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

ME 323 Final
Spring 2011
8:00 AM – 10:00 AM

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. 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

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

Prob. 1 ______________________

Prob. 2 ______________________

Prob. 3 ______________________

Prob. 4______________________

Total ________________________

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Some useful formulas

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$EIv'' = M$$
$$(EIv'')' = V$$
$$(EIv'')'' = p$$

$$\langle x-a\rangle^n = \begin{Bmatrix} 0 & f\ or x < a \\ (x-a)^n & f\ or x \ge a \end{Bmatrix} \quad n = 0,1,2,3\ldots$$

$$\int \langle x-a\rangle^n dx = \begin{Bmatrix} \langle x-a\rangle^{n+1} & f\ or n \le 0 \\ \frac{1}{n+1}\langle x-a\rangle^{n+1} & f\ or n \ge 0 \end{Bmatrix}$$

$$\sigma_M = \frac{\sqrt{2}}{2}\left[(\sigma_1-\sigma_2)^2 + (\sigma_2-\sigma_3)^2 + (\sigma_1-\sigma_3)^2\right]^{1/2}$$

$$P_{cr} = \frac{\pi^2 EI}{L_e^2} \qquad \sigma_{cr} = \frac{\pi^2 E}{(L_e/r)^2}$$

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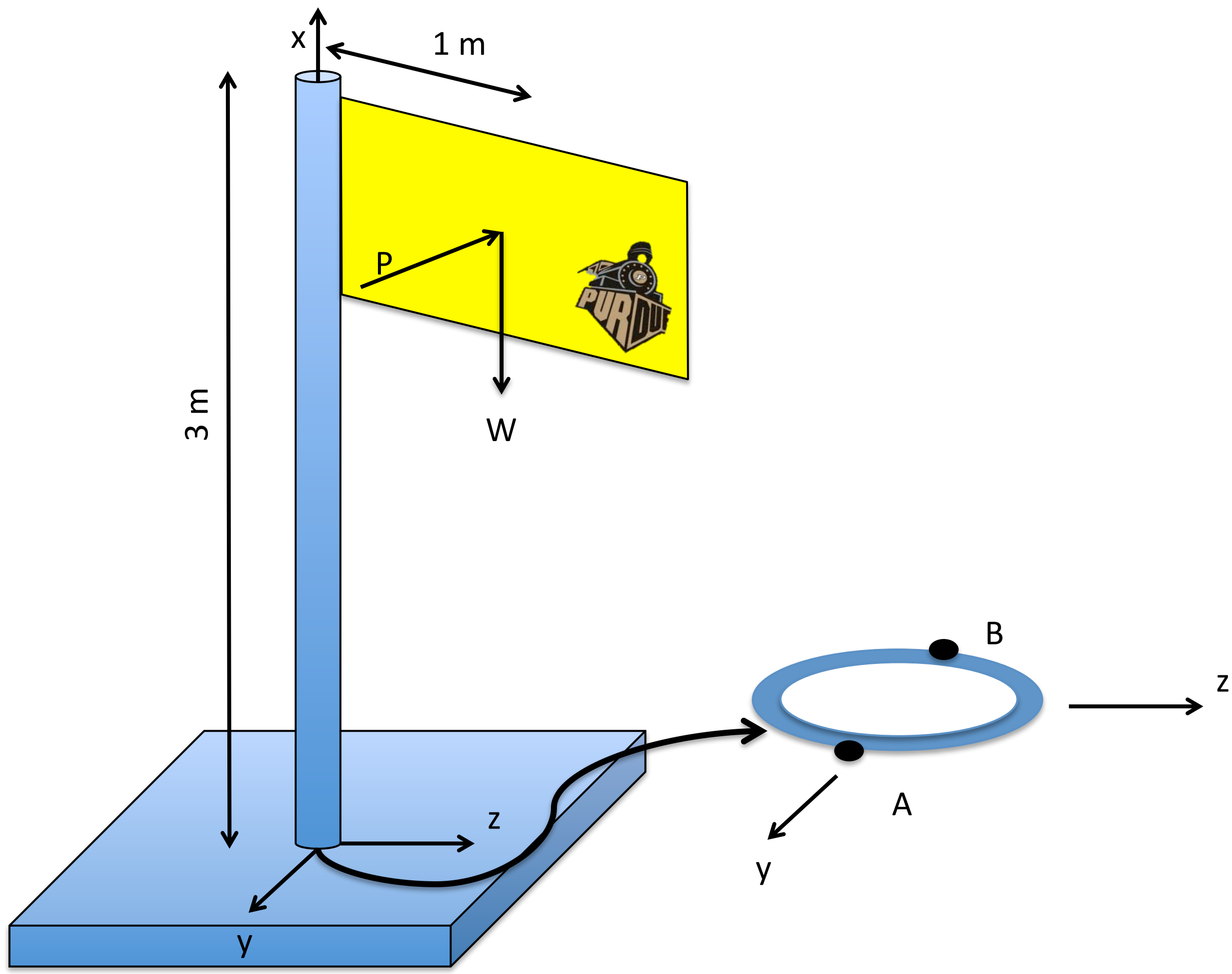
PROBLEM #1 *(30 points)*

A sign of weight W is supported by a pipe with outer diameter D and inner diameter d, For a wind load of P, determine the stress in the base at points A and B. Plot the stress in a properly oriented stress element.



