

**Problem 9-20**

The stress acting on two planes at a point is indicated. Determine the shear stress on plane *a-a* and the principal stresses at the point.

**Given:**  $\sigma_a := 80 \text{ MPa}$      $\sigma_b := 60 \text{ MPa}$

$\theta := 45 \text{ deg}$      $\beta := 60 \text{ deg}$

**Solution:**

$$\sigma_x := \sigma_b \cdot \sin(\beta)$$

$$\tau_{xy} := \sigma_b \cdot \cos(\beta)$$

Given

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

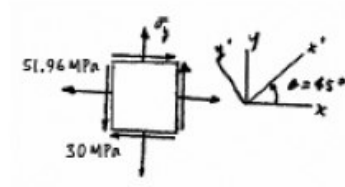
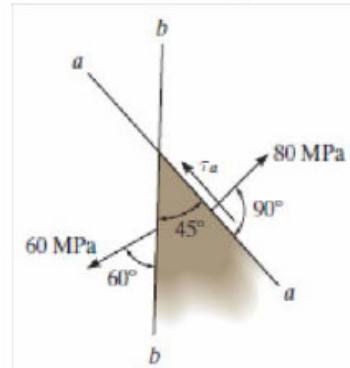
$$\tau_a = -\frac{\sigma_x - \sigma_y}{2} \cdot \sin(2\theta) + \tau_{xy} \cdot \cos(2\theta)$$

Guess     $\sigma_y := 1 \text{ MPa}$      $\tau_a := 1 \text{ MPa}$

$$\begin{pmatrix} \sigma_y \\ \tau_a \end{pmatrix} := \text{Find}(\sigma_y, \tau_a)$$

$$\begin{pmatrix} \sigma_y \\ \tau_a \end{pmatrix} = \begin{pmatrix} 48.04 \\ -1.96 \end{pmatrix} \text{ MPa}$$

**Ans**



**Principal Stress:**

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

$$\sigma_1 = 80.06 \text{ MPa} \quad \text{Ans}$$

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

$$\sigma_2 = 19.94 \text{ MPa} \quad \text{Ans}$$