Department of Civil Engineering

NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

Monsoon Semester 2010

End-Semester Examination, 22 Nov 2010

CEU201 MECHANICS OF SOLIDS

Name:_____

Roll. No:_____

Class: S_3; Batch: A / B

Time: 3 hours Maximum Marks: [50]

Instructions: (a) *Answer* **all** *questions*; (b) Provide neat sketches wherever necessary; (c) Assume any missing data after stating it clearly; and *most importantly* (d) Read the questions carefully before answering.

1. A horizontal rigid bar of weight W = 10 kN is supported by three slender circular rods that are equally spaced as shown in Fig. 1. The outer rods are made of brass (E_1 = 100 GPa) with diameter d_1 = 10 mm and length L_1 = 800 mm. The inner rod is steel (E_2 = 200 GPa) with diameter d_2 = 6 mm and length L_2 = 500 mm. Ignore the weight of the rods and calculate the stresses in each rod and the vertical displacement of the rigid bar. [5]

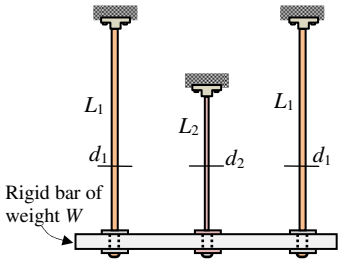

Figure 1

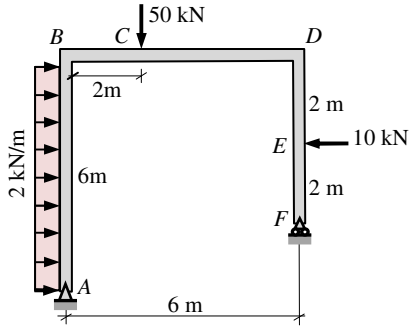

Figure 2

2. Write the shear force and bending moment equations and draw the shear force and bending moment diagrams for the plane frame depicted in Fig. 2, indicating salient values. [6]

3. A simply supported composite beam of span 6 m carries a uniformly distributed load of intensity w kN/m. The beam is constructed of a wood member 150 mm wide by 300 mm deep, reinforced on its lower side by a steel plate 5 mm thick and 150 mm wide. If the allowable bending stresses in wood and steel are σ_w = 6 MPa and σ_s = 200 MPa, what is the maximum allowable load w the beam can safely carry. E_w = 10 GPa and E_s = 200 GPa. [6]

4. The cross-section of a beam shown in Fig. 3 is subjected to a shear force 200 kN. Draw the shear stress distribution in the web, indicating salient values. [4]

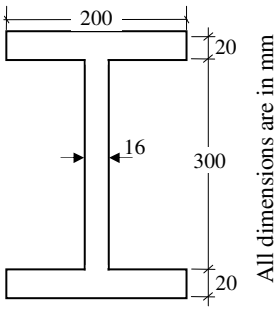

Figure 3

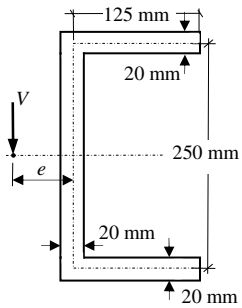

Figure 4

5. A simply supported beam of span 8 m carries a uniformly distributed load of intensity 50 kN/m. The beam has a rectangular cross-section of size 200×400 mm. Determine the principal stresses on a cross-section of the beam at quarter span at a height of 50 mm above the neutral axis. [Hint: Calculate normal stress σ_x and shear stress τ_{xy} due to bending at the location.] [5]

6. Locate the shear centre for the channel section shown in Fig. 4. If the section is subjected to a shear force V = 250 kN acting through the shear centre as shown, draw the horizontal shear stress distribution. Indicate salient values. [4]

7. A shaft has to transmit 3000 h.p at 60 rev/min. If the allowable shear stress is 100 MPa, find the necessary diameter for a solid shaft of circular section. If a hollow circular section is used with an internal diameter 0.75 of the external diameter, calculate the saving in weight per meter length of the shaft. Density of the material is 7800 kg/m^3. [Note: 1 h.p (horse power) = 746 watts] [4]

8. (a) Derive expressions for the strain energy in bending and torsion. [3]

   (b) Use the above to derive an expression for calculating the deflection of an open coiled spring subjected to an axial force. [3]

9. A cast iron pipe, 300 mm internal diameter and 75 mm thick, carries water under a pressure of 10 MPa. Sketch the distribution of radial and circumferential stresses across the thickness of the wall. [4]

10. A long copper cylinder with closed ends, 120 mm external diameter and 10 mm thick, is to be reinforced by winding closely a single layer of steel wire of 5 mm diameter. Calculate the necessary winding tension in the wire if an internal gauge pressure of 10 MPa in the cylinder is to give a tensile stress of 15 MPa in the cylinder walls. Determine also the final stress in the wire. Take *E* for copper as 0.6 times that for steel and Poisson's ratio 0.3. [6]

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