Name: _____ **Division:** **Div 1** **Div 2**
(Print) **(Last)** **(First)** **(Circle)** **Susilo** **Koslowski**

ME 323 MIDTERM EXAM 2
Spring 2011
8:00 PM – 9:00 PM

Instructions

1. Work each problem in the space provided.
2. Confine your work to the front side of the pages only.
3. Additional paper will be provided upon request.
4. Each problem is of equal value.
5. To obtain maximum credit for a problem, you must present your solution clearly. Accordingly:
    a. Identify coordinate systems
    b. Sketch free body diagrams
    c. State units explicitly
    d. Clarify your approach to the problem including assumptions
    e. Clearly mark final answers with boxes

6. **If your solution cannot be followed, it will be assumed that it is in error**.

Prob. 1 _____

Prob. 2 _____

Prob. 3 _____

Total _____

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Some useful formulas

$$\varepsilon_x = \frac{1}{E}\left[\sigma_x - \nu\left(\sigma_y + \sigma_z\right)\right] + \alpha\Delta T$$

$$\varepsilon_y = \frac{1}{E}\left[\sigma_y - \nu\left(\sigma_x + \sigma_z\right)\right] + \alpha\Delta T$$

$$\varepsilon_z = \frac{1}{E}\left[\sigma_z - \nu\left(\sigma_x + \sigma_y\right)\right] + \alpha\Delta T$$

$$\gamma_{xy} = \frac{1}{G}\tau_{xy} \quad \gamma_{xz} = \frac{1}{G}\tau_{xz} \quad \gamma_{yz} = \frac{1}{G}\tau_{yz}$$

