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Seat No.	

[4162]-119

S.E. (Mechanical) EXAMINATION, 2012

(Common to Mech. S/W Sem. I and Mech. Branch Sem. II)

STRENGTH OF MACHINE ELEMENTS

(2008 PATTERN)

Time : Three Hours **Maximum Marks : 100**

N.B. **:—** (*i*) Answer *three* questions from Section I and *three* questions from Section II.

(*ii*) Answers to the two Sections should be written in separate answer-books.

(*iii*) Neat diagrams must be drawn wherever necessary.

(*iv*) Figures to the right indicate full marks.

(*v*) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam table is allowed.

(*vi*) Assume suitable data, if necessary.

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SECTION I

UNIT I

1. (*a*) A uniform rod of cross-sectional area 'A', length 'L' is held vertically and fixed at top. Derive expression for strain energy due to self-weight. Assume Young's modulus of elasticity 'E' and mass density 'ρ'. [6]

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(b) In a tensile test on steel tube of external diameter 18 mm and internal diameter 12 mm, an axial pull of 2 kN produces stretch of 6.72×10^{-3} mm in a length of 100 mm and lateral contraction of 3.62×10^{-4} mm in a outer diameter. Calculate the values of three Modulii and Poisson's ratio of material. [6]

(c) A three bar assembly shown in Fig. 1 supports vertical load 'P'. Bars AB and BD are identical, each of length 'L' and cross-sectional area 'A_1'. Vertical rod BC is also of length 'L' but having area 'A_2'. All bars are having same modulus of elasticity 'E' and pinned at A, B, C and D. Determine axial force in each rod. [6]

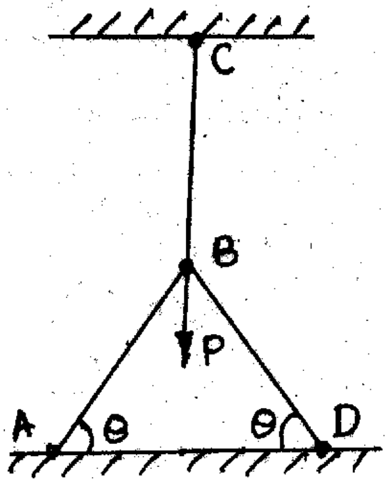

Fig. 1

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Or

2. (*a*) A vertical steel bar ABC is pin supported at its upper end as shown in Fig. 2 and loaded by 10 kN force at its lower end. A horizontal beam BDE is pinned to vertical bar at point 'B' and supported at point 'D'. Beam carries load of 25 kN at end 'E'. 'AB' is having length 500 mm and c/s area 160 mm^2. BC has length 750 mm and c/s area 100 mm^2. Modulus of elasticity E is 200 GPa. Calculate vertical displacement of point 'C' neglecting weight of bar and beam. [6]

