Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech/CE(N)/SEM-3/CE-301/2012-13

2012

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) B.M. in a beam section will be maximum where

a) shear force is zero

b) shear force is maximum

c) shear force changes sign

d) shear force is constant.

ii) A cantilever of length *' l '* carries a concentrated load *'W'* at the free end. If the length of the cantilever is doubled, the new value of a concentrated load at the free end producing the same deflection as before will be

a) $W/8$ b) $W/6$

c) $W/4$ d) $4W$.

iii) The radius of Mohr's circle for two equal but unlike principal stresses of magnitude σ is

a) $\sigma / 4$ b) $\sigma / 2$

c) σ d) none of these.

iv) For a set of concurrent (meeting at a point) forces acting on a rigid body, necessary and sufficient conditions for equilibrium is

a) $\sum V = \sum M = 0$ b) $\sum M = \sum H = 0$

c) $\sum V = \sum H = 0$ d) none of these.

v) Bending moment at supports in case of simply supported beams is always

a) less than unity b) more than unity

c) zero d) none of these.

vi) When a circular shaft of radius r is subjected to a given torque, then shear strain is ϕ proportional to

a) $1/r$ b) r

c) r^2 d) r^3.

vii) Maximum deflection of a simply supported beam of span L loaded with uniformly distributed load w per unit length is

a) $\frac{wL^3}{48EI}$ b) $(5/384)\frac{wL^4}{EI}$

c) $\frac{wL^4}{6EI}$ d) $(5/384)\frac{wL^3}{EI}$.

viii) A bar is under axial stress of 40 MPa. The maximum shear stress in the bar is

a) 0 MPa b) 5 MPa

c) 10 MPa d) 20 MPa.

ix) The effective slenderness ratio of a cantilever column of length L is

a) $0{\cdot}5\ L/r$ b) L/r

c) $\sqrt{2}\ L/r$ d) $2\ L/r$.

x) A truss hinged at one end, supported on rollers at the other, is subjected to horizontal load only. Its reaction at the hinged end will be

a) horizontal

b) vertical

c) resultant of horizontal and vertical.

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

a) 0·5 b) 1·0

c) 2 d) 2·5.

xii) Torsional rigidity of a shaft is given by

a) $\frac{T}{J}$ b) $\frac{T}{\theta}$

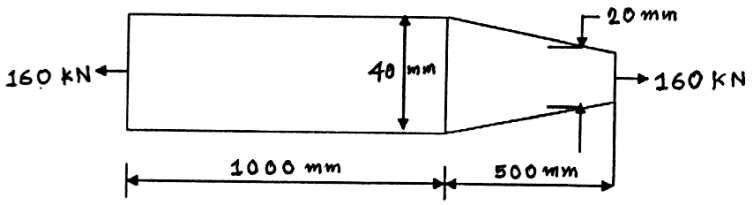
c) $\frac{T}{G}$ d) none of these.

GROUP – B

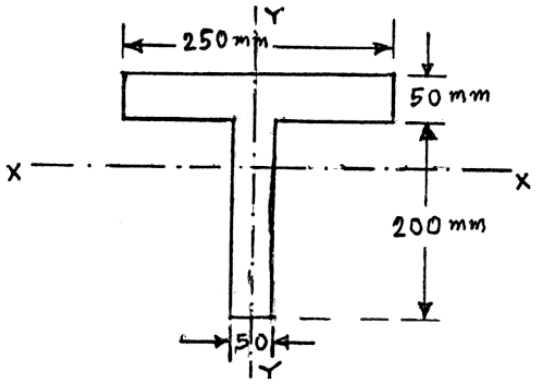
(Short Answer Type Questions)

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

2. A 1·5 m long steel bar is having uniform diameter of 40 mm for a length of 1 m and in the next 0·5 m its diameter gradually reduces from 40 mm to 20 mm as shown. Determine the elongation of this bar when subjected to an axial tensile load of 160 kN. Given E = 200 GN/m^2.



3. Determine the second moment of area of a T-section shown below about both the horizontal and the vertical axes passing through the centroid.



4. A rectangular beam 200 mm wide and 300 mm deep carries a uniformly distributed load of 10 kN/m over a simply supported span of 6 m. Determine

   i) the maximum stress in the beam due to bending

   ii) the radius of curvature for the section where bending is maximum if the modulus of elasticity is 200 GPa.

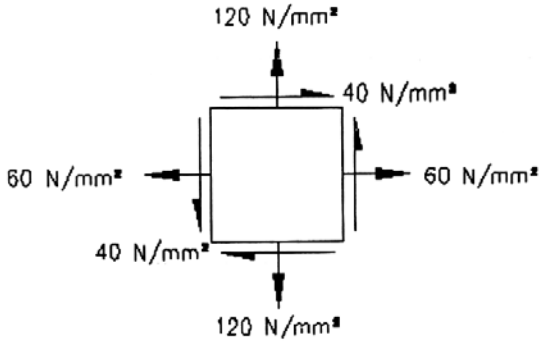
5. Wall thickness of a cylindrical shell of 800 mm internal diameter and 2 m long is 10 mm. If the shell is subjected to an internal pressure of 1·5 MPa, find the following :

   i) The maximum intensity of shear stress induced

   ii) The change in dimensions (*i.e.* internal diameter and length) of the shell. Take E = 2·05 GPa and Poisson's ratio = 0·3.

