B.Tech/CE/3rd Sem/CIVL-2102/2015

2015

STRENGTH OF MATERIAL

(CIVL 2102)

Time Alloted : 3 Hours *Full Marks : 70*

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable

GROUP - A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : **[10×1=10]**

   i) If Poisson's ratio of a material is μ, then the relation between Modulus of Elasticity (E) and Bulk Modulus (K) is given by

   (a) $E = 3K(1 - 2\mu)$ (b) $E = 2K(1 - \mu)$

   (c) $E = K(1 + 2\mu)$ (d) $E = 3K(2 + \mu)$

   ii) If τ_{avg} and τ_{max} are the average and maximum shear stress developed in a beam of rectangular cross section, then τ_{max} is equal to

   (a) $1.5\tau_{avg}$ (b) $2\tau_{avg}$

   (c) $3\tau_{avg}$ (d) $4\tau_{avg}$

iii) A prismatic steel bar, 25cm long and cross sectional area, 12.5cm^2 , is subjected to axial compressive forces, P = 2000 kg. If, E = 2×10^6 kg/cm^2, then the amount of stain energy developed in the bar is

(a) 1 kg-cm (b) 10 kg-cm

(c) 5 kg-cm (d) 2 kg-cm

iv) If σ_1 and σ_2 are major and minor principal stresses, then the maximum value of shear stress is given by

(a) $(\sigma_1 - \sigma_2)/3$ (b) $(\sigma_1 - \sigma_2)/2$

(c) $(\sigma_1^2 - \sigma_2^2)/2$ (d) $(\sigma_1 - \sigma_2)/4$

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

(a) 0.5 (b) 1.0

(c) 2.0 (d) 2.5

vi) A circular bar is subjected to a tonque 'T'. the polar moment of inertia of the bar is 'J' and modulus of rigidity of the material is 'G'. If the angle of twist is 'θ', then the torsional rigidity of the bar is,

(a) T/J (b) T/θ

(c) T/G (d) None of these

vii) The rate of change of bending moment is

(a) Shear force (b) Deflection

(c) Slope (d) Torsion

viii) The critical load P_{cr} for a column having flexural rigidily (EI) and length L as given by Euler's column formula and corresponding effective length for an ideal slender column built-in at its base and free at the top are given by

(a) π^2EI/ L^2 and L (b) $4\pi^2EI/ L^2$ and L/2

(c) $\pi^2EI/ (4L^2)$ and 2L (d) None of these

ix) The 'conjugate beam' corresponding to a cantilever beam subjected to transverse load is a
(a) fixed ended beam
(b) cantilever beam
(c) propped cantilever beam
(d) simply supported beam

x) A truss hinged at one end, supported on rollers at the other end is subjected to horizontal loads acting at every joint of one rafter member. The reaction at the hinged end will be
(a) horizontal
(b) vertical
(c) Both horizontal and vertical
(d) No reaction at hinged end

GROUP - B

2. (a) A circular mild steel bar of varying cross section is subjected to the axial forces as given in Fig.1. The diameter of the bar at location 'A' is 25mm, at 'B' is 50mm. The bar has uniform cross-section at 'BC'. Find out the total elongation of this bar. Consider modulus of elasticity (E) = 20×10^8 kN/m^2.

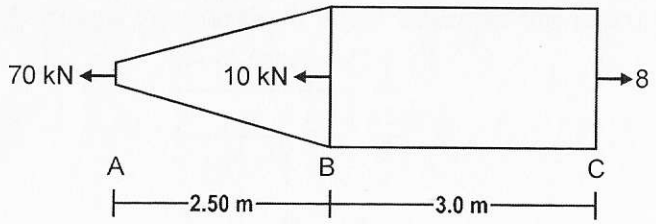

Figure 1

(b) A thin walled cylindrical shell of radius 'r' and wall thickness 't' is subjected to an internal pressure 'p'. Find out the expressions for hoop and longitudinal stresses for the shell. **6+6 = 12**

3. A square element is subjected to the two dimensional state of stress as shown in the Fig.2. Find out the major and minor principal stresses and the maximum shear stress using Mohr circle. Find out the normal and shear stresses on a plane incline at an angle 25 degree with the principal plane.

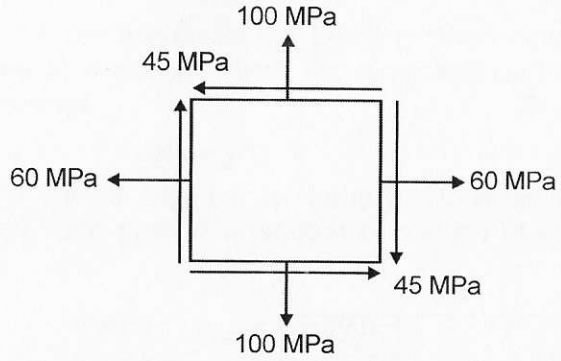

Figure 2

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GROUP - C

4. (a) Draw Shear Force and Bending Moment diagrams for the following simply supported beam of length l and carrying linearly varying load as shown in Fig.3.

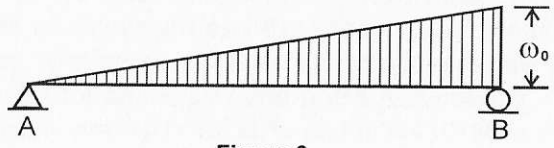

Figure 3

(b) For the above problem determine the value of maximum bending moment and its location from the support A.

