Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH (CE-OLD)/SEM-3/CE-304/2011-12

2011
STRUCTURAL MECHANICS

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

[Graph sheet(s) will be supplied by the institution on demand]

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) The strain energy stored in a body due to shear stress (q) is given by, with usual notation

a) $U = \frac{q}{2C} \times V$ b) $U = \frac{2C}{q} \times V$

c) $U = \frac{q^2}{2C} \times V$ d) $U = \frac{q^2}{2C} \times \frac{1}{V}$.

ii) The relation between modulus of elasticity (E), modulus of rigidity (C) and bulk modulus (K) is expressed as,

a) $E = \frac{3KC}{3K + C}$ b) $E = \frac{9KC}{3K + C}$

c) $E = \frac{9K}{3K + C}$ d) none of these.

iii) The normal stress corresponding to zero shear stress is known as

a) hoop stress b) principal stress

c) longitudinal stress d) tensile stress.

iv) The rate of change of bending moment with distance is

a) deflection

b) uniformly distributed load

c) shear force

d) slope.

v) A simply supported beam of length 3m carries a concentrated load of 12KN at a distance of 1 m from left support. The maximum bending moment in the beam is

a) 12KNm b) 24KNm

c) 8KNm d) 20KNm.

vi) The maximum bending moment in a simply support beam of span l and carrying a.u.d.l of intensity w per unit length is

a) $\frac{wl}{4}$ b) $\frac{wl^2}{8}$

c) $\frac{wl}{8}$ d) $\frac{wl^2}{2}$.

vii) Which is the correct bending formula ?

a) $\frac{M}{I} = \frac{Y}{I} = \frac{E}{R}$ b) $\frac{M}{I} = \frac{f}{I} = \frac{E}{R}$

c) $\frac{M}{I} = \frac{f}{E} = \frac{I}{y}$ d) $\frac{M}{E} = \frac{I}{R} = \frac{f}{y}$.

viii) When a beam is loaded transversally the maximum tensile stress shall develop at

a) the bottom fibres b) the top fibres

c) the neutral axis d) no where.

ix) In a closed – coiled helical spring the angle of helix is

a) more than 5^0 b) equal to 5^0

c) less than 5^0 d) equal to zero degree.

x) In a thin cylindrical pressure vessel the ratio of hoop to longitudinal stress is

a) 4 b) 1/4

c) 1/2 d) 2.

xi) The volumetric strain in a thin spherical pressure vessel is

a) $\frac{3\sigma_\theta}{E}(1-2\gamma)$ b) $\frac{3\sigma_\theta}{E}(1-\gamma)$

c) $\frac{\sigma_\theta}{3E}(1-2\gamma)$ d) $\frac{\sigma_\theta}{3E}(2.5-2\gamma)$.

xii) Equivalent length of a Chimney of height 20m is

a) $20\sqrt{2}$ b) 40

c) 10 d) $\frac{20}{\sqrt{2}}$.

xiii) The Young's modulus E, The shear modulus G and the Poisson's Ratio μ are related by

a) E = 2G(1-μ) b) E = 2G(1 + 2μ)

c) E = 2G(1 + μ) d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Define thin pressure versed.

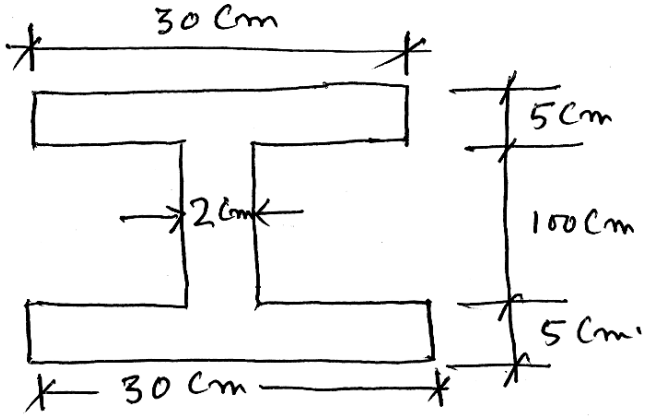
   Prove that hoop stress in a thin cylindrical vessel is $\sigma\theta = \frac{pR}{h}$

