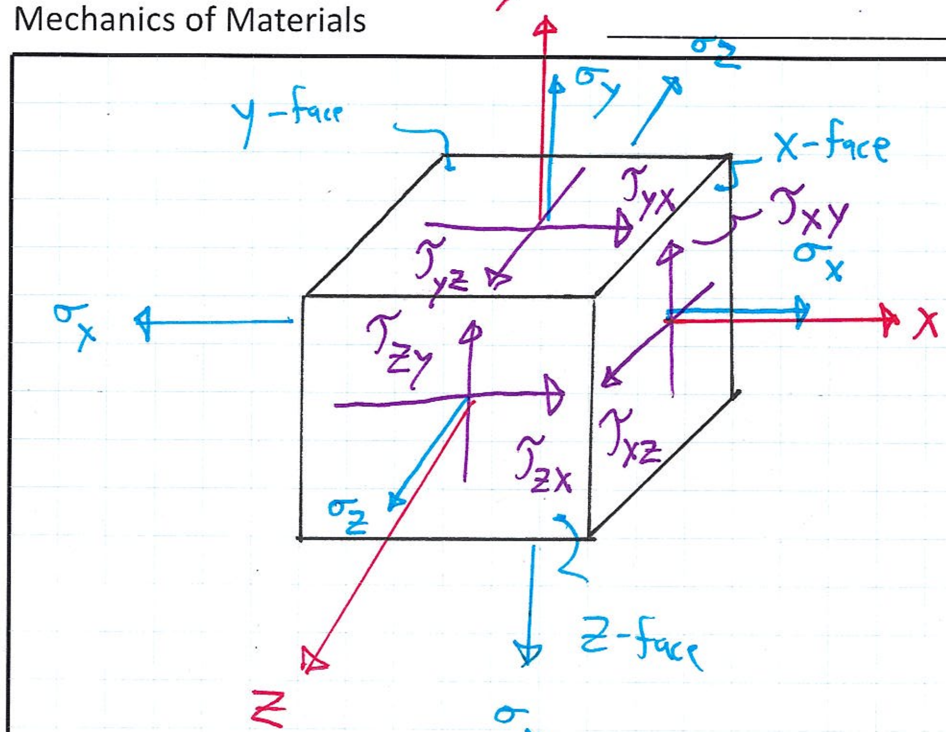


FROM EQUIL: $\tau_{xy} = \tau_{yx}$; $\tau_{zx} = \tau_{xz}$; Etc.

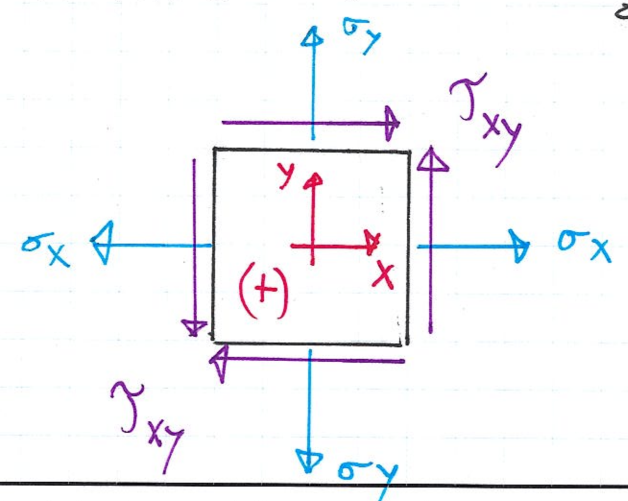
6 INDEPENDENT STRESS COMPONENTS: 3 Normals ; 3 shear