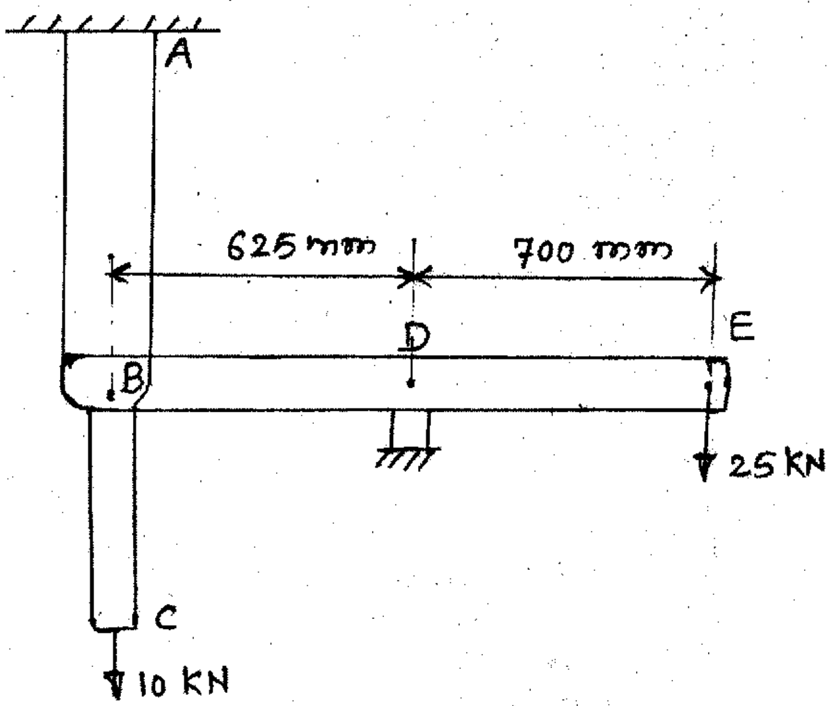

Fig. 2

(*b*) A hollow steel tube of 75 mm diameter and 2.5 mm thickness encloses centrally a solid copper bar of 40 mm diameter. The bar and tube are rigidly connected together at ends at 25°C. Find stresses in each metal when heated to 165°C. Also find increase in length if original length of assembly is 325 mm. Take :

$\alpha_s = 1.08 \times 10^{-5}$ per °C

$E_s = 200$ GPa

$\alpha_c = 1.7 \times 10^{-5}$ per °C

$E_c = 100$ GPa. [6]

(*c*) A composite bar is subjected to forces as shown in Fig. 3. Small end diameter of tapering bar and big end diameter are 12.5 mm and 40 mm respectively. Determine magnitude of force P such that net deformation in the bar does not exceed 1.5 mm. Take :

$E_{steel} = 200$ GPa, $E_{Al} = 70$ GPa. [6]

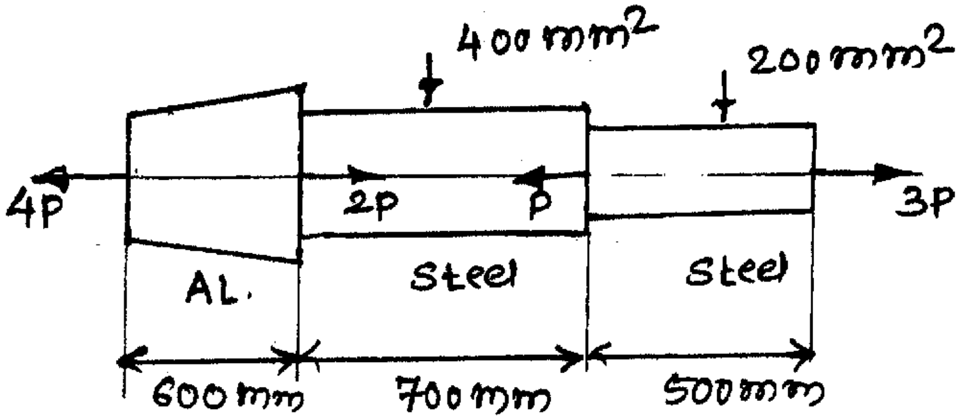

Fig. 3

UNIT II

3. (*a*) The overhanging beam is loaded as shown in Fig. 4. Draw shear force and bending moment diagram. Indicate all important points on diagram and find point of contraflexture if any. [8]

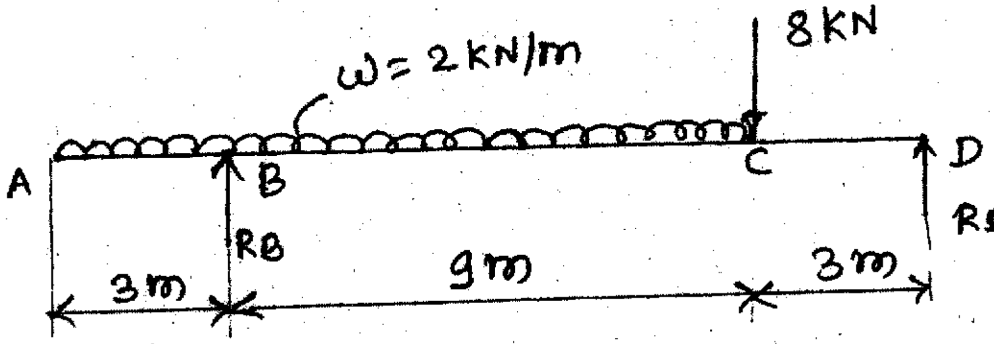

Fig. 4

(*b*) Determine slope at point 'C' and deflection at points 'C' and 'D' for the beam as shown in Fig. 5. Take EI = 4 × 10^4 kN-m^2. [8]

