Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(ME)(N)/PE(N)/PWE(N)/AUE(N)
/SEM-3/ME-302/2011-12

2011

STRENGTH OF MATERIALS

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 the following : $10 \times 1 = 10$

   i) The shear stress on the principal plane is

   a) $(\delta_x + \delta_y)/2$ b) $(\delta_x - \delta_y)/2$

   c) $(\delta_x + \delta_y)$ d) zero.

   ii) If a closed coil helical spring of axial stiffness k is cut to one-fourth, the axial stiffness changes to

   a) $k/4$ b) k

   c) $k/2$ d) $4k$.

iii) A point of contraflexure in a beam occurs at a point where

a) B.M. changes sign

b) S.F. changes sign

c) loading becomes zero

d) B.M. and S.F. become zero.

iv) Power transmitted by a shaft rotating at N rpm under a mean torque of T (Nm) is

a) $2\pi NT/60$ watts b) $2\pi NT/60$ kilowatts

c) $2\pi NT/60$ hp d) none of these.

v) Normal stress on an oblique plane inclined at angle 45° to the axis of a bar of square cross-section of side s when acted upon by a tensile force P is

a) P/s^2 b) $2P/s^2$

c) $P/2s^2$ d) $P/4s^2$.

vi) In a thin spherical shell, the hoop stress is generally given by (P is the pressure, d is the diameter and t is the thickness)

a) $Pd/4t$ b) $Pd/2t$

c) Pd/t d) $2Pd/t$.

vii) The stress in a body if suddenly loaded is ..... the stress induced, when the same load is applied gradually.

a) one-half b) equal to

c) twice d) four times.

viii) Rankine's formula is applicable to

a) long column b) short column

c) both (a) and (b) d) none of these.

ix) When a material is stressed to the point of failure, then the strain energy density is called

a) resilience b) toughness

c) modulus of resilience d) modulus of toughness.

x) The dimensions of Young's modulus of elasticity is given by

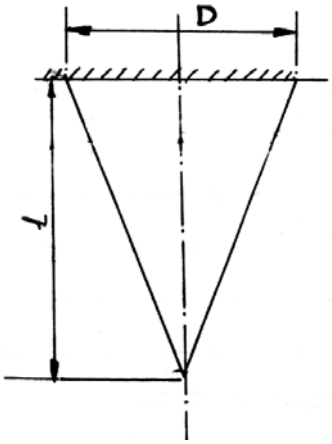
a) $M^1L^{-1}T^{-2}$ b) $M^1L^{-1}T^{-1}$

c) $M^1L^{-2}T^{-2}$ d) $M^1L^{-1}T^{-3}$.

GROUP – B
(Short Answer Type Questions)

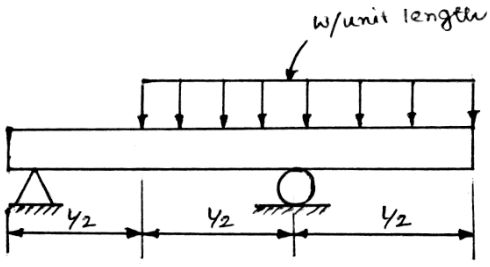
Answer any *three* of the following $3 \times 5 = 15$

2. A solid conical rod of base diameter D is suspended from the roof as shown in figure. Find the deflection of the free end due to its own weight if the specific gravity and modulus of elasticity are ρ and E respectively.



3. Two elastic bars are of equal length and of same material. One of the circular cross section is of 80 mm dia and the other is of square cross section of 80 mm side. Both absorb the same amount of strain energy, under axial forces. Compare the stresses in the 2 bars.

4. Construct shear force and bending moment diagrams for the simply supported beam with overhangs, loaded as shown in figure.



5. A cast-iron pipe of 750 mm diameter is used to carry water under a head of 60 m. Determine the thickness of the pipe if the permissible stress is to be 20 MPa.