STRESS IS 3D ⇒ MATRICES/COMPUTER

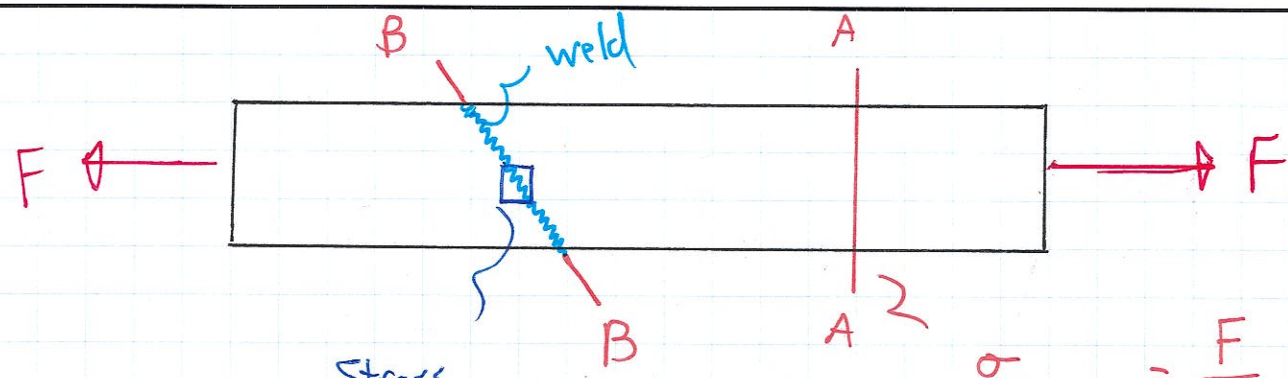
MANY PROBLEMS CAN BE SOLVED w/ PLANE STRESS

(i.e. All Stress is in a Plane -or- 2D)

FOR PLANE STRESS → σ_z , τ_z are zero (Z stress free face)

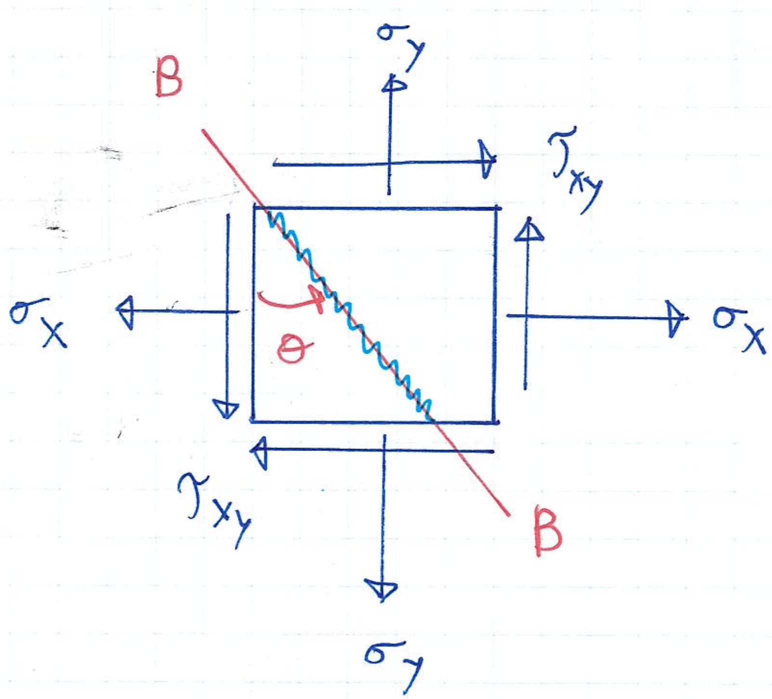


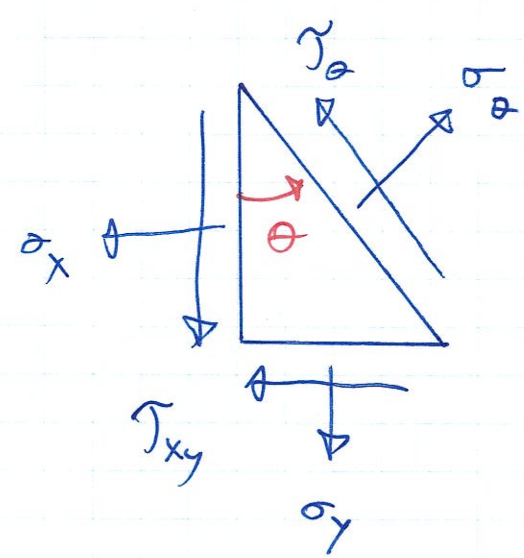
(POS. SIGN CONV.)

