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

ME 323 MIDTERM EXAM 1
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 ________________________

Some useful formulas

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

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

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

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

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

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

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

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

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

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

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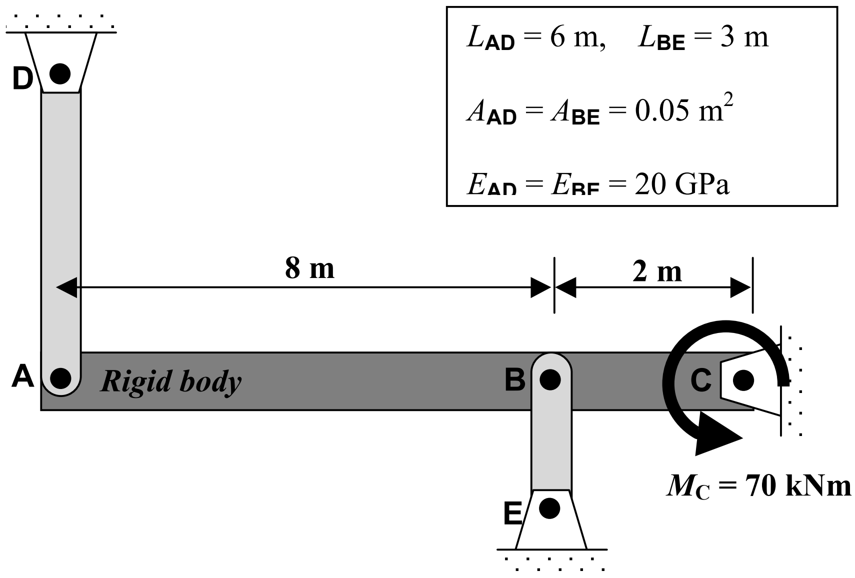
PROBLEM #1 *(40 points)*

The bar **ABC** is a rigid body and it is held in place by two deformable bars (**AD** and **BE**). Bars **AD** and **BE** are made of the same material and have the same cross sectional area. The length of **AD** is twice the length of **BE**.



If a point moment M_C is applied to point **C**, find:

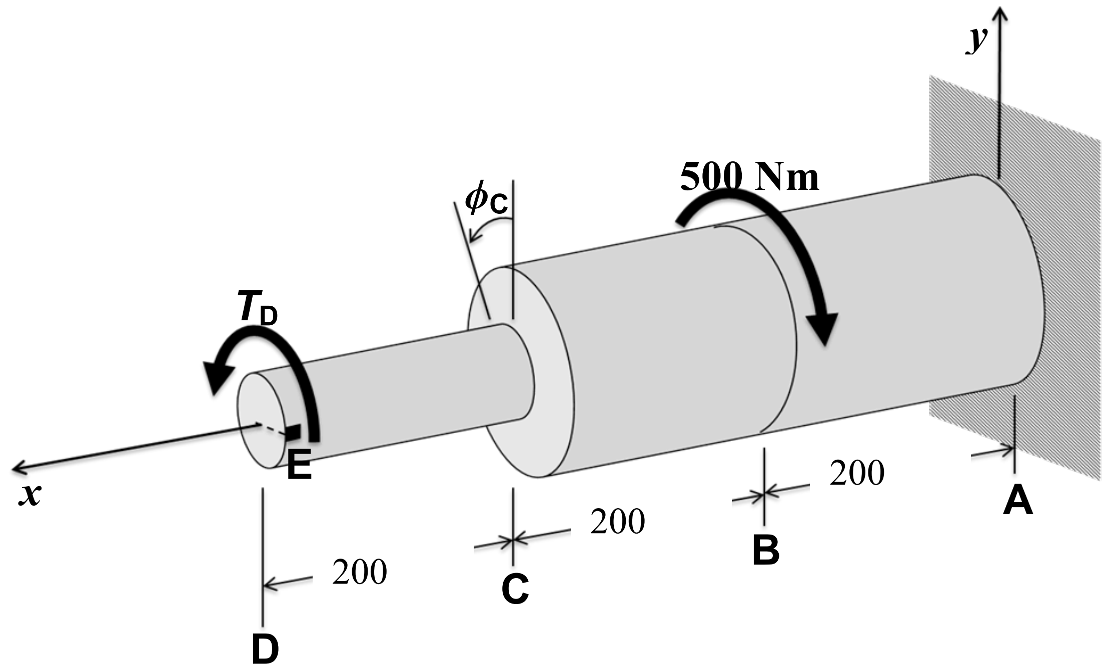
a. normal stress in the bar **AD**.
b. the minimum diameter of the pin at point **D** to the nearest mm with a factor of safety **FS**=3, if the material of the pin has shear strength of 400 MPa.

PROBLEM #2 *(40 points)*

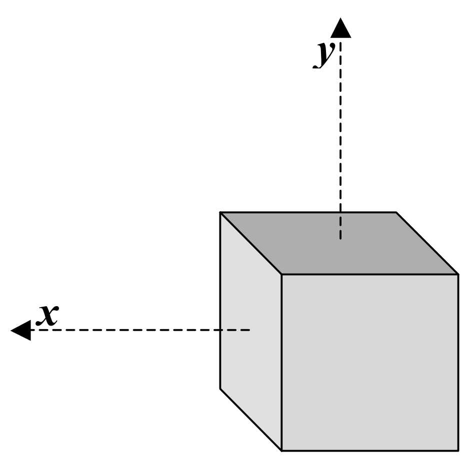
The steel shaft **AD** (G=80GPa) is subjected to torsional loads at points **B** and **D**. The diameters are d_1=50 mm and d_2=25mm.

(a) Determine the torque T_D at **D** that would make the rotation at **C** equal to zero, that is make $\phi_C = 0$.

(b) Determine the stress at point **E** and draw the state of stress in the stress element in the figure below.



Draw the state of stress of point **E** in the stress element:



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PROBLEM #3 (20 points)

The two rod element shown in the figure below is stress free when they are assembled together. The temperature in element (2) is increased by ΔT such that the gap, d, is closed, find the value of ΔT in terms of L_1, A_1, E_1, α_1 and L_2, A_2, E_2, α_2