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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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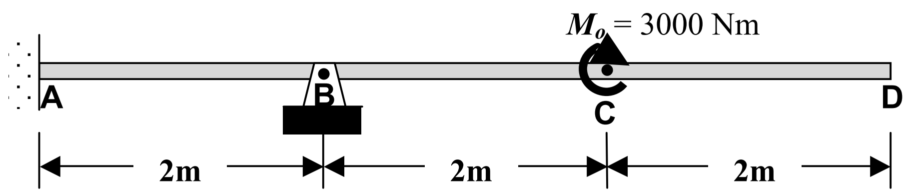
PROBLEM #1 *(30 points)*

A point moment M_o = 3000 Nm were applied to the beam as shown in the diagram. The beam is fixed at **A** and pinned at **B**.



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

a. the support reactions
b. the *deflection* at **C**

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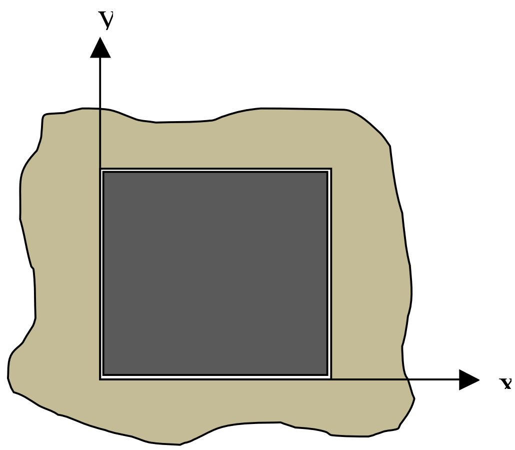
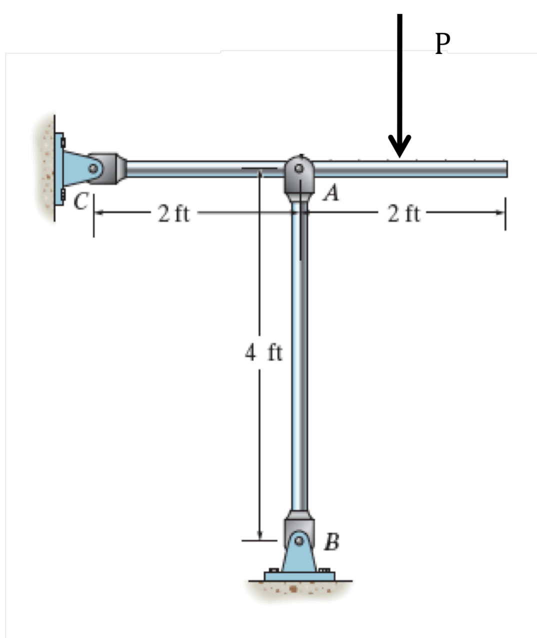
PROBLEM #2 *(20 points)*

1. A cubic block of unit length made of linearly elastic material and having a thermal expansion coefficient α is constrained on all its four sides in the xy plane as shown in the figure below. It is free to expand only in the z direction. The block is uniformly heated to increase its temperature by ΔT . The block is initially stress-free. Determine the dimensions in the three directions of the block after the rise in temperature.



2. Determine the maximum load P (applied at 1ft to the right of A) that can be applied to the bar (E=29 10^3ksi) so that the strut AB does not buckle. The strut has radius r =1in. and it is pin connected to the ends.



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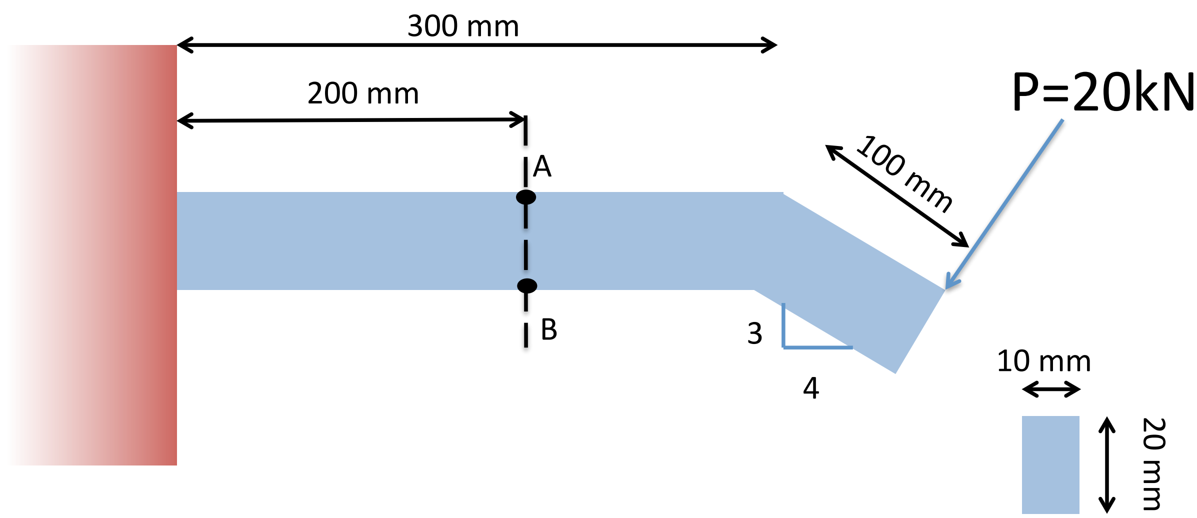
PROBLEM #3 (30 points)

The bracket shown in the figure below is acted upon by a load of P = 20 kN. Calculate the stresses in A and B and show your results in a properly oriented stress element.



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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.