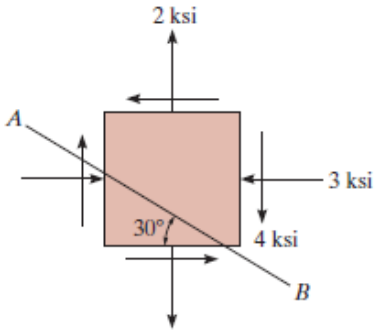
CE 270
Fall 2011
Solution – Homework 14

9–11. Solve Prob. 9–10 using the stress-transformation equations developed in Sec. 9.2. Show the result on a sketch.



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

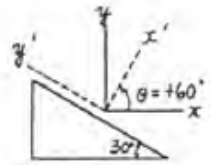
$\theta = +60°$ $\sigma_x = -3$ ksi $\sigma_y = 2$ ksi $\tau_{xy} = -4$ ksi

Stress Transformation Equations: Applying Eqs. 9-1 and 9-2.

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

$$= \frac{-3 + 2}{2} + \frac{-3 - 2}{2}\cos 120° + (-4 \sin 120°)$$

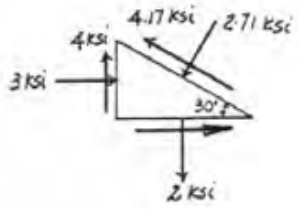
$$= -2.71 \text{ ksi} \qquad \textbf{Ans.}$$



$$\tau_{x'y'} = -\frac{\sigma_x - \sigma_y}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

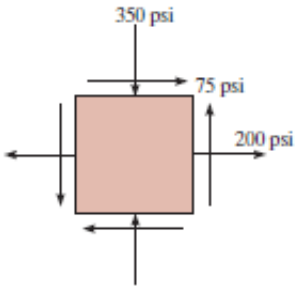
$$= -\frac{-3 - 2}{2}\sin 120° + (-4 \cos 120°)$$

$$= 4.17 \text{ ksi} \qquad \textbf{Ans.}$$



Negative sign indicates $\sigma_{x'}$, is a *compressive* stress

•9–13. Determine the equivalent state of stress on an element if the element is oriented 60° clockwise from the element shown. Show the result on a sketch.



In accordance to the established sign covention,

$\theta = -60°$ (Fig. *a*) $\quad \sigma_x = 200$ psi $\quad \sigma_y = -350$ psi $\quad \tau_{xy} = 75$ psi

Applying Eqs 9-1, 9-2 and 9-3,

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

$$= \frac{200 + (-350)}{2} + \frac{200 - (-350)}{2}\cos(-120°) + 75\sin(-120°)$$

$$= -277.45 \text{ psi} = -277 \text{ psi} \qquad \textbf{Ans.}$$

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

$$= \frac{200 + (-350)}{2} - \frac{200 - (-350)}{2}\cos(-120°) - 75\sin(-120°)$$

$$= 127.45 \text{ psi} = 127 \text{ psi} \qquad \textbf{Ans.}$$

$$\tau_{x'y'} = -\frac{\sigma_x - \sigma_y}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

$$= -\frac{200 - (-350)}{2}\sin(-120°) + 75\cos(-120°)$$

$$= 200.66 \text{ psi} = 201 \text{ psi} \qquad \textbf{Ans.}$$

Negative sign indicates that $\sigma_{x'}$ is a compressive stress. These result, can be represented by the element shown in Fig. *b*.