Name: _____
(Print) (Last) (First)

ME 323 MIDTERM EXAM 1
Spring 2009
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

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

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

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

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

$$FS = \frac{Failure\ (ultimate)\ Stress}{Allowable\ Stress}$$

$$\tau = Gr\frac{\phi}{L}$$

$$\tau = \frac{Tr}{I_p}$$

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

$$I_{p\_Circular\_Cross\_Section} = \frac{\pi d^4}{32}$$

$$I_{p\_Hollow\_Circular\_Cross\_Section} = \frac{\pi(d_o{}^4 - d_i{}^4)}{32}$$

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

$$e = u\cos(\theta) + v\sin(\theta)$$

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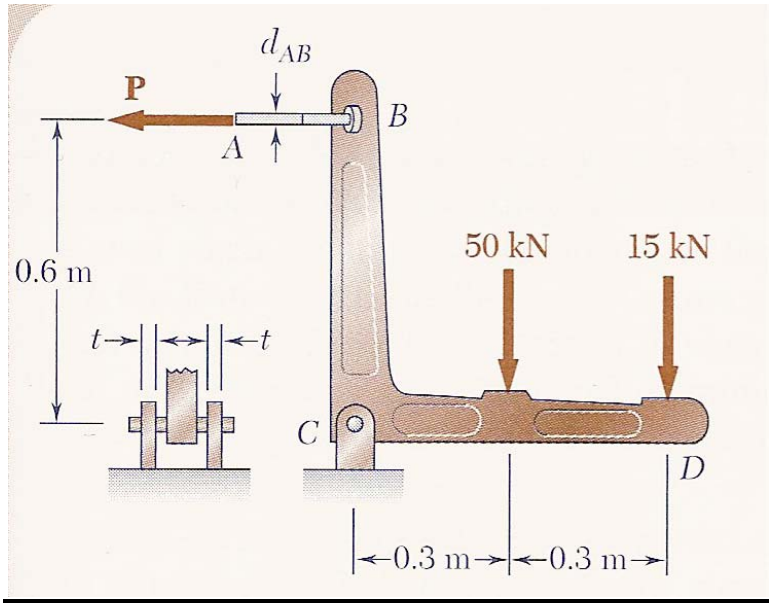
PROBLEM #1 *(30 points)*

Two forces are applied to the bracket BCD as shown in the figure. The pin at C is to be made of steel having an ultimate shearing stress of 350MPa. Determine the diameter of the pin C for which the factor of safety with respect to shear is 3.3.



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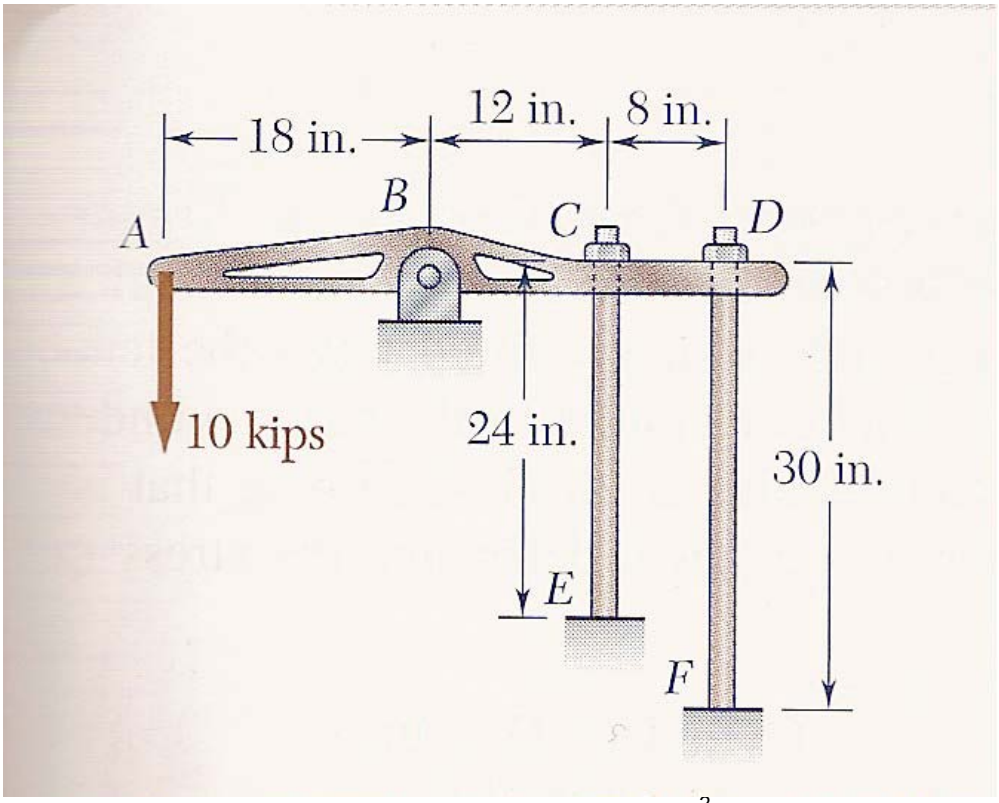
PROBLEM #2 *(35 points)*

