USN

06ME34

Third Semester B.E. Degree Examination, Dec 08 / Jan 09
Mechanics of Materials

Time: 3 hrs.

Max. Marks:100

Note : ***Answer any FIVE full questions, selecting at least TWO from each part.***

PART – A

1 a. Define i) Poisson's Ratio ii) Bulk modulus iii) Factor of safety. **(03 Marks)**

b. Derive an expression for total deformation of a tapering rectangular bar of cross – section b_1 and b_2, when it is subjected to an axial force 'P'. **(07 Marks)**

c. A round bar with stepped portion is subjected to the forces as shown in fig.1(c). Determine magnitude of force P, such that net deformation in the bar does not exceed 1mm. E for steel is 200 GPa and that for Aluminium is 70 GPa. Big end diameter and small end diameter of the tapering bar are 40mm and 12.5mm respectively. **(10 Marks)**

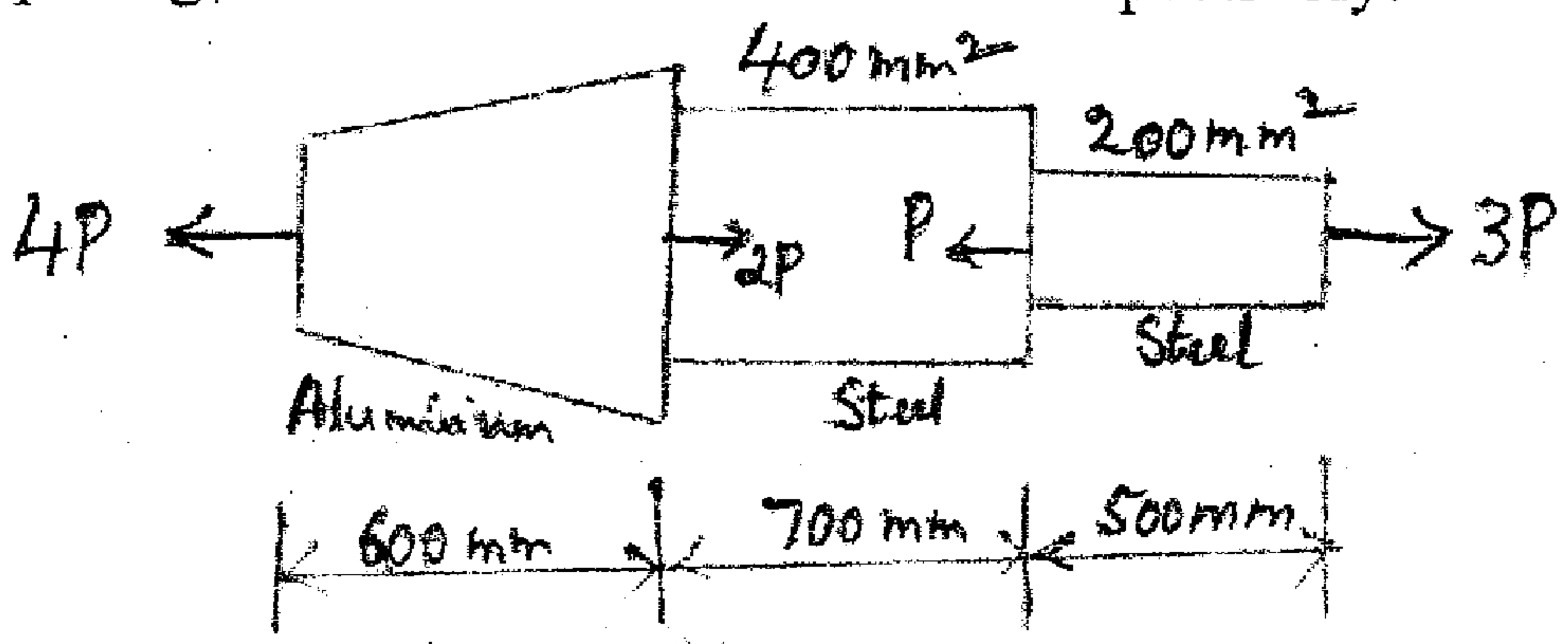


Fig.1(c)

2 a. Derive an expression for relationship between Young's modulus, modulus of Rigidity and Poisson's ratio. **(10 Marks)**

b. A compound bar is made of a central steel plate 60mm wide and 10mm thick to which copper plates 40mm wide and 5mm thick are connected rigidly on each side. The length of the bar at normal temperature is 1 meter. If the temperature is raised by 80^0C, determine the stresses in each metal and change in length. Take $E_s = 200$ GN/m^2 ; $E_c = 100$ GN/m^2 ; $\alpha_s = 12\times 10^{-6}/^0C$; $\alpha_c = 17\times 10^{-6}/^0C$. **(10 Marks)**

