Total No. of printed pages = 9

CT-401/SA/4th Sem/2017/N

STRUCTURAL ANALYSIS

Full Marks – 70

Pass Marks – 28

Time – Three hours

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

Note :

(i) Answer all the questions.

(ii) Section-1 contains MCQ's (Q1-Q18). (Q1-Q12) carries 1 mark each. (Q13-Q17) carries 2 marks each. Q18 carries 3 marks.

(iii) Section-2 consists of (Q19-Q22). Marks are indicated alongside the questions.

SECTION – 1

1. Principle of superposition is applicable when

   (a) deflections are linear functions of applied forces.

   (b) material obeys Hooke's law.

(c) the action of applied forces will be affected by small deformations of the structure.

(d) None of the above.

2. The Castigliano's second theorem can be used to compute deflections

(a) in statically determinate structures only

(b) for any type of structure

(c) at the point under the load only

(d) for beams and frames only

3. When a uniformly distributed load, longer than the span of the girder, moves from left to right, then the maximum bending moment at mid-section of span occurs when the uniformly distributed load occupies

(a) less than the left half span

(b) whole of the left half span

(c) more than the left half span

(d) whole span

4. For a two-hinged arch, if one of the supports settles down vertically, then the horizontal thrust

(a) is increased

(b) is decreased

(c) remains unchanged

(d) becomes zero

5. The deflection at any point of a perfect frame can be obtained by applying a unit load at the joint in

(a) vertical direction

(b) horizontal direction

(c) inclined direction

(d) the direction in which the deflection is required

6. The principle of virtual work can be applied to elastic system by considering the virtual work of

(a) internal forces only

(b) external forces only

(c) internal as well as external forces

(d) None of the above

7. The fixed support in a real beam becomes in the conjugate beam a

(a) roller support

(b) hinged support

(c) fixed support

(d) free end

8. When a uniformly distributed load, shorter than the span of the girder, moves from left to right, then the conditions for maximum bending moment at a section is that

(a) the head of the load reaches the section

(b) the tail of the load reaches the section

(c) the load position should be such that the section divides it equally on both sides

(d) the load position should be such that the section divides the load in the same ratio as it divides the span

9. An arch with three hinges, is a _____ structure. Fill in the blank using suitable option.

(a) statically determinate

(b) statically indeterminate

(c) geometrically unstable

(d) structurally sound but indeterminate

10. Degree of kinematic indeterminacy of a pin-jointed plane frame is given by

(a) $2j - r$

(b) $j - 2r$

(c) $3j - r$

(d) $2j + r$

11. Bending moment at any section in a conjugate beam gives in the actual beam

(a) Slope

(b) Curvature

(c) Deflection

(d) Bending moment

12. The number of independent equations to be satisfied for static equilibrium of a plane structure is

(a) 1

(b) 2

(c) 3

(d) 6

13. The maximum bending moment due to a train of wheel loads on a simply supported girder

(a) always occurs at centre of span

(b) always occurs under a wheel load

(c) never occurs under a wheel load

(d) None of the above

14. Castigliano's first theorem is applicable

(a) for statically determinate structures only

(b) when the system behaves elastically

(c) only when principle of superposition is valid

(d) None of the above

15. In the slope deflection equations, the deformations are considered to be caused by

(i) bending moment

(ii) shear force

(iii) axial force

The correct answer is

(a) Only (i)

(b) (i) and (ii)

(c) (ii) and (iii)

(d) (i), (ii) and (iii)

16. If there are m unknown member forces, r unknown reaction components and j number of joints, then the degree of static indeterminacy of a pin-jointed plane frame is given by

(a) $m + r + 2j$

(b) $m - r + 2j$

(c) $m + r - 2j$

(d) $m + r - 3j$

17. A single rolling load of 8 kN rolls along a girder of 15m span. The absolute maximum bending moment will be

(a) 8 kN.m

(b) 15 kN.m

(c) 30 kN.m

(d) 60 kN.m

18. A cantilever carries a uniformly distributed load W over its whole length and a force W acts at its free end upward. The net deflection of the free end will be

(a) zero

(b) $(5/24)\ (WL^3/EI)$ upward

(c) $(5/24)\ (WL^3/EI)$ downward

(d) None of these

SECTION – 2

19. A three hinged circular arch hinged at the springing and crown points has a span of 40m and a central rise of 8m. It carries a uniformly distributed load of 20 kN/m over the left half of the span together with a concentrated load of 100 kN at the right quarter span point. Find the reactions at the supports, normal thrust and shear at a section 10m from the left support. 11

20. Four point loads 10, 20, 20 and 15 kN have centre to centre spacing of 2m between consecutive loads and they traverse along a girder of 30m span from left to right with 15 kN load landing. Calculate the maximum bending moment and shear force at 8m from the left support. 11

21. A portal frame is consisting of three points A, B and C. The portion AB is vertically placed to the horizontal plane fixed at point A, portion BC is bent a right angle to AB which is jointed at B, and point C is free. If a vertical downward point load of 20 kN is applied at C, determine the vertical and horizontal deflection of the free end C. Given, $E = 200$ kN/mm^2, $I = 30 \times 10^7$ mm^4, length of AB = 4m, length of BC = 3m and I for portion AB is double that of portion BC. 11

22. (a) A cantilever beam AB, with a total span of L is fixed supported at A and free at B, is loaded for a length of L/2 of the total span over the portion BC with a UDL of W kN/m. Find the rotation and deflection at the free end of the cantilever beam. 6

(b) A simply supported beam AB, supported at A and B is loaded with a point load of 60 kN at the midspan C. Length of the beam AB is 8m and I (moment of inertia) for portion BC is double that of portion AC. Determine the rotations at A, B and deflection at C for the beam. 6