



- Notes :
1. All questions carry marks as indicated.
  2. Solve Question 1 OR Questions No. 2.
  3. Solve Question 3 OR Questions No. 4.
  4. Solve Question 5 OR Questions No. 6.
  5. Solve Question 7 OR Questions No. 8.
  6. Solve Question 9 OR Questions No. 10.
  7. Solve Question 11 OR Questions No. 12.
  8. Assume suitable data whenever necessary.
  9. Illustrate your answers whenever necessary with the help of neat sketches.
  10. Use of non programmable calculator is permitted.
  11. Use of design data book is permitted.

1. a) Plot a tensile test diagram for steel. Explain it's salient features. 5  
 b) An axial load of 56 kN is applied to a bar of 36 mm diameter and 1 meter length. The extension of the bar is measured to be 0.265 mm where as the reduction in diameter is 0.003 mm. Calculate the Poisson's ratio and value of three moduli (E, G & K). 8
2. a) A steel rod of 30 mm diameter and 5 meter long is connected to two grips and rod is maintained at a temperature of 90°C. Determine the stress and pull exerted when the temperature falls to 25°C if - 6  
 i) the ends do not yield and                      ii) the ends yield by 1.2 mm  
 b) A brass bar having cross-sectional area of 1000 mm<sup>2</sup> is subjected to axial forces as shown in fig. 2 (b). Find the total elongation of the bar. Take E = 105 GPa. 7

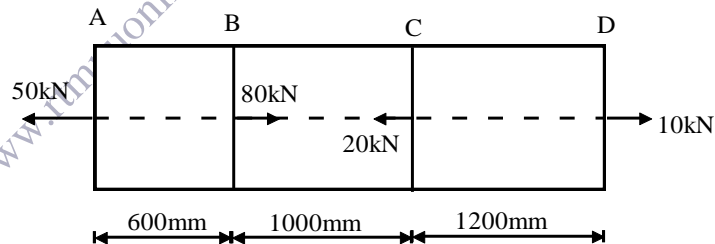


Fig. 2(b)

3. Draw the shear force and bending moment diagram for the beam shown in fig. 3. Also find the point of contraflexure if any. 13

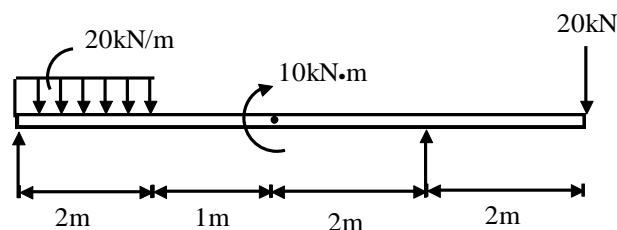


Fig. 3

4. a) Prove the relation  $\frac{\sigma_b}{y} = \frac{M}{I} = \frac{E}{R}$  for simple bending. Where  $\sigma_b \rightarrow$  Bending stress ;  $I \rightarrow$  moment of inertia ;  $M \rightarrow$  Bending moment,  $E \rightarrow$  Young's modulus,  $R \rightarrow$  Radius of curvature &  $y \rightarrow$  dist. From neutral axis. 7
- b) A simply supported of span 1.3 meter having a cross-section 150 mm wide and 250 mm deep carries a point load 'W' at the centre . The permissible stress are  $7 \text{ N/mm}^2$  in bending and  $1.5 \text{ N/mm}^2$  in shearing. Calculate the safe load 'W'. 6
5. An overhanging beam ABC is loaded as shown in fig. 5. Find the slope over each support and at the right end. Find also the maximum upward deflection between the supports and the deflection at the right end. Take  $I = 5 \times 10^8 \text{ mm}^4$  &  $E = 2 \times 10^5 \text{ N/mm}^2$ . 13
- Fig. 5
6. a) A rectangular block of material is subjected to a tensile stress of  $100 \text{ N/mm}^2$  on one plane and a tensile stress of  $50 \text{ N/mm}^2$  on a plane at right angles, together with shear stress of  $60 \text{ N/mm}^2$  on the faces. Find. 9
- the direction of principal planes.
  - the magnitude of principal stress
  - the magnitude of greatest shear stress
- b) Write note on "Mohr's Circle of Stresses". 4
7. a) A hollow shaft is required to transmit 600 kw at 120 RPM, the maximum torque being 25% greater than the mean. The shear stress is not to exceed 60 MPa and twist in a length of 3 meters not to exceed 1.3 degrees. Find the external diameter of shaft, if the ratio of internal diameter to the external diameter is 3/8. Take modulus of rigidity as 84 GPa. 8
- b) Define polar modulus ZP. Develop the value of polar modulus for solid circular section and solid rectangular section. 6
8. a) Explain with neat sketch the crushing and buckling failure of column. 6
- b) A 4-meter long cast iron hollow column with both ends firmly fixed, supports an axial load of 400 kN. The inside diameter of column is 0.6 times the external diameter. Determine the section of column. Assume factor of safety to be 5, crushing stress 560 MPa and Rankine's constant =  $1/1600$ . 8
9. a) Explain with neat sketch the creep & it's various stages. 5
- b) A weight of 1 kN falls 30 mm on to a collar fixed to a steel bar of 1.2 meter length. The steel bar is of 30 mm diameter for half of it's length and 15 mm for the rest half. Determine the maximum stress and extension in the bar.  $E_{st} = 200 \text{ GPa}$ . 8

- 10.** a) Derive the expression for strain energy stored in a body due to torsion **6**  
i.e.  $S.E. = \frac{\tau^2}{4c} \cdot \text{volume}$
- b) A simply supported beam of span ' $l$ ' carries a point load ' $w$ ' at mid span. Find the strain energy stored by the beam and hence calculate the deflection. **7**
- 11.** a) A machine component is subjected to a flexural stress which fluctuates between 300 N/mm<sup>2</sup> and - 150 N/mm<sup>2</sup>. Determine the value of minimum ultimate strength according to **9**  
i) Gerber relation  
ii) modified Goodman relation &  
iii) Soderberg relation  
Take  
Yield point strength = 0.55 ultimate strength  
Endurance strength = 0.5 ultimate strength  
and factor of safety = 2.
- b) What is meant by 'Stress Concentration' ? Enlist various methods used to reduce its effect. **5**
- 12.** A pulley is keyed to a shaft midway between two bearings. The shaft is made of SAE 1030. The bending moment at pulley varies from - 150 N.m to 300 N.m as the torque on the shaft varies from - 50 N.m to +140 N.m. Obtain the diameter of shaft for infinite life. Assume factor of safety of 1.5 ; size effect factor 0.85 & surface finish factor of 0.88. **14**

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