34

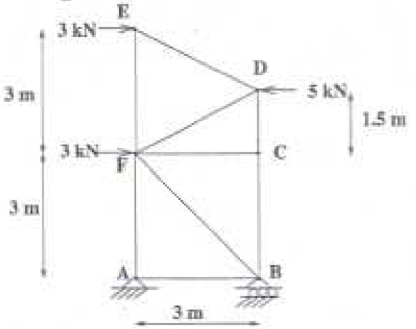
Thapar University, Patiala

ES102 Solid Mechanics, 2^{nd} Semester 2006-07
End-semester Examination
B.E., 1^{st} year (D, E & F sections)

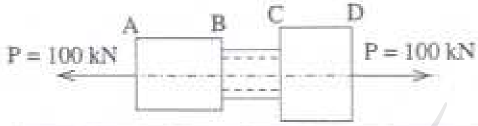
Max. marks: 100 **Time: 3 hrs**

Note: (i) *Clearly write your tutorial group no. on top right hand corner of the answer sheet*
(ii) *Attempt* **any five** *questions*
(iii) *Give neat labeled sketches wherever necessary*

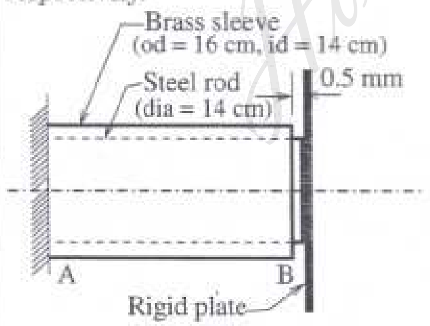
Q.1(a) Find forces in the members AF, FC and CB for the truss loaded and supported as shown in Fig. **[12]**



Q.1(b) A stepped circular section bar ABCD of steel (E = 210 GPa) has the part AB (solid, dia = 50 mm, length = 60 mm), part BC (hollow, od = 30 mm, length = 50 mm) and part CD (solid, dia = 70 mm, length = 50 mm) . What should be the inner diameter of part BC if the tensile stress in it is 200 MPa? What is the total elongation of the bar ABCD? **[8]**

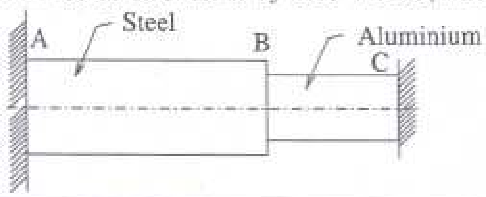


Q.2 A steel rod of length 30 cm is fixed to the vertical wall at A. A brass sleeve of length AB = 29.95 cm is placed concentrically around the rod and is also fixed to the wall at A as shown in Fig. A rigid plate is attached to the free end of the rod. Assuming elastic behavior, at what temperature of the assembly the stress in the brass is 50 MPa? What is the corresponding stress in the steel rod? Also, determine the net axial movement of the rigid plate. Take Young's moduli as 200 GPa and 100 GPa for steel and brass respectively. Coefficients of thermal expansion for steel and brass are $12 \times 10^{-6}/^{o}C$ and $19 \times 10^{-6}/^{o}C$ respectively. **[20]**

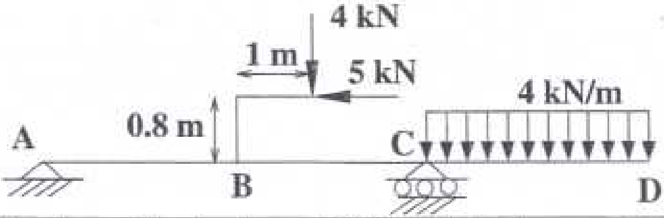


Q.3(a) Derive the torsion formula for circular section shafts. **[10]**

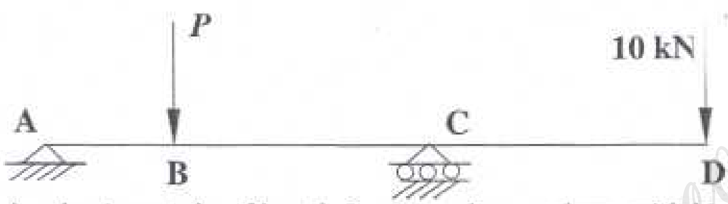
Q.3(b) A composite solid circular section shaft ABC has the part AB of steel of (dia = 7 cm, length = 30 cm, G = 80 GPa) and part BC of aluminum (dia = 5 cm, length = 12 cm, G = 26 GPa). The ends A and B are fixed. What torque should be applied at the section at B so as to twist it by 0.05°? Also, find the maximum shear stresses in the two parts. **[10]**



Q.4 Draw the axial force, shear force and bending moment diagrams for the beam ABCD shown in Fig. Clearly indicate the values at important points. Also, determine the point(s) of contra-flexure, if any. AB = BC = CD = 2 m. **[20]**



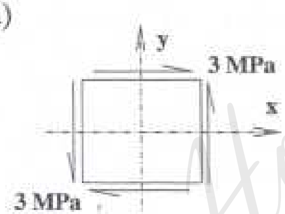
Q.5(a) For the overhanging beam ABCD loaded and supported as shown in Fig. 1, compute the magnitude of the load P that would cause the elastic curve to be horizontal at the support C. EI is constant through out. AB = 1 m, BC = CD = 2 m. **[14]**



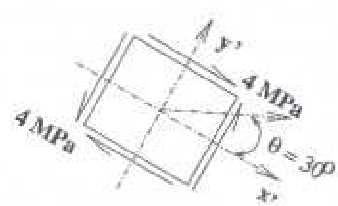
Q.5(b) An aluminum tube of length 8 m is used as a column with hinged ends carrying a 1.2 kN axial compressive load. If the outer diameter of the tube is 50 mm, compute the limiting value of the inner diameter that would be safe against buckling. Use E = 70 GPa for aluminum. **[6]**

Q.6 The state of stress at a point is the result of two loadings. When acting alone, the first loading produces the 3 MPa pure shear with respect to the xy-axes as shown in Fig. (a). The second loading alone results in the 4MPa pure shear with respect to the x'y'-axes as shown in Fig. (b). The angle between the two sets of axes is $\theta = 30^o$ as shown. If the two loadings act simultaneously, determine (i) the state of stress at this point with respect to xy-axes; and (ii) the principal stresses and the principal planes. Show the results on properly oriented elements **[20]**

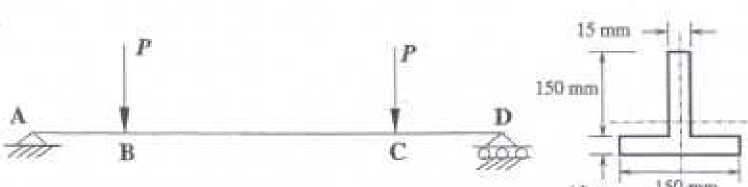
(a)



(b)



Q.7 The cast iron inverted T - section beam supports two concentrated loads of magnitude P each. The working stresses are 48 MPa in bending tension, 140 MPa in bending compression and 30 MPa in bending shear. Find the maximum allowable value of P. AB = CD = 1 m, BC = 3 m. **[20]**



Note: Students can see there evaluated answer-sheets on 30^{th} May, 2007 at 12.30 p.m. in room nos. D115 (D-section), D116 (E-section) and F102 (F-section).