(c) What is the value of shear force at that location?

(d) A simply supported beam with overhanging ends carries transverse loads as shown in the Fig.4. If ωl = P, what is the ratio a/*l* for which the bending moment at the middle of the beam will be zero?

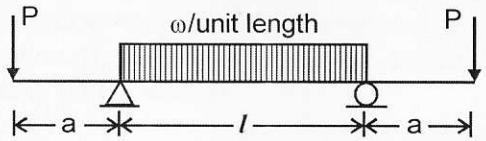

Figure 4

(e) Calculate the shear force V_B and the bending moment M_B at the section just to the left of the wall at B, for the cantilever beam in Fig.5.

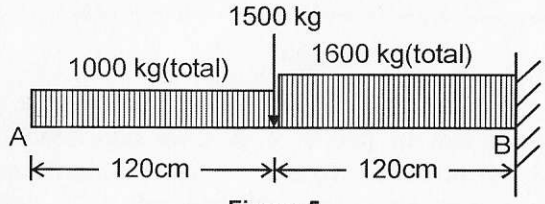

Figure 5

3+2+1+3+3 = 12

5. (a) A simply supported beam of span *l* = 2.7m has the T-section as shown in Fig.6. The beam carries a load P = 500 kg at a point 90 cm from the right-hand support. Calculate the maximum shear stress in the beam.

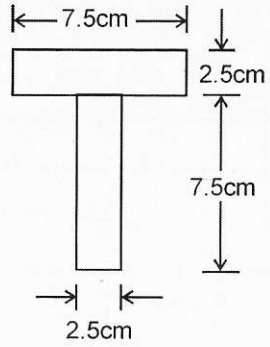

Figure 6

(b) A simply supported beam having a span a 3.6m is to carry a uniformly distributed load of intensity 1600 kg/m. The cross-section is to be rectangular with depth h and width b = h/2. If the allowable bearing stress in tension or compression is 84 kg/cm^2, what is the required depth h of the cross-section?

(c) Derive the expression for bending stress developed in a beam $\sigma = My/I$, where the symbols have their usual meanings. **5+2+5 = 12**

Group - D

6. Find out the member forces in the truss as shown in Fig.7. Use method of section or method of joints.

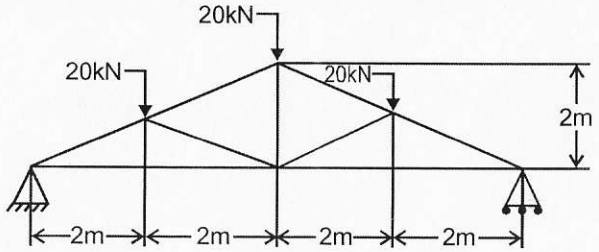

Figure 7

12

7. A solid circular shaft of length 2.0 m is fixed at one end and free at the other end. The first 1.0 m length of the shaft is made of aluminium and the second 1.0m length is made of brass. Maximum allowable shear stresses are 75 MPa and 50 MPa for aluminium and brass respectively. The modulus of rigidity are 0.27×10^5 MPa and 0.34×10^5 MPa for aluminium and brass,respectively. Find out the maximum allowable torque acting at the free end of that shaft if its angle of twist is restricted upto 1°. **12**

GROUP - E

8. (a) A simply supported beam AB carrying a load P at the middle has cross-sectional moment of inertia I over the left half of the span and 2I over the right half as shown in Fig.8. Using the moment-area method, find the angles of rotation θ_A and θ_B of the end tangents and the deflection under load P.

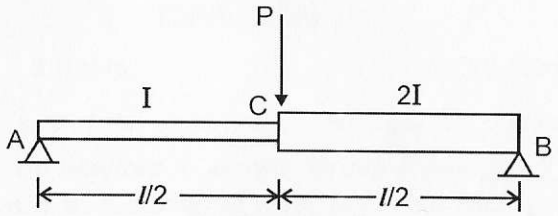

Figure 8

(b) A simply supported steel beam carries a vertical concentrated load W = 100kg at mid-span. Calculate the amount of strain energy stored in the beam if the span, "*l*" = 3m and the cross-section is a rectangle of width b = 5 cm and depth h = 2.5cm.

(c) A simply supported beam AB carries a concentrated load "P" at point D as shown in Fig.9. Find the deflection δ of the point D from the cord line AB and the angle "θ_A" between this cord line and the tangent at A by conjugate beam method.

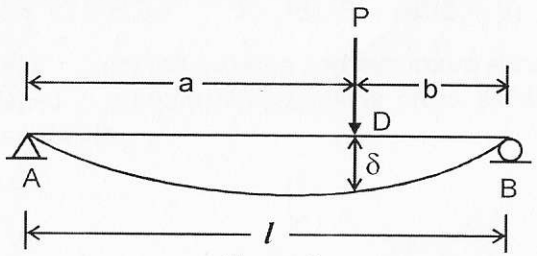

Figure 9

(d) Develop the equation of elastic line and find the maximum deflection at the middle of the span of a simply supported beam of length, "*l*" and carrying a *udl* of "w" per unit length using double inegration method.

3+3+3+3 = 12

9. An ideal cantilever slender column of length "L" is considered. It is rectangular in cross section having dimensions "b" and "d". Find out the buckling loads and buckling shapes of this column for first three modes of buckling. **12**