PMM/KS/15/7005

Faculty of Engineering & Technology

Fourth Semester B.E. (Mechanical Engg.) (C.B.S.) Examination

MECHANICS OF MATERIALS

Time—Three Hours] [Maximum Marks—80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Solve **SIX** questions as follows :

Q. No. **1 OR** Q. No. **2**

Q. No. **3 OR** Q. No. **4**

Q. No. **5 OR** Q. No. **6**

Q. No. **7 OR** Q. No. **8**

Q. No. **9 OR** Q. No. **10**

Q. No. **11 OR** Q. No. **12.**

(3) Due credit will be given to neatness and adequate dimensions.

(4) Illustrate your answers wherever necessary with the help of neat sketches.

(5) Use of Drawing instruments is permitted.

(6) Use of Non-programmable calculator is permitted.

(Contd.)

(7) Use of Design Data Book is permitted.

(8) Assume suitable data wherever necessary.

1. (a) Explain Poisson's Ratio. 3

(b) Define factor of safety. State the factors on which selection of factor of safety depends. 3

(c) A composite bar made up of steel and aluminium is held between two supports. The bar is stress free at 40 °C. What will be the stresses in the two bars when the temperature is 20 °C if :

(i) Supports do not yield

(ii) The supports come nearer to each other by 0.1 mm ?

Given : $E_{st} = 210$ GPa ; $E_{Al} = 74$ GPa

$\alpha_{st} = 11.7 \times 10^{-6}/°C$; $\alpha_{Al} = 23.4 \times 10^{-6}/°C$

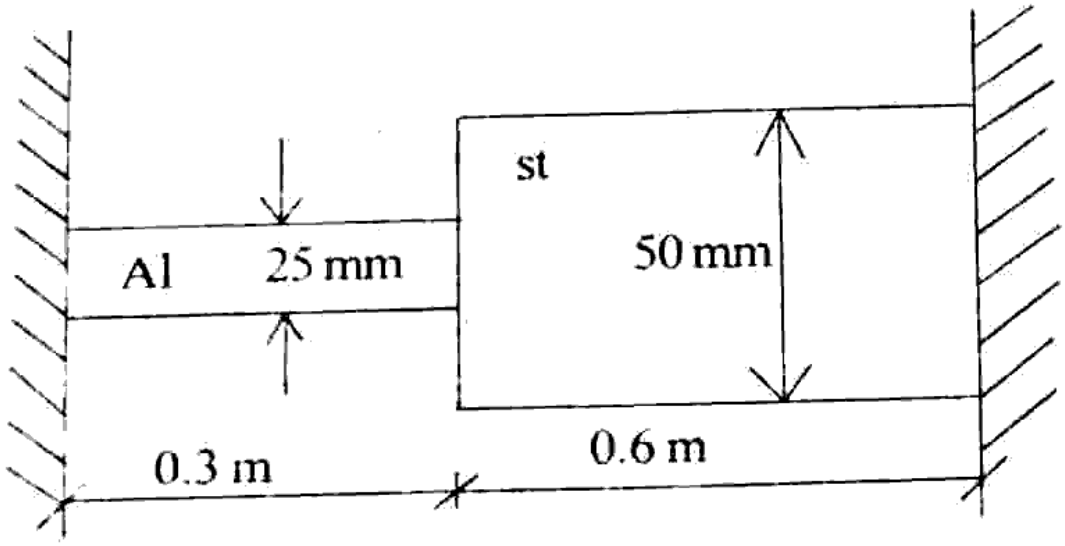

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Fig. 1 (c)

OR

2. (a) A rectangular block 200 mm × 80 mm × 60 mm is subjected to axial loads as follows :

(i) 480 kN (T) in the direction of its length (i.e. 200 mm)

(ii) 800 kN (C) on 200 mm × 80 mm face

(iii) 900 kN (T) on 200 mm × 60 mm face.

Find change in the volume of the block. Take $\mu = 0.25$ and $E = 2 \times 10^5$ N/mm^2. 6

(b) A rigid beam AB 240 cm long is hinged at A and supported by two steel wires CD and EF as shown in Fig. 2 (b) ; wire CD is 6 m long and 12 mm in diameter whereas wire EF is 3 m long and 8 mm in diameter. Find stresses in each wire.

