Uva Wellassa University, Sri Lanka
End Semester Examination – July 2010
SCT 364-2 Strength of Materials

Time: Two (02) hours

Total 08 Questions
Answer ~~four~~ five **(05)** questions only

1) The three-bar truss *ABC* shown in Fig.Q01 has a span L = 3 m and is constructed of steel pipes having cross-sectional area A = 3900 mm^2 and modulus of elasticity E = 200 GPa. Identical loads P act both vertically and horizontally at joint *C*, as shown.
   a) If P = 650 kN, what is the horizontal displacement of joint *B*?
   b) What is the maximum permissible load value P_{max} if the displacement of joint *B* is limited to 1.5 mm?

(20 marks)

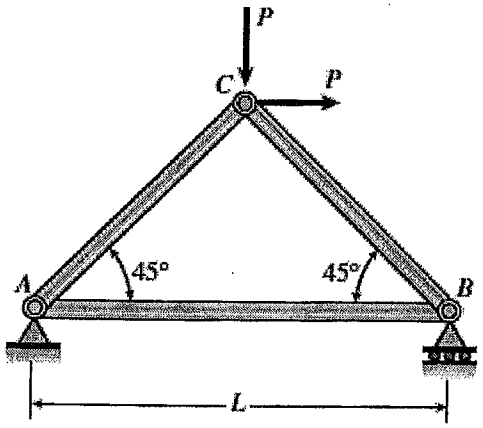

Fig.Q01

2) The horizontal rigid beam *ABCD* is supported by vertical bars *BE* and *CF* and is loaded by vertical forces P_1 = 400 kN and P_2 = 360 kN acting at points *A* and *D*, respectively (see Fig.Q02). Bars *BE* and *CF* are made of steel (E = 200 GPa) and have cross-sectional areas A_{BE} = 11,100 mm^2 and A_{CF} = 9,280 mm^2. The distances between various points on the bars are shown in the figure. Determine the vertical displacements δ_A and δ_D of points *A* and *D*, respectively.

(20 marks)

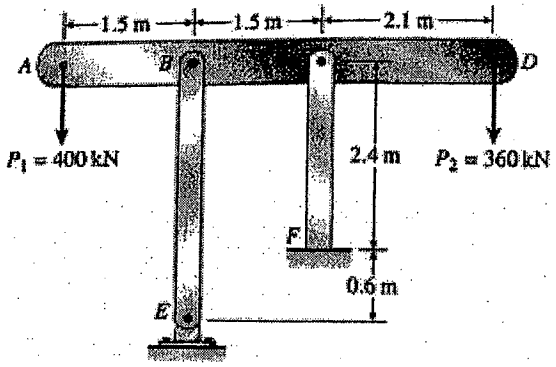

Fig.Q02

3) Three prismatic bars, two of material *A* and one of material *B*, transmit a tensile load *P* (see Fig.Q03). The two outer bars (material *A*) are identical. The cross-sectional area of the middle bar (material *B*) is 50% larger than the cross-sectional area of one of the outer bars. Also, the modulus of elasticity of material *A* is twice that of material *B*.
(a) What fraction of the load *P* is transmitted by the middle bar?
(b) What is the ratio of the stress in the middle bar to the stress in the outer bars?
(c) What is the ratio of the strain in the middle bar to the strain in the outer bars?

(20 marks)

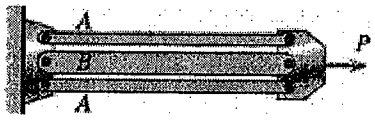

Fig.Q03

4) The fixed-end bar *ABCD* consists of three prismatic segments, as shown in the Fig.Q04. The end segments have cross-sectional area $A_1 = 840$ mm^2 and length $L_1 = 200$ mm. The middle segment has cross-sectional area $A_2 = 1260$ mm^2 and length $L_2 = 250$ mm. Loads P_B and P_C are 25.5 kN and 17.0 kN, respectively.
(a) Determine the reactions R_A and R_D at the fixed supports.
(b) Determine the compressive axial force F_{BC} in the middle segment of the bar.

(20 marks)

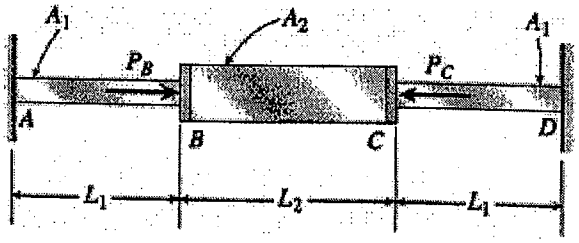

Fig.Q04

5) Two hollow tubes are connected by a pin at *B* which is inserted into a hole drilled through both tubes at *B* (see cross-section view at *B* in Fig.Q05). Tube *BC* fits snugly into tube *AB* but neglect any friction on the interface. Tube inner and outer diameters d_i (i = 1, 2, 3) and pin diameter d_p are labeled in the Fig.Q05. Torque T_0 is applied at joint *C*. The shear modulus of elasticity of the material is *G*.
Find expressions for the maximum torque $T_{0,max}$ which can be applied at *C* for each of the following conditions.
(a) The shear in the connecting pin is less than some allowable value ($\tau_{pin} < \tau_{p,allow}$).
(b) The shear in tube *AB* or *BC* is less than some allowable value ($\tau_{tube} < \tau_{t,allow}$).
(c) What is the maximum rotation ϕ_C for each of cases (a) and (b) above?