3 a. Define Principal Stresses and Principal Planes. **(03 Marks)**

b. Prove that the sum of normal stresses on any two mutually perpendicular planes is a constant in a general two dimensional stress system. **(07 Marks)**

c. A plane element is subjected to stresses as shown in fig.3(c). Determine principal stresses, maximum shear stress and their planes. Sketch the planes determined. **(10 Marks)**

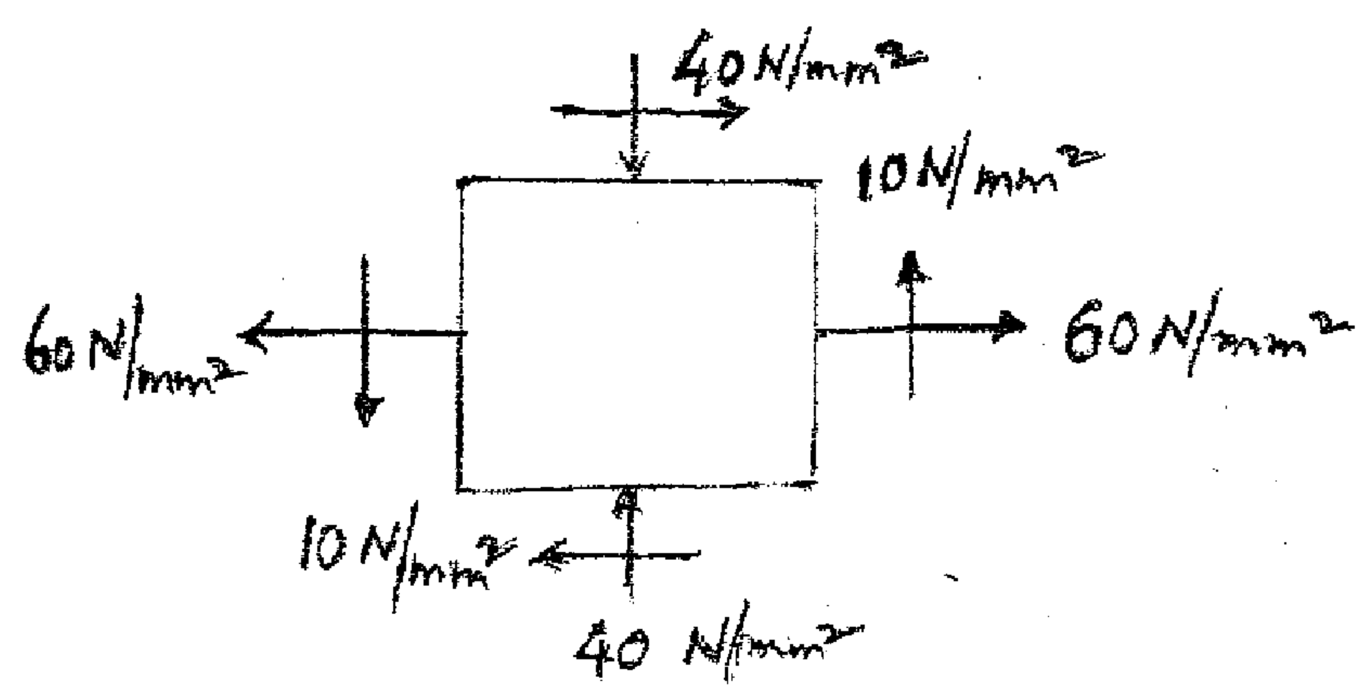


Fig.3(c)

4 a. Briefly discuss the stresses developed and their distribution along the thickness of the walls of pressure vessels. **(04 Marks)**

