

Con. 3548-10.

AN-2434

(3 Hours)

[Total Marks : 100

- N.B. :** (1) Question No. 1 is **compulsory**. Answer any **four** from the remaining six questions.
 (2) Assume **suitable** data wherever **required**. **Clearly** state the assumptions and justify the **same**.
 (3) Illustrate answers with **sketches**, wherever **required**.
 (4) Write legibly with **blue or black** ink pen. Use pencil only to draw **diagrams** and **graphs**.

1. Answer any four from the following: -

- Find expression for the total elongation of a bar due to its own weight. when the bar is fixed at its upper end and hanging freely at the lower end.
 - Define bulk modulus. Derive an expression for Young's modulus, in terms of bulk modulus and Poisson's Ratio.
 - Draw the shear force and bending moment diagram for a simply supported beam of length l , subtended to a clockwise couple M at the centre of the beam.
 - Calculate the maximum bending stress induced in a cast iron pipe of external diameter 40 mm , internal diameter 20 mm and length 4 m , when the pipe is supported at its ends and carries a point load of 80 N at centre.
 - In a hollow circular shaft, the outer and inner diameters are 200 mm and 100 mm respectively. If the shear stress is not to exceed 40 N/mm^2 , find the maximum torque, which the shaft can safely transmit.
 - What is *equivalent length of a column*? Give the ratio of equivalent length and actual length of columns, with various end conditions. Also, write the expression for crippling load, P for various end conditions.
- 2.a) A beam **AB**, 20 m long supported on two intermediate props 12 m apart, carries a uniformly distributed load of 6 kN/m together with concentrated load of 30 kN at the left end **A** and 50 kN at the right end **B**. The props are so located, that the reactions are same at each support. Determine the position of the props and draw shear force and bending moment diagrams. Mark the value of maximum bending moment and shear force.
- b) A weight of 200 kN is supported at three short pillars, each 500 mm^2 in section. The central pillar is of steel and outer ones are of copper. The pillars are so adjusted that at a temperature of $15\text{ }^\circ\text{C}$, each carries equal load. The temperature is then raised to $115\text{ }^\circ\text{C}$. Estimate the stresses in each pillar at $15\text{ }^\circ\text{C}$ and $115\text{ }^\circ\text{C}$.

Take,

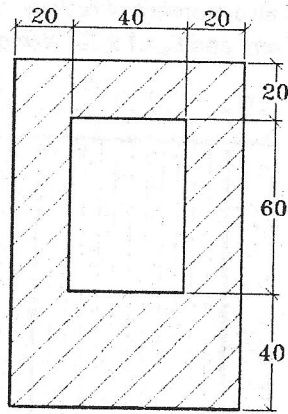
$$E_s = 2 \times 10^5 \text{ N/mm}^2$$

$$E_c = 0.8 \times 10^5 \text{ N/mm}^2$$

$$\alpha_s = 1.2 \times 10^{-5} / ^\circ\text{C}$$

$$\alpha_c = 1.85 \times 10^{-5} / ^\circ\text{C}$$

3. a) The cross section of a cast iron machine element used as a beam is shown in figure. 10
 The permissible stresses in tension and compression are 25 N/mm^2 and 30 N/mm^2 respectively. Determine the moment of resistance of the section for both positive and negative bending moment.



[TURN OVER

(a) The cross-section of a beam is shown in figure. The permissible stresses in tension and compression are 25 N/mm^2 and 30 N/mm^2 respectively. Determine the moment of resistance of the section for both positive and negative bending moment.

(b) The cross-section of a beam is shown in figure. The permissible stresses in tension and compression are 25 N/mm^2 and 30 N/mm^2 respectively. Determine the moment of resistance of the section for both positive and negative bending moment.

(c) The cross-section of a beam is shown in figure. The permissible stresses in tension and compression are 25 N/mm^2 and 30 N/mm^2 respectively. Determine the moment of resistance of the section for both positive and negative bending moment.

(d) The cross-section of a beam is shown in figure. The permissible stresses in tension and compression are 25 N/mm^2 and 30 N/mm^2 respectively. Determine the moment of resistance of the section for both positive and negative bending moment.