   Where h = wall thickness

   p = internal pressure

   R = mean radius 1 + 4

3. A built up beam as shown in figure is simply supported at ends. Compute its length given that when it is subjected to a load of 40KN per metre length, it deflects by 1 cm. Find out the safe load if this beam is used in a column with both end fixed. Assume a factor of safety of 4. Use Euler's formula E = 210GPa



4. Find out the slope and deflection of a simply supported beam carrying of a simply supported beam carrying a uniformly distributed load over the whole span.

5. When a bar of certain material, 4cm × 4cm in cross-section, is subjected to a pull of 160 kN the extension on a gauge length of 20cm is 0.01cm and decrease in each side of the section is 0.0005cm. Calculate the Young's modulus of Elasticity "E", Poisson's ratio "μ", modulus of Rigidity "G", and bulk modulus of Elasticity "K" of the material.

6. Compare the crippling loads given by Euler's and Rankine's formulae for a tubular steel strut, 2.5m long and having outer and inner diameters of 4.0 cm & 3.5 cm respectively. Assume pin-ended conditions both at top and bottom.

   Given : Yield stress in compression = 320 Mpa, Young's modulus = 2×10^5 Mpa.

7. A beam of circular cross-section of diameter "d" is simply supported on a span of 8m. A load of 2 kN is applied at a distance of 3m from one end. Determine the diameter of the section if maximum bending stress developed in the beam is 90.54 Mpa.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

8. a) In testing a 10mm diameter mild steel bar in tension it was found that a load of 10.5 kN caused an extension of 0.125 mm on a gauge length 200mm. The maximum load was 37.48 kN and the load beyond which stress strain was not proportional was 19.6 kN. The extension

of the 200 mm length was 39 mm and the diameter at fracture was 7.7 mm. Find

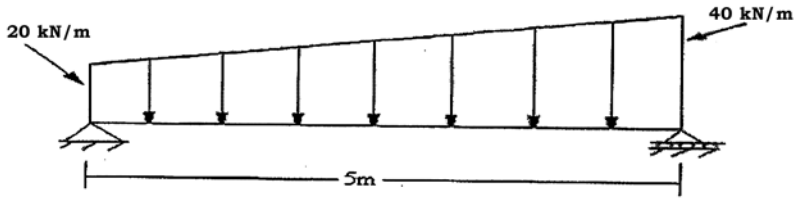
(i) limit of elasticity (ii) Young's modulus (iii) percentage elongation at fracture (iv) percentage reduction and (v) tensile strength of mild steel.

b) A reinforced concrete column has square section of side 0.5 m and has four steel rods of 25 mm diameter. Find the stress in the steel and concrete when the column carries a load of 2 MN. Take m (modular ratio) for steel and concrete as 15. 8 + 7

9. a) The principal tensile stresses at a point across two perpendicular planes are 100N/mm^2 and 60 N/mm^2. Find the normal and tangential stresses and its obliquity on a plane at 20° with the major principal plane and also draw the corresponding Mohr's circle of stress.

b) A thin cylindrical shell of 400 mm diameter is to be designed for an internal pressure of 2.4 MPa. Find the suitable thickness of the shell, if the allowable hoop stress is 50 MPa. 10 + 5

10. Draw the bending moment and shear force diagrams for the beam as shown in the figure :



11. a) Deduce an expression for shear stress distribution in a beam of circular cross-section.

    b) A beam of I – section 50cm deep and 20 cm wide, has equal flange 2cm thick and web 1cm thick. It carries at a cross–section a shear force of 200kN. Determine the maximum shear stress distribution in the beam and the ratio of maximum shear to mean shear. 7 + 8

12. a) What are the assumptions are made in Euler's theory of buckling of columns ?

    b) Deduce an expression to find out the critical load / Euler load and Euler stress for a column hinged at both end. 6 + (6 + 3)