

Code : 101206

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2012 (A)

## MECHANICS OF SOLID—I

Time : 3 hours

Full Marks : 70

## Instructions:

- (i) The marks are indicated in the right-hand margin.  
 (ii) There are **TEN** questions in this paper.  
 (iii) Attempt any **FIVE** questions.

1. (a) Draw stress-strain curve for brittle materials, and show how its yield point is determined. 8
- (b) A load of 2000 kN is applied on a short concrete column 300 mm × 200 mm. The column is reinforced with four steel bars of 10 mm diameter, one in each corner. Find the stresses in the concrete and steel bars. Take  $E$  for steel as  $2.1 \times 10^5 \text{ N/mm}^2$  and for concrete as  $1.4 \times 10^4 \text{ N/mm}^2$ . 8
2. (a) Define Poisson's ratio. Prove that the Poisson's ratio of the incompressible material like rubber is 0.5. 6

- (b) A steel rod of 30 mm diameter and 400 mm length was tested in a testing machine. At a load of 135 kN, the extension in a gage length of 50 mm was measured to be 0.045 mm and the reduction in diameter was 0.008 mm. Determine Poisson's ratio and values of three elastic moduli for the test material. 8

3. Draw the shear force and bending moment diagram for the beam loaded as shown in Fig. 1. Determine (a) position of maximum bending moment and (b) position of point of contraflexure, if any : 14

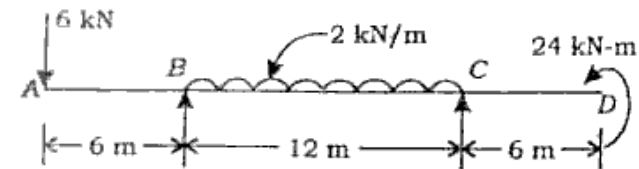


Fig. 1

4. (a) Define the following terms : 6
- (i) Pure bending  
 (ii) Neutral axis  
 (iii) Section modulus  
 (iv) Moment of resistance

- (b) A beam of an I-section shown in Fig. 2 is simply supported over a span of 4 metres. Determine the load that the beam can carry per metre length, if the allowable stress in the beam is  $30.82 \text{ N/mm}^2$  ;

8

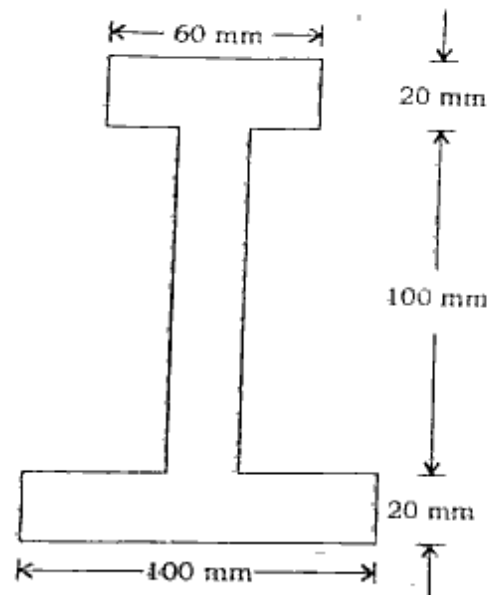


Fig. 2

5. A beam of length 10 m is simply supported at its ends and carries two point loads of 100 kN and 60 kN at a distance of 2 m and 5 m respectively from the left support. Calculate the deflection under each load and maximum deflection.

14

6. (a) What assumptions are made in the theory of pure torsion?

4

- (b) A hollow shaft having an internal diameter 50% of its external diameter transmits 600 kW at 150 r.p.m. Determine the external diameter of the shaft if the shear stress is not to exceed  $65 \text{ N/mm}^2$  and the twist in a length of 3 m should not exceed 1.4 degree. Assume maximum torque = 1.2 mean torque and modulus of rigidity =  $1 \times 10^5 \text{ N/mm}^2$ .

10

7. (a) What is Mohr's stress circle? What is the importance of this circle?

6

- (b) At a point in a stressed body, the state of stress on two planes  $45^\circ$  apart is shown in Fig. 3. Determine the two principal stresses ;

8

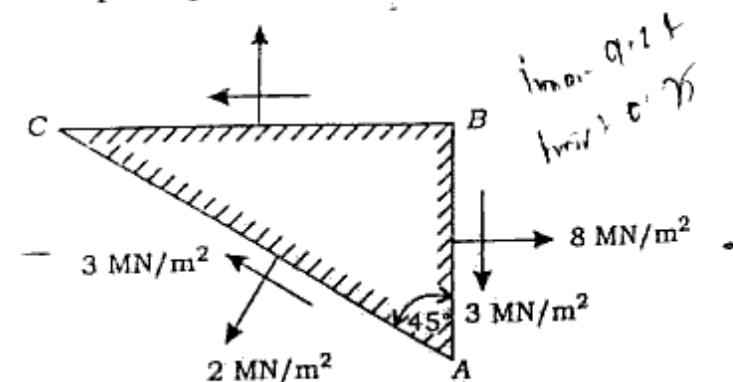


Fig. 3

8. (a) Write the limits of eccentricity in the following cases : 11
- (i) Rectangular section
  - (ii) Circular section
- (b) An 800 mm long shaft carries a flywheel weighing 4 kN at its midway. The shaft transmits 24 kW at a speed of 240 r.p.m. Determine the diameter of the shaft if the shear stress is not to exceed 20 MPa. 8
9. (a) State and prove the Castigliano's theorems. 7
- (b) Using energy method, find the vertical deflection and slope at the free end of a cantilever beam of span  $l$  subjected to uniformly distributed load  $w$  throughout the beam. 7
10. Write short notes on any *four* of the following : 14
- (a) Generalised Hooke's law
  - (b) Thermal stresses
  - (c) Singularity functions
  - (d) Elastic strain energy
  - (e) Strength of a section

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