(20 marks)

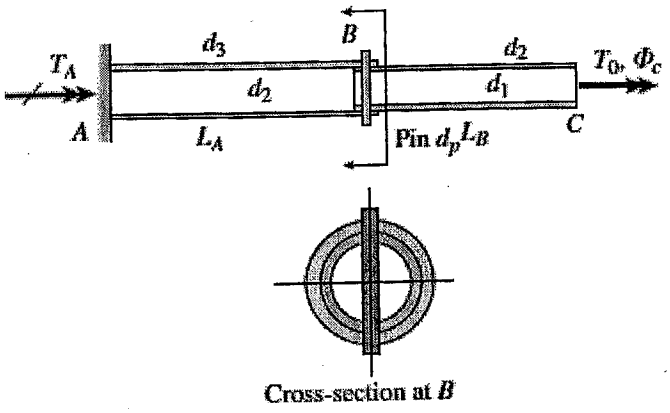

Fig.Q05

6) A hollow steel shaft *ACB* of outside diameter 50 mm and inside diameter 40 mm is held against rotation at ends *A* and *B* (see Fig.Q06). Horizontal forces *P* are applied at the ends of a vertical arm that is welded to the shaft at point *C*.
Determine the allowable value of the forces *P* if the maximum permissible shear stress in the shaft is 45 MPa.

(20 marks)

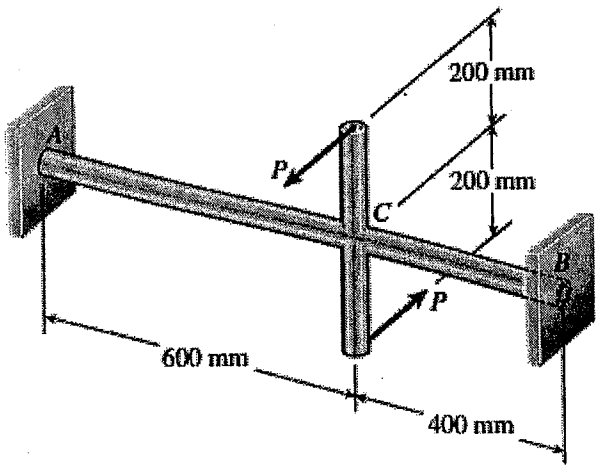

Fig.Q06

7) A stepped shaft *ACB* is held against rotation at ends *A* and *B* and subjected to a torque T_0 acting at section *C* (see Fig.Q07). The two segments of the shaft (*AC* and *CB*) have diameters d_A and d_B, respectively, and polar moments of inertia I_{PA} and I_{PB}, respectively. The shaft has length *L* and segment *AC* has length *a*.

(a) For what ratio *a/L* will the maximum shear stresses be the same in both segments of the shaft?

(b) For what ratio *a/L* will the internal torques be the same in both segments of the shaft?

(20 marks)

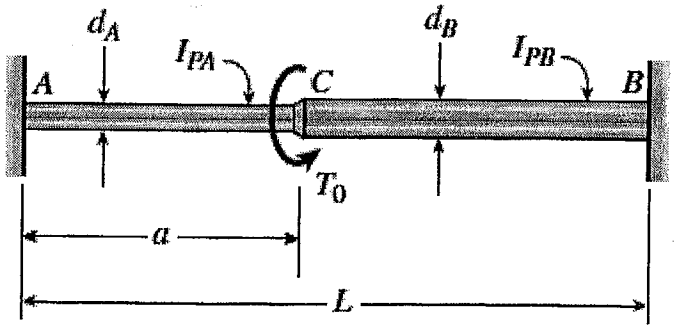

Fig.Q07

8) Two aluminum strips are securely bonded to a brass bar of 30 x 30 mm square cross section. Using the data given below, determine the largest permissible bending moment when the composite member is bent about a horizontal axis.

	Aluminum	**Brass**
Modulus of elasticity:	70 GPa	105 GPa
Allowable stress:	100 MPa	160 MPa

(20 marks)

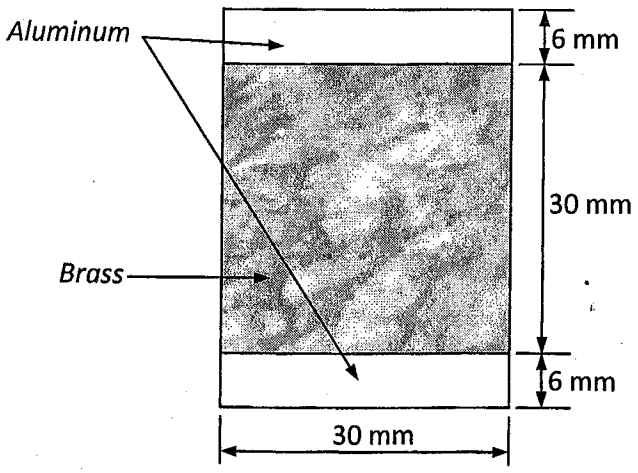

Fig.Q08