FUNDAMENTALS OF STRENGTH OF MATERIALS
(CIV2101)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) For a thin rectangular plate of width 'a' and height 'b', where 'a' and 'b' are measured along the x-axis and y-axis respectively, where is the centroid of the rectangle located?
(a) At $\left(\frac{a}{2}, \frac{b}{2}\right)$ (b) At (0,0) (c) At (a,b) (d) At $\left(\frac{a}{2}, 0\right)$

(ii) The bending moment diagram for a cantilever beam with a uniformly distributed load is
(a) Triangular (b) Parabolic (c) Rectangular (d) Circular

(iii) If σ_1 and σ_2 are the principal stresses then the value of shear stress on a principal plane will be
(a) $(\sigma_1+\sigma_2)/2$ (b) $(\sigma_1-\sigma_2)/2$ (c) 0 (d) σ_1

(iv) A thin cylindrical shell of internal diameter 'D', external diameter 'd' and thickness 't' is subjected to internal pressure 'p'. The change in diameter is given by
(a) $\frac{pD^2}{4tE}(2-\mu)$ (b) $\frac{pD^2}{4tE}(1-2\mu)$ (c) $\frac{pd^2}{4tE}(1-2\mu)$ (d) $\frac{pd^2}{2tE}(2-\mu)$

(v) In a beam subjected to bending, the maximum bending stress occurs
(a) At the neutral axis
(b) At the centroid of the cross-section
(c) At the surface farthest from the neutral axis
(d) At the center of the beam's length

(vi) Force in the member BD of the pin-jointed frame as shown in Fig. 1 below is

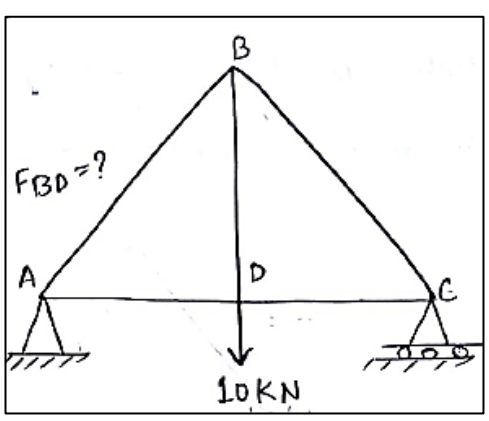


Fig. 1

(a) 0 (b) 20 kN (c) 10 kN (compressive) (d) 10 kN (tensile)

(vii) If a shaft of diameter 'd' is subjected to a torque T, the maximum shear stress is
(a) $\frac{32T}{\pi d^3}$ (b) $\frac{16T}{\pi d^2}$ (c) $\frac{16T}{\pi d^3}$ (d) $\frac{64T}{\pi d^4}$

(viii) In the Conjugate Beam Method, the bending moment diagram of the conjugate beam represents
(a) The shear force distribution in the original beam
(b) The deflection distribution of the original beam
(c) The axial force in the original beam
(d) The bending moment distribution in the original beam

(ix) Strain energy in a structural member is
(a) The energy required to break the material
(b) The energy stored in the material due to deformation under load
(c) The energy dissipated as heat during deformation
(d) The energy used to overcome internal friction in the material

(x) When both ends of the column are fixed, the crippling load is P_{cr}. If one ends of the column is made free, the value of crippling load will be changed to
(a) $P_{cr}/16$ (b) $P_{cr}/4$ (c) $P_{cr}/2$ (d) $4P_{cr}$

Fill in the blanks with the correct word

(xi) The area under the shear force diagram between two points is equal to the change in the _____ between those two points.

(xii) The parallel axis theorem states that the moment of inertia about any axis parallel to the centroidal axis is equal to the moment of inertia about the centroidal axis plus the product of the area and the _____ squared.

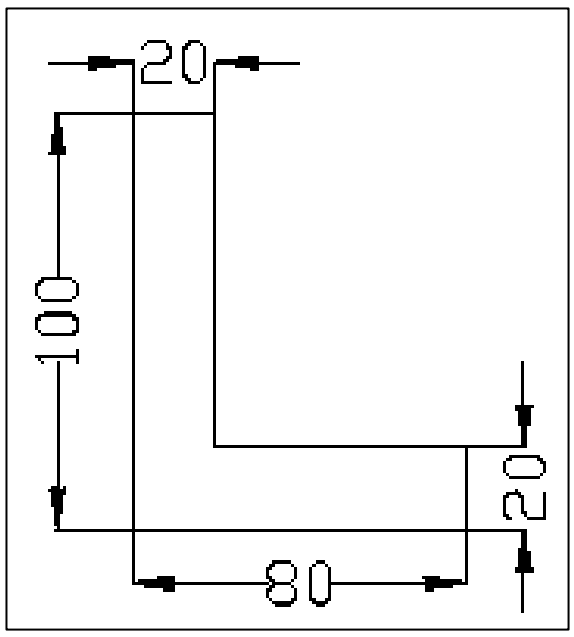
(xiii) In structural engineering, the larger the moment of inertia of a beam's cross-section, the _____ the beam's resistance to bending and deflection.