(e) The cross-section of a beam is shown in figure. The permissible stresses in tension and compression are 25 N/mm^2 and 30 N/mm^2 respectively. Determine the moment of resistance of the section for both positive and negative bending moment.

(f) The cross-section of a beam is shown in figure. The permissible stresses in tension and compression are 25 N/mm^2 and 30 N/mm^2 respectively. Determine the moment of resistance of the section for both positive and negative bending moment.

(g) The cross-section of a beam is shown in figure. The permissible stresses in tension and compression are 25 N/mm^2 and 30 N/mm^2 respectively. Determine the moment of resistance of the section for both positive and negative bending moment.

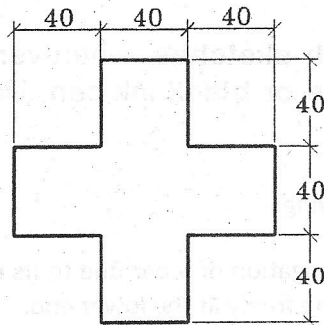
(h) The cross-section of a beam is shown in figure. The permissible stresses in tension and compression are 25 N/mm^2 and 30 N/mm^2 respectively. Determine the moment of resistance of the section for both positive and negative bending moment.

(i) The cross-section of a beam is shown in figure. The permissible stresses in tension and compression are 25 N/mm^2 and 30 N/mm^2 respectively. Determine the moment of resistance of the section for both positive and negative bending moment.

(j) The cross-section of a beam is shown in figure. The permissible stresses in tension and compression are 25 N/mm^2 and 30 N/mm^2 respectively. Determine the moment of resistance of the section for both positive and negative bending moment.

Handwritten notes and signatures at the bottom of the page, including a signature and some illegible text.

- b) The simply supported beam of span 4 m carries a central point load of 400 kN. The beam cross section is shown in figure. Draw shear stress distribution diagram and find the value of maximum shear stress. 10



4. a) A short column of rectangular cross section 80 mm x 60 mm carries a load of 40 kN at a point 20 mm from longer side and 35 mm from the shorter side. Determine the maximum compression and tensile stresses in the section. 10
- b) Find the Euler Crushing load for a hollow cylindrical cast iron column 200 mm external diameter and 25 mm thick, if it is 6 m long and hinged at both ends. 10
 Take, $E = 1.2 \times 10^6 \text{ N/mm}^2$
- Compare the load with the crushing load as given by Rankine formula, taking $f_c = 550 \text{ N/mm}^2$ and $\alpha = 1/1600$.
5. a) A cantilever of length 2 m carries a uniformly distributed load of 2 kN/m over a length of 1 m from the free end and a point load of 1kN at the free end. Find slope and deflection at the free end, if $E = 2.1 \times 10^5 \text{ N/mm}^2$ and $I = 6.667 \times 10^7 \text{ mm}^4$. 10
- b) A hollow shaft of external diameter 120 mm transmits 300 kW power at 200 rpm. Determine the maximum internal diameter, if maximum stress in the shaft is not to exceed 60 N/mm². 10
6. a) A closed cylindrical vessel, made of steel plates 4 mm thick with plane ends carries fluid under a pressure of 3 N/mm². The diameter of the cylinder is 250 mm and length is 750 mm. Calculate the longitudinal and hoop stresses in the cylinder wall and determine changes in diameter, length and volume of the cylinder. 10
 Take, if $E = 2.1 \times 10^5 \text{ N/mm}^2$, $1/m = 0.286$
- b) An elemental cube is subjected to tensile stresses of 30 N/mm² and 10 N/mm² acting on two mutually perpendicular planes and a shear stress of 10 N/mm² on these planes. Draw the Mohr's circle and hence determine the magnitude and direction of principal stresses and also the greatest shear stress. Verify the answers analytically. 10
7. a) An object of weight 100 N falls by gravity a vertical distance of 5 m when it is suddenly stopped by a collar at the end of a vertical rod of length 10 m and diameter 20 mm. The top of the bar is rigidly fixed to a support. Calculate the maximum stress and strain induced in the bar due to the impact. 10
 Take, $E = 2 \times 10^5 \text{ N/mm}^2$.

