3 Hours ***Total Marks: 80***

- ***Question-1 is compulsory.***
- ***Answer any three from remaining five questions.***
- ***Assume any suitable data wherever required but justify the same. Assumptions made should be clearly stated.***
- ***Illustrate answers with sketches wherever required.***

Q1 *Answer any four of the following*

a A round bar of 50 mm diameter and 2.5 m long of a certain material has Young's modulus of 1.1 x 10^5 N/mm^2 and modulus of rigidity of 4.5 x 10^4 N/mm^2. Find the bulk modulus of the bar. ***5***

b A simply supported beam of span 6 m carries a point load of 12 kN at a distance 1 m from left hand support. Draw bending moment and shear force diagrams. ***5***

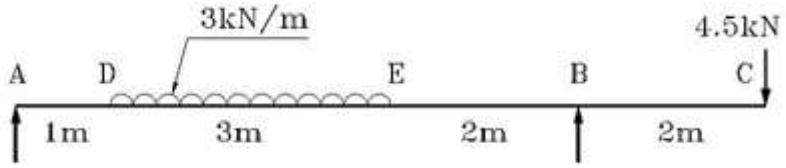
c A cantilever beam of 4 m carries a point load of 10 kN at the free end. If EI is constant, then find the maximum slope and maximum deflection. ***5***

d State the assumptions made in the theory of pure bending and derive the formula, ***5***

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

e Calculate the diameter of vessel having thickness 12.5 mm which can withstand 100 N/mm^2 stress at a pressure of 2.5 N/mm^2. ***5***

Q2a Draw shear force and bending moment diagrams for the beam loaded as shown below. Mark all important points. ***10***



b Calculate strain energy due to bending for a simply supported beam having span 5 m and a point load of 10 kN at center in terms of EI. ***10***

Q3a A solid circular shaft transmits 30 kW power at 100 RPM. Find the minimum diameter of the shaft to limit shear stress to 80 MPa. What percentage of saving would be made, if this solid shaft were replaced by a hollow one, whose internal diameter to external diameter ratio is 0.6? Keep the same length, material and maximum shear stresses for the shafts. ***10***

b A hollow circular cast iron column with outer diameter 400 mm and inner diameter 340 mm is 6 m long and both ends are fixed. Using Rankine formula and Euler's formula, determine safe axial load the column can carry. ***10***
Take σ_c = 550 MPa, 1/α = 1600, E= 200 GPa. FOS = 4

Q4a A spherical shell of internal diameter 900 mm and thickness 10 mm is subjected to an internal pressure of 1.4 N/mm^2. Determine increase in diameter and increase in volume. E= 200 GPa, μ= 1/3. ***10***

b A steel rail 30 m long is at a temperature of 24˚C. Estimate the elongation when temperature increases to 44˚C. ***10***

1. Calculate the thermal stress in the rail under the following two conditions:
   i. No expansion gap provided
   ii. If 6 mm gap is provided for expansion
2. If the stress developed is 60 MPa, what is the gap left between the rails?

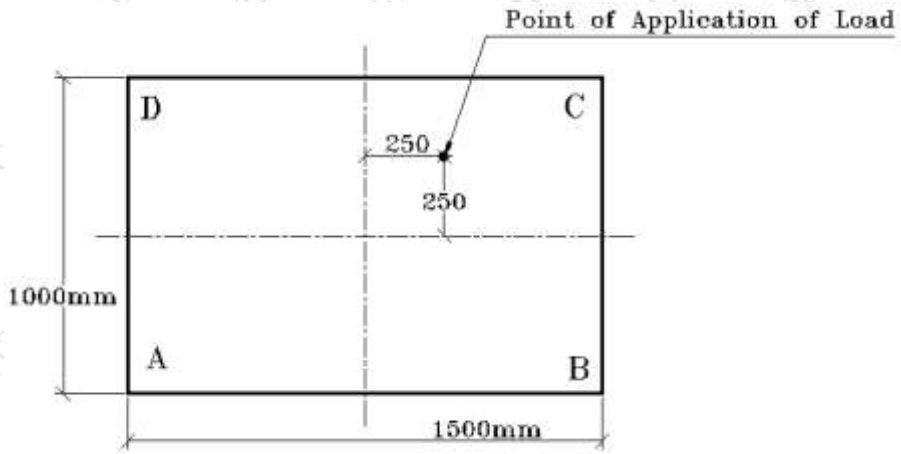
Take E = 200 GPa, $\alpha = 18 \times 10^{-6}$/˚C

Q5a Simply supported beam span 10 m is loaded with uniformly distributed load of intensity 1 kN/m for a length of 5 m from left support and a point load of 6 kN at a distance 2 m from right support. Determine slope at left support and deflection under 6 kN load. E = 200 GPa, $I = 1 \times 10^8$ mm^4 ***10***

b An elemental cube is subjected to tensile stresses of 30 N/mm^2 and 20 N/mm^2 acting on two mutually perpendicular planes and a shear stress of 10 N/mm^2 on these planes. Draw the Mohr's circle of stresses and hence or otherwise determine the magnitudes and directions of principal stresses and also the greatest shear stress. Verify the values analytically. ***10***

Q6a The simply supported beam of span *6 m* carries a central point load of *300 kN*. The beam is rectangular cross section having dimensions 60 mm x 100 mm. Calculate maximum bending stress and maximum shear stress to be resisted by the section .Also draw bending stress and shear stress distribution diagrams. ***10***

b A rectangular pier is subjected to a compressive load of 450 kN as shown in the figure. Find the stress intensities at the four corners of the pier. ***10***



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