PROBLEM #1 (25%)

a) The stress state given below is applied to an element of the aluminum alloy skin of an aircraft. Calculate the maximum shear stress and the direction(s) in which it acts. Express the direction(s) as counterclockwise angles relative to the $x_1$ axis.

$$\begin{pmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} \end{pmatrix} = \begin{pmatrix} 200 & -100 & 0 \\ -100 & -100 & 0 \\ 0 & 0 & 0 \end{pmatrix} \text{ MPa}$$

Use Mohr's Circle

$$C = +50 \text{ MPa}$$

$$R = \sqrt{(150)^2 + (100)^2} = 180 \text{ MPa}$$

$$\sigma_{\text{max}} = R = 45 - \frac{1}{2} \tan^{-1}\left(\frac{100}{150}\right) = \Theta = 28.2^\circ$$

and $90 + \Theta = 118.2^\circ$