(xiv) Limiting values of Poisson's ratio are _____ and _____.

(xv) A hollow shaft will transmit _____ (more/less) power than a solid shaft of same weight and material.

Group - B

2. (a) Find the centroid of the lamina shown in Fig. 2. *[(CO3)(Analyse/HOCQ)]*



All dimensions are in mm.

Fig. 2

(b) Determine the value of moment of inertia of the section mentioned in Fig. 2 along both the axes. *[(CO4)(Remember/LOCQ)]*

6 + 6 = 12

3. (a) A rigid bar as shown in the Fig. 3 below is suspended by three vertical rods in a horizontal position. The cross sectional area of brass bar 10 mm2 and modulus of elasticity is 1×10^5 MPa. The steel bars have cross sectional area 5 mm2 and modulus of elasticity is 2×10^5 MPa. Find out stresses in these bars and the distance 'X', where the 50 kN load may be applied by keeping the bar horizontal. Compare the role of centralized control in traditional and distributed databases.

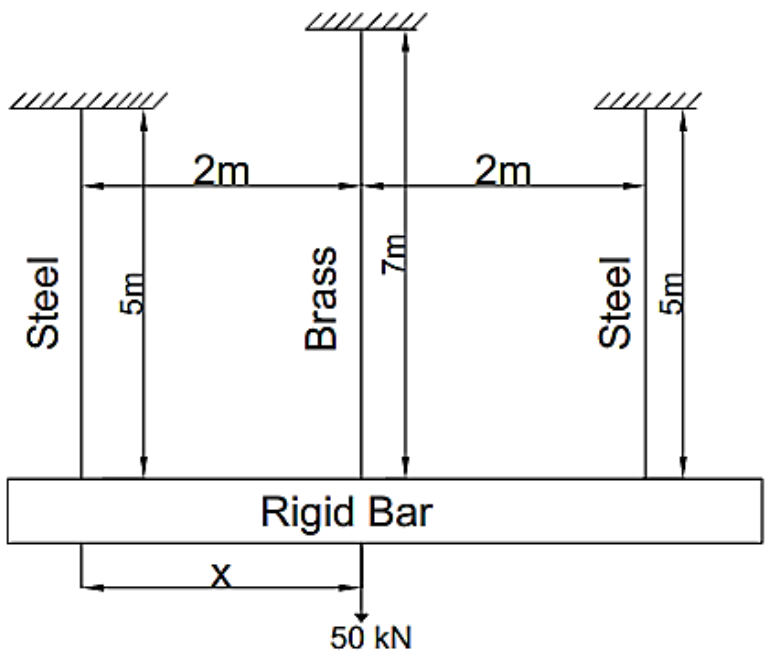


Fig. 3

[(CO1)(Analyse/HOCQ)]

(b) Find the magnitude of the force P, required to keep the 100 kg mass in the position by the string as shown in Fig. 4.

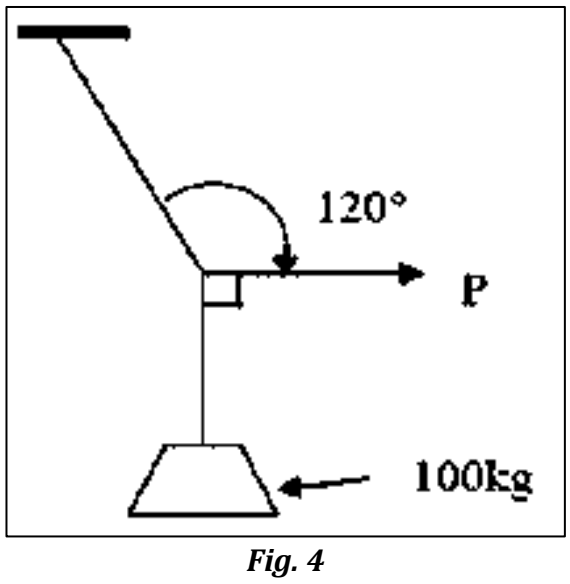


Fig. 4

[(C01)(Apply/IOCQ)]