Take $E = 2 \times 10^5$ MPa. 7

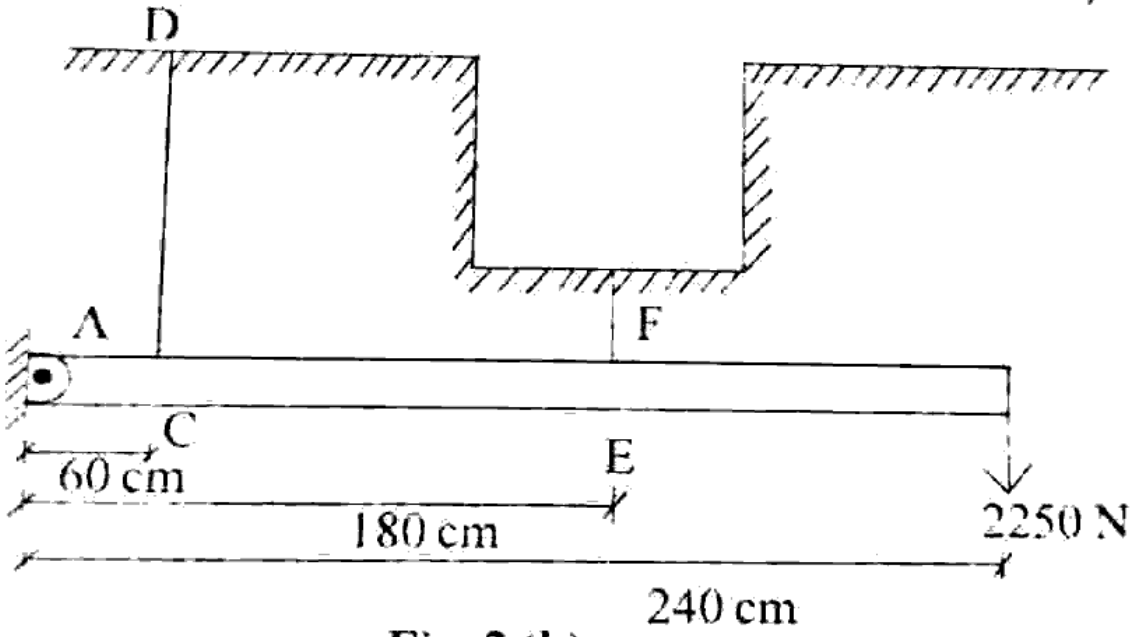

Fig. 2 (b)

3. Draw the shear force and bending moment diagram for the beam as shown in Figure 3. Also calculate the maximum bending moment.

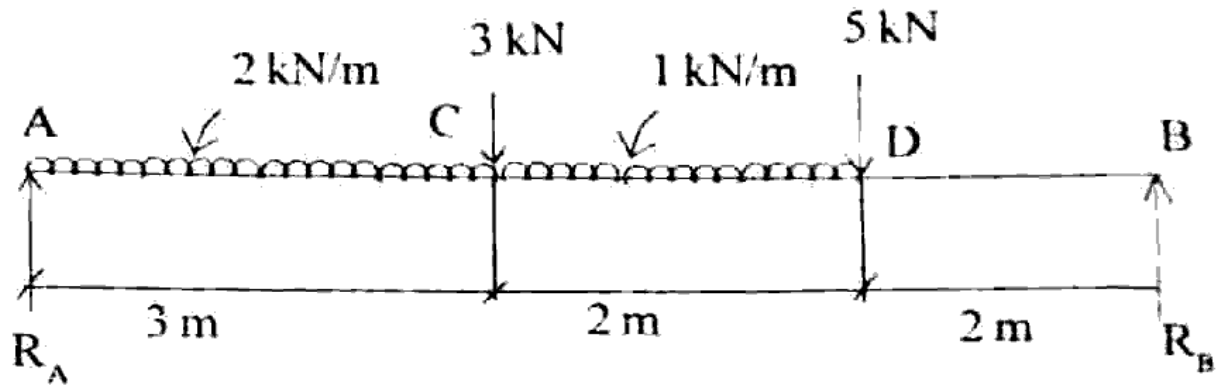

Fig. 3 14

OR

4. (a) A horizontal beam of uniform cross-section and 10 m long is simply supported at 2 m from each end ; so that the distance between two supports is 6 m and each overhang is 2 m. This beam carries UDL of 4.6 kN/m over its entire length. The cross-section is shown in Fig. 4 (a). Find the maximum value of tensile and compressive stress developed in the beam. 9

