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S.E. (Mechanical) Semester- IV (Revised Course 2007-08)
 EXAMINATION NOV/DEC 2019
 Mechanics of Solids

[Duration : Three Hours]

[Total Marks : 100]

Instructions:

- 1) Answer **any five** questions with atleast **one** question from each module.
- 2) Assume missing dimensions/data, **if any**
- 3) All dimensions in the figures are in **mm** unless otherwise indicated therein.

MODULE I

- 1 a) The composite bar shown in Fig.1 is rigidly fixed at the ends A and B. Determine the (10) reaction developed at the ends when the temperature is raised by 18°C . Given $E_{Al} = 70 \text{ GPa}$, $E_S = 200 \text{ GPa}$, $\alpha_{Al} = 11 \times 10^{-6}/^\circ\text{C}$ and $\alpha_S = 12 \times 10^{-6}/^\circ\text{C}$

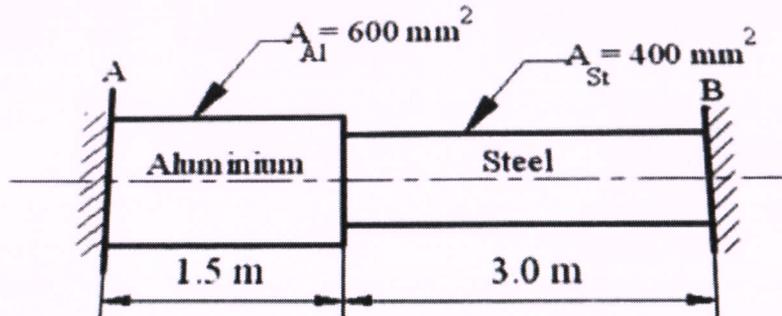


Fig.1

- b) At a point on the surface of a shaft the stresses are $\sigma_x = -50 \text{ MPa}$, $\sigma_y = 10 \text{ MPa}$, and (10) $\tau_{xy} = -40 \text{ MPa}$, as shown in Fig.2. Using Mohr's circle, determine the following quantities: (1) the stresses acting on an element inclined at an angle = 45° , (2) the principal stresses, and (3) the maximum shear stresses.

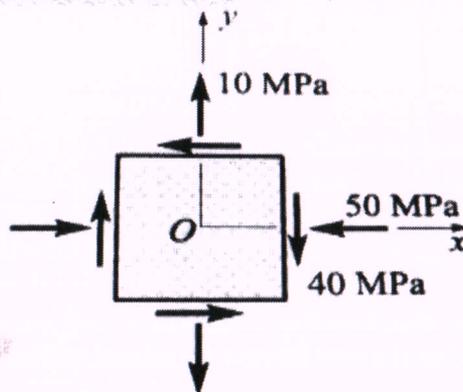


Figure-2

- 2 a) Two brass rods and one steel rod together support a load as shown in Fig.3 . If the (10) stresses in brass and steel are not to exceed 60 N/mm^2 and 120 N/mm^2 respectively, find the safe load that can be supported. Take E for steel = $2 \times 10^5 \text{ N/mm}^2$ and for brass = $1 \times 10^5 \text{ N/mm}^2$. The cross-sectional area of steel rod is 1500 mm^2 and of each brass rod is 1000 mm^2 .

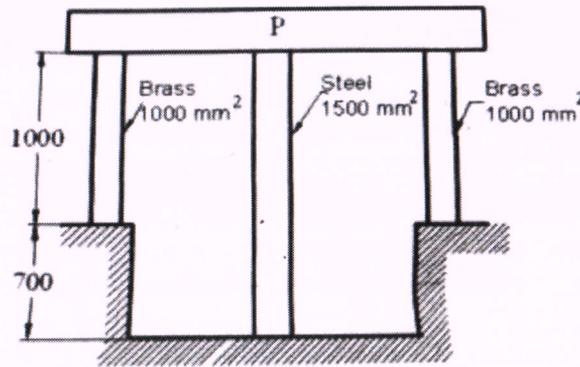


Fig. 3

- b) A round bar 40 mm diameter is subjected to an axial pull of 80 kN and reduction in (10) diameter was found to be 0.00775 mm. Find the Poisson's ratio and Young's modulus for the material of the bar. Take value of shear modulus as 40 GPa.