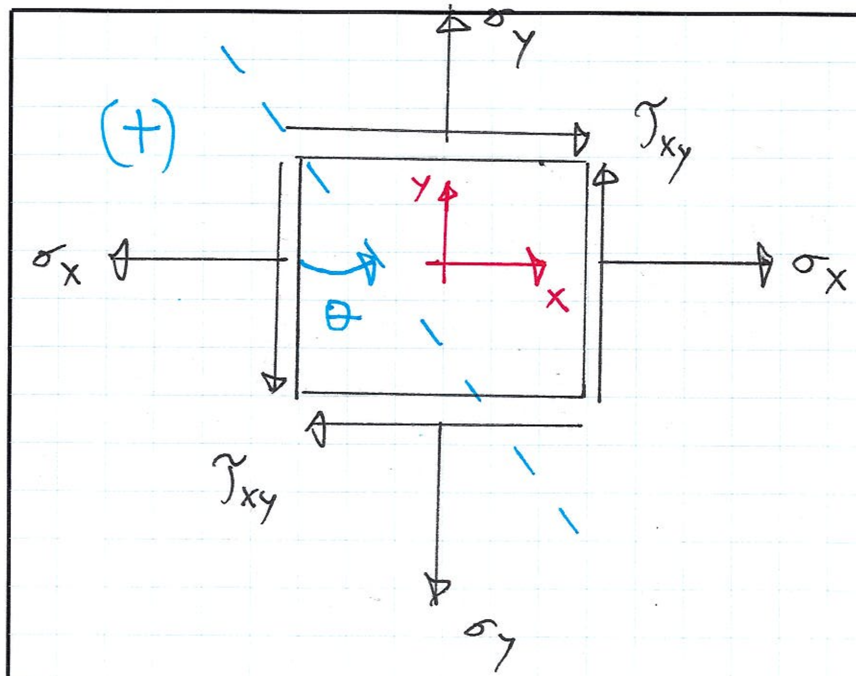


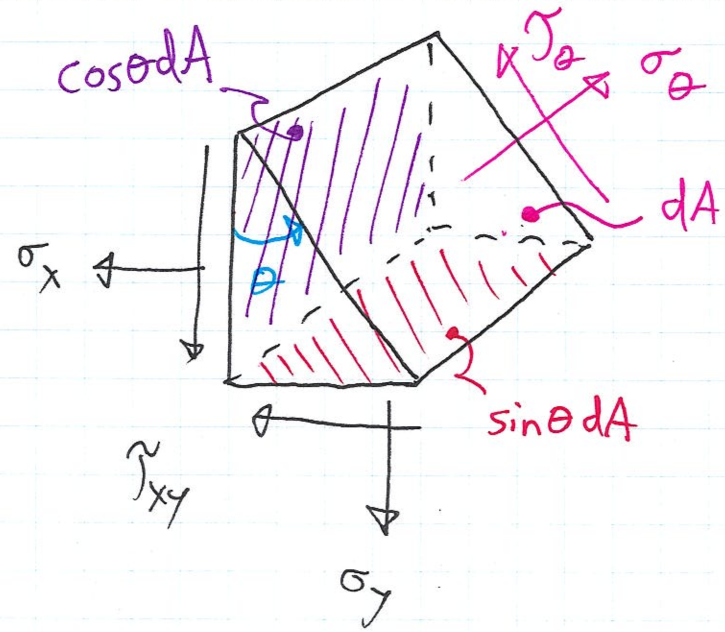
Stress block

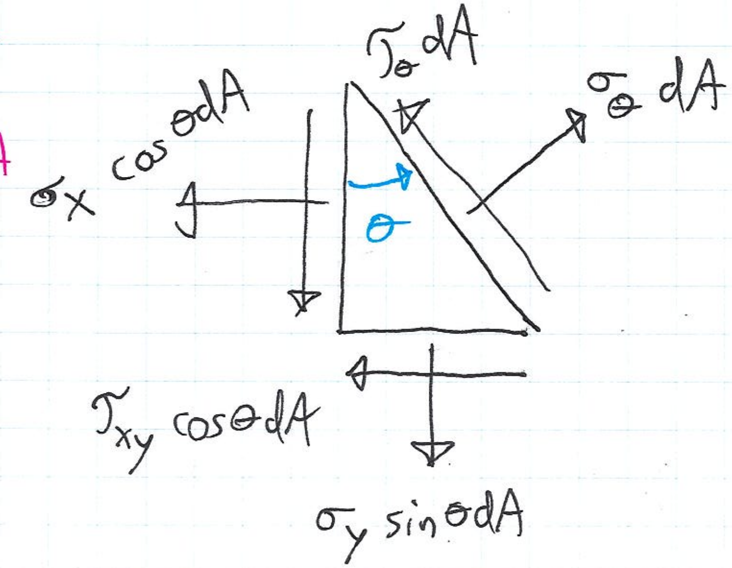
$$\sigma_{normal} = \frac{F}{A}$$











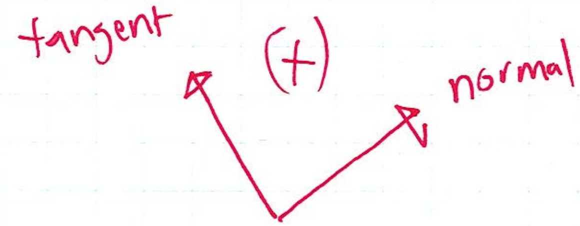
STRESSES

FORCES

$$\sigma_\theta = \left(\frac{\sigma_x + \sigma_y}{2}\right) + \left(\frac{\sigma_x - \sigma_y}{2}\right)\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$\tau_\theta = -\left(\frac{\sigma_x - \sigma_y}{2}\right)\sin 2\theta + \tau_{xy}\cos 2\theta$$

} STRESS TRANS. EQNS.



APPLY EQUIL { $\Sigma F_n = 0$, $\Sigma F_t = 0$

* θ is measured CCW from a vertical line
* Use a double angle trig. identity

MIN/MAX NORMAL STRESSES (PRINCIPAL STRESSES)

$\sigma_\theta = \sim$

$$\frac{d\sigma_\theta}{d\theta} = 0 \Rightarrow \tan 2\theta = \left(\frac{2\tau_{xy}}{\sigma_x - \sigma_y}\right)$$

$2\theta_1$ $\quad 2\theta_2 = 2\theta_1 \pm 180^\circ$

-or-

θ_1 $\quad \theta_2 = \theta_1 \pm 90^\circ$

MIN/MAX SHEAR STRESSES

not the same

$\tau_\theta = \sim$

$$\frac{d\tau_\theta}{d\theta} = 0 \Rightarrow \tan 2\theta_s = -\left(\frac{\sigma_x - \sigma_y}{2\tau_{xy}}\right)$$

$2\theta_{s1}$ $\quad 2\theta_{s2} = 2\theta_{s1} \pm 180^\circ$

-or-

θ_{s1} $\quad \theta_{s2} = \theta_{s1} \pm 90^\circ$

Use the stress transformation equations as discussed in class to determine the normal and shearing stresses on the indicated plane for the state of stress shown. Enter the magnitudes of your calculated stresses in the blocks provided being sure to indicate the proper sign.

