

December 2019

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 Group-A & B, taking at least two from each group.

1. A. Choose the correct alternative from the given options (any ten): 1×10
- i) A cantilever of span 'L' has a moment 'M' acting at the free end. The shear force developed at the free end is – (A) ML (B) M/L (C) 2M/L (D) Zero.
 - ii) The B.M at a section is maximum where shear force is – (A) Maximum (B) Constant (C) Changes sign (D) Numerically equal to BM_{max} .
 - iii) For a given material if E, K and $1/m$ represent Young's Modulus, Bulk Modulus and Poisson's Ratio respectively, then – (A) $K = \frac{E}{3(1+\frac{2}{m})}$ (B) $K = \frac{E}{3(1-\frac{2}{m})}$ (C) $K = \frac{E}{3(1+\frac{1}{m})}$ (D) $K = \frac{E}{3(1-\frac{1}{m})}$.
 - iv) Strain energy stored in a body per unit volume when strained up to limit of proportionality is known as – (A) Resilience (B) Proof Resilience (C) Modulus of Resilience (D) Modulus of Rigidity.
 - v) A rectangular column of depth 'd' and breadth 'b' under any load is to have throughout compressive stress. The eccentricity of load along axis of the depth or breadth should not exceed – (A) d/2 or b/2 (B) d/3 or b/3 (C) d/4 or b/4 (D) d/6 or b/6.
 - vi) Maximum deflection at free end of a cantilever beam of span 'L' under a concentrated load of 'P' at the free end is – (A) $PL^3/2EI$ (B) $PL^3/3EI$ (C) $PL^3/6EI$ (D) $PL^3/8EI$.
 - vii) Euler's crippling load for a column of length 'L' with one end fixed and other hinged is – (A) $\frac{\pi^2 EI}{L^2}$ (B) $\frac{4\pi^2 EI}{L^2}$ (C) $\frac{\pi^2 EI}{4L^2}$ (D) $\frac{2\pi^2 EI}{L^2}$.
 - viii) A fixed beam of span 'L' is loaded with a udl of 'w' per unit length. The B.M at centre of the span will be – (A) $wL^2/8$ (B) $wL^2/12$ (C) $wL^2/16$ (D) $wL^2/24$.
 - ix) In general plane framed determinate structures in equilibrium if 'm' is the number of members, 'j' is the number of joints and 'r' is the number of reaction components, then – (A) $m+r = 2j$ (B) $m+r = 3j$ (C) $m = 2j+r$ (D) $m = 3j+r$.
 - x) In Moment Area Method, the moment of M/EI diagram about a particular point gives – (A) Shear force of that point (B) Bending Moment about that point (C) Slope at that point (D) Deflection at that point.
 - xi) The sum of distribution factors of at a joint in Moment Distribution Method is – (A) Zero (B) Less than 1 (C) 1 (D) More than 1.

- xii) In a symmetrical I-section beam, maximum shear stress will occur at – (A) Centre of Web (B) The extreme fibre (C) Junction of flange and web (D) NA of flange portion.

B. Fill in the blanks with appropriate values (any five):

2×5

- The maximum eccentricity which a load can have without producing tension in a short hollow circular column of outside diameter 'D' and inside diameter 'd' is _____.
- The left half of a simply supported beam of span 'L' is loaded with udl of 'w' per unit length. The reaction at the right support will be _____.
- The Euler's crippling load for a 2m long slender steel rod of uniform cross section hinged at both ends is 1 kN. Then the Euler's crippling load for a 1m long steel rod of same cross section and fixed at both ends is _____ kN.
- A fixed beam of span 'L' is loaded with a moment 'M' at mid span. The fixed end moment at left support will be _____.
- Normal stresses at a point in a plane stressed element are $\sigma_1 = 80$ MPa and $\sigma_2 = 60$ MPa acting on two mutually perpendicular axes. Normal stress on the plane inclined at 60° to the direction of σ_1 will be _____ MPa.
- If depth and span of a rectangular cantilever beam is doubled, then the deflection at the free end due to a point load 'W' at that end will be _____ to the initial deflection.
- A wooden beam of rectangular cross section of size 10 cm (depth) × 5 cm (width) carries maximum shear force of 2000 kgf. Shear stress developed at neutral axis of the beam section will be _____ kgf/cm².

