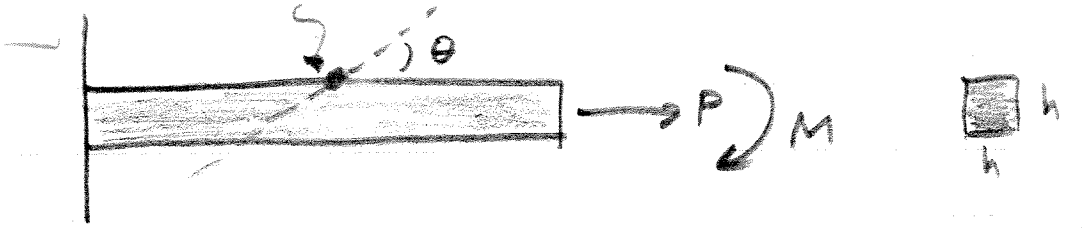
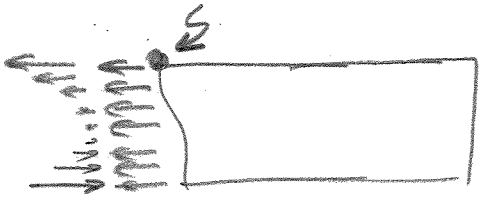
ME 423 Test #1



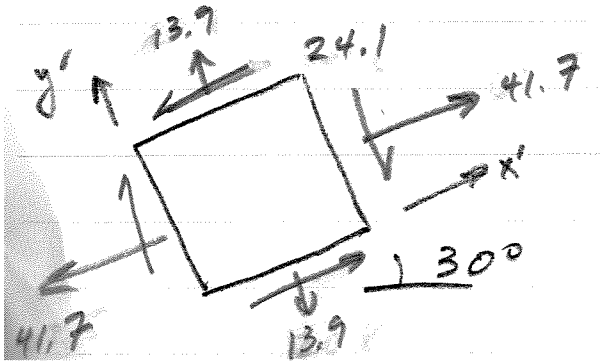
The cantelever beam of square cross-section is subject to axial force & bending moment as shown. Find the stresses $\sigma_{x'}$, $\sigma_{y'}$, $\tau_{x'y'}$ at the indicated point (on the beam surface) and display them on the element faces. Here $h = 60$ mm, $P = 100$ kN, $M = 1$ kN-m, $\theta = 30°$.



$$\left.\begin{aligned} &\frac{My}{I} + \frac{P}{A} = \sigma_x \\ &I = \tfrac{1}{12}h^4 \\ &y = \tfrac{1}{2}h \\ &A = h^2 \end{aligned}\right\} \quad \sigma_x = \frac{6M}{h^3} + \frac{P}{h^2} = \frac{6(10^3)}{(.06)^3} + \frac{100(10^3)}{(.06)^2} = 55.6 \text{ MPa}$$

(1.14) with $\sigma_y = 0$, $\tau_{xy} = 0$ $\quad \theta = 30°$

$$\Rightarrow \quad \sigma_{x'} = \tfrac{1}{2}\sigma_x(1 + \cos 2\theta) = 3\sigma_x/4 = 41.7$$
$$\sigma_{y'} = \tfrac{1}{2}\sigma_x(1 - \cos 2\theta) = \sigma_x/4 = 13.9$$
$$\tau_{x'y'} = -\tfrac{1}{2}\sigma_x \sin 2\theta = -\sqrt{3}\sigma_x/4 = -24.1$$



$\sigma_{x'} = 41.7$ MPa

$\sigma_{y'} = 13.9$ MPa

$\tau_{x'y'} = -24.1$ MPa