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Submitted To :

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Question No : 1

Given Data:.

The State of stress which are given as;

$$\sigma_x = -40 \text{ MPa}$$
$$\sigma_y = 70 \text{ MPa}$$
$$\tau_{xy} = -50 \text{ MPa}$$

Required Data:

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

Solution:.

The given stresses are

$$\sigma_x = -40 \text{ MPa}$$
$$\sigma_y = 70 \text{ MPa}$$
$$\tau_{xy} = -50 \text{ MPa}$$

When we rotate the element of beam at 15° in clock wise direction then we find:

σ_{x_1}, σ_{y_1} and $\tau_{x_1 y_1}$

Now first we find σ_{x_1} ::

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

So

$$\sigma_{x_1} = \frac{-40+70}{2} + \left(\frac{-40-70}{2}\right)\cos 2(-150^\circ) + (-50)\sin 2(-15^\circ)$$

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

Now we have to find σ_{y_1}

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

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

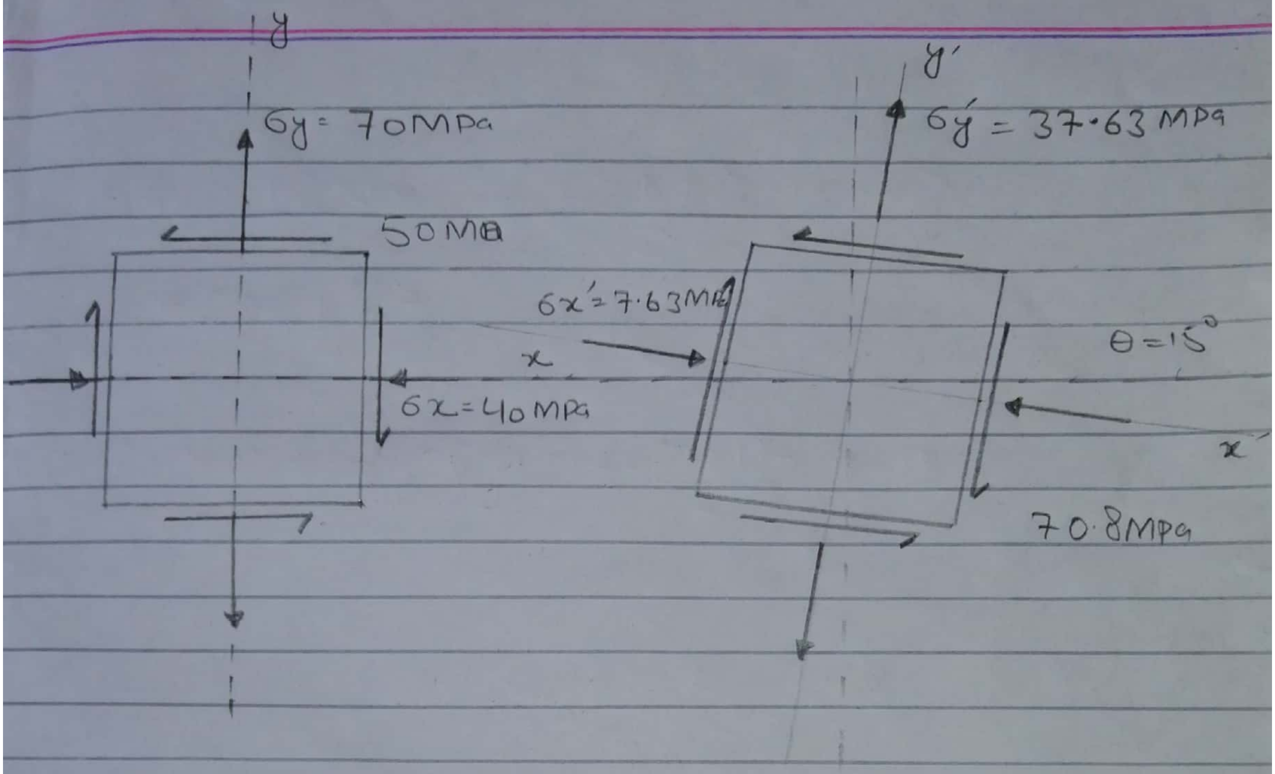
$$\boxed{\sigma_{y_1} = 37.63 \text{ MPa}}$$

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

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

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

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


y
σy = 70MPa
50MPa
σx = 40MPa
x
y'
σy' = 37.63 MPa
σx' = 7.63MPa
θ = 15°
x'
70.8MPa

Q No # 2

Given Data:.
The state of stresses which are given
$\sigma x = -40$ MPa
$\sigma y = 70$ MPa
$\tau xy = -50$ MPa

a) **First we find principle Plane:**

$$\tan 2\theta p = \frac{2\tau xy}{\sigma x - \sigma y}$$

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

$$\tan 2\theta p = 0.9091$$

$$2\theta p = \tan^{-1}(0.9091)$$

θp_1 :

$$\theta p = \frac{42.27}{2}$$

$$\boxed{\theta p_2 = 21.14^\circ} \text{ (for x-axis)}$$

θp_2 :

$$2\theta p = 42.27 + 180$$

$$\theta p = \frac{222.27}{2}$$

$$\boxed{\theta p_1 = 111.735^\circ} \text{ (for y-axis)}$$

Now we find principle Stress as;

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

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

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

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

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

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

Now we gona chick which angle goes with which principle stress ;

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

$$= \frac{-40 + 70}{2} + \left(\frac{-40 - 70}{2}\right) \cos 2(21.14) + (-50) \sin 2(21.4)$$

$$\boxed{\sigma_{x_1} = -59.33 \text{ MPa}}$$

Hence ;

$\sigma_1 = 89.33 MPa$ With $\theta_{P_1} = 111.135°$

$\sigma_2 = -59.33 MPa$ With $\theta_{P_2} = 21.14°$

Part B

Given Data

$\sigma x = -40$
$\sigma y = 70$ MPa
$\tau xy = -50$ MP

Required Data

Max In-plane Shear Stress

$$\tau_{max} \text{ in plane} = \sqrt{\left(\frac{\sigma x - \sigma y}{2}\right)^2 + \tau xy^2}$$

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

$$= 74.3 \text{ MPa}$$

$$\sigma avg = \frac{\sigma x + \sigma y}{2}$$

$$= \frac{-40 + 70}{2}$$

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

Now we have find Max Shear plane

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

$$= \frac{(-40 - 70)/2}{\tau_{xy}}$$

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

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

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

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