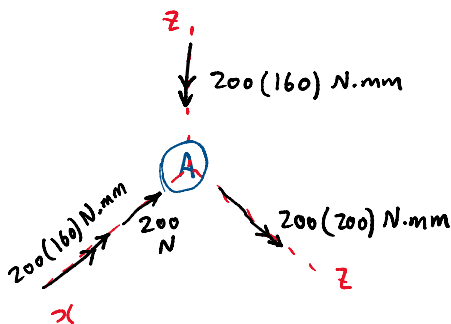
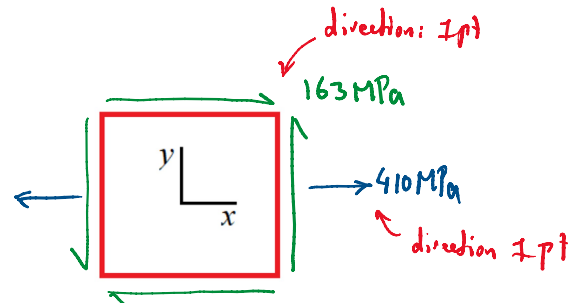
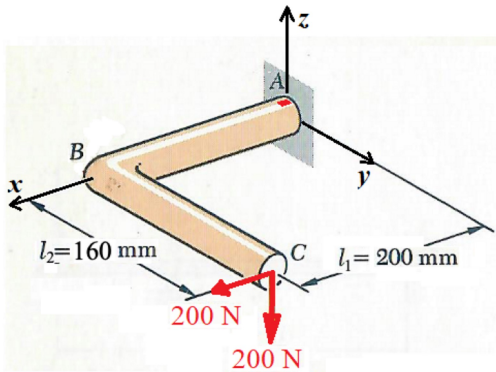


Exam 1 problem 2

2. (30 pts) The bent bar ABC shown is loaded at point C with two 200-N forces. The diameter of the cross-section of the bar is 10 mm.

(a) Compute the stress components (all six components) for the element shown on the top of the cross-section at A and show them on the element shown to the right of the figure.

(b) Compute the stress components (all six components) for the *critical element* at the cross-section at A , i.e., sketch the critical stress element and show the stress components.



$$A = \frac{\pi}{4}(10\text{ mm})^2, I = \frac{\pi}{64}(10\text{ mm})^4, J = \frac{\pi}{32}(10\text{ mm})^4$$

a)

$$\sigma_{xx} = + \frac{200\text{ N}}{\frac{\pi}{4}(10\text{ mm})^2} + \frac{(200 \times 200\text{ N}\cdot\text{mm})(5\text{ mm})}{\frac{\pi}{64}(10\text{ mm})^4} = 2.5465\text{ MPa} + 407.4367\text{ MPa} \Rightarrow \sigma_{xx} = 410\text{ MPa} \quad 1\text{ pt}$$

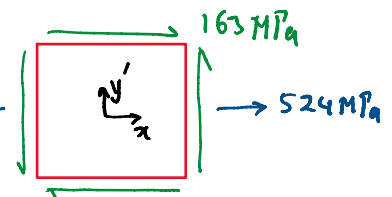
$$\tau_{xy} = \tau = \frac{(200 \times 160\text{ N}\cdot\text{mm})(5\text{ mm})}{\frac{\pi}{32}(10\text{ mm})^4} = 162.9747\text{ MPa} \Rightarrow \tau_{xy} = 163\text{ MPa} \quad 1\text{ pt}$$

$\sigma_{yy} = 0, \sigma_{zz} = 0, \sigma_{xz} = 0, \sigma_{yz} = 0$
 1pt 1pt 1pt 1pt

b): critical point of section A: $M = \sqrt{(200 \times 200)^2 + (200 \times 160)^2} = 51224.99\text{ N}\cdot\text{mm}$
 3pts →

$$\sigma_{xx} = + \frac{200\text{ N}}{\frac{\pi}{4}(10\text{ mm})^2} + \frac{(51224.99\text{ N}\cdot\text{mm})(5\text{ mm})}{\frac{\pi}{64}(10\text{ mm})^4} = 2.5465\text{ MPa} + 521.7735\text{ MPa} \Rightarrow \sigma_{xx} = 524\text{ MPa} \quad 1\text{ pt}$$

$$\tau_{xy} = \tau = 163\text{ MPa} \quad 1\text{ pt}$$



$\sigma_{yy'} = 0, \sigma_{zz'} = 0, \sigma_{xz'} = 0, \sigma_{yz'} = 0$
 0.5pt 0.5pt 0.5pt 0.5pt