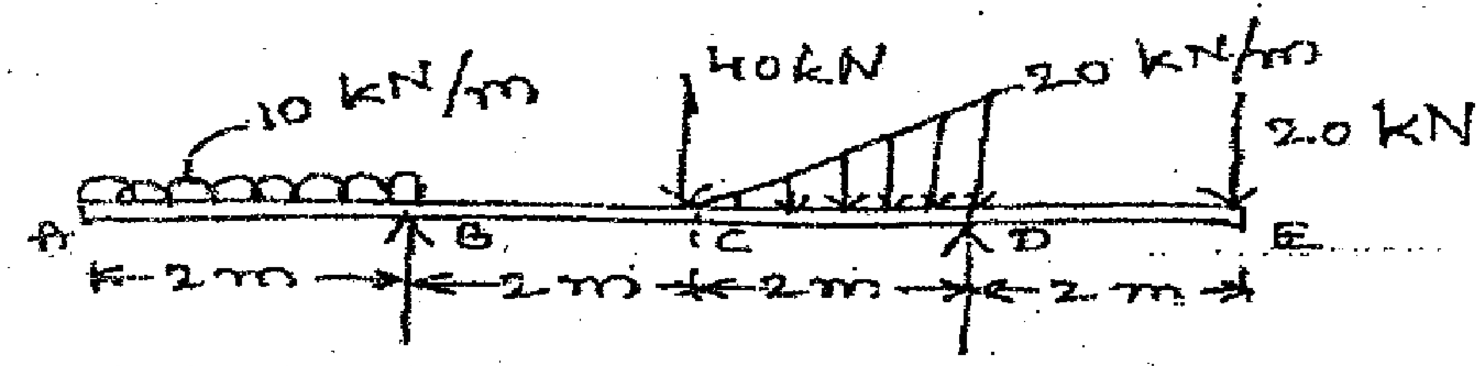
b. A thin cylinder of diameter 'd', thickness 't' is subjected to an internal pressure of 'p'. Prove that the change in volume, $dV = \frac{Pd}{4tE}(5-4\mu)V$, where, E = Young's modulus of elasticity, μ = Poisson's ratio and V = volume of the pressure vessel. **(08 Marks)**

c. A thick cylinder of internal diameter 160 mm is subjected to an internal pressure of 40 N/mm^2. If the allowable stress in the material is 120 N/mm^2, find the required wall thickness of the cylinder. **(08 Marks)**

PART – B

5 Draw the shear force and bending moment diagrams for a overhanging beam shown in Fig.5 and locate the points of contra flexure. **(20 Marks)**

Fig.5.

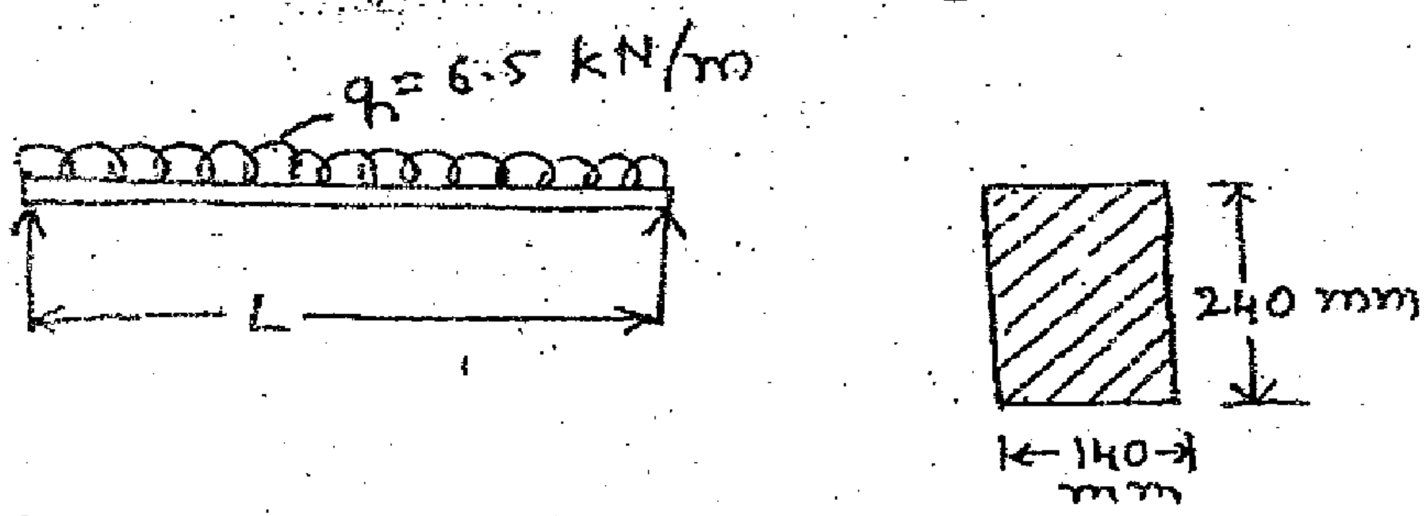


6 a. State the assumptions made in developing the theory of simple bending. **(04 Marks)**

b. Derive an expression for the bending stress and the radius of curvature for a straight beam subjected to pure bending. **(08 Marks)**

c. Determine the maximum allowable span length 'L' for a simple beam as shown in Fig.6(c). The beam is of rectangular cross section (140 mm x 240 mm) subjected to a uniformly distributed load q = 6.5 kN/m and the allowable bending stress is 8.2 MPa. **(08 Marks)**

Fig.6(b).



