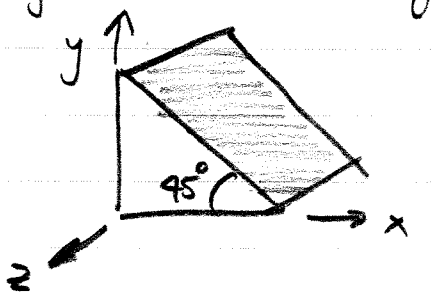
ME 423 Test #2

key

The state of stress with respect to x, y, z -axes is given by

$$\underset{\sim}{\sigma} = \begin{bmatrix} -20 & 0 & 0 \\ 0 & 30 & 40 \\ 0 & 40 & -10 \end{bmatrix}.$$

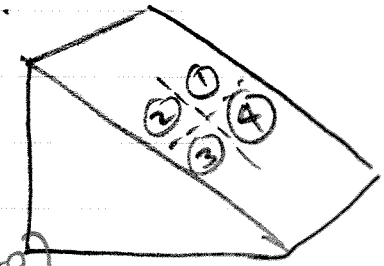
For the surface



(1) What is the normal stress and is it tensile or compressive?

(2) What is the magnitude of the shear stress?

(EC) In what quadrant on the surface does the shear stress point?



$$\underset{\sim}{n} = \begin{bmatrix} 1/\sqrt{2} \\ 1/\sqrt{2} \\ 0 \end{bmatrix} \qquad \text{traction } \underset{\sim}{t} = \begin{bmatrix} -20 & 0 & 0 \\ 0 & 30 & 40 \\ 0 & 40 & -10 \end{bmatrix} \frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = \frac{1}{\sqrt{2}} \begin{bmatrix} -20 \\ 30 \\ 40 \end{bmatrix}$$

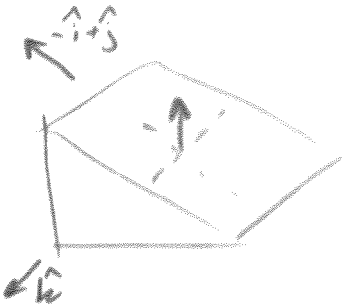
$$\sigma_{normal} = \underset{\sim}{n} \cdot \underset{\sim}{t} = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} \cdot \frac{1}{\sqrt{2}} \begin{bmatrix} -20 \\ 30 \\ 40 \end{bmatrix} = \frac{1}{2}(-20+30) = 5$$

$$\underset{\sim}{\tau}_{shear} = \underset{\sim}{t} - \sigma_{normal}\,\underset{\sim}{n} = \frac{1}{\sqrt{2}} \begin{bmatrix} -20 \\ 30 \\ 40 \end{bmatrix} - \frac{5}{\sqrt{2}} \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = \frac{1}{\sqrt{2}} \begin{bmatrix} -25 \\ 25 \\ 40 \end{bmatrix} = \frac{5}{\sqrt{2}} \begin{bmatrix} -5 \\ 5 \\ 8 \end{bmatrix}$$

$$|\tau_{shear}| = \frac{5}{\sqrt{2}} \left(5^2 + 5^2 + 8^2\right)^{1/2} = 5\sqrt{57} \approx 37.7$$

the direction $\begin{bmatrix} -5 \\ 5 \\ 8 \end{bmatrix} = 5(-\hat{i} + \hat{j}) + 8\hat{k}$ → (2)

(1) or (2) (2) or (3)



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(1) 5 tensile (2) $5\sqrt{57}$ (EC) quadrant (2)