Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH (CE-NEW)/SEM-3/CE-301/2011-12

2011
SOLID 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.

GROUP – A
(Multiple Choice Type Questions)

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

   i) The ratio of maximum normal stress to the maximum shear stress in an axially loaded bar is

   a) 1.0 b) 0.5

   c) 2.0 d) 3.0.

   ii) 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) 0.0 d) σ_1.

   iii) The ratio of longitudinal stress to circumferential stress in a thin cylindrical pressure vessel is

   a) 1 b) 0.5

   c) 2 d) 0.25.

iv) To solve a truss problem by the method of joints, the number of unknowns at a joint should not be

a) less than 2 b) more than 2

c) less than 3 d) more than 3.

v) When a bar of length l, width b and thickness t is subjected to a tensile force along its longitudinal axis, its

a) l, b and t all increase

b) l increases, but b and t decrease

c) l decreases, but b and t increase

d) t decreases, but l and b increase.

vi) 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.

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

a) hoop stress b) principal stress

c) longitudinal stress d) tensile stress.

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

a) deflection

b) uniformly distributed load

c) shear force

d) slope.

ix) The bending moment on a section is a maximum or a minimum where the shearing force

a) is zero b) is a minimum

c) is a maximum d) changes its sign

x) The bending stress on a section of a T-beam in case of sagging bending moment is maximum at

a) top fibre b) centroid

c) bottom fibre d) none of these.

xi) Euler's buckling load for a column of length l, fixed at one end and hinged at the other will be given by

a) $\pi^2 EI/(2l^2)$ b) $\pi^2 EI/(4l^2)$

c) $4\pi^2 EI/l^2$ d) $2\pi^2 EI/l^2$.

xii) The length, coefficient of thermal expansion and Young's modulus of bar 'A' are twice that of 'B'. If the temperature of both the bars is increased by the same amount while preventing any expansion, the ratio of stress developed in bar 'A' to that in 'B' will be

a) 2 b) 4

c) 8 d) 16.

xiii) Two closed thin vessels, one cylindrical and the other spherical, with equal internal diameter and wall thickness are subjected to equal internal fluid pressure. The ratio of hoop stresses in the cylindrical vessel to that of spherical one is

a) 4 b) 2

c) 1 d) 0.5.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Prove that volumetric strain for cylindrical pressure vessel is given as $e = pr(5 - 4\mu)/2tE$. The symbols are of their usual meaning.

3. Prove $M/I = \sigma/Y = E/R$. The symbols are of their usual meaning.

4. A mass M is hung by two steel wires as shown in fig. 1. The cross-sectional area of wire AB = 200 sq. mm and BC = 400 sq. mm. If the allowable tensile stress of wire material is 100 MPa, what mass M can be safely supported by the wires ?

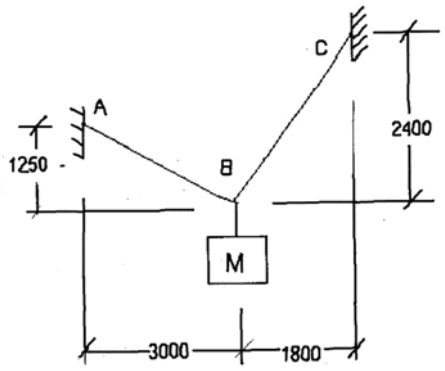

Fig. 1

5. A bill-board supporting steel truss is shown in fig. 2. The cross-sectional area of all members is 100 mm^2. Calculate the stress in each member due to horizontal forces as indicated. The truss joints are pinned.

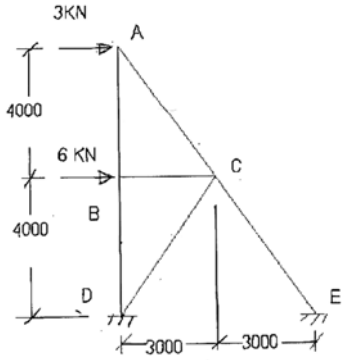

Fig. 2

6. A cantilever beam *AB* of span *L* and constant cross-section is fixed at *A* and free at *B*. It is subjected to a u.d.l. of intensity *W*. If *E* be the Young's modulus of the beam material and *I* is the moment of inertia of the beam cross-section about the axis of bending, show that the free end deflection of this beam at B is given by $WL^4/(8EI)$.