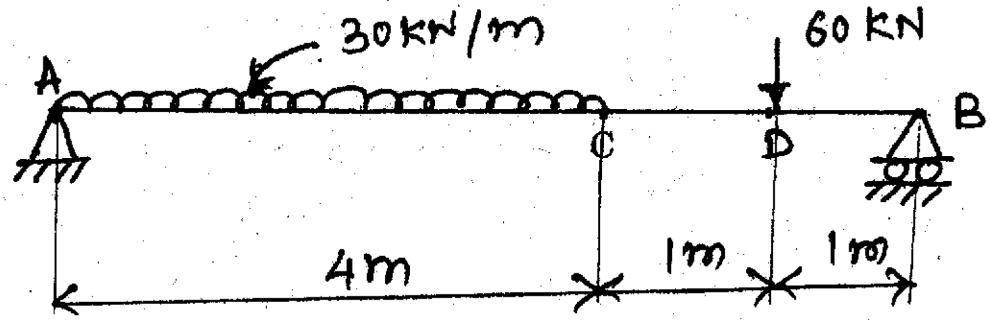

Fig. 5

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Or

4. (*a*) Derive expression for slope and deflection at free end of cantilever beam of length 'L', carrying UVl as shown in Fig. 6. [6]

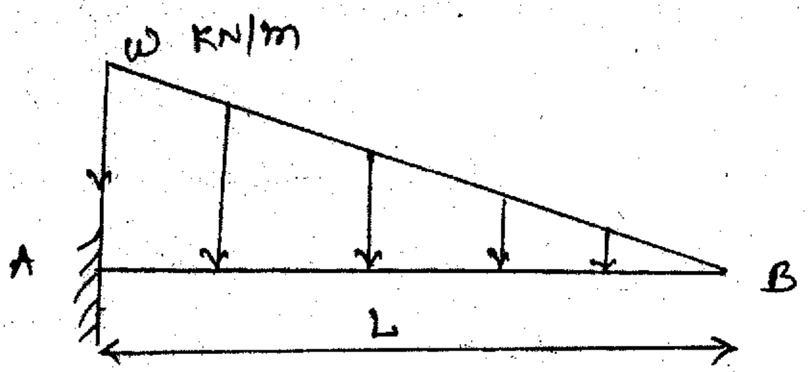

Fig. 6

(*b*) Shear force diagram for beam is as shown in Fig. 7. Identify location and nature of support. Draw loading and bending moment diagram indicating all important points. Also indicate point of contraflexure if any. [10]