8 + 4 = 12

Group - C

4. (a) Construct the shear force and bending moment of the following beam shown in Fig. 5. *[(CO3)(Analyse/HOCQ)]*

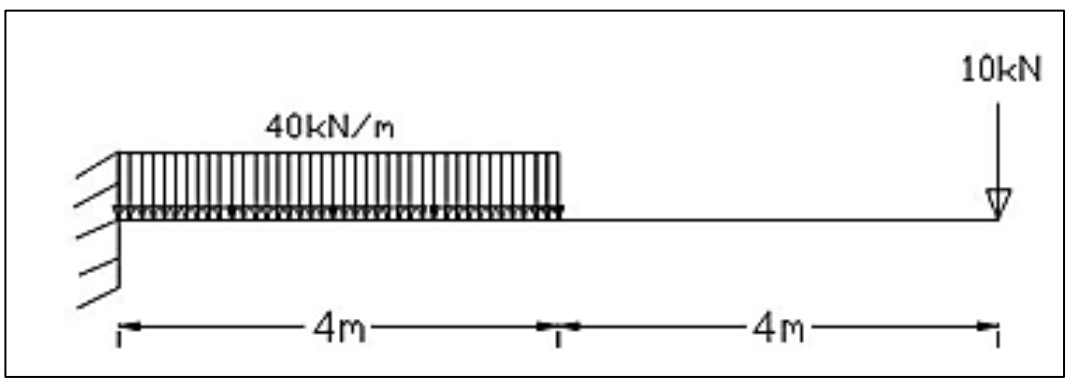


Fig. 5

(b) Construct the shear force and bending moment diagram of the following beam shown in Fig. 6. *[(CO4)(Remember/LOCQ)]*

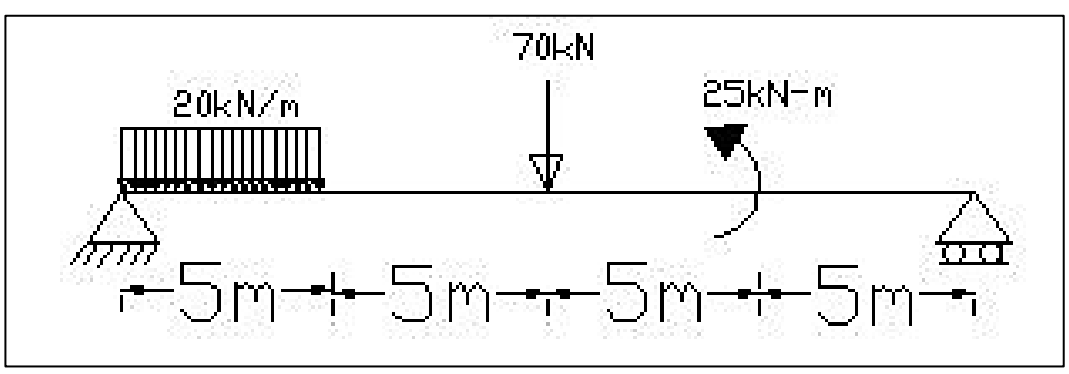


Fig.6

6 + 6 = 12

5. (a) At a point in the web of a simply supported girder, the horizontal bending tensile stress is 80 MPa and the shearing stress at the same point is 35 MPa. The inclined surface on which stresses acting is 35^0 with respect to vertical plane. Determine the following:
   (i) Principal stresses
   (ii) Maximum shear stress
   (iii) Tensile stress, which when acting alone would produce the same maximum shear stress. *[(CO3)(Analyse/HOCQ)]*

   (b) A thin cylindrical shell of thickness 5 mm and diameter 350 mm is subjected to an internal pressure which produces a strain of 1/2500 in the diameter. Find the internal pressure and the consequent hoop and longitudinal stresses. *[(CO4)(Analyse/HOCQ)]*

6 + 6 = 12

Group - D

6. (a) A simply supported beam has span 12m and depth 350mm. The section of the beam is symmetric. The moment of inertia of the beam section is 9.6×10^7 mm^4. If the permissible bending stress is 125 MPa, find (i) The safe point load that can be places at the center of the beam and (ii) The safe UDL that can be placed over the whole span of the beam. Neglect the self-weight of the beam. *[(CO3)(Analyse/HOCQ)]*