7. A mild steel specimen tested in tension has the following data : Diameter = 2 cm, Gauge Length = 20 cm, Extension under 10 kN load = 0.0032 cm, Yield point load = 82 kN, Maximum load = 133kN, Length after fracture = 25.2 cm, Diameter at neck = 1.26 cm. Calculate Young's modulus, yield point stress, ultimate stress, percentage elongation. percentage reduction in area, maximum permissible stress with a factor of safety of 2. Based on the above permissible stress, what is the safe maximum tension of a rod 10 mm in diameter ?

   What will be its elongation if the length of the rod is 2.5 m ?

GROUP – C

(Long Answer Type Questions)

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

8. a) 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.

   b) Calculate the magnitude and nature of the forces in the members of the truss shown in Fig. 3 :

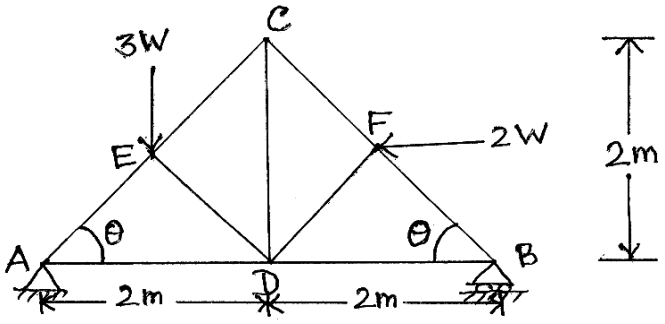

Fig. 3 7 + 8

9. a) The principal tensile stresses at a point across two perpendicular planes are 100 N/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. a) What is Hoop stress and how is it related to longitudinal stress in thin cylindrical pressure vessel ? What is the maximum value of it in plane shear stress for cylindrical pressure vessels ?

b) A spherical stainless steel tank having a dia. of 400 mm is used to store propane gas at a pressure of 2.4 MPa. The yield stress of steel in tension is 112 MPa. E = 200 GPa and μ = 0.28. Also the normal strain must not exceed 1000×10^{-6}. Determine the minimum permissible thickness of the tank. 6 + 9

11. a) What are the maximum normal and shear stresses in an axially loaded bar ? What is the relation between the two ?

b) An elastic steel bar of variable cross-section is subjected to axial loads as shown in fig. 4. The cross-sectional area of AB, BC and CD are 1000 sq. mm, 2000 sq. mm and 1000 sq. mm respectively. Evaluate the elongation of the bar. Take $E = 2 \times 10^5$ MPa.

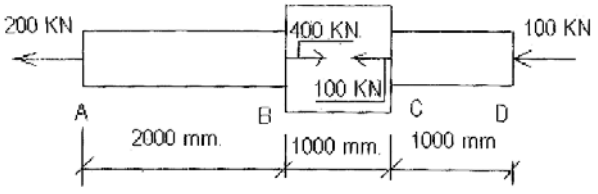

Fig. 4 5 + 10

12. Draw the bending moment and shear force diagrams for the beam as shown in Fig. 5.

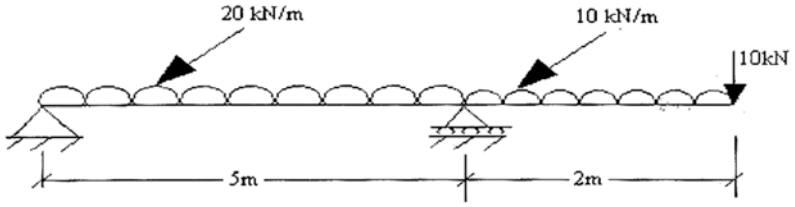

Fig. 5

13. A hollow closed cylindrical shell made of 1 cm thick steel plate, 2 m long, has an internal diameter of 1000 mm. If it is subjected to an internal fluid pressure of 2 MPa, find the magnitudes of hoop (circumferential) stress and meridional (longitudianal) stress. What are the values of change in diameter and length of the shell ? Also, find the value of change in volume of the shell.