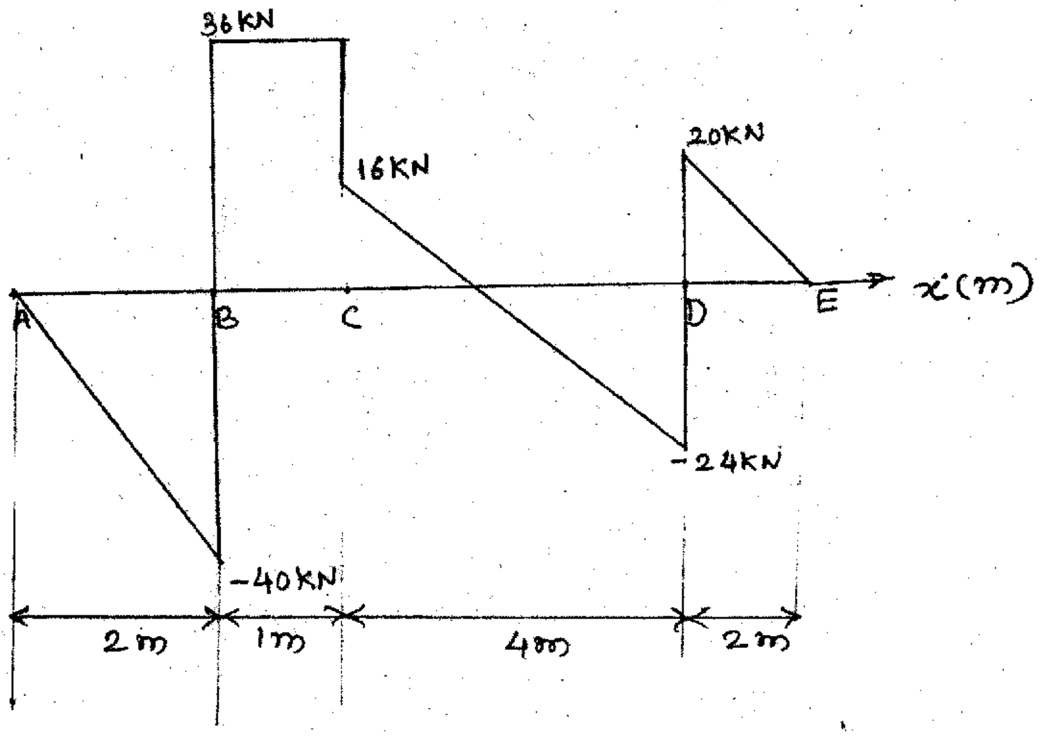

Fig. 7

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UNIT III

5. (*a*) An element in plane stress is subjected to stresses as shown in Fig. 8. Determine principal stresses and show them on sketch of properly oriented element. Determine maximum shear stress and show them on properly oriented element. [8]

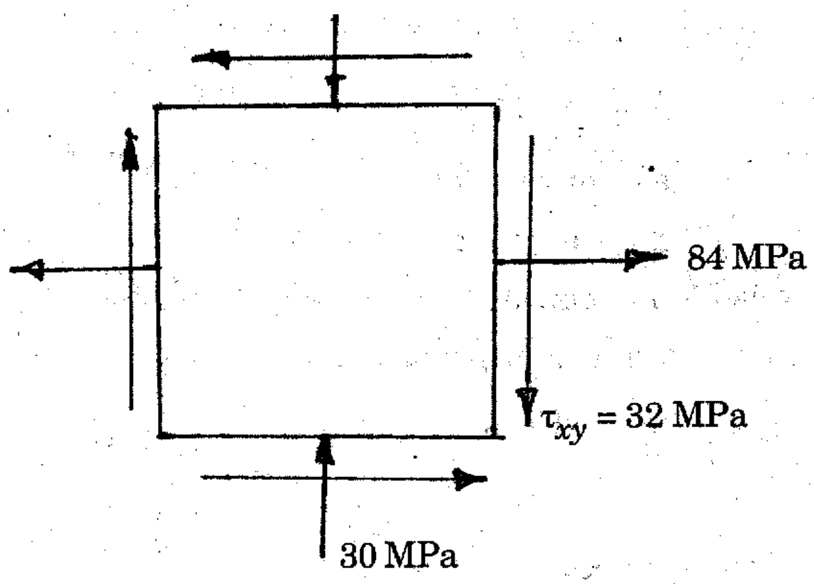

Fig. 8

(*b*) Stresses induced at critical point in a m/c component made of steel are as follows :

$$\sigma_x = 120 \text{ MPa}$$

$$\sigma_y = -40 \text{ N/mm}^2$$

$$\tau_{xy} = 80 \text{ N/mm}^2.$$

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Calculate factor of safety by :

(1) Max. Shear stress theory

(2) Max. Normal stress theory

(3) Max. Distortion energy theory.

Take S_{yt} = 380 N/mm^2. [8]

Or

6. (*a*) At a point in strained material, stress pattern is as shown in Fig. 9 by using Mohr's circle, determine :

(1) Normal and shear stresses on plane AC as shown in figure.

(2) Magnitude and nature of principal stresses.

(3) Orientation of principal planes.

(4) Max. shear stress. [8]

