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06ME34

Third Semester B.E. Degree Examination, December 2011
Mechanics of Materials

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define: i) Hooke's law ii) Poisson's ratio iii) Elastic limit iv) Modulus of rigidity **(04 Marks)**

b. Derive an expression for the extension of a member subjected to a tensile load P. The length of the member being L and its Young's modulus is E. **(04 Marks)**

c. A member ABCD is subjected to point loads P_1, P_2, P_3 and P_4 as shown in Fig.Q1(c). Calculate the force P_2 necessary for equilibrium, if $P_1 = 45$ kN, $P_3 = 450$ kN and $P_4 = 130$ kN Determine the total elongation of the member, assuming the modulus of elasticity to be 2.1×10^5 N/mm^2. **(12 Marks)**

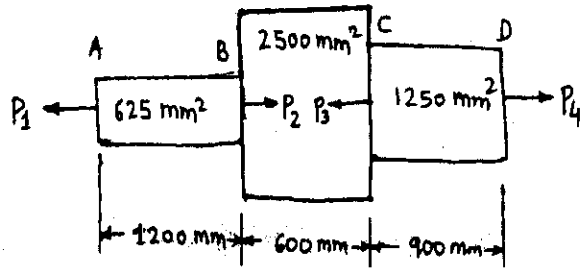

Fig.Q1(c)

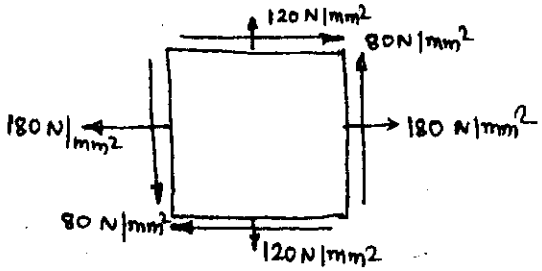

Fig.Q3(c)

2 a. Define: i) Volumetric strain ii) Bulk modulus. **(02 Marks)**

b. Establish the relationship between Young's modulus (E), modulus of rigidity (G) and Poisson's ratio (γ). **(08 Marks)**

c. A steel rail is 12.6m long and is laid at a temperature of 24°C. The maximum temperature expected is 44°C.

i) Estimate the minimum gap between two rails to be left so that temperature stresses do not develop.

ii) Calculate the thermal stresses developed in the rails if a gap of 2mm is provided for expansion.

iii) If the stress developed is 20 MN/m^2 , what is the gap left between the rails?

Take $E = 2\times10^5$ MN/m^2 and $\alpha = 12\times10^{-6}$/°C. **(10 Marks)**

3 a. Define: i) Principal stresses ii) Principal planes. **(04 Marks)**

b. In a general two dimensional stress system, show that sum of normal stresses in any two mutually perpendicular directions is constant. **(06 Marks)**

c. The state of stress at a point in a strained material is as shown in Fig.Q3(c). Determine i) The direction of principal planes ii) The magnitude of principal stresses iii) The magnitude of maximum shear stress & its direction. Indicate all the above planes by a sketch. **(10 Marks)**

4 a. A cylindrical shell is 3m long and is having 1m internal diameter and 15mm thickness. Calculate the maximum intensity of shear stress induced and also the changes in dimensions of the shell, if it is subjected to an internal fluid pressure of 1.5 N/mm^2.

Take $E = 2\times10^5$ N/mm^2 and $\gamma = 0.3$. **(10 Marks)**

b. A pipe of 400mm internal diameter and 100mm thickness contains a fluid at a pressure of 80 N/mm^2. Find the maximum and minimum hoop stress across the section. Also sketch the radial and hoop stress distribution across the section. **(10 Marks)**

PART – B

5 a. Classify beams (based on type of supports) and loads and sketch them. **(06 Marks)**

b. Draw the shear force and bending moment diagrams for the beam shown in Fig.Q5(b).

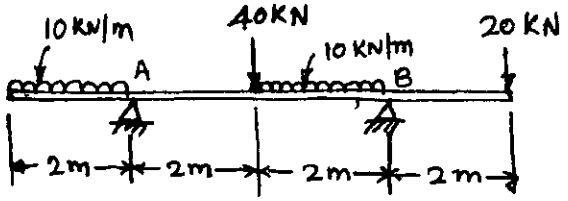

Fig.Q5(b) **(14 Marks)**

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

b. Derive an expression for the relationship between bending stress and radius of curvature of a beam. **(06 Marks)**

c. A cast iron beam has an I section with a top flange 80mm×40mm, web 120mm×20mm and bottom flange 160mm×40mm. If the tensile stress is not to exceed 30N/mm^2 and compressive stress 90 N/mm^2, what is the maximum uniformly distributed load the beam carry over a simply supported span of 6m, if the large flange is in tension. **(10 Marks)**

7 a. Derive an expression for the maximum deflection of a cantilever beam carrying a point load at its free end. **(08 Marks)**

b. Find the maximum deflection and the maximum slope for the beam loaded as shown in Fig.Q7(b). Take flexural rigidity EI = 15×10^9 kN.mm^2. **(12 Marks)**

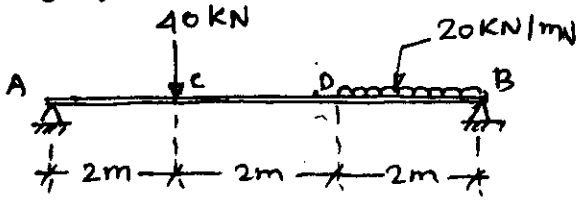

Fig.Q7(b)

8 a. State the assumptions made in the theory of pure torsion. **(04 Marks)**

b. Determine the diameter of a solid shaft which will transmit 440 kW at 280 rpm. The angle of twist must not exceed one degree per meter length and the maximum torsional stress is to be limited to 40 N/mm^2. Assume G = 84 kN/mm^2. **(08 Marks)**

c. A 2m long pin ended column of square cross section is to be made of wood. Assuming E = 12 GPa and the allowable stress being limited to 12 MPa, determine the size of the column to support a load of 95 kN. Use a factor of safety 3 and the Euler's crippling load for buckling. **(08 Marks)**

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