B.E. (Mechanical Engineering) Fourth Semester (C.B.S.)

Mechanics of Materials

P. Pages : 4 **NRT/KS/19/3372**

Time : Three Hours Max. Marks : 80

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. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Diagrams and chemical equations should be given whenever necessary.
11. Illustrate your answers whenever necessary with the help of neat sketches.
12. Use of non programmable calculator is permitted.
13. Use of design data book is permitted.

1. a) A circular steel bar is subjected to various forces as shown in Fig. 1. a) Determine the total elongation in the bar. **7**

$E = 2\times10^5\ N/mm^2$.

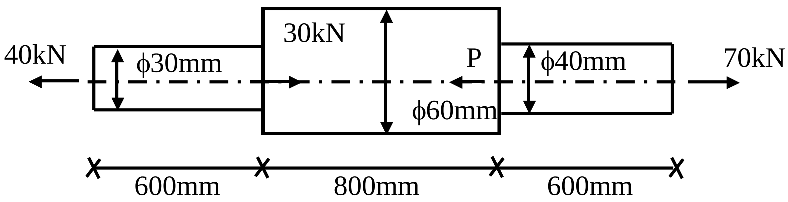


Fig. 1 (a)

b) Explain in brief the stress strain curve for a ductile material with labelled diagram. **6**

OR

2. a) A composite bar made of aluminium and steel is held between the supports as shown figure 2. a) The bars are stress free at a temperature of 37ºC. What will be the stress in the two bars when the temperature is 20ºC if. **7**

i) The supports are unyielding and

ii) The supports yield and come nearer to each other by 0.10mm.

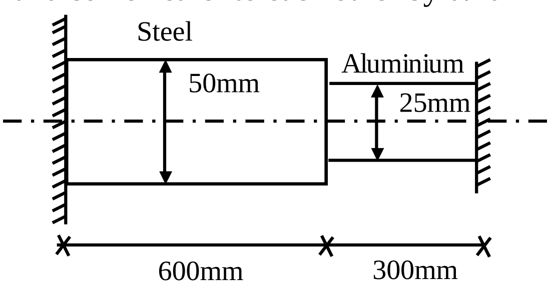


Fig. 2 (a)

It can be assumed that the change of temperature is uniform all along the length of the bar.

for steel: $E_s = 210\,GPa;\ \alpha_s = 11\cdot7\times10^{-6}/^\circ C$

for Aluminium: $E_a = 74GPa;\ \alpha_a = 23\cdot4\times10^{-6}/^\circ C$

b) A CI flat 300mm long and of $30mm \times 50mm$ uniform section is acted upon by the following forces uniformly distributed over the respective cross section; **6**

25kN in the direction of (x) length (tensile);

350kN in the direction of width (y) (compressive);

and 200kN in the direction of (z-durn) thickness (tensile). Determine the change in volume of the flat.

Take $E = 140\,GN/m^2$ and m = 4 Refer fig. 2. b).

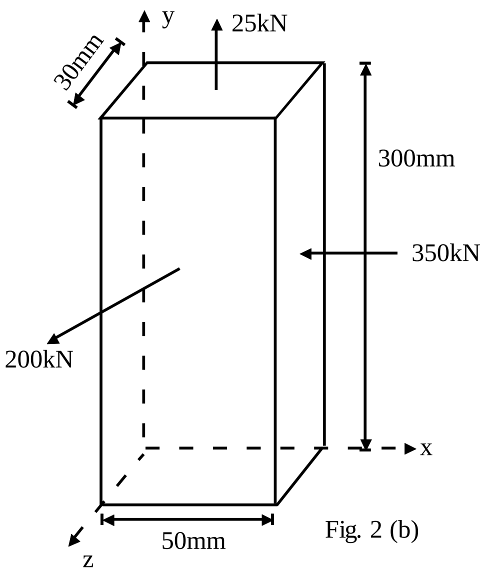


Fig. 2 (b)

3. Draw shear force and bending moment diagram for the beam as shown in the Fig. 3). The beam is simply supported at the ends. **14**

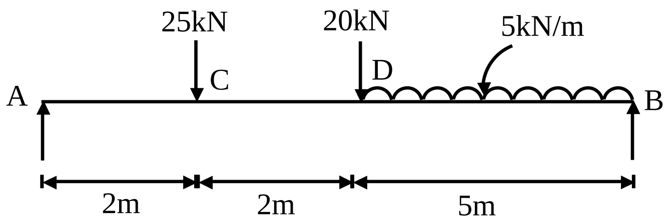


Fig. (3)