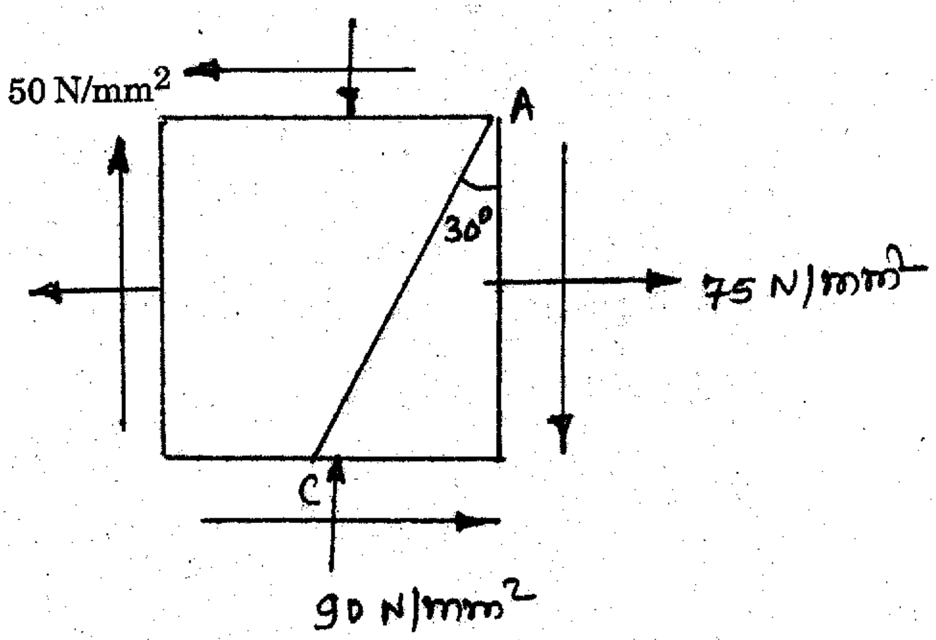

Fig. 9

(*b*) Explain Maximum strain energy theory and Maximum distortion energy theory. [6]

(*c*) Define principal plane and principal stress. [2]

SECTION II

UNIT IV

7\. (*a*) Derive the expression for shear stress induced at a distance 'Y' from neutral axis in the cross-section of a beam subjected to shear force. [6]

(*b*) A simply supported beam with overhang is loaded with point load as shown in Fig. 10. The cross-section of beam is I-section. The allowable bending stresses in tension and compression are σ_t = 150 MPa and σ_c = 100 MPa. Find the safe load '*w*' on the overhang. [10]

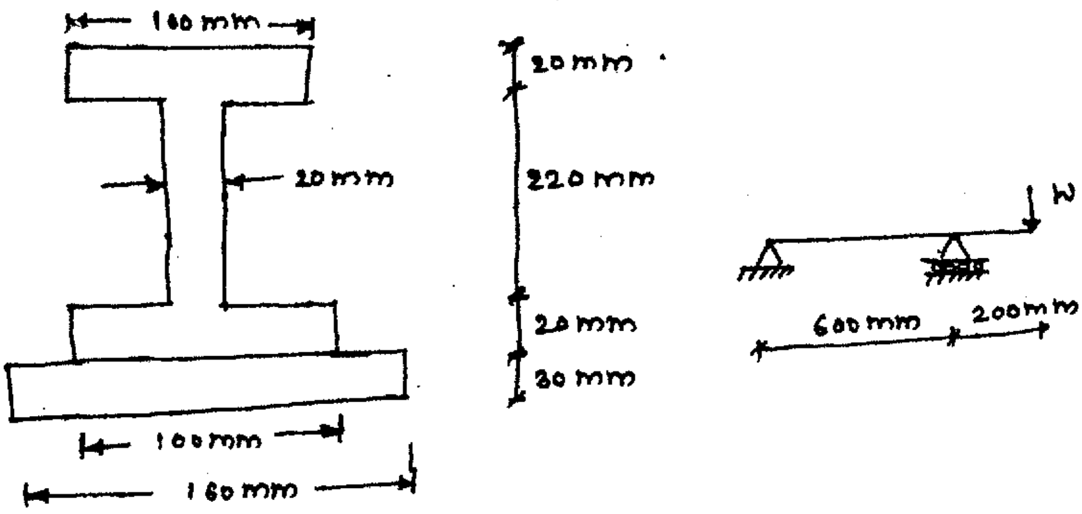

Fig. 10

Or

8. (*a*) A simply supported beam carries an udl of 25 kN/m over the entire span. The cross-section of the beam is as shown in Fig. 11. If the maximum bending stress is 60 MPa, find the span of the beam. Also find the maximum shear stress developed in the section. Draw the shear stress distribution diagram. [8]

