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## Third Semester B.E. Degree Examination, Dec.2019/Jan.2020

### Strength of Materials

Time: 3 hrs.

Max. Marks: 100

**Note: Answer any FIVE full questions, choosing ONE full question from each module.**

#### Module-1

- 1 a. Define : (i) Stress      (ii) Strain (04 Marks)  
 b. Derive the expression for elongation of tapering circular bar due to an axial load P. Use standard notations. (08 Marks)  
 c. A circular bar of uniform cross sectional area of  $1000 \text{ mm}^2$  is subjected to forces as shown in Fig. Q1 (c). If Young's modulus for the material is 200 GPa, determine the total deformation. (08 Marks)

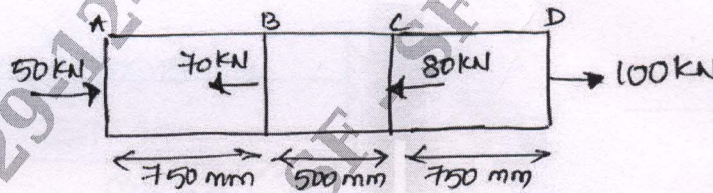


Fig. Q1 (c)

OR

- 2 a. Derive the relationship between Young's modulus, modulus of rigidity and Poisson's ratio. (06 Marks)  
 b. A bar of 30 mm diameter is subjected to a pull of 60 kN. The measured extension on gauge length of 200 mm is 0.1 mm and change in diameter is 0.004 mm. Calculate (i) Young's modulus (ii) Poisson's ratio (iii) Bulk modulus. (06 Marks)  
 c. A steel rod of 200 mm diameter passes centrally through a copper tube of 50 mm external diameter and 40 mm internal diameter. The tube is closed at each end and the nuts are tightened on the projecting points of rod. If the temperature of the assembly is raised by  $50^\circ\text{C}$ . Calculate the temperature stresses developed in copper and steel.  
 Take  $E_s = 200 \text{ GN/m}^2$ ;  $E_c = 100 \text{ GN/m}^2$  and  $\alpha_s = 12 \times 10^{-6} \text{ per } ^\circ\text{C}$  and  $\alpha_c = 18 \times 10^{-6} \text{ per } ^\circ\text{C}$ . (08 Marks)

#### Module-2

- 3 a. Define (i) Principal stress (ii) Principal plane (04 Marks)  
 b. Derive expression for normal stress and tangential stress for a member subjected to uniaxial loading. (06 Marks)  
 c. At a point in a strained material, the stresses are as shown in Fig. Q3 (c). Determine the  
 (i) Principal stress  
 (ii) Normal and tangential stress on the plane AB.  
 (iii) Maximum shear stress. (10 Marks)

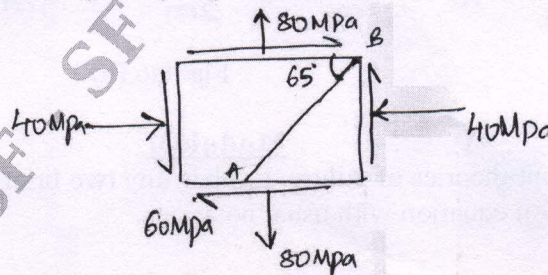


Fig. Q3 (b)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
 2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

- 4 a. Derive expression for hoop stress and longitudinal stress for a thin cylindrical vessel subjected to an internal fluid pressure. (10 Marks)
- b. Determine the maximum and minimum hoop stress across the section of a pipe of 400 mm internal diameter and 100 mm thick, when the pipe contains a fluid at a pressure of  $8 \text{ N/mm}^2$ . Also sketch the radial pressure distribution and hoop stress distribution. (10 Marks)

**Module-3**

- 5 a. Derive the relationship between load intensity, shear force and bending moment. (08 Marks)
- b. For a simply supported beam subjected to a UDL of intensity  $W/\text{unit length}$  throughout plot the SFD and BMD and prove that maximum bending moment is  $\frac{\omega l^2}{8}$ . (06 Marks)
- c. For the Cantilever beam shown in Fig. Q5 (c), plot the SFD and BMD.

