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SECTION : A

MODULE : 8^{TH} SEMESTER

(Q. 1)

Sol: $\delta x = -40 MPa$

$\delta y = 70 MPa$

$\tau_{xy} = -50 MPa$

we need to find δx_1, δy_1 and $\tau_{x_1 y_1}$

Now, substitute numerical values to transformation

$$\delta_{x_1} = \frac{\delta x + \delta y}{2} + \frac{\delta x - \delta y}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$$

So $$\delta x_1 = \frac{-40 + 70}{2} + \frac{(-40-70)}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$$

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

$$\delta x_1 = -7.63 MPa$$

Now $$\delta y_1 = \frac{\delta x + \delta y}{2} - \frac{\delta x - \delta y}{2} \cos 2\theta - \tau_{xy} \sin 2\theta$$

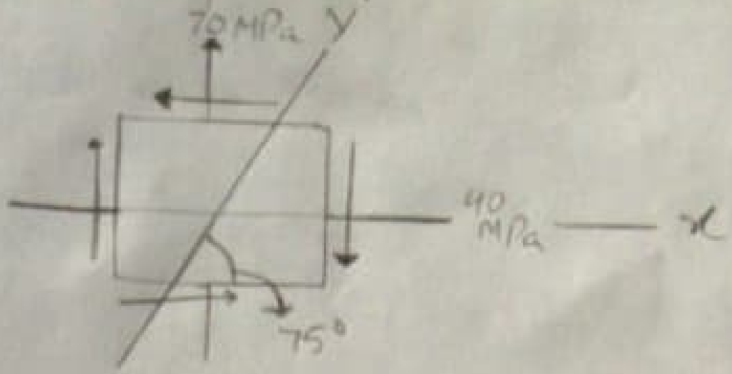
$$\sigma_{y_1} = \frac{-40+70}{2} - \frac{(-40-70)}{2}\cos 2(-15) - (-50)\sin 2(-15)$$

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

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

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

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



QUESTION # 02 (a)

SOLUTION: First we find principle plane:

$$\tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}, \quad \tan 2\theta_p = \frac{2(-50)}{-40-70} =$$

$$\tan \times 2\theta_p = 0.9091$$

$$2\theta_{P_2} = \tan^{-1}(0.9091) = 42.27$$

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

$$\boxed{\theta_{P_2} = 21.14^\circ} \text{ (for x-axis)}$$

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

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

$$\boxed{\theta_{P_1} = 111.135^\circ} \text{ (for y-axis)}$$

Now we find principal stress.

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

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

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

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

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

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

We must check which angle goes with which principal stress.

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

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

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

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

The state of stresses which are given as

$\sigma_x = -40$ Mpa

$\sigma_y = 70$ Mpa

$\tau_{xy} = -50$ Mpa

Required data

Maximum In-plane shear stress =?

Maximum shear plane ?

Solution :-

frist we find Max in-plane shear stress.

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

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

$$|\tau_{max\ in\ plan}| = 74.3\ MPa$$

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

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

Now we have to find Max. Shear plan

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

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

$\tan 2\theta_s = -1.1$

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

$\boxed{\theta_s = -23.90}$