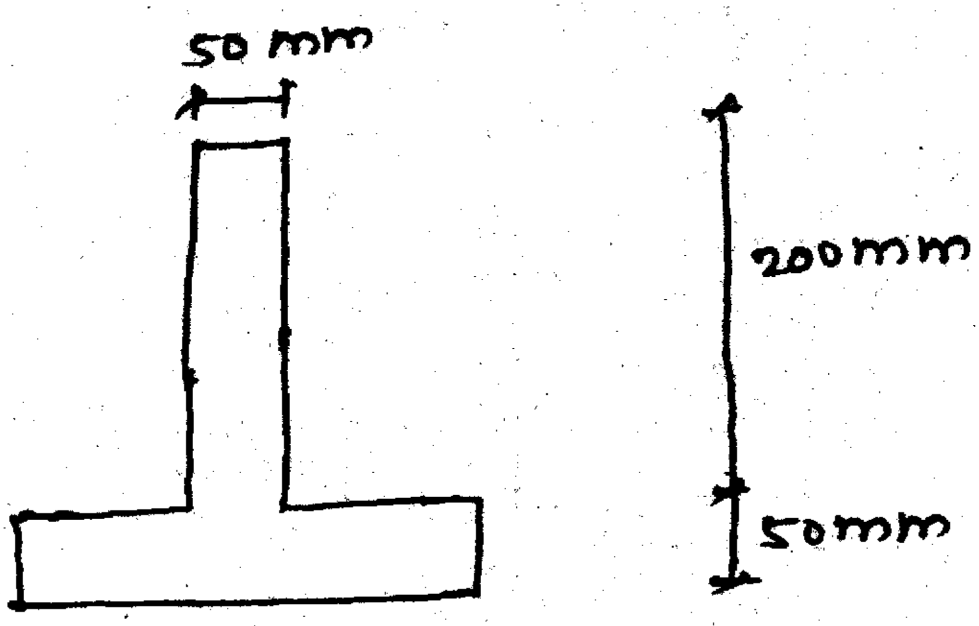

Fig. 11

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(*b*) The cross-section of beam is as shown in Fig. 12. Determine maximum tensile and compressive stresses when the beam is subjected to udl of 2 kN/m and length of span is 3 m for :

(*i*) cantilever

(*ii*) simply supported.

The beam resists bending moment about neutral horizontal axis. [8]

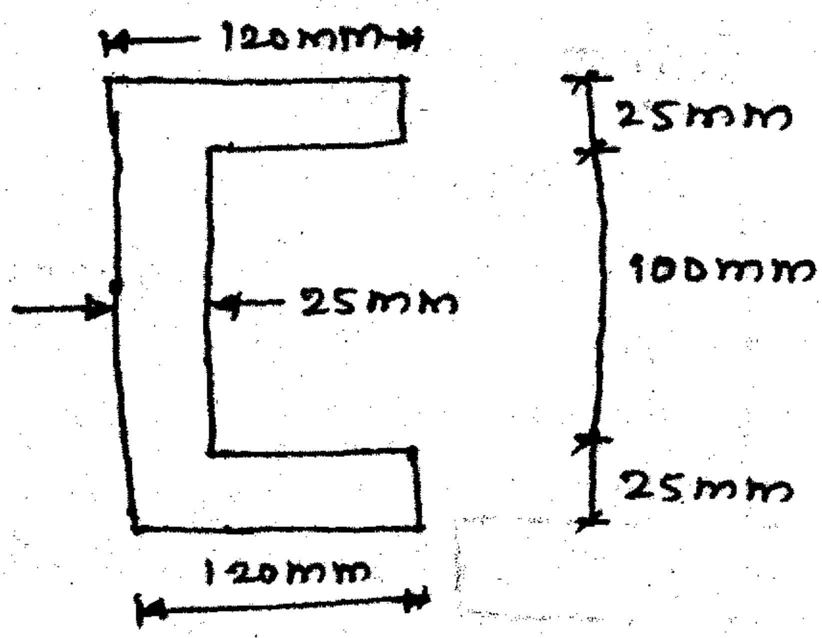

Fig. 12

UNIT V

9. (*a*) Bar ABC fixed at both ends consist of solid circular portion AB and hollow circular portion BC as shown in Fig. 13. Derive (*a*/L) ratio for which reactive torque at A and C are of equal magnitude. [4]