   (b) Explain the term shear flow. *[(CO2)(Apply/IOCQ)]*

10 + 2 = 12

7. (a) A solid circular shaft of diameter d =40mm, length L= 1.3m. The bar is subjected to torque T acting at the ends. If the allowable shear stress is 42 MPa and the allowable angle of twist is 2.5^0, determine the maximum permissible torque. (Assume Modulus of Rigidity (G) = 80 GPa). *[(CO5)(Analyse/HOCQ)]*

   (b) Find out the member forces in the truss as shown in Fig. 7 given below, using method of joints. *[(CO5)(Analyse/HOCQ)]*

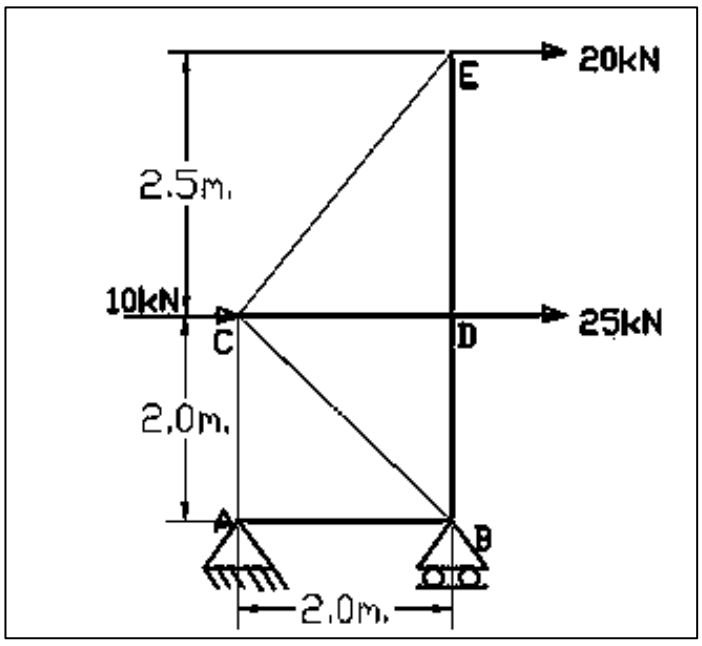


Fig. 7

4 + 8 = 12

Group - E

8. (a) Calculate the value of deflection at the mid-point and rotation at the left support of the simply supported beam as shown in Fig. 8 below using double integration method. Assume EI to be constant throughout. *[(CO3)(Analyse/HOCQ)]*

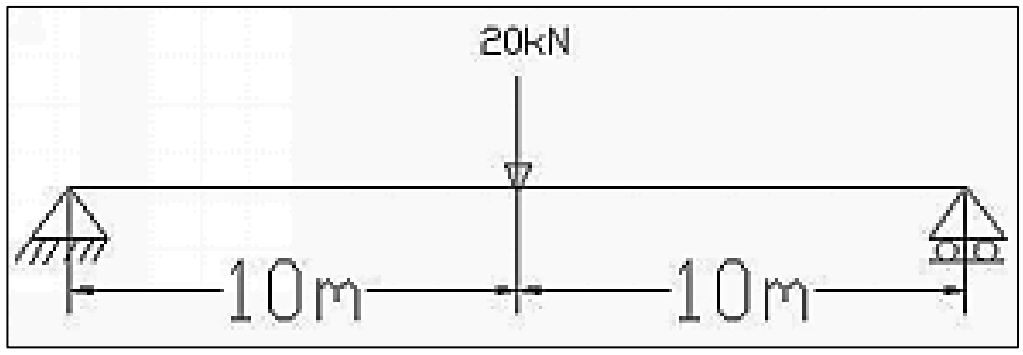


Fig. 8

(b) Derive the expression for strain energy stored in a bar due to axial load. *[(CO4)(Remember/LOCQ)]*

10 + 2 = 12

9. (a) Determine the buckling load for a strut of tee section, the flange width being 100 mm, overall depth 80 mm and the both flange and stem 10 mm thick. The strut is 3 m long and is hinged at both ends. Take, E = 200 GN/m^2. *[(CO5)(Analyse/HOCQ)]*

(b) Determine the minimum thickness required for a steel pipe column of outer diameter 160 mm. and 7.2 m. length, to carry an axial load of 200 kN. Assume a factor of safety of 2.5. Take E = 200 kN/mm^2. *[(CO5)(Analyse/HOCQ)]*

7 + 5 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	14.58	6.25	79.17