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.***

I *Answer any four of the following:*

a. What are elastic constants? Explain the relationship among them. ***05***

b. A simply supported beam of 5 m long carries a point load of ***w*** at centre. If the slope at end is not to exceed 1°, determine corresponding deflection at the centre. ***05***

c. Draw shear force and bending moment diagrams for a simply supported beam of span 10 m, which is subjected to a load of 24 kN at center. ***05***

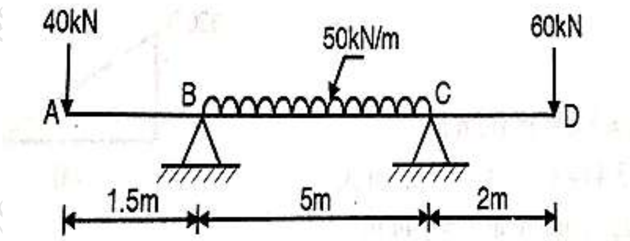
d. State the assumptions made in the theory of pure bending and derive the formula, ***05***

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

e. A short column of external diameter 400 mm and internal diameter 200 mm carries an eccentric load of 90 kN. Find the greatest eccentricity, which the load can have without producing tension on the cross section. ***05***

f Compare the strain energy stored in a bar of 2 m long and 87.4 mm diameter when a load of 60 kN is applied (i) suddenly and (ii) gradually.

IIa. Draw shear force and bending moment diagrams for the beams loaded as shown in figure. ***10***

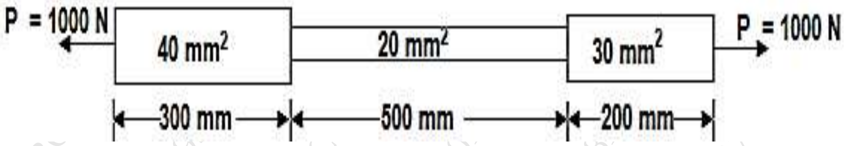


IIb A 1500 mm long wire of 25 mm^2 cross sectional area is hanged vertically. It receives a sliding collar of 100 N weight and a stopper at the bottom end. The collar is allowed to fall on the stopper through 200 mm height. Determine the instantaneous stress induced in the wire and corresponding elongation. Also, determine the strain energy stored in the wire. Take modulus of elasticity of wire as 200 GPa. ***10***

IIIa A simply supported beam, with a span of 1.3 m and a rectangular cross section of 150 mm wide and 250 mm deep, carries a concentrated load of **W** at the centre. If the allowable stresses are 7 N/mm, what is the value of the safe load **W**? Also draw bending stress distribution diagram *10*

IIIb. An elemental cube is subjected to tensile stresses of 30 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. *10*

IVa. A composite rod is 1000 mm long. Its two ends are 40 mm^2 and 30 mm^2 in area and their length are 300 mm and 200 mm, respectively. The middle portion of the rod is 20 mm^2 in area and 500 mm long. If the rod is subjected to an axial tensile load of 1000 N, find its total elongation. Take E = 200 GPa. *10*

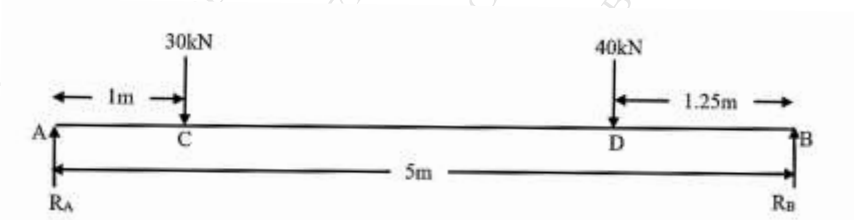


IVb. A cylindrical tank of 750 mm internal diameter, 12 mm thickness and 1.5 m length is completely filled with an oil of specific weight 7.85 kN/m^3 at atmospheric pressure. If the efficiency of longitudinal joints is 75% and that of circumferential joints is 45%, find the pressure head of oil in the tank. Also, calculate the change in volume. Take permissible tensile stress of tank plate as 120 MPa and E = 200 GPa, and $\mu = 0.3$. *10*

Va. Figure shows a simply supported beam of span 5 m carrying two point loads. Find *10*

i. the deflection at the section of the point loads.
ii. Slope at A
iii. maximum deflection of the beam.

Take E=200 GPa, I=7332.9 cm^4.



Vb A cube of 200 mm diameter is subjected to a compressive force of 3.6 MN on each face. Change in volume of the cube is 5000 mm^3. Determine Young's modulus, rigidity modulus and bulk modulus, if Poisson's ratio is 0.3. *10*

VIa. A slender pin ended aluminium column 1.8 m long and of circular cross-section is to have an outside diameter of 50 mm. Calculate the necessary internal diameter to prevent failure by buckling, if the actual load applied is 13.6 kN and the critical load applied is twice the actual load. ***10***

Take $E_a = 70\ GN/m^2$.

VIb. 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***

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