Total No. of printed pages = 4

CE 181307

22/12/23

Roll No. of candidate [| | | | | | | | |]

2023

B.Tech. 3rd Semester End-Term Examination

STRUCTURAL ANALYSIS – I

(New Regulation and New Syllabus)

Full Marks – 70 | Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No. 1 and any *four* from the rest.

1. Pick up the correct answer : (10 × 1 = 10)

(i) Most of the real-world structures are statically determinate. State whether the above statement is true or false. (1)

(a) True (b) False

(ii) A point of contraflexure in a bending moment diagram indicates ________. (1)

(a) Bending moment changes sign

(b) Negative bending moment

(c) Zero shear force

(d) Shear force changes sign

(iii) The deflection of a simply supported beam with a uniformly distributed load ω per unit length, having flexural rigidity EI and of length L is (1)

(a) $\frac{3\omega L^4}{584EI}$ (b) $\frac{5\omega L^4}{348EI}$

(c) $\frac{5\omega L^4}{384EI}$ (d) $\frac{3\omega L^4}{584EI}$

[Turn over

(iv) The maximum deflection of cantilever beam of length L with a point load W at the free end is (1)

(a) $\frac{WL^3}{3EI}$ (b) $\frac{WL^3}{8EI}$

(c) $\frac{WL^3}{48EI}$ (d) None of the above

(v) The unit load method used in Structural analysis is (1)

(a) Applicable only to statically indeterminate structures

(b) Another name for stiffness method

(c) An extension of Maxewll's reciprocal theorem

(d) Derived from Castigliano's theorem

(vi) The final bending moment of an arch any section is (1)

(a) Beam moment + H moment at that section

(b) Beam moment – H moment at that section

(c) Beam moment × H moment at that section

(d) Beam moment / H moment at that section

(vii) If the actual beam has both end fixed, then ends of the conjugate beam will be (2)

(a) Fixed at one end and free at the other

(b) Fixed at both ends

(c) Free at both ends

(d) None of the above

(viii) A uniformly distributed load $\omega\ kN/m$ is acting over the entire length of 8 meters long cantilever beam. If the shear force at the midpoint of cantilever beam is 12 kN. What is the value of ω? (2)

(a) 6 (b) 5

(c) 4 (d) 3

2. (a) Draw the loading diagram of the shear force diagram shown in figure 1. Determine the loading on the beam and hence draw the bending moment diagram. Locate the point of contraflexure, if any. Consider AB = 1 meter, BC = 6 meter and CD = 1.5 meter. (7)

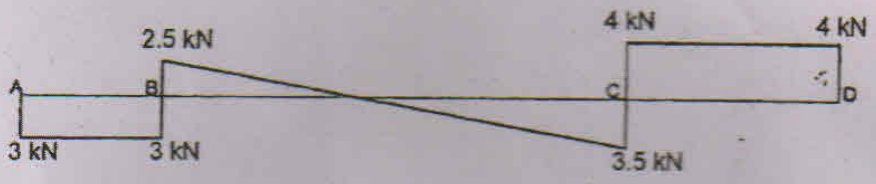

Figure 1

(b) Analyse and draw the shear Force diagram and Bending Moment diagram of the beam shown in figure 2. Determine the maximum bending moment and locate the point of contraflexure, if any. (8)

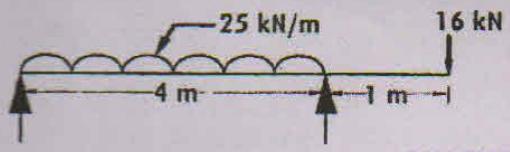

Figure 2

3. (a) What are the theorems involved in the "area moment" method? (2)

(b) A point load 'W' is acting at a distance of 'L_1' from the fixed support of the cantilever. The length of the cantilever is 'L'. Using double integration method, determine the slope and determine the slope and deflection at the free end of the cantilever. (5)

(c) A simply supported beam AB of span 6 meters is carrying a point load of 40kN at a distance 4.5 meters from the left end A. Calculate the slopes at A and B and the deflection under the load. Take EI = 25×10^{12} N-mm^2. Use the Macaulay's method. (8)

4. (a) Derive the expression of strain energy stored due to bending. (4)

(b) State and prove the Maxwell's reciprocal deflection theorem. (1 + 4)

(c) Using first theorem of Castigliano, find the deflection at the free end of a cantilever of length 'L' carrying a uniformly distributed load of 'w' per unit run over the whole span. Assume uniform flexural rigidity. (6)

5. (a) Using unit load method, determine the vertical deflection of the joint B of the pin jointed truss shown in figure 3. The support A and C are hinged and roller support respectively. The area of the all the members are 150 mm^2. Take E = 200 kN/mm^2 and AD = DC = BD = 3 meters (5)

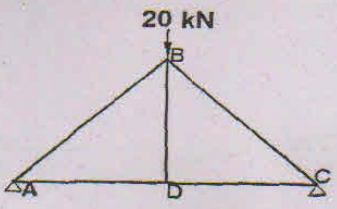

Figure 3

(b) A three hinged semicruclar rch of radius R carries uniformly distributed load of 'W' per unit run over the whole span. Find the horizontal thrust at each support and the location and magnitude of the maximum bending moment for the arch. (5)

(c) A two hinged semicircular arch of radius 'R' carries a concentrated load 'W' at the crown. Show that the horizontal thrust at each supports is $\frac{W}{\pi}$. Assume uniform flexural rigidity. (5)

6. (a) A cord supported at its ends 40 meters apart carries loads of 20 kN and 12 kN at a distance of 10 m, 20 m and 30 m from the left end. If the point on the cord where the 10kN loads is supported is 13 meters below the level of ends supports, determine (1) The reactions at the supports, (2) The tension in the different parts of the cord and (3) The total length of the cord. (2 + 3 + 3)

(b) A cable is supported between two points 30 meter horizontally apart. The left support is 3 m above the right support. The cable carries a load of 2 kN/m on the horizontal span. The lowest point of the cable is 6 m below the left support. Find the maximum tension in the cable. (7)

7. (a) What is kinematic indeterminancy? (3)

(b) What is Load path in structures? Why load path is important in structural engineering? (2 + 4)

(c) Figure 4 shows a rigid jointed frame. Determine the degree of static indeterminancy of the frame. (6)

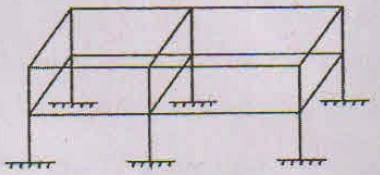

Figure 4