3-29-2020

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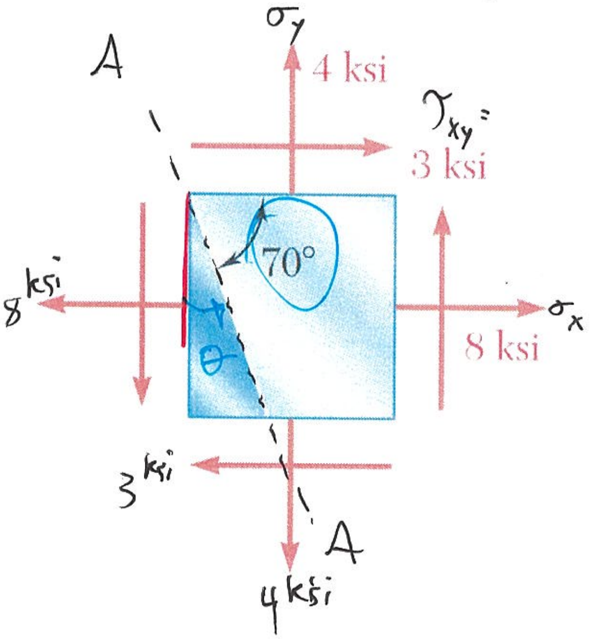
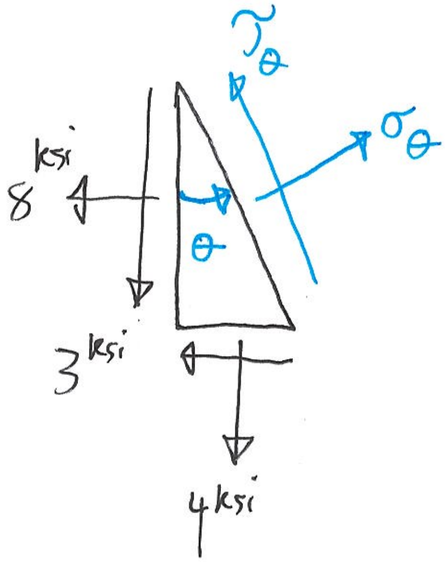




σ_θ = [ ] ksi

τ_θ = [ ] ksi

$\sigma_x = 8^{ksi}$

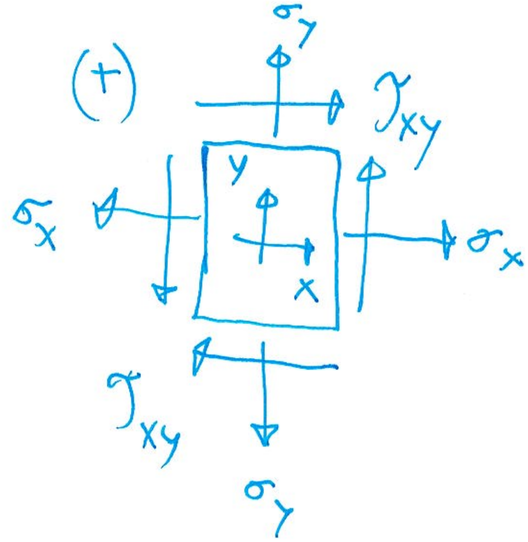
$\sigma_y = 4^{ksi}$

$\tau_{xy} = 3^{ksi}$

$\theta = 20°$

"Measured CCW from a vert. line"

POS. SIGN CONV.



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

$$= \frac{8^{ksi} + 4^{ksi}}{2} + \left(\frac{8^{ksi} - 4^{ksi}}{2}\right)\cos(2 \cdot 20°) + (3^{ksi})\sin(2 \cdot 20°)$$

$$\sigma_\theta = +9.46\ ksi$$

$$\tau_\theta = -\left(\frac{\sigma_x - \sigma_y}{2}\right)\sin 2\theta + \tau_{xy}\cos 2\theta$$

$$= -\left(\frac{8^{ksi} - 4^{ksi}}{2}\right)\sin(2\cdot 20^\circ) + \left(3^{ksi}\right)\cos(2\cdot 20^\circ)$$

$$= \underline{\underline{1.013^{ksi}}}$$

PROPERLY ORIENTED SKETCH