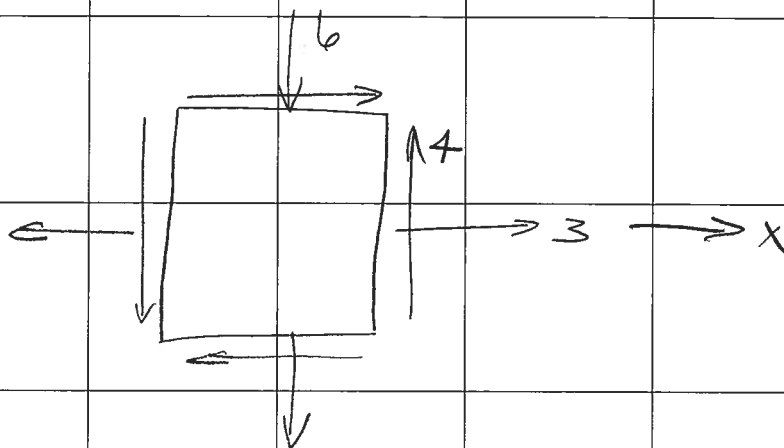
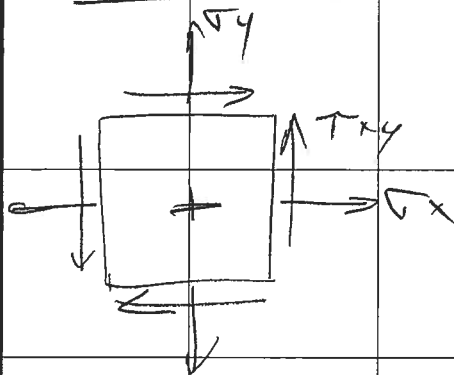


Calculate the principal stresses and the maximum and minimum shearing stresses for the state of plane stress shown. Show these stresses on properly oriented sketches.



Determine the proper signs of σ_x , σ_y , and τ_{xy}



$$\sigma_x = 3$$

$$\sigma_y = -6$$

$$\tau_{xy} = 4$$

Determine the angles for the principal stresses

(1)	$\tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$				
(2)	$\tan 2\theta_p = \frac{2(4)}{3 - (-6)}$				
(3)	$2\theta_p = 41.63^\circ$				
	or				
(4)	$2\theta_p = 41.63^\circ + 180^\circ = 221.63^\circ$				
<u>Calculate stresses for $2\theta = 41.63^\circ$</u>					
(5)	$\sigma_\theta = \frac{\sigma_x + \sigma_y}{2} + \left(\frac{\sigma_x - \sigma_y}{2}\right) \cos 2\theta + \tau_{xy} \sin 2\theta$				
(6)	$\sigma_{20.82^\circ} = \frac{3 + (-6)}{2} + \left(\frac{3 - (-6)}{2}\right) \cos 41.63^\circ + 4 \sin 41.63^\circ$				
(7)	$\sigma_{20.82^\circ} = -1.5 + 4.5 (1.7475) + 4 (.6643)$				
(8)	$\sigma_{20.82^\circ} = -1.5 + 3.364 + 2.657$				
(9)	<u>$\sigma_{20.82^\circ} = 4.521$</u>				
(10)	$\tau_\theta = -\left(\frac{\sigma_x - \sigma_y}{2}\right) \sin 2\theta + \tau_{xy} \cos 2\theta$				
(11)	$\tau_{20.82^\circ} = -\left(\frac{3 - (-6)}{2}\right) \sin 41.63^\circ + 4 \cos 41.63^\circ$				
(12)	$\tau_{20.82^\circ} = -(4.5)(.6643) + 4 (1.7475)$				

$$(13) \quad \tau_{20.82^\circ} = -2.9894 + 2.9900$$

$$(14) \quad \tau_{20.82^\circ} = .0006 \approx 0 \quad \text{OK}$$

Calculate Stresses for $2\theta = 221.63^\circ$

$$(15) \quad \sigma_{110.82} = \frac{3+(-6)}{2} + \left(\frac{3-(-6)}{2} \right) \cos 221.63^\circ + 4 \sin 221.63^\circ$$