OR

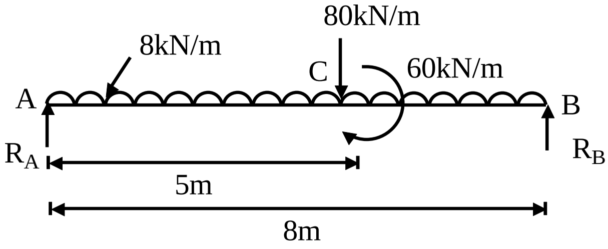
4. a) A square beam of $20mm \times 20mm$ in section and 2m long is supported at the ends. The beam falls when a point load of 400N is applied at the centre of beam. What U.D.L. per unit length will break a cantilever of the same material 40mm wide, 60mm deep and 3m long? **7**

b) Prove that the maximum shear stresses over a circular section is 4/3 times the average shear stress: **7**

$$\tau_{max} = \frac{4}{3}\,\tau_{average}$$

5. A steel beam is simply supported at the ends on a span of 8m and carries a uniformly distributed load of 8 kN/m on the whole span. In addition, a connection made to the beam at 5m from the left end exerts a downward load of 80kN together with a clockwise couple of 60 kNm acting in the plane of bending of the beam. Determine the location and the magnitude of the maximum deflection. **13**

I_{xx} for the beam section = $4 \cdot 79 \times 10^8 \text{ mm}^4$ and $E = 200 \text{kN}/\text{mm}^2$.



OR

6. a) A plane element is subjected to the stresses as shown in Fig. 6 **10**

i) Determine analytically the principal stresses and their directions.

ii) The maximum shearing stresses and the directions of the plane on which they occur.

iii) Check the answer by using Mohr's circle method.

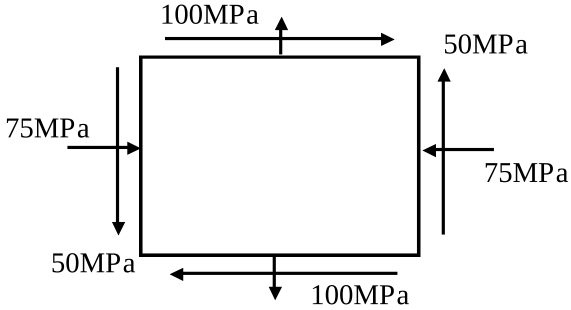


Fig. 6 (a)

b) Define the term principal plane and principal stress. **3**

7. a) Derive the relation for circular shaft when subjected to torsion as given below: **6**

$$\frac{T}{J} = \frac{C\theta}{L} = \frac{\tau}{R}$$

where

T - maximum trusting torque (N-mm)

R - Radius of shaft (mm)

L = Length of the shaft (mm)

θ = Angle of Twist.

C = Modulus of rigidity,

τ = Shear stress

b) A hollow shaft of diameter ratio 3/8 is required to transmit 600kW at 100rpm, the maximum torque being 20% greater than the mean torque. The shear stress is not to exceed $63 \text{mN}/\text{m}^2$ and the twist in a length of 3m is not to exceed 1.4 degrees. Calculate the maximum external diameter satisfying the above conditions. **7**

OR

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8. a) A hollow cylindrical CI column whose outside diameter is 200mm and has a thickness of 20mm. It is 4.5m long and is fixed at both the ends. Calculate the safe load by Rankine formula using a factor of safety of 4. **8**
Also calculate the Slenderness ratio and the ratio of Euler's to Rankine critical loads. Take $\sigma_c = 550\,\mathrm{N/mm^2}$, $\alpha = \frac{1}{1600}$ in Rankin formula and consider $E = 8 \times 10^4\,\mathrm{N/mm^2}$.

b) Prove that Crippling load by Euler's formula for column having both the ends hinged is given by. **5**

$$F_{cr} = \frac{\pi^2 EI}{L^2}$$

9. a) A wagon weighing 35kN is attached to a wire rope and moving down an inclined plane at speed of 3.6km/hr, when the rope jams and the wagon is suddenly brought to rest. If the length of the rope is 60m at the time of sudden stoppage. Calculate the maximum instantaneous stress and the maximum instantaneous elongation produced due to sudden stoppage. Take $E = 200\ \mathrm{GN/m^2}$. **7**

b) A 2m long bar of 125mm diameter is subjected to an axial load of 1.5kN. Determine the maximum stress developed in the bar if the load is applied. **6**
i) Gradual
ii) Sudden
iii) Falls through a height of 30mm.
E = 200GPa.

OR

10. a) What are the various modes of fracture? Explain the effect of thickness and flew size on fracture. **7**

b) Explain in brief the various phases of creep phenomenon. **6**

11. a) Explain in brief the endurance strength with the help of S-N-diagram (stress Vrs No. of cycle). **4**

b) A hollow steel shaft of SAE1040 has outer and inner diameter of 50mm and 30mm respectively. It is subjected to following loads: **10**
i) Bending moment = 300 Nm
ii) Torque = 200Nm
iii) Axial Load = 12,000 N
Using two different theories of failure, determine factor of safety.

OR

12. A shaft made of SAE1030 rough finish steel is subjected to a **14**
i) Torsional load that varies from CCW 300000 N-mm (CW) to 100000 N-mm.
ii) Bending moment applied at the critical section varies from + 400000 N-mm to -200000 N-mm.
Determine the required shaft diameter at the critical section by maximum shear stress theory and normal stress theory. Assume factor of safety on yield point stress as 2.

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