6. Find out the expression of Euler's critical load for column, the ends of which are both fixed.

GROUP – C
(Long Answer Type Questions)

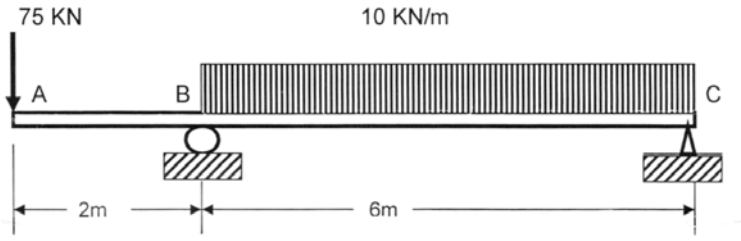
Answer any *three* of the following. $3 \times 15 = 45$

7. i) Deduce relation between Young's modulus (E), modulus of rigidity (G) and Poisson's ratio (γ). 7

   ii) Three tubes A, B and C are fitting loosely one over the other. Tube A is inside and tube C is outside. Each tube has a thickness of 10 mm and length 300 mm. Inner tube A has an internal diameter of 100 mm. If an axial thrust of 150 kN is applied, find for each tube (a) load carried, (b) stress developed and (c) shortening due to load. Take E_A = 200 GPa, E_B = 100 GPa and E_C = 50 GPa. 8

8. a) State the theorems of Area-moment method. Also mention its specific use in the deflection analysis of beams. 3 + 2

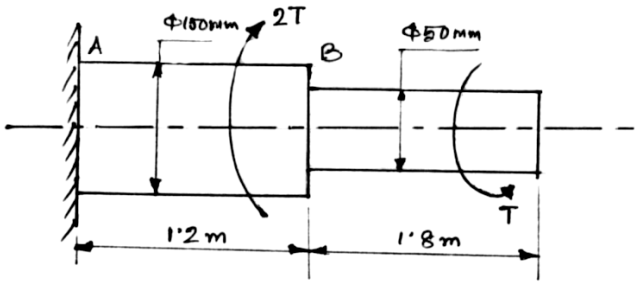
   b) A beam ABC of length 8 metres is supported and loaded as shown in figure. Calculate (i) the defection at A, (ii) slope at B and (iii) the maximum deflection of the beam. 10



9. a) An element in a strained body is subjected to a tensile stress of 150 MPa and a shear stress of 50 MPa tending to rotate the element in an anticlockwise direction. Find (i) the magnitude of the normal and shear stress on a section included at 40° with the tensile stress and (ii) the magnitude and direction of maximum shear stress that can exist on the element. 8

b) Derive an expression for the bending stress on the extreme fibres of a bar having a small initial curvature, starting the assumptions made. 7

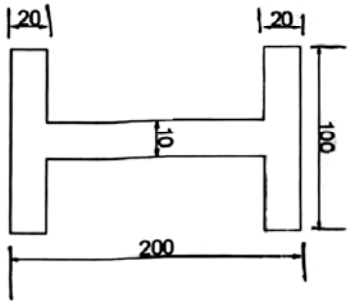
10. a) The stepped steel shaft is shown in figure is subjected to a torque (T) at the free end and torque ($2T$) in the opposite direction at the junction of the two sizes. What is the total angle of twist at the free end, if max shear stress in the shaft is limited to 70 MPa ? Assume the modulus of rigidity to be 84GPa. 7



b) Two closed coiled helical springs wound from the same wire, but with different core ratio having equal no. of coils are compressed between rigid plates at their ends. Calculate the max shear stress induced in each spring, if the wire diameter is 10 mm and the load applied between the rigid plates is 500. The core radius of the springs are 100 mm and 75 mm respectively. 8

11. a) Find the load carrying capacity of a column according to Rankine-Gordon formula. 7

b) A steel column with I section of dimensions given in the figure deflects 12 mm when used as a simply supported beam carrying a uniformly distributed load of 50 kN/m. Find what axial compression load can it carry when used as a column fixed at both ends. Use Euler's formula with a factor of safety = 3. Given E = 200 GN/m^2. 8



(All dimensions are in mm)

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