The 1/2in. diameter rod CE and the 3/4in. diameter rod DF are attached to the rigid bar ABCD. The rods are made of aluminum (E=10.6 10^6 psi). Determine the force on each rod for the following loading condition.



Cross section area of member CE: $A_{CE} = 0.196$ in^2
Cross section area of member DF: $A_{DF} = 0.442$ in^2

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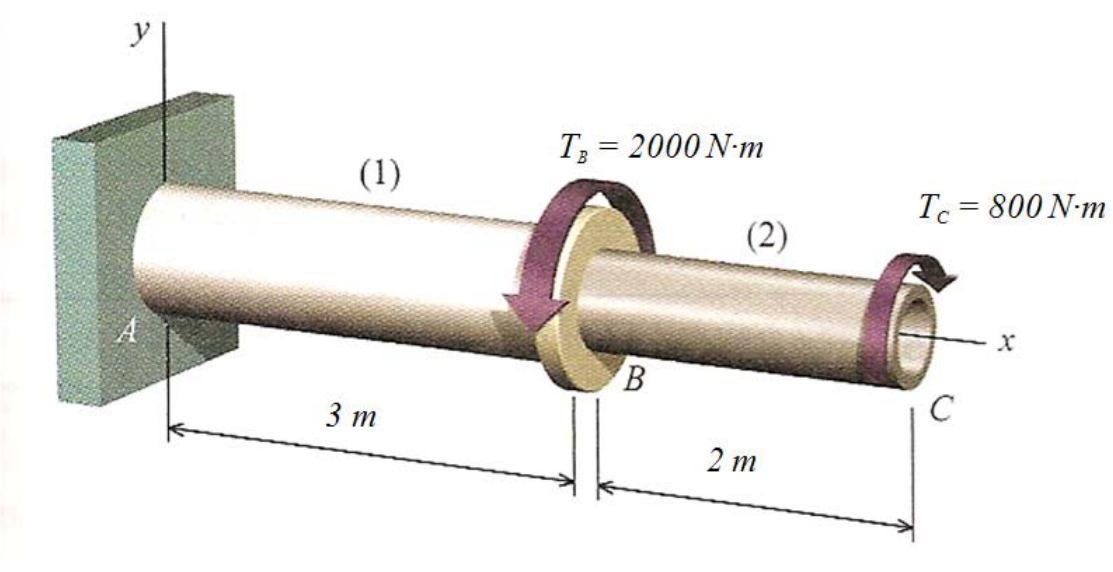
PROBLEM #3 (35 points)

The compound shaft shown in the figure consists of aluminum segment (1) and steel segment (2). Aluminum segment (1) is a solid bar with diameter $D_1 = 100\ mm$ and a shear modulus $G_a = 30\ GPa$. Steel segment (2) is a tube with an outside Diameter $D_2 = 60\ mm$, a wall thickness $t_2 = 5mm$ and a shear modulus $G_s = 80\ GPa$. The compound shaft is subjected to torques applied at *B* and *C*, as shown in the figure.

a. Determine the rotation angle at *B* and *C* with respect to the support at A.



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