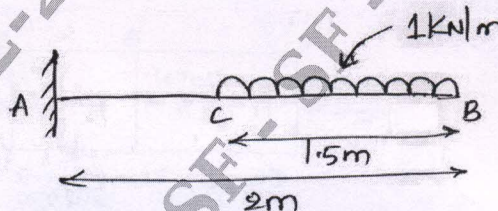


Fig. Q5 (c)

(06 Marks)

OR

- 6 a. A simply supported beam is subjected to a UDL of  $30 \text{ kN/m}$  together with a point load of  $30 \text{ kN}$  as shown in Fig. Q6 (a). Draw SFD and BMD. Find also point of zero shear and its corresponding BM.

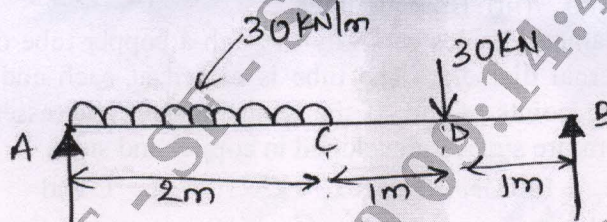


Fig. Q6 (a)

(10 Marks)

- b. For the overhanging beam shown in Fig. Q6 (b), plot the SFD and BMD. Locate points of contraflexure if any.

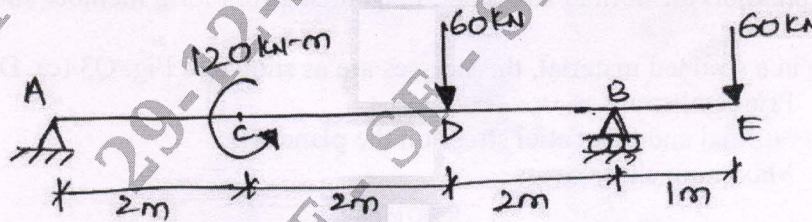


Fig. Q6 (b)

(10 Marks)

**Module-4**

- 7 a. State the different theories of failure. Explain any two briefly. (10 Marks)
- b. Derive the torsion equation with usual notations. (10 Marks)

**OR**

- 8 a. A solid shaft is to transmit 300 kN-m at 100 rpm. If the shear stress of the material should not exceed 80 MPa, find the diameter required. What percentage saving in weight would be obtained if this shaft is replaced by a hollow one whose  $d_i = 0.6d_o$ , the length, material and shear stress remaining same. (10 Marks)
- b. Determine the diameter of a bolt which is subjected to an axial pull of 9 kN together with a transverse shear force of 4.5 kN using,  
 (i) Maximum principal stress theory  
 (ii) Maximum principal strain theory.  
 Given the elastic limit in tension = 225 N/mm<sup>2</sup>; Factor of safety = 3  
 Poisson's ratio = 0.3 (10 Marks)

**Module-5**

- 9 a. What are the assumptions in bending theory? (04 Marks)
- b. Derive the equation  $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$  of theory of simple bending with usual notations. (08 Marks)
- c. A rolled steel joint of I-section has the dimensions as shown in Fig. Q9 (c). This beam of I-section carries a UDL of 40 kN/m run on a span of 10 m. Calculate the maximum stress produced due to bending.

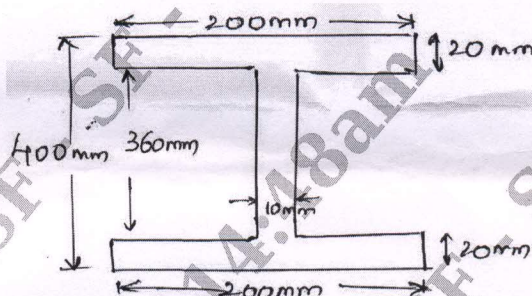


Fig. Q9 (c)

(08 Marks)

**OR**

- 10 a. State the assumptions made in Euler's theory. (04 Marks)
- b. Derive the Euler's equation for buckling load on an elastic column with both ends pinned or hinged. (08 Marks)
- c. A simply supported beam of length 40 m is subjected to a UDL of 30 kN/m over the whole span and deflects 15 mm at the centre. Determine the crippling loads when this beam is used as a column with the following conditions:  
 (i) One end fixed and other end hinged.  
 (ii) Both ends pin jointed.  
 Take length of beam,  $l = 4000$  mm and UDL,  $w = 30$  kN/m, Deflection at centre = 15 mm. (08 Marks)

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