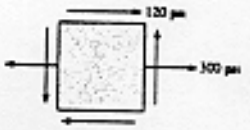
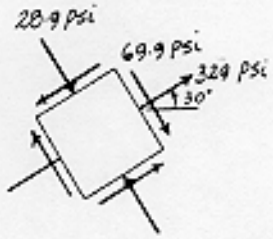
9–9. Determine the equivalent state of stress on an element if the element is oriented 30° counterclockwise from the element shown.



Normal and Shear Stress : In accordance with the established sign convention,

$$\theta = 30^\circ \qquad \sigma_x = 300 \text{ psi} \qquad \sigma_y = 0 \qquad \tau_{xy} = 120 \text{ psi}$$

Stress Tranformation Equations : Applying Eqs. 9 – 1, 9 – 2 and 9 – 3.



$$\sigma_{x'} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$
$$= \frac{300 + 0}{2} + \frac{300 - 0}{2}\cos 60^\circ + 120\sin 60^\circ$$
$$= 329 \text{ psi}$$ Ans

$$\sigma_{y'} = \frac{\sigma_x + \sigma_y}{2} - \frac{\sigma_x - \sigma_y}{2}\cos 2\theta - \tau_{xy}\sin 2\theta$$
$$= \frac{300 + 0}{2} - \frac{300 - 0}{2}\cos 60^\circ - 120\sin 60^\circ$$
$$= -28.9 \text{ psi}$$ Ans

$$\tau_{x'y'} = -\frac{\sigma_x - \sigma_y}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$
$$= -\frac{300 - 0}{2}\sin 60^\circ + 120\cos 60^\circ$$
$$= -69.9 \text{ psi}$$ Ans