MODULE II

- 3 a) A simply supported beam, 6m long is loaded with uniformly distributed load of 50 kN/m (10) over the entire span. Draw the shear force and bending moment diagram for the loaded beam. At a section 1.2 m from its left end, find shear force and bending moment magnitudes to be resisted. Also determine the magnitudes of maximum shear stress and maximum bending stress induced in the beam section. The cross-section of the beam is shown in Fig.4

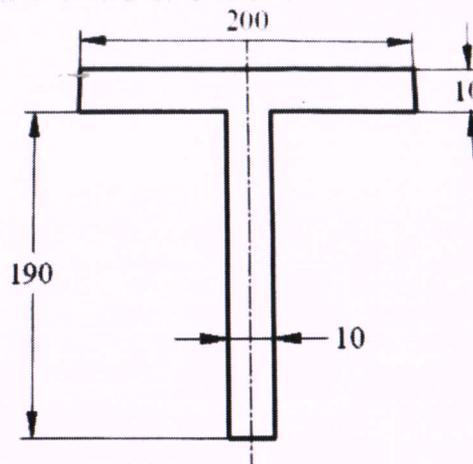


Fig. 4

- b) For the angle section shown in Fig. 5 determine the orientations of the principal (10) centroidal axes and the magnitudes of the principal centroidal moments of inertia.

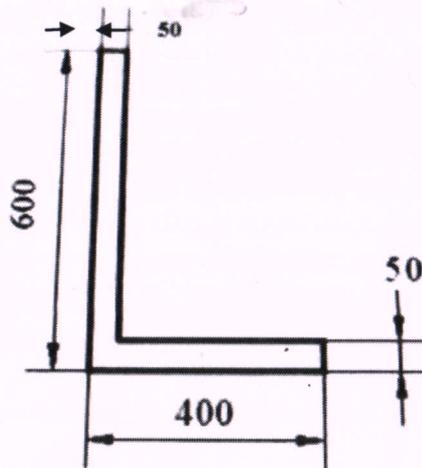


Fig. 5

- 4 a) Draw the shear force and bending moment diagram for the overhanging beam loaded as (10) shown in Fig. 6 and also locate the point of contra-flexure.

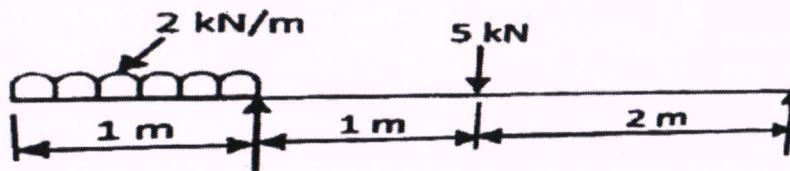


Fig. 6

- b) An I-section beam has flanges 100 mm wide and 12 mm thickness, a web of 120 mm (10) height and 10 mm thickness. At a section along the length, it is subjected to bending moment of 15 kN-m and shear force of 10kN. Find the maximum bending stress and maximum shear stress at that section. Draw the shear stress distribution diagram.

MODULE III

- 5 a) For a tubular strut 2.25 m long having outside diameter and inside diameter as 37.5 mm (10) and 32.5 mm respectively, loaded through pin joint at both ends; compare the crippling loads given by Rankine's and Euler's formula. Take Rankine's constant, $a = 1/7500$, Modulus of elasticity, $E=200$ GPa and Yield stress = 315 MPa
- b) An offset link is loaded as shown in Fig.7 . Determine the cross-sectional dimensions of (10) the link, where $b = 4t$ and the maximum normal stress is to be limited to 100 MPa.

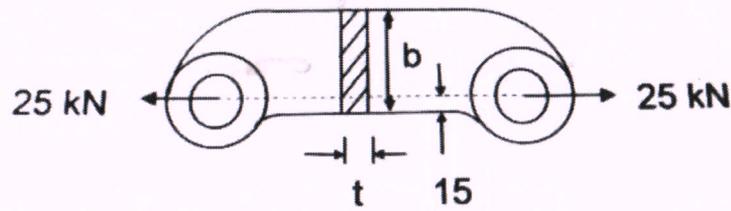


Fig. 7

- 6 a) A hollow shaft of 55 mm external diameter and 35 mm internal diameter is subjected to a (10) torque of 2.5 kN-m to produce an angular twist of 0.6° measured over a length of 0.3 m of the shaft. Calculate the value of modulus of rigidity, G . Also, calculate the maximum power which could be transmitted by the shaft at 2000 rpm, if the maximum allowable shearing stress is 70 N/mm^2 .
- b) Derive the relations for equivalent bending moment and equivalent torque for a shaft (10) subjected to a bending moment M and a simultaneous torque T .

MODULE IV

- 7 a) Determine the deflection at the free end of a cantilever beam of span L , subjected to a (10) point load, P and applied moment, M at the free end using energy principles.
- b) A thick cylindrical with inside radius 150 mm and thickness 50 mm is subjected to an (10) internal fluid pressure of 17.5 MPa. Determine the maximum hoop stress in the cylinder cross section. Show the variation of the radial and hoop stress across the cylinder wall.
- 8 a) A cylinder vessel 3 m long and 500 mm in diameter with 10 mm thick shell plate is (10) subjected to an internal pressure of 3 MPa. Calculate the change in the volume of the shell if the modulus of elasticity and Poisson's ratio for the cylinder material is 200 GPa and 0.3 respectively. (10)
- b) State and derive Castigliano's Second Theorem.