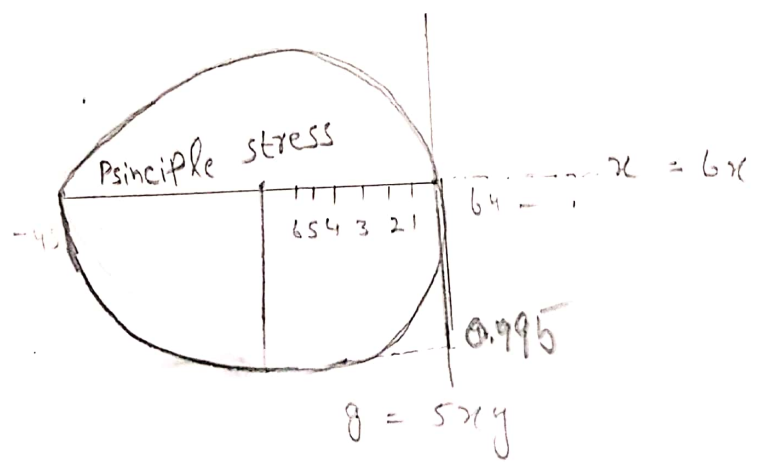
$$\Rightarrow (-0.995, 0$$

Radius of Mohr's circle

$$r = \sqrt{\left(\frac{\sigma x - \sigma y}{2}\right)^2 + \tau x^2 y} = \sqrt{\left(\frac{-1.99}{2} - 0\right)^2 + (4.327)^2}$$

$$r = \sqrt{0.99 + 18.72} = \pm 4.44 \text{ or } \sqrt{19.71}$$

$$r = 19.71$$



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