UNIVERSITY of ARKANSAS
1871

MEEG 3013 **Name:** _____

(Underline your **last name**.)

Test I ( ) **ID#:** _____

1. (30%) A torque **T** is applied at end *A* of the composite shaft to cause it to have an angle of twist ϕ_A = 15°. Knowing that the modulus of rigidity is 11.2×10^6 psi for the steel and 3.9×10^6 psi for the aluminum, determine (*a*) the maximum shearing stress $(\tau_{max})_s$ in the steel core, (*b*) the maximum shearing stress $(\tau_{max})_a$ in the aluminum jacket, (*c*) the magnitude *T* of the torque.

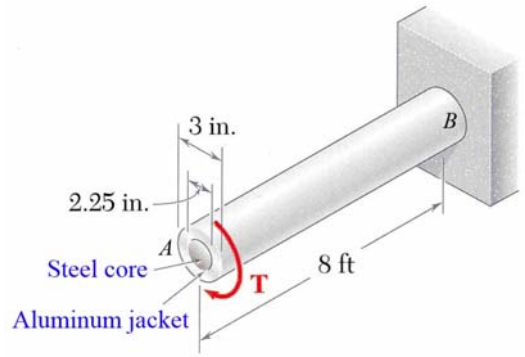

Fig. P1

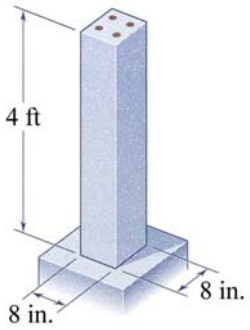

Fig. P2

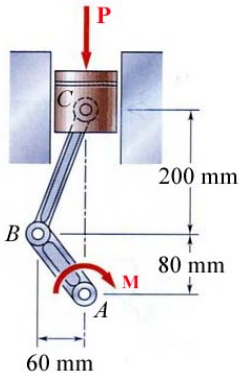

Fig. P3

2. (30%) A 4-ft concrete post is reinforced by four steel bars, each of 0.75-in. diameter. It is known that $E_s = 29 \times 10^6$ psi, $\alpha_s = 6.5 \times 10^{-6}$/°F, $E_c = 3.6 \times 10^6$ psi, and $\alpha_c = 5.5 \times 10^{-6}$/°F. If the tensile stress developed in the concrete due to thermal expansion is known to be 70 psi, determine (*a*) the temperature rise ΔT, (*b*) the normal stresses σ_s induced in the steel, (*c*) the change in length δ_{post} of the post.

3. A moment **M** = 1.55 kN·m ↻ is applied to the crank of an engine as shown, where the connecting rod *BC* has a uniform cross section of 450 = mm^2 and will fail under an ultimate load of 50 kN, and the force **P** is required to hold the engine system in equilibrium. *Circle on this test sheet* the correct or nearest item for each of the following:

A. (7%) The magnitude of the force **P** is

(*a*) 17.86 kN. (*b*) 18.45 kN. (*c*) 19.05 kN. (*d*) 19.64 kN. (*e*) 20.2 kN. (*f*) 20.8 kN. (*g*) 21.4 kN.

B. (7%) The average normal stress in the connecting rod *BC* is

(*a*) 51.1 MPa. (*b*) 49.7 MPa. (*c*) 48.3 MPa. (*d*) 47.0 MPa. (*e*) 45.6 MPa. (*f*) 44.2 MPa. (*g*) 42.8 MPa.

C. (6%) The factor of safety of the connecting rod *BC* in this position is

(*a*) 2.60. (*b*) 2.51. (*c*) 2.44. (*d*) 2.37. (*e*) 2.30. (*f*) 2.23. (*g*) 2.17.

4. (20%) Non-numerical problem.

A. Define Poisson's ration ν.

B. Define shearing strain γ.

C. Describe Saint-Venant's principle.

D. (*a*) Where do stress concentrations develop? (*b*) Define stress concentration factor *K*.