Closed Books
Closed Notes

MEEG 4103

Midterm Exam

Name: ______________________________
(Underline your **last name**.)

ID#: ______________________________

1. (30%) A steel countershaft ($E = 30 \times 10^6$ psi) with roller bearings at O and B is in equilibrium as shown, where $T_1 = 9T_2$. Taking the bearings as simple supports, determine *(a)* the deflection y_C at C, *(b)* the minimum shaft diameter $d_{\min}$ needed, using ⅛-in. increments, if the slope at either bearing should not exceed $0.05°$, *(c)* the value of y_C when the shaft diameter is $d_{\min}$.

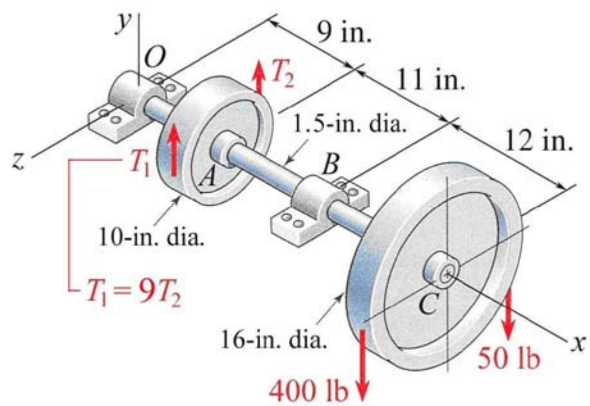

Fig. P1

2. (20%) Using the traction vector formula

$$t_i = \sigma_{ji} n_j$$

derive the octahedral normal stress σ_{oct} and the octahedral shear stress τ_{oct} in terms of the principal stresses: σ_1, σ_2, σ_3. Include pertinent sketches in the derivation.

3. (20%) Describe the *octahedral-shear-stress theory* and show that this theory gives the same equivalent stress (σ') for yielding as that given in the distortion energy theory.

4. (30%) A bar of AISI 1040 hot-rolled steel has a minimum yield strength in tension and compression of 42 kpsi. Using the *distortion-energy* and *maximum-shear-stress theories*, computing the von Mises stress, drawing the stress element, and drawing Mohr's circle diagrams, determine the factor of safety n for the following plane stress states:

(*a*) $\sigma_x = 30$ kpsi, $\tau_{xy} = -8$ kpsi

(*b*) $\sigma_x = -24$ kpsi, $\sigma_y = -12$ kpsi, $\tau_{xy} = -8$ kpsi

(*c*) $\sigma_x = 12$ kpsi, $\sigma_y = 28$ kpsi, $\tau_{xy} = 6$ kpsi