Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech/(CE)OLD/SEM-3/CE-304/2012-13

2012

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.

GROUP – A
(Multiple Choice Type Questions)

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

   i) The shear force on a beam and the displacement are related by

   a) $V = EI \frac{d^2 y}{dx^2}$ b) $V = EI \frac{d^3 y}{dx^3}$

   c) $V = EI \frac{d^4 y}{dx^4}$ d) Not related.

   ii) When a bar of length '*l*', width '*b*' and thickness '*t*' is subjected to a tensile force along its longitudinal axis, its

   a) length, width and thickness increase

   b) length increases, width and thickness decrease

   c) length decreases, width and thickness increase

   d) thickness decreases, length and width increase.

iii) Intersecting points of Mohr's circle with X axis represents

a) principal stresses

b) normal stresses on planes at 45°

c) shear stresses on planes at 45°

d) none of these.

iv) When a bar is subjected to a change of temperature and its deformation is prevented, the stress induced in the bar is

a) tensile stress b) compressive stress

c) shear stress d) thermal stress.

v) When a body is subjected to a direct tensile stress in one plane only, the ratio of the maximum shear stress developed to the applied tensile stress is

a) 1 b) 1/2

c) 2/3 d) 2.

vi) A beam extending beyond the supports is called

a) simply supported beam

b) fixed beam

c) cantilever

d) over hanging beam.

vii) Euler's formula holds good only for

a) short columns

b) long columns

c) both short and long columns

d) medium columns only.

viii) A thin cylindrical shell of diameter '*d*', length '*l*' and thickness '*t*' is subjected to an internal pressure '*p*'. The hoop stress in the shell is

a) $\frac{pd}{t}$ b) $\frac{pd}{2t}$

c) $\frac{pd}{4t}$ d) None of these.

ix) The maximum deflection of a cantilver beam of length *L* subjected to a UDL of *w* / unit length over the span is

a) $\frac{wL^3}{3EI}$ b) $\frac{wL^3}{8EI}$

c) $\frac{wL^3}{48EI}$ d) $\frac{5wL^3}{384EI}$.

x) In a thin cylindrical shell, the ratio of longitudinal stress to hoop stress is

a) 0·5 b) 1·0

c) 2·0 d) 4·0.

xi) The slenderness ratio is the ratio of

a) effective area of column to least radius of gyration

b) least radius of gyration of column cross-section to effective area of column cross-section

c) least radius of gyration to effective length of column

d) effective length to least radius of gyration.

xii) 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.

xiii) The maximum shearing force of a cantilever of span *'l'* carrying uniformly distributed load of *'w'* per unit length is

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

c) wl d) None of these.

GROUP – B
(Short Answer Type Questions)

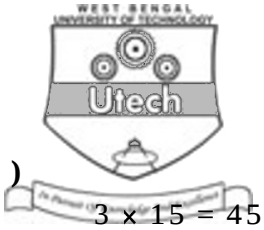
Answer any *three* of the following. 3 × 5 = 15

2. A short reinforced concrete column 250 mm × 250 mm in cross-section has 4 number of 20 mm diameter bars. This column is subjected to an axial compressive load of 300 kN. Find the stresses in steel and concrete if the modular ratio of steel to concrete is 12. What will be the safe maximum value of load according to the elastic theory, if the stresses in concrete and steel are not to exceed 6 MPa and 120 MPa respectively ?

3. A cantilever beam made of a rectangular section, $b \times d$, has a span of 1·5 m. It is subjected to a concentrated load '*W*' at the free end. If the deflection of the beam is not to exceed span/250, find the safe maximum value of the concentrated load '*W*'. Given $E = 2 \times 10^5$ MPa, width $b = 4$ cm, depth $d = 10$ cm.

4. A long column of square cross-section has a slenderness ratio of 128·25. Euler's buckling load for this column is 48 k N. If Young's modulus is equal to 2×10^5 MPa, find the cross-sectional dimension of the column.

5. An element of a beam above its neutral axis is subjected to a horizontal axial tensile stress of 80 MPa and a shear stress of 40 MPa. What are the values of principal stresses in this element ? Show the principal stresses in Mohr's circle through a sketch.



GROUP – C
(Long Answer Type Questions)

Answer *all* of the following. 3 x 15 = 45

6. A mild steel specimen tested in tension has the following data :

   Diameter = 2 cm, Gauge length = 20 cm. Extension under a load of 10 kN = 0·0032 cm, yield point load = 82 kN, maximum (ultimate) load = 133 kN, length after fracture = 25·2 cm, diameter at neck after fracture = 1·26 cm.

   Calculate : Young's modulus, yield point stress, ultimate stress, percentage elongation, percentage reduction in stress, percentage reduction in area, working stress with a factor of safety of 2. Also, calculate the permissible maximum tension in a rod of 8 mm diameter & elongation of this rod if its length is 2·5 m.

7. A wooden beam 150 mm × 250 mm depth is simply supported over a span of 5 m. When a concentrated load W is placed at a distance a, ($a < 2{\cdot}5$ m), from the left hand support, the maximum bending and shearing stresses developed in the beam are respectively 3 MPa & 0·3 MPa. Find the value of the load W and the distance a.

8. A hollow shaft 40 cm external diameter and 20 cm internal diameter is subjected to a twisting moment of 400 kNm. If $G = 8 \times 10^4$ MPa, find the maximum shear stress in the shaft. Determine the twist in a length of 10 times the external diameter. Find also the shear stress at the inside edge of the shaft and draw the diagram showing the variation of shear stress through the wall of the shaft.