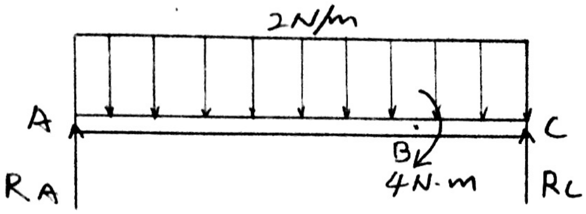
Midterm 2 Solution

Problem 1

FBD:

a)

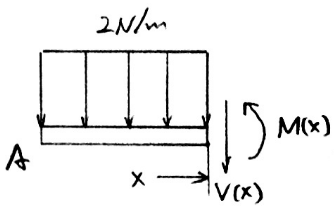


$\Sigma M_A = 0 \quad 2N/m \cdot 2m \cdot 1m + 4N \cdot m - R_C \cdot 2m = 0$

$R_C = 4N$

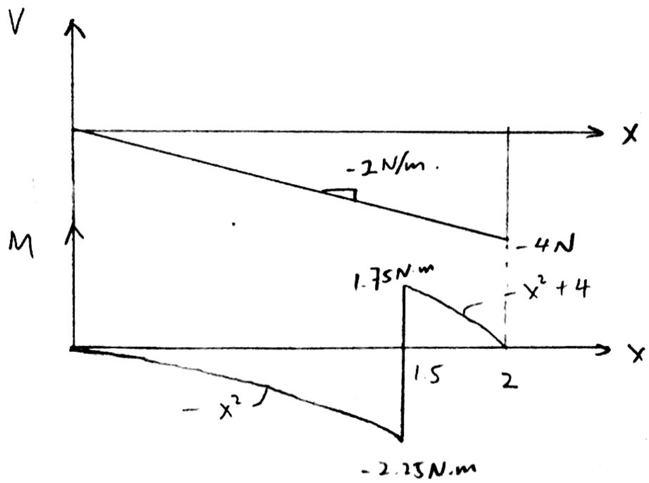
$\Sigma F_y = 0 \quad R_C + R_A - 2N/m \cdot 2m = 0$

$R_A = 0 N$



$\Sigma F_y = 0 \quad V(x) = -2x$

$\Sigma M_A = 0 \quad M(x) = -x^2$



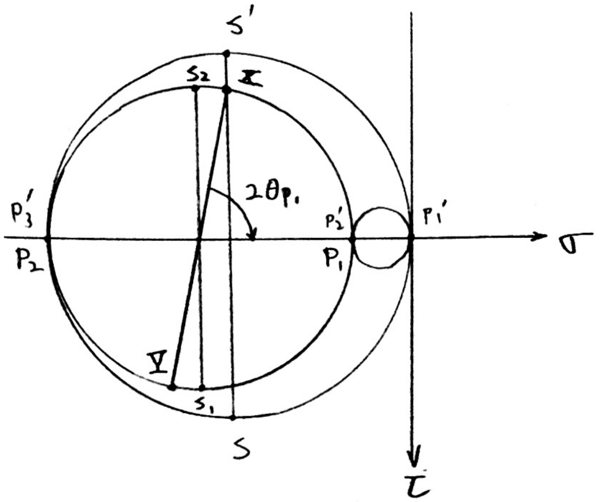
b) M_{max} at $x = 1.5$ $\quad y_{max} = 0.05 \quad \sigma_{max}$ at $(1.5, 0.05)$

V_{max} at $x = 2$ $\quad Q_{max}$ at $y = 0 \quad \tau_{max}$ at $(2, 0)$

Problem 2

a) $\sigma_x = -6\,ksi$ $\sigma_y = -8\,ksi$ $\tau_{xy} = -5\,ksi$

$\sigma_{avg} = \frac{\sigma_x + \sigma_y}{2} = -7\,ksi$ $R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = 5.1\,ksi$



b) $\sigma_1 = \sigma_{avg} + R = -1.9\,ksi$ $\sigma_2 = \sigma_{avg} - R = -12.1\,ksi$