6. A cantilever beam of span L, flexural rigidity EI is subjected to a hogging bending moment M at the free end. Calculate the maximum deflection by direct integration.

7. The state of stress at a point in a strained material is shown in figure. Determine the principal stresses and maximum shear stress.



GROUP – C

(Long Answer Type Questions)

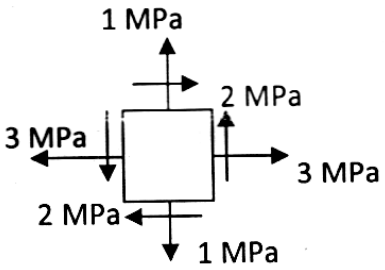
Answer any *three* of the following. $3 \times 15 = 45$

8. a) What is the value of maximum strain in spherical pressure vessel and what is the value of in-plane shear stress in spherical pressure vessels ?

   b) The cylindrical pressure vessel with hemispherical end caps is made of steel. The vessel has a uniform thickness of 20 mm and an outer dia of 400 mm. When the vessel is pressurized to 4·5 MPa, determine the change in the overall length of the vessel. Take E = 200 GPa, μ = 0·3. 6 + 9

9. a) What are More's circle of stress, principal planes and principal stresses ?

b) The state of stress for an element is shown in figure below :



i) Find the principal stresses and show their sense on a properly oriented element.

ii) Find the maximum shear stresses with the associated normal stresses and show the results on a properly oriented element. 5 + 10

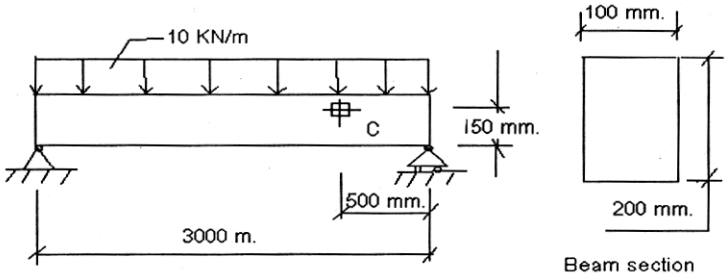
10. A steel shaft is to be manufactured either as a solid circular bar or as a circular tube. A torque of 1500 N-m is to be resisted without exceeding a shear stress of 50 MPa and an angle of twist of 1°/m.

a) Determine the required dia of solid shaft.

b) Determine the required dia of hollow shaft if the thickness is 1/10th of outer dia.

c) Find the ratio of diameters between hollow and solid shafts & ratio of weights between hollow and solid shafts and give your comment. G = 78 GPa.

11. A simply supported beam as shown in figure is subjected to u.d.l. of 10 kN/m including its own weight. Determine the normal & shear stresses at point *'C'*. Also find maximum normal & shear stresses.

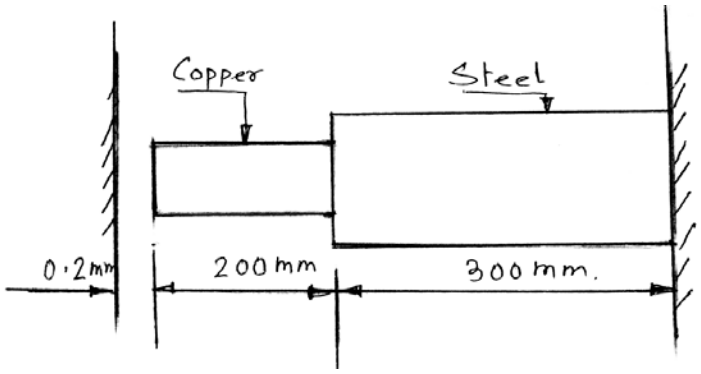


12. a) The composite bar as shown in the figure is 0·2 mm short of distance between the rigid supports at room temperature. What is the maximum temperature rise which will not produce stress in the bar ? Find the stresses included when the temperature rise is 40°C.

Given $A_s : A_c = 4:3, \alpha_s = 12\times10^{-6}/°C$ and

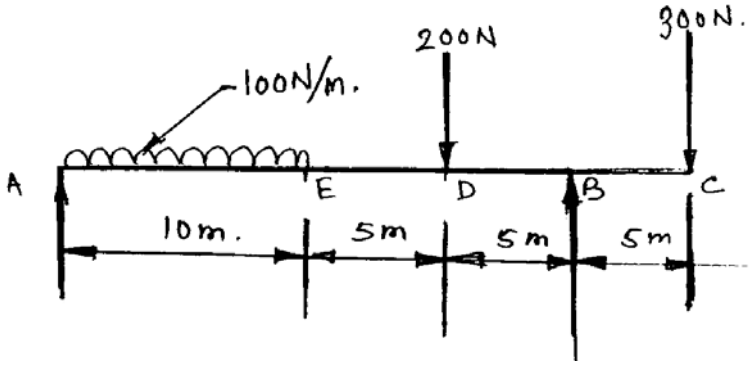
$\alpha_c = 17\cdot5\times10^{-6}/°C$, $E_s = 2\times10^5\ \text{N/mm}^2$ and

$E_c = 1\cdot2\times10^5\ \text{N/mm}^2$.



b) 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 $E = 200\,\text{GN/m}^2$. 8 + 7

13. A beam 25 m long is supported at *A* and *B* and loaded as shown in the figure. Sketch the SF and BM diagrams and find (i) the position and magnitude of maximum BM and (ii) the position of the point of contraflexure.



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