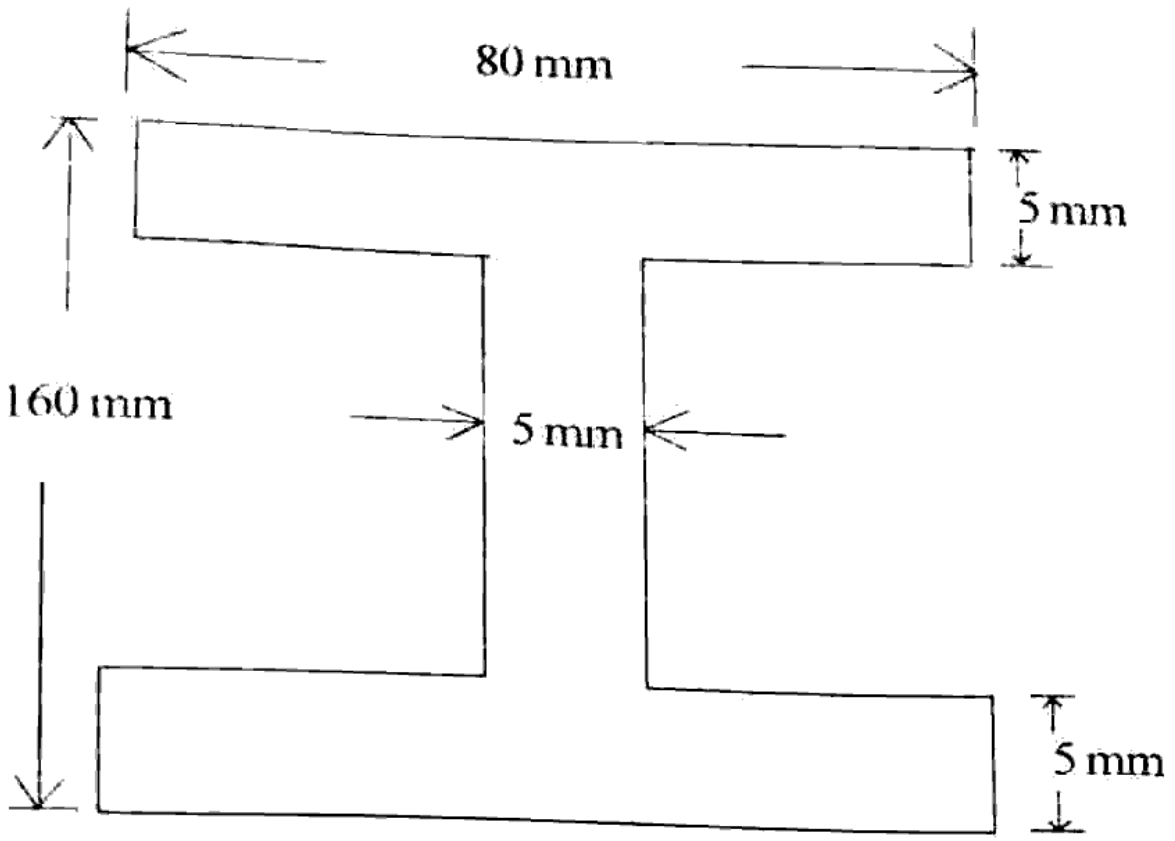

Fig. 4 (a)

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

$$\tau_{max} = \frac{4}{3}\tau_{average}$$ 5

5. A beam PQRS shown in Fig. 5, PQ = QR = 1 m, RS = 2 m is supported at P and S. It carries concentrated load of 20 kN at Q and VDL of 10 kN/m on span RS. Determine deflection of the beam at Q and R. Also find slope at the centre of the beam. Take E = 200 GPa ;

$I = 20 \times 10^{-6}\ m^4$.

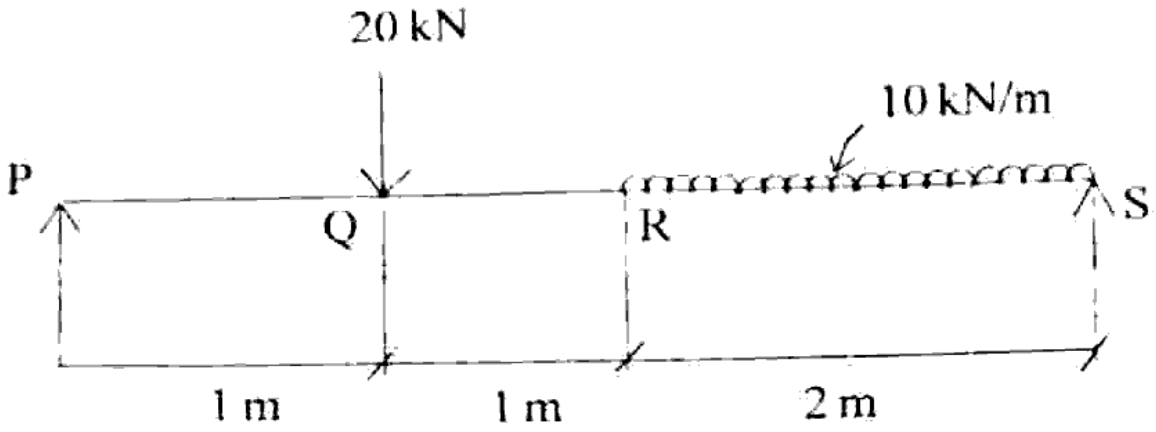

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Fig. 5

OR

6. (a) A plane element is subjected to stresses as shown in Fig. 6 (a) :