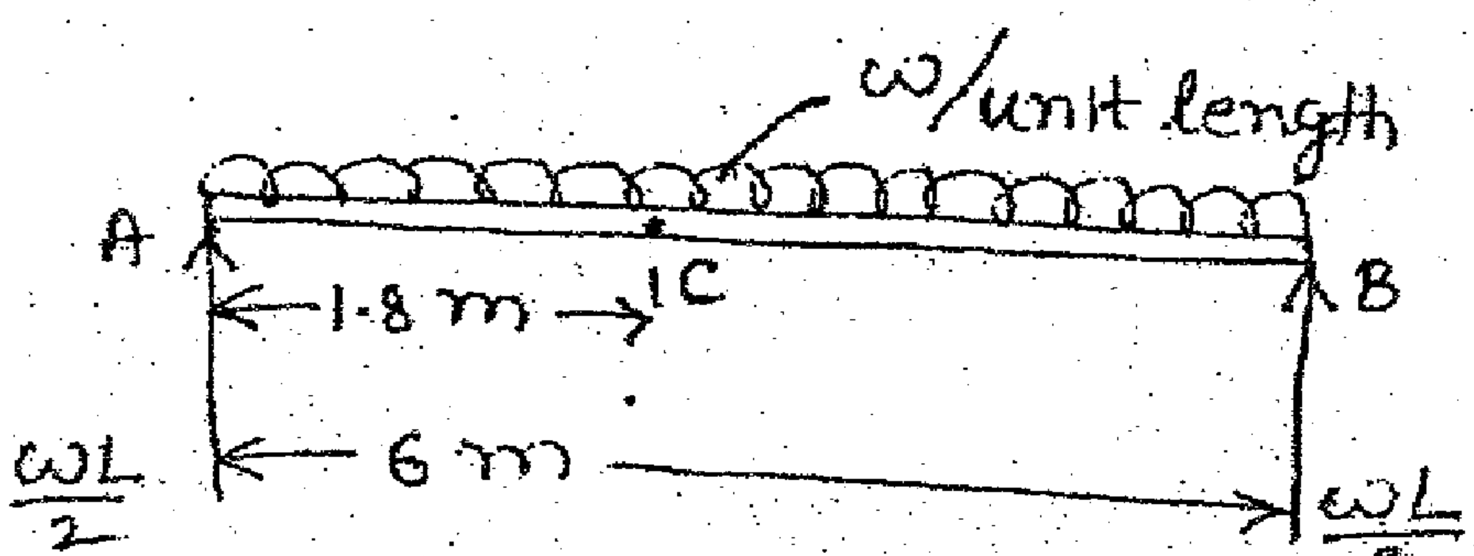
7 a. Derive an expression with usual notations for the maximum deflection in a beam subjected to point load at the mid span. **(08 Marks)**

b. A steel girder of 6m length acting as a beam carries a uniformly distributed load w N/m run throughout it's length, as shown in Fig.7(b). If I = 30 x 10^{-6} m^4 and depth 270 mm, calculate:

i) Magnitude of 'w' so that the maximum stress developed in the beam section does not exceed 72 MN/m^2.

ii) The slope and deflection in the beam at a distance of 1.8 m from one end. Take E = 200 GN/m^2. **(12 Marks)**

Fig.7(b).



8 a. A hollow steel shaft 3m long must transmit a torque of 25 kN-m. The total angle of twist in this length is not to exceed 2.5^0 and allowable shearing stress is 90 MPa. Determine inside and outside diameter of the shaft if G = 85 GPa. **(10 Marks)**

b. Find the Euler's crippling load for a hollow cylindrical steel column of 38 mm external diameter and 2.5 mm thick. Take length of the column as 2.3 m and hinged at it's both ends. Take E = 2.05 x 10^5 N/mm^2. Also, determine the crippling load by Rankin's formula using constants as 335 N/mm^2 and $\frac{1}{7500}$. **(10 Marks)**

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