December 2018

MECHANICS OF STRUCTURE

Time Allowed: 3 Hours *Full Marks: 70*

Answer to Question No.1 is compulsory and to be answered first.
This answer is to be made in separate loose script(s) provided for the purpose.
Maximum time allowed is 45 minutes, after which the loose answer scripts will be collected and fresh answer scripts for answering the remaining part of the question will be provided.
On early submission of answer scripts of Question No.1, a student will get the remaining script earlier.

Answer any five questions from the rest.

1. Answer the following questions (any twenty): 1x20

Fill in the blanks:

i) If the entire span of a simply supported beam is subjected to uniformly varying loading, the nature of shear force diagram will be _____.

ii) If the actual length of a column is L and it is effectively held in position and restrained against rotation at one end, other end neither effectively held in position nor restrained against rotation, its effective length is _____.

iii) With usual notation the mathematical condition of a perfect frame is _____.

iv) For a cross section of beam bending stress is maximum at _____.

v) For a cross- section of beam Shear stress is generally maximum at _____.

vi) The shape of Core or Kernel area of a rectangular section is a _____.

vii) In moment distribution _____ of the balanced moment will be carried over to the far support.

viii) The maximum deflection of a simply supported beam of span L with Flexural rigidity EI subjected to uniformly distributed load w per m in entire length is given by _____.

State whether "TRUE" or "FALSE":

ix) If in a simply supported beam there is an intermediate couples, the shear force will suddenly change at that point.

x) A long column fails by crushing only.

xi) For a lean to truss the top chord member will be subjected to tensile stress under (DL+LL) conditions.

xii) For an unsymmetric cross section of beam the maximum bending compressive stress and maximum bending tensile stress may not be the same.

xiii) With usual notations the shear stress at any fibre is given by $\tau = \frac{VIb}{ay}$.

xiv) For a single span fixed beam AB of span L subjected to a concentrated load W at a distance ' a ' (a<L) from A the fixed end moment at B is $\frac{Wa(L-a)^2}{L^2}$.

xv) If numerically direct stress and bending stress are equal, at some point the net stress will be 0 (zero).

xvi) In a joint with 3(three) members in moment distribution process the distribution factors may be 0.3, 0.3 and 0.35.

Choose the correct answer:

xvii) For a fixed beam of span L subjected to uniformly varying load (triangular) with maximum loading w at centre and 0(zero) loading at both ends the fixed end moment at both ends are ($\frac{WL^2}{2}$ / $\frac{5WL^2}{96}$ / $\frac{9WL^2}{128}$).

xviii) In frame analysis for a joint of 3 members with 2 horizontal and one vertical members with no external load at the joint the force in vertical member is (0/ maximum/ cannot be estimated).

xix) For circular cross section of beam the ratio of maximum shear stress and average shear stress is (1.5/$\frac{4}{3}$/2.0).

xx) If f, y, I, M be respectively bending stress, distance from neutral axis, moment of Inertia and bending moment at a section; their relationship is ($M = \frac{fI}{y}$ / $M = \frac{fy}{I}$ / $f = \frac{My}{I}$).

xxi) The core or karnel of circular cross section of dia. d is a circle of dia.($\frac{d}{2}$ / $\frac{d}{4}$ / $\frac{d}{8}$).

xxii) With usual notations the maximum deflection of a Cantilever of span L is given by ($\frac{WL^3}{3EI}$ $\frac{WL^3}{8EI}$ $\frac{WL^3}{8EI}$).

xxiii) The final shear in a beam is (algebraic sum of plain shear and elastic shear/ only plain shear/ only elastic shear).

xxiv) Accordingly to Rankine's theory of Column ($\frac{1}{P_c} = \frac{1}{P_E} + \frac{1}{P}$ / $\frac{1}{P} = \frac{1}{P_c} + \frac{1}{P_E}$ / $\frac{1}{P_E} = \frac{1}{P_c} + \frac{1}{P}$).

2. A Beam ABC of total length 13m is simply supported at A and B whereas C is the free end. AB is of length 10m and BC is of 3m. BC portion of the beam is subjected to uniformly Distributed loading of 30KN/m. A varying load with o (zero) intensity at A and 60KN/m intensity at a distance 6m from A towards B is also there and there is a couple of counter clockwise moment 100KN-m at a distance 8m from A to B. Draw the Shear Force and Bending Moment Diagram for this overhanging Beam stating Shears and moments at significant location. 10

3. a) With normal notations write the equation of Bending Stress and explain (No proof is required).
b) A hollow circular bar used as a beam has outside diameter twice of the inside diameter. If it is subjected to a maximum bending moment of 40 KN-m and the allowable bending stress is 100N/mm², determine the inside diameter of the bar. 4+6

4. A simply supported Timber beam is 2m long and is of rectangular section with depth twice the width. It carries a point load of 10KN at the centre and a uniformly distributed loading of 10KN/m over the whole length. Find the suitable cross- section of the beam if the permissible shear stress for the timber is 0.8 N/mm² and bending stress in tension or compression is 10 N/mm². 10

6. The width of flanges of an I-section is b and the overall depth is 2b. The thickness (t) of the web and the flanges is uniform. Neglecting the higher powers of (t), find the ratio of the intensities of the maximum shear stress and the mean shear stress. 10

7. A Circular masonry chimney is of 30m height and its outer diameter and inner diameters are 3m and 2m respectively. The unit weight of wall materials is 20,000N/m³ and design wind pressure is 1000N/m² with a wind shape factor 0.8. Calculate the maximum or minimum stress below the base of the chimney. 10

8. By double integration method find the maximum slope and deflection at centre of a Simply Supported Beam of span L and flexural rigidity EI, subjected to uniformly distributed loading of w per m. 10

9. a) State Rankine's theory for capacity of load of a Column. How Euler's theory is modified/explained by Rankine's theory?
   b) A hollow alloy tube having internal and external diameters as 36mm and 52mm respectively is 6m long. It extends by 3mm under a tensile load of 50KN. Determine the Euler's crippling load for the tube when used as a strut with both ends pinned. 4+6

10. a) Find the maximum fixed end moment for a fixed beam AB of span L subjected to uniformly distributed loading of w per unit length by any method (Only the statement of formula is not sufficient).
    b) A fixed beam AB has span 7m. It is subjected to 2 concentrated loads 40KN and 60KN from 3m and 5m from A. Find maximum support moments at A and B. 5+5

11. a) What is Resilience and Proof Resilience?
    b) A 1.5 long steel bar has a cross-sectional area of 800mm². With an elastic limit of 180N/mm², determine its proof resilience. Take E= 205 X 10³N/mm². 4+6

12. A 3 span Continuous beam ABCD of uniform flexural rigidity EI and same length AB=BC=CD=6m has a fixed end A and simply supported at B,C and D. Span BC is subjected to uniformly distributed loading of 30KN/m. A concentrated load of 120KN is placed at a distance 4m from A to B and another concentrated load 90 KN is placed at mid span of CD. Find the support moments of the beam by Moment Distribution Method. 10

13. a) What is perfect frame? What are mathematical criteria for a frame to be perfect?
    b) Analyse the frame shown below to find the member forces: 2+8