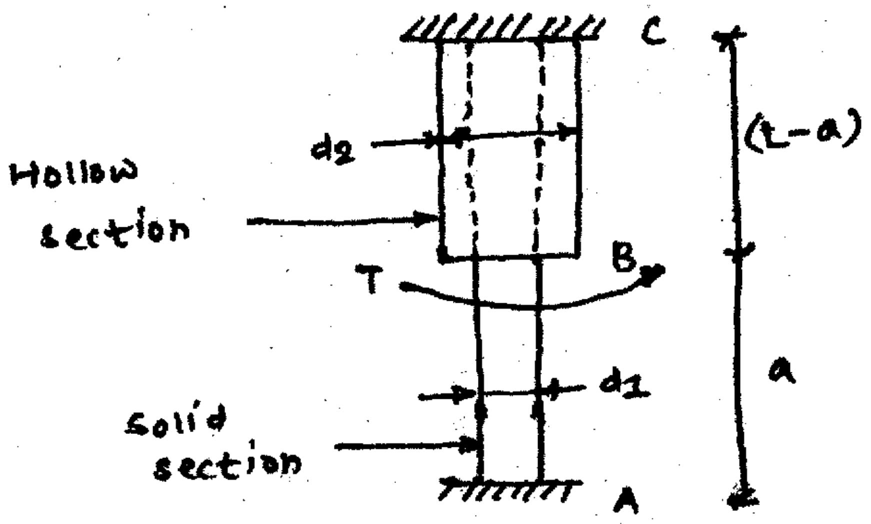

Fig. 13

(*b*) A composite shaft consists of a steel rod of 60 mm diameter surrounded by a closely fitting tube of brass. Find the outside diameter of the brass tube, when a torque of 1 kN-m is applied on the composite shaft and shared equally by the two material. Take G_{st} = 84 GPa and G_{br} = 42 GPa.

Also determine the common angle of twist in a length of 4 m. [6]

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(*c*) Derive Euler's formulae for buckling load for column with hinged ends. [6]

Or

10. (*a*) A solid steel shaft is subjected to a torque of 45 kN-m. If the angle of twist is 0.5° per meter length of shaft and shear stress is not to exceed 90 N/mm^2, find :

(*i*) Suitable diameter of shaft.

(*ii*) Final maximum shear stress and angle of twist for the diameter of shaft selected.

(*iii*) Maximum shear strain in shaft.

Take modulus of rigidity as 80 GPa. [8]

(*b*) Compare the crippling load given by Euler's and Rankine's formula for a tabular steel strut 2.3 m long having external diameter is 38 mm and internal diameter is 33 mm. Strut is fixed at one end and hinged at other end. Take σ_c = 335 MPa, E = 205 GPa, a = 1/7500. [8]

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UNIT VI

11. (*a*) Explain the term 'product life cycle'. [4]

(*b*) Explain various steps in the process of designing a machine component. [6]

(*c*) A bracket shown in Fig. 14 is subjected to a pull of 5 kN acting at an angle of 45° to vertical. The bracket has a rectangular section whose depth is two times its thickness. If the permissible tensile stress is 55 N/mm^2, determine the cross-section of the bracket. [8]

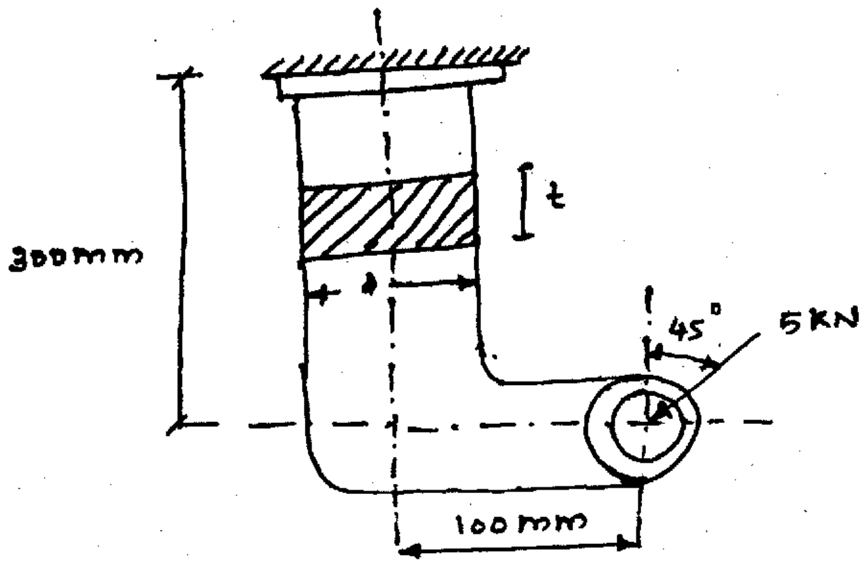

Fig. 14

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Or

12. (*a*) Design a cotter joint to transmit a load of 90 kN in tension or compression. Assume the following stresses for socket, spigot and cotter. Assume thickness of cotter is 40% of rod diameter :

Allowable tensile stress = 90 MPa

Allowable crushing stress = 120 MPa

Allowable shear stress = 60 MPa. [10]

(*b*) Explain the term design synthesis. [4]

(*c*) Explain briefly the consideration of energy requirement. [4]

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