$$(16) \quad \sigma_{110.82} = -1.5 + 4.5 (-.7475) + 4 (-.6643)$$

$$(17) \quad \sigma_{110.82} = -1.5 - 3.364 - 2.657$$

$$(18) \quad \sigma_{110.82} = -7.521$$

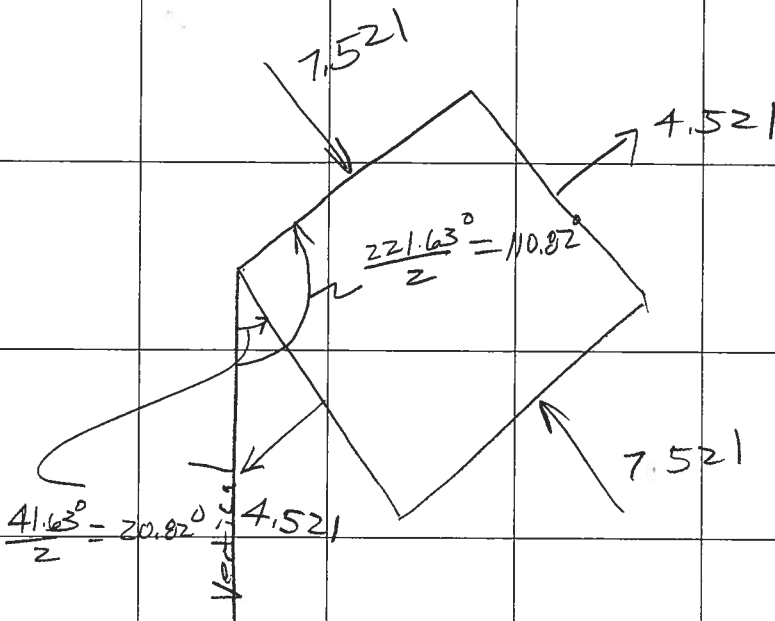
$$(19) \quad \tau_{110.82} = - \left(\frac{3-(-6)}{2} \right) \sin 221.63^\circ + 4 \cos 221.63^\circ$$

$$(20) \quad \tau_{110.82} = -4.5 (-.6643) + 4 (-.7475)$$

$$(21) \quad \tau_{110.82} = 2.989 - 2.990$$

$$(22) \quad \tau_{110.82} = -.001 \approx 0 \quad \text{OK}$$

Show the principal Stresses on a properly oriented sketch



$$\sigma_{\max} = 4.521$$

$$\sigma_{\min} = -7.521$$

Maximum and Minimum Normal Stresses
of Principal Stresses

Determine the angles for the maximum
and minimum shearing stresses.

$$(23) \quad \tan 2\theta_s = - \frac{\sigma_x - \sigma_y}{2\tau_{xy}}$$

$$(24) \quad \tan 2\theta_s = - \frac{3 - (-6)}{2(4)}$$

$$(25) \quad \tan 2\theta_s = - \frac{9}{8}$$

$$(26) \quad 2\theta_s = -48.37^\circ$$

or

$$(27) \quad 2\theta_s = -48.37^\circ + 180^\circ = 131.63^\circ$$

Calculate Stresses for $2\theta_s = -48.37^\circ$

(2e) $\sigma_{-24.19^\circ} = -1.5 + 4.5(\cos -48.37^\circ) + 4(\sin -48.37^\circ)$

(2a) $\sigma_{-24.19} = -1.5 + 4.5(.6643) + 4(-.7475)$

(3c) $\sigma_{-24.19^\circ} = -1.5 + 2.989 - 2.990$

(31) $\sigma_{-24.19^\circ} = -1.501$

(32) $\tau_{-24.19^\circ} = -(4.5)\sin(-48.37^\circ) + 4\cos(-48.37^\circ)$

(33) $\tau_{-24.19^\circ} = -(4.5)(-.7475) + 4(.6643)$

(34) $\tau_{-24.19} = 3.364 + 2.657$

(35) $\tau_{-24.19} = 6.021$

Calculate Stresses for $2\theta_s = 131.63^\circ$

(36) $\sigma_{65.82} = -1.5 + 4.5(\cos 131.63^\circ) + 4\sin 131.63^\circ$

(37) $\sigma_{65.82} = -1.5 + 4.5(-.6643) + 4(.7475)$

(38) $\sigma_{65.82} = -1.5 - 2.989 + 2.99$

(39) $\sigma_{65.82} = -1.499 \approx \sigma_{-24.19} = -1.501$ OK

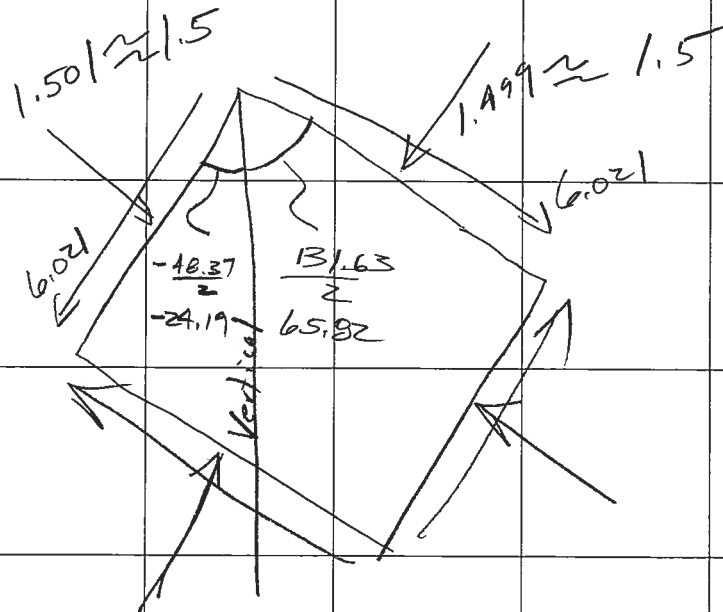
(40) $\tau_{65.82} = -4.5 \sin 131.63 + 4 \cos 131.63^\circ$

(41) $\tau_{65.82} = -4.5 (1.7475) + 4 (-.6643)$

(42) $\tau_{65.82} = -3.364 - 2.657$

(43) $\tau_{65.82} = -6.021 = -\tau_{-24.19^\circ}$ OK

Show the maximum and minimum shearing stresses on a properly oriented sketch



Maximum and Minimum Shearing Stresses