D=125 mm, d=100mm, P=2kN, W=1kN

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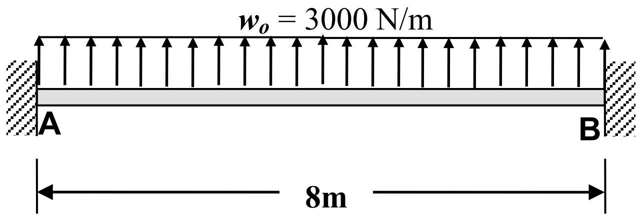
PROBLEM #2 *(30 points)*

A distributed load w_o = 3000 N/m were applied to the beam as shown in the diagram. The beam is fixed at **A** and **B**.



If E = 200 GPa and $I = 35\times10^{-6}\,m^4$, find:

a. the support reactions
b. the *maximum deflection* of the beam

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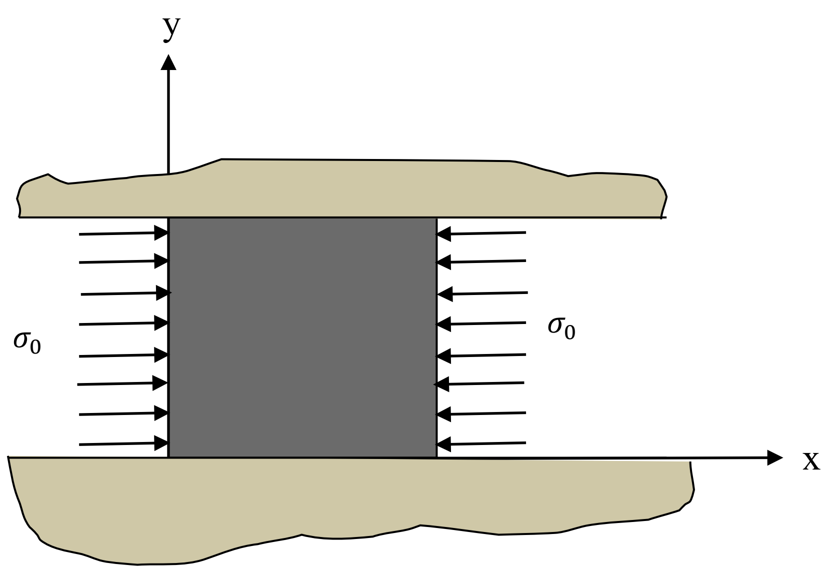
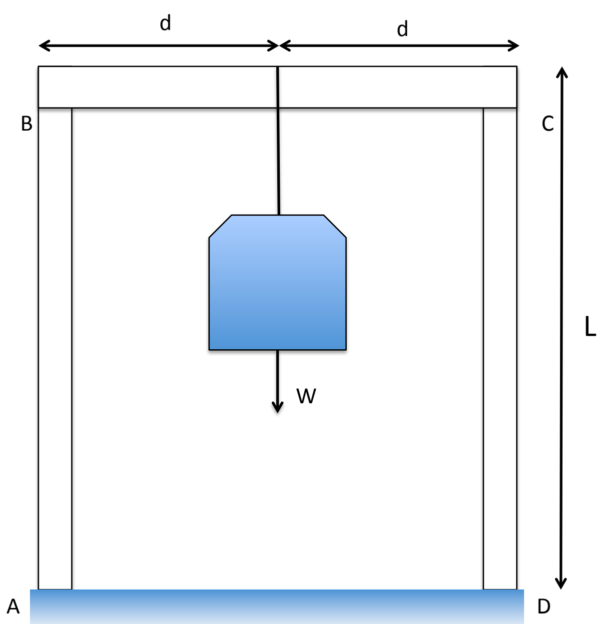
PROBLEM #3 (20 points)

1. A cubic block of *unit* length made of linearly elastic material (E, ν) is compressed between two rigid, perfectly smooth surfaces by an applied stress $\sigma_x = -\sigma_0$ as shown in the figure below. The only other non-zero stress is the stress σ_y induced by the restraining surfaces at $y = 0$ and $y = 1$. Determine the value of the restraining stress σ_y. Also, determine the change in the x and z dimensions of the block.



2. A stiff beam BC is supported by two identical columns whose flexural rigidity is EI. Assuming that the columns are prevented from rotating at either end estimate the maximum weight W that the system can hold before buckling.



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PROBLEM #4 (20 points)

At a certain point in a member subjected to a plane stress, the stresses σ_x, σ_y and τ_{xy} have the values shown in the figure below.

a. Construct the Mohr's circle of stress.
b. Determine the principle stresses.
c. Determine the maximum shear stress.
d. Show the principal stresses in a properly oriented stress element.