$$FS = \frac{Failure\ Stress}{Allowable\ Stress}$$

$$e = \frac{FL}{EA} + L\alpha\Delta T$$

$$\tau = \frac{T\rho}{J}$$

$$\tau = G\frac{\phi r}{L}$$

$$\phi = \frac{TL}{GJ}$$

$$J_{solid} = \frac{\pi d^4}{32}$$

$$J_{hollow} = \frac{\pi(d_o{}^4 - d_i^4)}{32}$$

$$\sigma = -\frac{My}{I}$$

$$\tau = \frac{VQ}{It}; \qquad Q = A'\bar{y}'$$

$$I_{\text{rectangle}} = \frac{1}{12}bh^3$$

$$I_{\text{circle}} = \frac{\pi}{4}r^4$$

Centroid of a semicicle $= \bar{y} = \frac{4r}{3\pi}$

$$\sigma_a = \frac{pr}{2t}$$

$$\sigma_h = \frac{pr}{t}$$

$$\sigma_{sphere} = \frac{pr}{2t}$$

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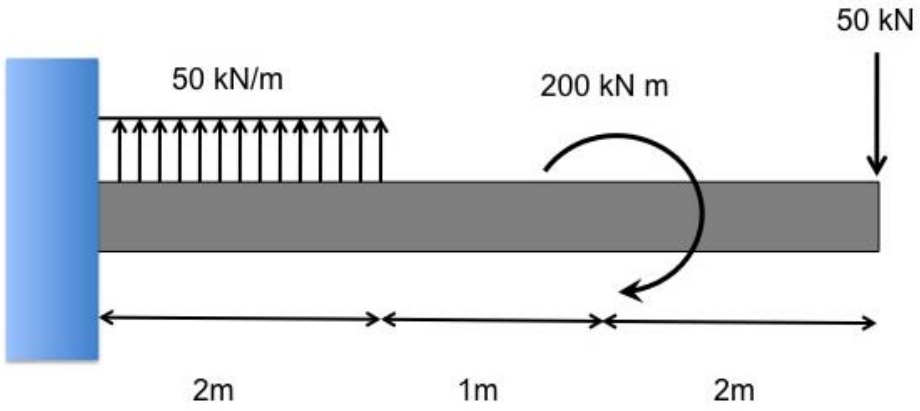
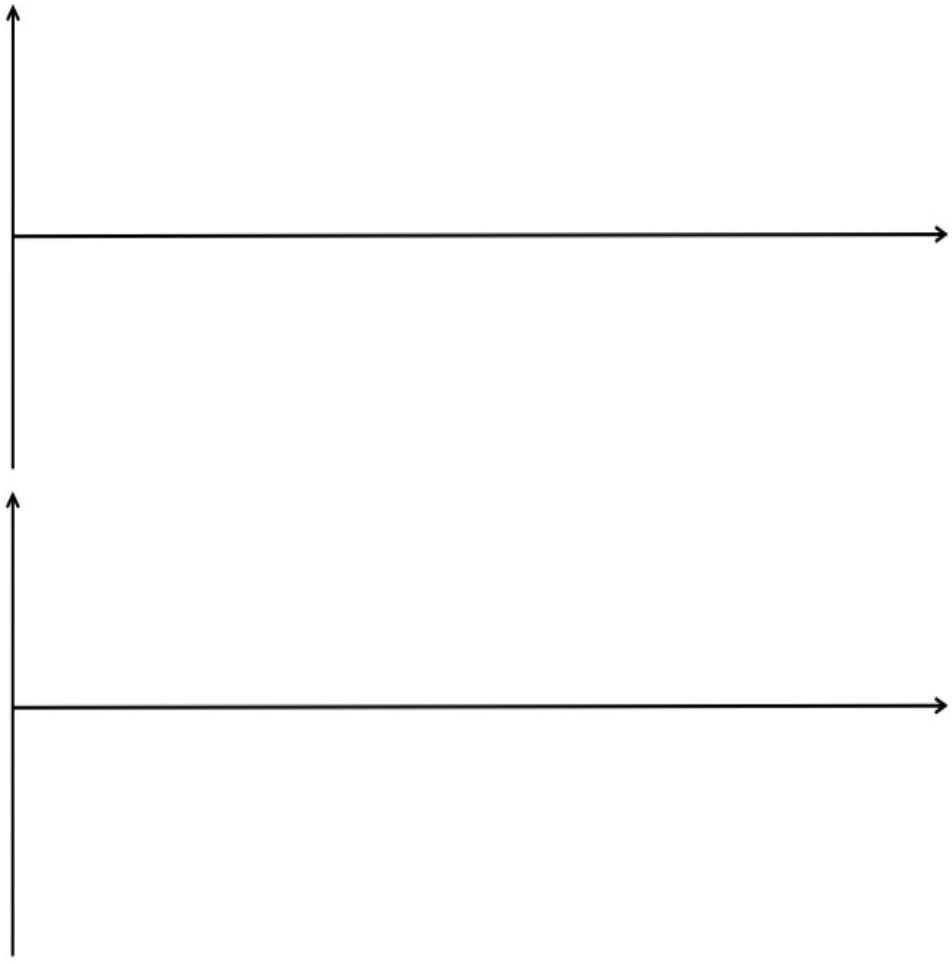
PROBLEM #1 *(35 points)* Construct the shear and bending moment diagrams. *Clearly write all the information in the diagrams (only the diagrams will be graded).*





