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Subject # MOS(II)

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Q#1

Given Data

The state of stresses which are given as;

$\sigma_x = -40 MPa$

$\sigma_y = 70 MPa$

$\tau_{xy} = -50 MPa$

Required Data

⇒ Determine the state of stress at point rotated at 15° in clock wise direction.

Solution

The given stresses are

$\sigma_x = -40 MPa$

$\sigma_y = 70 MPa$

$\tau_{xy} = -50 MPa$

(2)

When we rotate the element of beam at 15° in clockwise direction then we find σ_{x_1}, σ_{y_1} and $\tau_{x_1 y_1}$

First we find σ_{x_1},

$$= \sigma_{x_1} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$$

$$= \sigma_{x_1} = \frac{-40+70}{2} + \left(\frac{-40-70}{2}\right) \cos 2(-15^\circ) + (-50) \sin 2(-15^\circ)$$

$$= \boxed{\sigma_{x_1} = -7.63 \text{ MPa}}$$

⇒ Now we have to find σ_{y_1}

$$\sigma_{y_1} = \frac{\sigma_x + \sigma_y}{2} - \frac{\sigma_x - \sigma_y}{2} \cos 2\theta - \tau_{xy} \sin 2\theta$$

$$\sigma_{y_1} = \frac{-40+70}{2} - \left(\frac{-40-70}{2}\right) \cos 2(-15) - (-50) \sin 2(-15)$$

$$\boxed{\sigma_{y_1} = 37.63 \text{ MPa}}$$

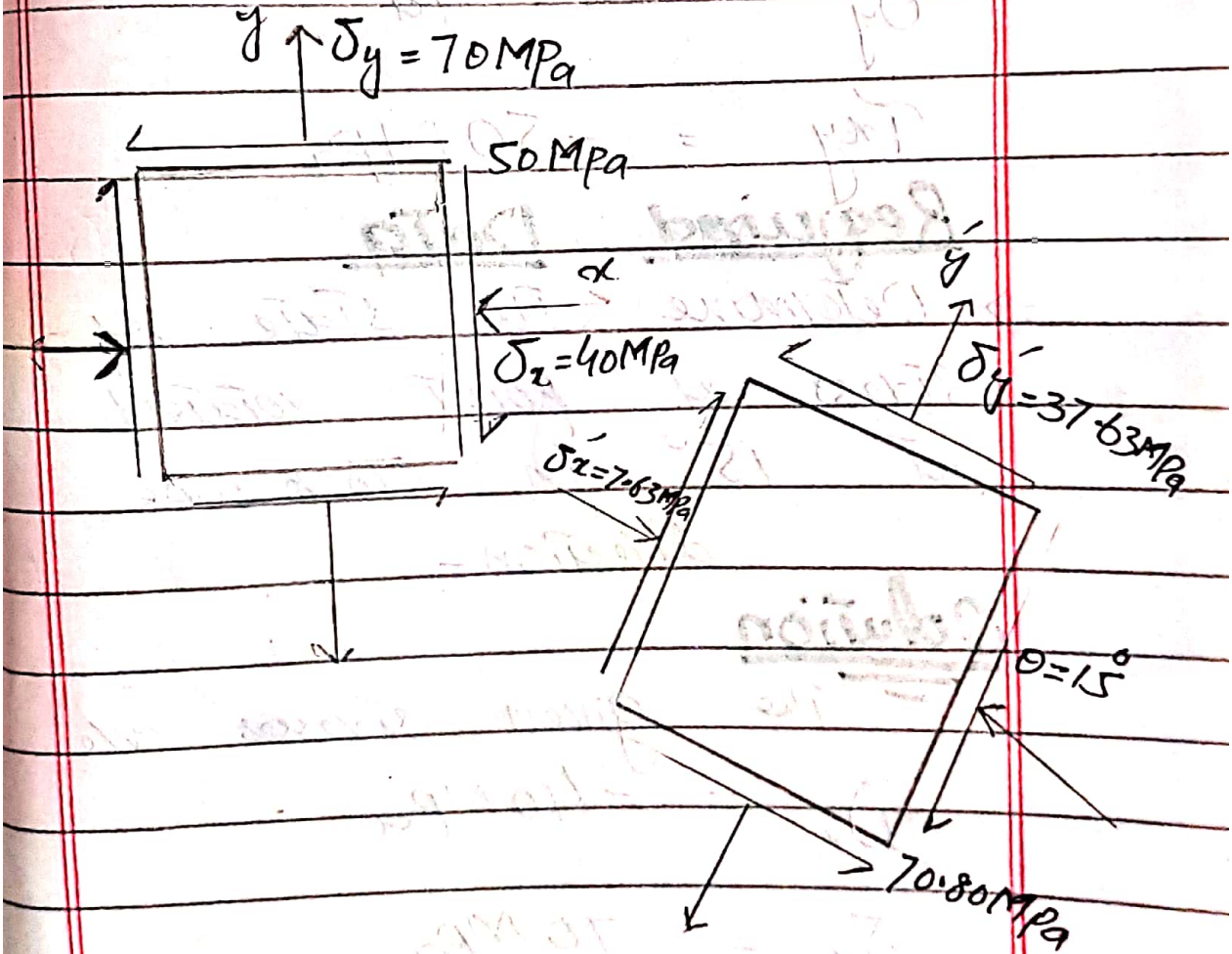
(3)

