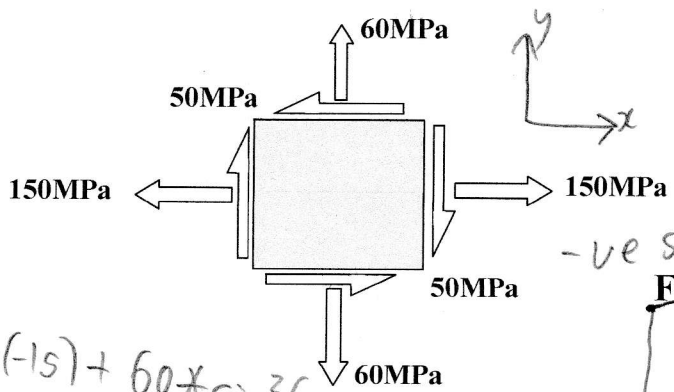
clockwise = negative

Q3. For the stress block shown in Figure 3a, using the stress equations;
a) Calculate the stresses $\sigma_{x'}$, $\sigma_{y'}$ and $\tau_{x'y'}$ on a stress block rotated 15° clockwise from the x-y axes.
b)Calculate the principal (normal) stresses and the principal in-plane shear stress (and corresponding normal stresses) and their orientation (rotation angle). Sketch both these situations on stress blocks. Assume plane stress conditions.



-ve shear

Figure 3a

(a) $\sigma_{x'} = 150 * \cos^2(-15) + 60 * \sin^2(-15) - 50 \sin(-30)$
$= 139.9519053 + 4.019237886 + 25$
$= 168.9711432$ MPa

$\sigma_{y'} = 150 \sin^2(-15) + 60 \cos^2(-15) - -50 \sin(-30)$
$= 10.04809472 + 55.98076211 + -25$
$= 66.02885683$ MPa $- 25$ MPa
$= 41.02885683$ MPa

$\tau_{x'y'} = \left(\frac{60-150}{2}\right) \sin(-30) + -50 \cos(-30)$
$= 7.5 - 43.30127019$
$= -35.80127019$ MPa

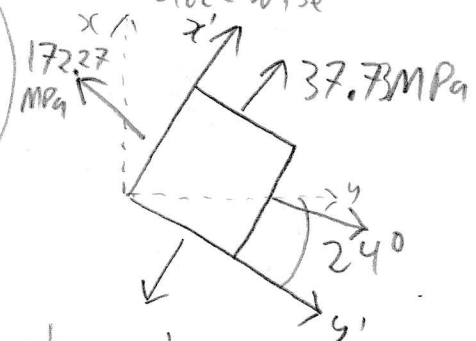
(b) $\sigma_{1,2} = \frac{150+60}{2} \pm \sqrt{\left(\frac{150-60}{2}\right)^2 + (-50)^2}$
$= 105 \pm \sqrt{2,025 + 2,500}$
$= 105 \pm 67.26812024$
$= 172.2681202$ MPa, $37.7318797\,6$ MPa

$\tan 2\alpha_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$
$= \frac{-100}{150-60}$
$= -1.11111$
$2\alpha_p = -48.0127875$
$\alpha_p = -24.00639375 \sim -24°$

Confirm which is $\sigma_{x'}$ & $\sigma_{y'}$

$\sigma_{x'} = 150 \cos^2 24 + 60 \sin^2(-24) + -50 \sin(-48)$
$= 125.184 + 9.926081809 + 37.15774127$
$= 172.2681186$

$\sigma_{x'} = \sigma_1$ $\sigma_{y'} = \sigma_2$
$-24°$ = clockwise



Max in plane shear overlap of

$$\tau_{MAX} = \frac{172.268 - 37.732}{2}$$

$$= 67.268 \text{ MPa} \quad +ve$$

$$\tan 2\alpha_s = \frac{-(\sigma_x - \sigma_y)/2}{\tau_{xy}}$$

$$= \frac{-(150 - 60)/2}{-50}$$

$$= 0.9$$

$$2\alpha_s = 41.9872125$$

$$\alpha_s = 20.99°$$

$$= 21° \; +ve = \text{anticlockwise}$$

Idiot check: 21° & -24°
difference of 45°

In case of max shear

$$\sigma_{x'} = \sigma_{y'} = 150\cos^2(21) + 60\sin^2(21) - 50\sin(42)$$

$$= 130.7358619 + 7.018866706 - 33.45653032$$

$$= 104.2979983 \text{ MPa}$$