(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. 9

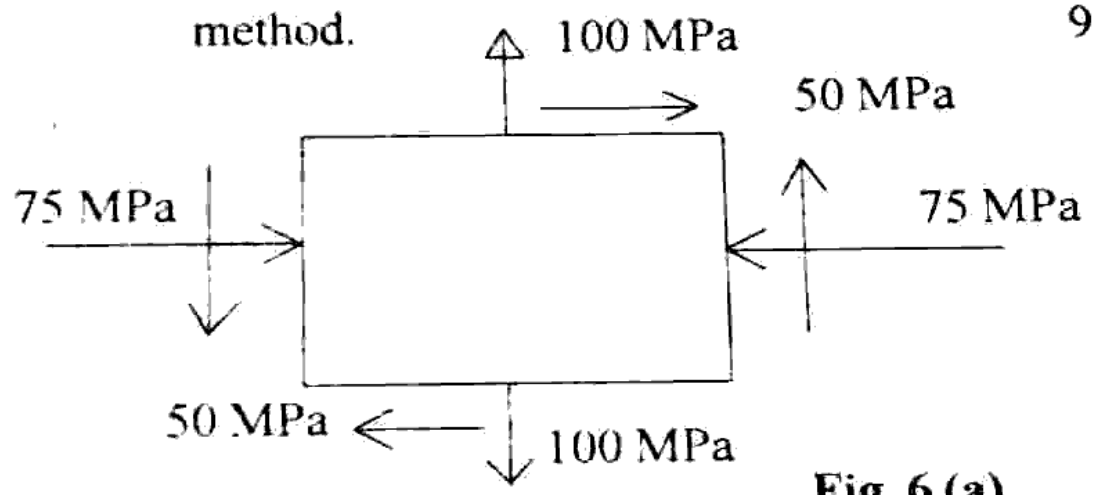

Fig. 6 (a)

(b) An element is subjected to uniaxial state of stress in x-direction of intensity σ_x. Derive the expression for normal stress σ_θ and shear stress τ_θ acting on a plane inclined at angle θ to x-axis. 4

7. (a) Prove the relation :

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

where,

T = Torque transmitted

J = Polar moment of inertia

σ_s = Maximum shear stress

R = Radius of shaft

C = Modulus of rigidity

θ = Angle of twist

L = Length of shaft. 5

(b) A hollow shaft of diameter ratio 3/8 is required to transmit 600 kW at 110 rpm, the maximum torque being 20% greater than mean torque. Shear stress in the material should not exceed 63 MPa and the twist in the length of 3 m is not to exceed 1.4°. Calculate the dimensions of the shaft satisfying the above conditions.

Given C = 84 GPa. 8

OR

8. (a) For a hollow cast iron column with outside diameter 200 mm and thickness 25 mm, length 4.5 m with both the ends fixed, calculate the safe load by Rankine formula using factor of safety 4. Also calculate slenderness ratio and ratio of Euler's to Rankine load.

Given $\sigma_c = 550$ N/mm^2 ; $\alpha = \frac{1}{1600}$

$E = 9.4 \times 10^4$ N/mm^2. 9

(b) Define the following terms :

(i) Slenderness ratio

(ii) Crippling load. 4

9. (a) Explain in brief various phases of creep phenomenon. 5

(b) A 10 mm diameter mild steel bar of length 1.5 m is stretched by a weight of 120 N dropping freely through 20 mm before commencing to stretch the bar. Find the maximum instantaneous stress and elongation produced in the bar. 8

OR

10. (a) What are the various modes of fracture ? Explain the effect of thickness and flow size on fracture. 5

(b) A vertical round steel bar 2100 mm long is securely held at its upper end A weight falls through a height of 30 mm on the stop provided at the bottom and the maximum stress produced in the bar was 163 MPa. Determine the stress when the load is applied :

(i) Gradually

(ii) Suddenly

(iii) Through a height of 50 mm

Given $E = 2 \times 10^5$ N/mm^2. 8

11. (a) Explain different theories of failure in detail. 4

(b) A shaft made up of 5 AE 1030 is subjected to the following loading conditions :

(i) Axial load 10 kN

(ii) Torque 250 Nm

(iii) Bending moment 300 Nm.

Determine factor of safety using maximum principal stress theory and maximum shear stress theory for a shaft of diameter 50 mm. 10

OR

12. A shaft of diameter 50 mm made up of 5AE 1020 is subjected to the following loading condtions :

(i) Axial load varying from 15 kN (T) to 5 kN (C)

(ii) Bending moment varying from 450 Nm (CW) to 150 Nm (CCW)

(iii) Torque varying from 350 Nm (CW) to 100 Nm (CCW).

The expected reliability is 95% and the system operates at room temperature with no stress risers. Determine the factor of safety for a ground finish. 14