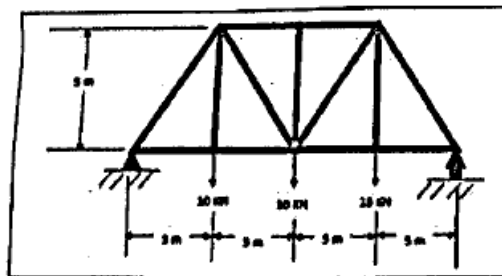
Group-A

2. An element has a tensile stress of 600 MPa and a compressive stress of 400 MPa acting on two mutually perpendicular planes. An equal shear stress of magnitude 100 MPa is acting on these planes. Find out the Principal stresses and maximum shear stress. 10

3. A T-section is used as a simply supported beam of span 4 m. It carries a udl of 8 kN/m over its entire span including self weight. Calculate the maximum compressive and tensile stresses occurring in the section. Sectional properties of the T-section are given in the table below: 10

Width of Flange	Thickness of Flange	Depth of Web	Thickness of Web
120 mm	20 mm	140 mm	15 mm

4. Check the determinacy of the following simply supported Pratt-truss and calculate the member forces and support reactions. 10

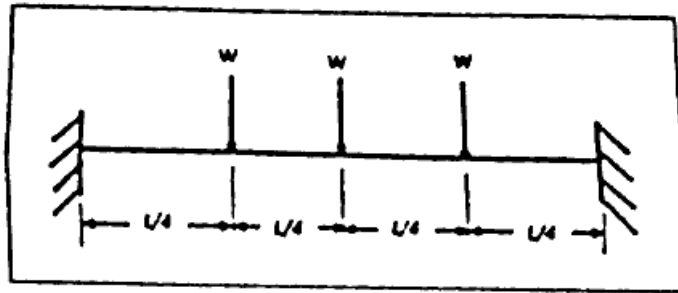


5. Two bars of same material and same length are subjected to equal gradually applied tensile loads. Bar-I is having a diameter of '2d' throughout its entire length while Bar-II has diameter of 'd' over the middle one-third portion and '2d' for the remaining two-third portion. Find the ratio of the strain energy developed in the two bars. 10

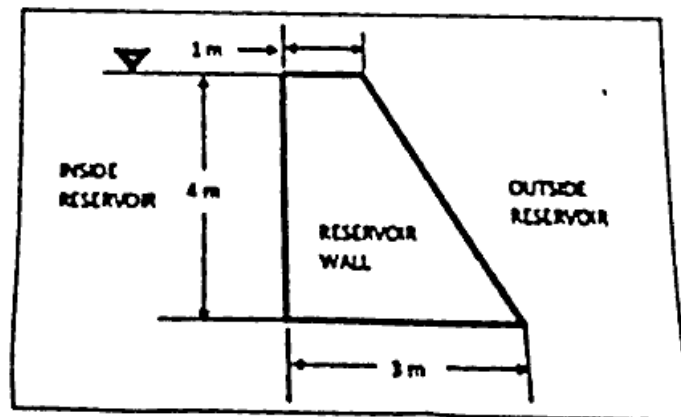
6. a) A simply supported beam of span 5m is carrying a clockwise moment of 50 kNm at a distance of 2m from left support. Draw the Bending Moment Diagram and Shear Force Diagram of the beam. No other load is acting on the beam and self-weight of it may be neglected.
- b) A simply supported beam of span 6m is carrying a uniformly varying load with magnitude 750 N/m from left support to 1500 N/m at right support. Construct the BMD and SFD and find the position of the maximum BM over the beam. 3+7

Group-B

7. A two span continuous beam ABC is carrying a udl of 10 kN/m over its entire length. Span AB=BC=10m. It is carrying a point load of 20 kN at the middle of span AB. Support at A is hinged and supports at B and C are roller. Apply 3-Moment Theorem to solve the problem. 10
8. A cantilever beam of span 5m is carrying a udl of 12 kN/m for a length of 2m from the free end. Determine the slope and deflection at the free end by applying Moment Area Method. Consider EI as constant. 10
9. A hollow cast iron column hinged at both ends is 4m long. Its external and internal diameters are 20cm and 15cm respectively. Find the maximum safe load it can carry with a FOS of 4. Yield stress of cast iron may be taken as 550 MPa and Rankine's constant (α) = 1/1600. 10
10. Analyse the fixed end beam of span 8 m as given below and draw the BMD & SFD. Point load (W) acting at each node as shown below = 20 KN. 10



11. A reservoir of height 4 m is 1 m wide at the top and 3 m wide at the base has vertical wall in contact with water. Calculate the maximum and minimum stresses at the base for tank full condition. Unit weight of masonry may be taken as 20 KN/m³. 10



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