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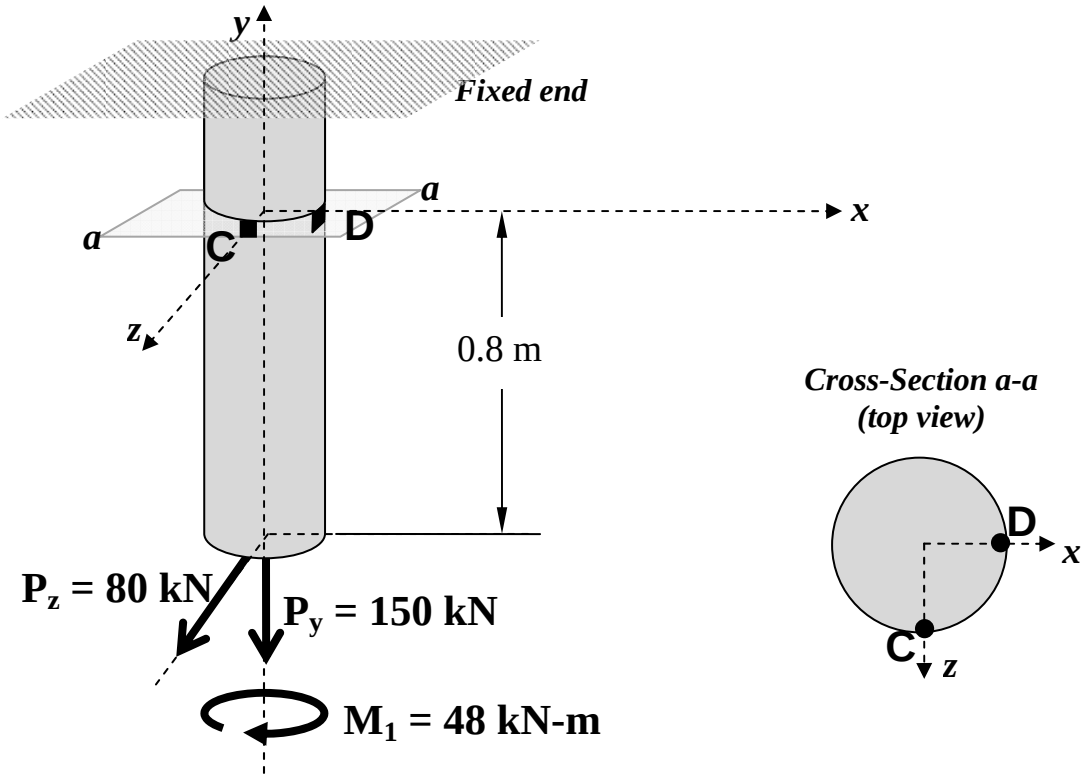
PROBLEM #2 *(35 points)*

Given:
Two point forces and a moment were applied on a solid rod (***radius = 0.1 m***), as shown in the diagram. The force $\mathbf{P_y}$ = 150 kN acted along the rod's axis (in –*y* direction), the force $\mathbf{P_z}$ = 80 kN acted in the +*z* direction, and the moment $\mathbf{M_1}$ = 48 kN-m acted in the -y direction. Neglect the effect of gravity.



Find:
a) The internal resultants acting on the surface *a-a*
b) The state of stress at point **C** (show in a stress element with coordinate system)
c) The state of stress at point **D** (show in a stress element with coordinate system)

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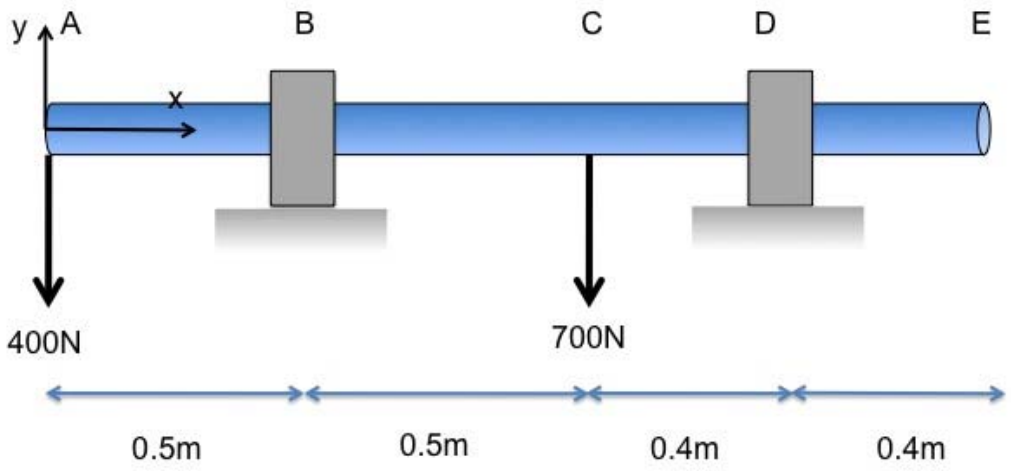
PROBLEM #3 (30 points)

A solid steel shaft with 10 cm radius supports the loads shown in the figure. The bearings at B and D are roller supports.

(a) Find the magnitude and location (x and y coordinates) of the maximum shear stress in the shaft.



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