Also we have to find $\tau_{x_1y_1}$

$$\tau_{x_1y_1} = -\frac{(\sigma_x - \sigma_y)}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

$$\tau_{x_1y_1} = -\frac{(-40-70)}{2}\sin 2(-15^0) + (-50)\cos 2(-15)$$

$$\boxed{\tau_{x_1y_1} = -70.80\ MPa}$$



Question : 02

Part: a

Given Data

⇒ The State of Stresses which are given as;

$\delta_x = -40\ MPa$

$\delta_y = 70\ MPa$

$\tau_{xy} = -50\ MPa$

Required Data

principal plane = ?

principal Stresses = ?

Solution

⇒ First we find plane

$$\tan 2\theta_p = \frac{2\tau_{xy}}{\delta_x - \delta_y}$$

$$\tan 2\theta_p = \frac{2(-50)}{-40-70}$$

$$\tan 2\theta_p = 0.9091$$

$$2\theta_p = \tan^{-1}(0.9091) = 42.27$$

$$\theta_{P_2} = \frac{42.27}{2}$$

$$\boxed{\theta_{P_2} = 21.14^\circ}$$

Also

$$2\theta_{P_1} = 42.27 + 180$$

$$2\theta_{P_1} = 222.27$$

$$\theta_{P_1} = \frac{222.27}{2}$$

$$\boxed{\theta_{P_1} = 111.135^\circ}$$ Y-Axis

Now we have to find principal stresses are;

$$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\sigma_1 = \frac{-40+70}{2} + \sqrt{\left(\frac{-40-70}{2}\right)^2 + (-50)^2}$$

$$\boxed{\sigma_1 = 89.33 \text{ MPa}}$$

Also

$$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\sigma_2 = \frac{-40+70}{2} - \sqrt{\left(\frac{-40-70}{2}\right)^2 + (50)^2}$$

$$\boxed{\sigma_2 = -59.33 \text{ MPa}}$$

Hence

$\sigma_1 = 89.33 \text{ MPa}$ with $\theta_{p_1} = 111.135^\circ$

$\sigma_2 = -59.33 \text{ MPa}$ with $\theta_{p_2} = 21.14^\circ$

Part: b;

Given data:

$\sigma_x = -40 \text{ MPa}$

$\sigma_y = 70 \text{ MPa}$

$\tau_{xy} = -50 \text{ MPa}$

Required data

Max In-plane shear stress = ?

Max: Shear plane = ?

Solution

First we find max in plane shear

$$|\tau_{max\ in\ plane}| = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}}$$

$$= \sqrt{\left(\frac{-40-70}{2}\right)^2 + (-50)^2}$$

$$|\tau_{max\ in\ plane}| = 74.3 \text{ MPa}$$

(7)

$$\sigma_{avg} = \frac{\sigma_x + \sigma_y}{2} = \frac{-40 + 70}{2}$$

$$\boxed{\sigma_{avg} = 15}$$

Now we have to find max shear plane

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

$$\tan 2\theta = \frac{-(-40-70)}{\frac{2}{-50}}$$

$$\tan 2\theta_s = -1.1$$

$$\theta_s = \tfrac{1}{2} \tan^{-1}(1.1)$$

$$\boxed{\theta_s = -23.9^0}$$