(b) A hollow shaft of external diameter 90 mm. and internal diameter 60 mm. is subjected to a torque of 8000 Nm. Find the maximum shearing stress. Find also the diameter of solid shaft to resist the same torque at the same maximum shear stress as for the hollow shaft.

7 + 5 = 12

7. (a) Show that the following relation holds true. Symbols have their usual meanings.
$M/I = \sigma/y = E/R$.

(b) Derive the expression for shear stress distribution across the cross section of a beam.

(c) Explain the term shear flow.

6 + 4 + 2 = 12

Group – E

8. (a) Evaluate the value of deflection and rotation at the midpoint (at point B) of the simply supported beam shown in Fig.6 using conjugate beam method. Assume EI between A to B is 2EI and that of B to C is EI.

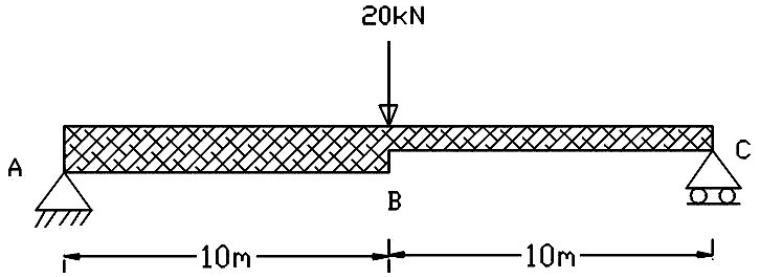


Fig. 6

(b) Derive the expression for strain energy stored in a bar due to axial load.

10 + 2 = 12

9. (a) Find out the critical load for a long column having one end fixed and other end free using Euler's theory. The column has length '*l*', uniform cross-sectional area 'A' and rigidity 'EI'.

(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.

6 + 6 = 12

FUNDAMENTALS OF STRENGTH OF MATERIALS
(CIVL 2101)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Maximum deflection of a cantilever beam carrying a point load *P* at the free end with length, *l* and Young's modulous, E and moment of inertia, I is given by
(a) $Pl/3EI$ (b) $3Pl/EI$ (c) Pl^3/EI (d) $Pl^3/3EI$.

(ii) Shear force is zero, where bending moment is
(a) Maximum (b) Minimum (c) Changes slope (d) Zero.

(iii) Point of contraflexure is that point, where
(a) bending moment diagram changes its sign
(b) shear force diagram changes its sign
(c) axial force diagram changes its sign
(d) bending moment takes a value zero.

(iv) If bending moment at any section is given by *M*, then expression for strain energy stored in a beam is
(a) $\int_0^l \frac{M^2 dx}{2E}$ (b) $\int_0^l \frac{2M dx}{EI}$ (c) $\int_0^l \frac{M dx}{2E}$ (d) $\int_0^l \frac{M^3 dx}{3EI}$

(v) Hook's law holds good upto
(a) Elastic limit (b) Proportional limit
(c) Breaking point (d) Plastic limit.

(vi) For a material to be considered incompressible, its Poisson's ratio should approach
(a) 0.25 (b) 0 (c) 0.5 (d) 1.

(vii) A material is referred to as perfectly rigid if modulus of elasticity of the material is
(a) infinity (b) zero (c) equal to carbon (d) unity.

(viii) The radius of Mohr's circle when the particle is subjected to pure shear stress τ is
(a) $\tau/2$ (b) τ (c) 2τ (d) 0.

(ix) Torque required to produce unit rotation per unit length of the shaft is expressed as
(a) EI (b) EA (c) GJ (d) GI.

(x) The ratio of critical buckling load for columns with both ends hinged to columns with both ends fixed is
(a) 0.25 (b) 4 (c) 0.5 (d) 2.

Group – B

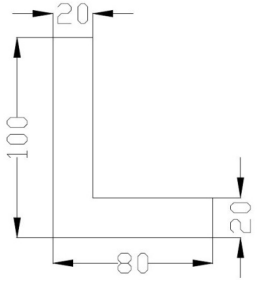
2. (a) What is ductile material and brittle material?

(b) A hollow steel cylinder of length L = 30 cm., inside diameter d = 15 cm. and uniform wall thickness t = 0.3 cm. is filled with concrete and compressed between rigid parallel plates by a load P = 50000 kg. Calculate the compressive stress in each material and the total shortening of the cylinder if modulus of elasticity of steel is 2×10^6 kg/cm^2 and modulus of elasticity of concrete is 2×10^5 kg/cm^2. Assume that, both materials obey Hooke's law.

(c) What is bulk modulus?

2 + 8 + 2 = 12

3. (a) Find the centroid of the lamina shown in fig.1.



All dimensions are in mm.
Fig. 1

(b) Draw and explain the stress-strain diagram of mild steel.

6 + 6 = 12

Group – C

4. (a) Explain the terms Hoop and meridonial stresses.

(b) Explain the relationship between applied UDL, shear force and bending moment.

(c) The principal stresses at a point inside a loaded body shown in Fig.2 are 100 N/mm^2 and 75 N/mm^2. Find the normal, tangential and resultant stresses across a plane passing through 60^0 to the plane of 100 N/mm^2 stress.

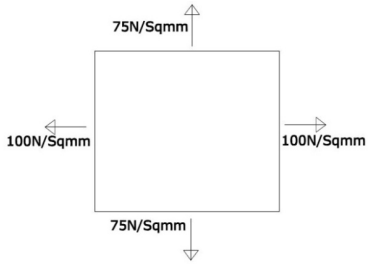


Fig. 2

2 + 3 + 7 = 12

5. Construct the shear force and bending moment of the following beams shown in Fig.3 and Fig.4.

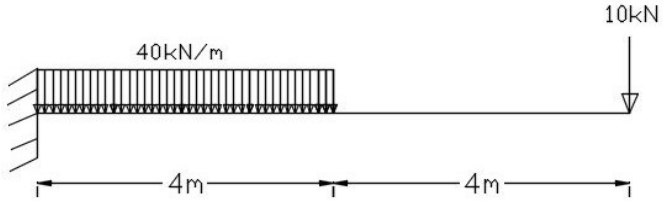


Fig. 3

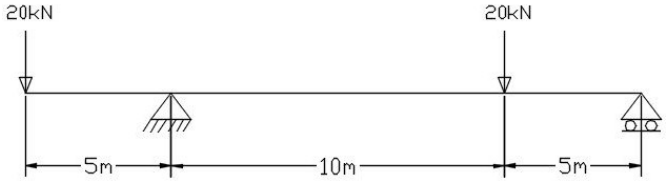


Fig.4

(6 + 6) = 12

Group – D

6. (a) Determine the forces in the various members of the truss shown in Fig.5.

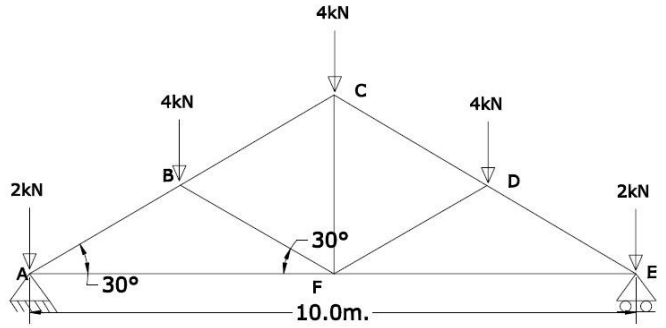


Fig.5