$2\theta_{p_1} = \tan^{-1}\left(\frac{5}{1}\right) = 78.69°$

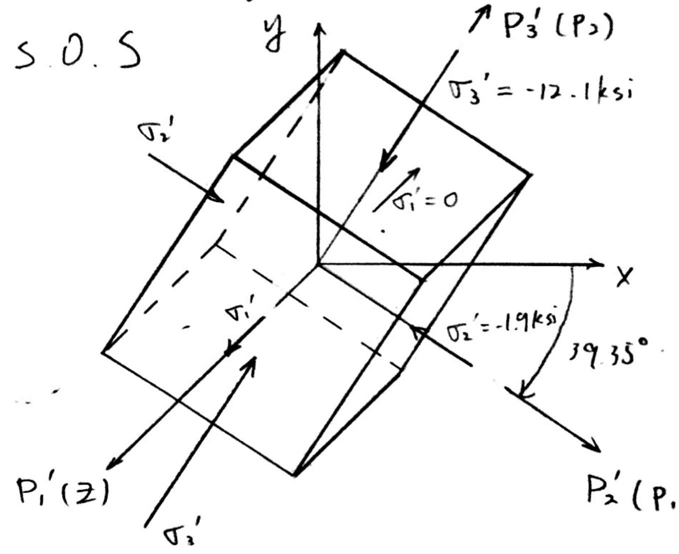
$\theta_{p_1} = 39.35°$ (CW)

In triaxial stress $\sigma_1 > \sigma_2 > \sigma_3$

$\sigma_1' = 0$ $\sigma_2' = \sigma_1 = -1.9\,ksi$ $\sigma_3' = \sigma_2 = -12.1\,ksi$

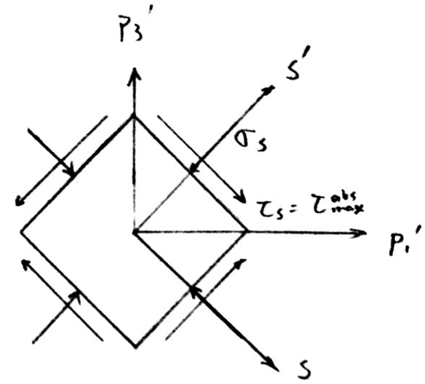
where P_2' is 39.35° clockwise from x axis

S.O.S



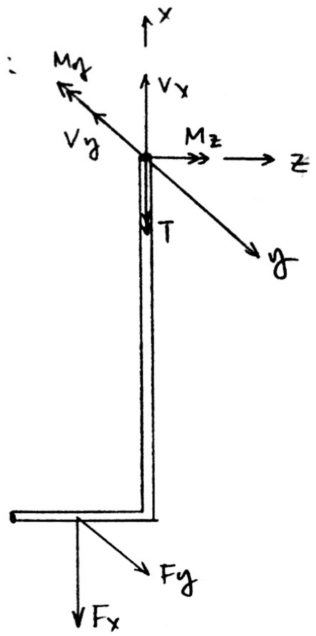
c) $\tau_{max}^{abs} = \left|\frac{\sigma_1' - \sigma_3'}{2}\right| = 6.05\,ksi$

τ_{max}^{abs} acts in $P_1'(z) - P_3'(P_2)$ plane :



Problem 3

FBD:



a) $\Sigma F_x = 0 \qquad V_x - F_x = 0 \qquad V_x = 1000\,N$

$\Sigma F_y = 0 \qquad V_y - F_y = 0 \qquad V_y = 10\,N$

$\Sigma M_x = 0 \qquad F_y \cdot 0.5m - T = 0 \qquad T = 5\,N \cdot m$

$\Sigma M_y = 0 \qquad F_x \cdot 0.5m - M_y = 0 \qquad M_y = 500\,N \cdot m$

$\Sigma M_z = 0 \qquad M_z - F_y \cdot 2m = 0 \qquad M_z = 20\,N \cdot m$

b) $$\sigma_A = \frac{V_x}{A} - \frac{M_z \cdot y}{I_z} = \frac{1000}{\pi \cdot 0.025^2} - \frac{20 \cdot 0.025}{\frac{\pi\ 0.05^4}{64}} = -1.120\,MPa$$

$$\tau_A = \frac{Tr}{I_p} = \frac{5 \cdot 0.025}{\frac{\pi \cdot 0.05^4}{32}} = 0.204\,MPa$$

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