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**10ME/AU/PM/TL34**

# Third Semester B.E. Degree Examination, June 2012
## Mechanics of Materials

Time: 3 hrs. Max. Marks:100

**Note:** ***Answer FIVE full questions, selecting at least TWO questions from each part.***



### PART – A

**1** a. Define: i) Poisson's ratio; ii) Modulus of rigidity; iii) Bulk modulus; iv) Factor of safety. **(04 Marks)**

b. Show that the extension produced due to self weight of a bar of uniform cross section fixed at one end and suspended vertically is equal to half the extension produced by a load equal to self weight applied at the free end. **(08 Marks)**

c. A member ABCD is subjected to point loads $P_1$, $P_2$, $P_3$ and $P_4$ as shown in Fig.Q.1(c). Calculate the force $P_2$ necessary for equilibrium, if $P_1$ = 45 kN, $P_3$ = 450 kN and $P_4$ = 130 kN. Determine the total elongation of the member, assuming the modulus of elasticity to be $2.1 \times 10^5$ N/mm$^2$. **(08 Marks)**

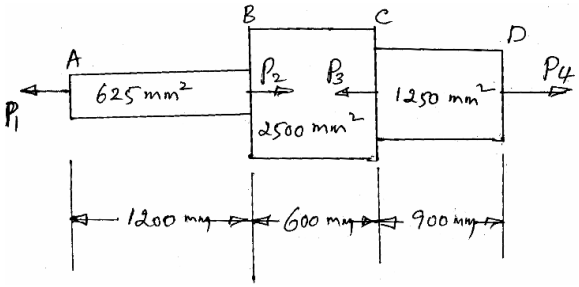


Fig.Q.1(c)

**2** a. Define volumetric strain. A bar of uniform rectangular section of area A is subjected to an axial load P. Show that the volumetric strain is given by $\in_v = \frac{P}{AE}\left(1 - \frac{2}{m}\right)$, where E is the Young's modulus and $\frac{1}{m}$ is the Poisson's ratio. **(04 Marks)**

b. The modulus of rigidity of a material is $0.8 \times 10^5$ N/mm$^2$ when a 6mm × 6mm rod of this material was subjected to an axial pull of 3600N, it-was found that the lateral dimension of the rod changed to 5.9991mm × 5.9991mm. Find the Poisson's ratio and the modulus of elasticity. **(06 Marks)**

c. A horizontal rigid bar AB weighing 200kN is hung by three vertical rods, each of 1m length and 500mm$^2$ in cross section as shown in figure Fig.Q.2(c). The central rod is of steel and the outer rods are copper. If the temperature rise is 40$^o$C, estimate the load carried by each rod and by how much the load will descend.
Take:
$E_s$ = 200 GN/m$^2$
$E_c$ = 100 GN/m$^2$
$L_s = 1.2 \times 10^{-5}$ /$^o$C
$L_c = 1.8 \times 10^{-5}$ /$^o$C **(10 Marks)**

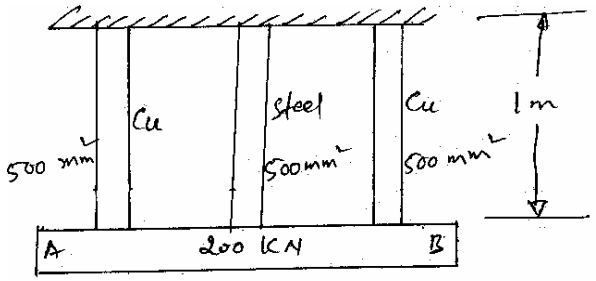


Fig.Q.2(c)

**3** a. A rectangular bar is subjected to two direct stresses $\sigma_x$ and $\sigma_y$ in two mutually perpendicular directions. Prove that the normal stress ($\sigma_n$) and shear stress ($\tau$) on an oblique plane which is inclined at an angle $\theta$ with the axis of minor stress are given by

$$\sigma_n = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \text{Cos}2\theta \quad \text{and} \quad \tau = \frac{\sigma_x - \sigma_y}{2} \text{Sin}2\theta.$$ **(08 Marks)**

b. A point in a strained material is subjected to stresses shown in Fig.Q.3(b). Using Mohr's circle, determine the normal and tangential stresses across the oblique plane. Check the answer analytically. **(12 Marks)**

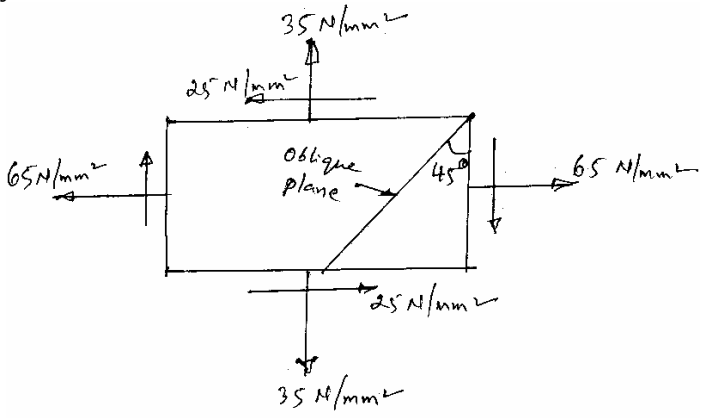


Fig.Q.3(b)

**4** a. A cantilever of uniform section carries a point load at the free end. Find the strain energy stored by the cantilever and hence calculate the deflection at the free end. **(06 Marks)**

b. Calculate the i) Change in diameter; ii) Change in length and iii) Change in volume of a thin cylindrical shell 1000mm diameter, 10mm thick and 5m long when subjected to internal pressure of 3 N/mm$^2$. Take the value of E = $2 \times 10^5$ N/mm$^2$ and 1/m = 0.3. **(06 Marks)**

c. A pressure vessel with outer and inner diameters of 400mm and 320mm respectively is subjected to an external pressure of 8MPa. Determine the circumferential stress induced at the inner and outer surfaces. Prove that the longitudinal strain is constant through out the cylinder. **(08 Marks)**

## PART – B

**5** a. Define: i) Shear force; ii) Bending moment; iii) Point of cartraflexure. **(03 Marks)**

b. Draw shear force and bending moment diagrams for a simply supported beam subjected to couple at midspan, as shown in Fig.Q.5(b). **(05 Marks)**

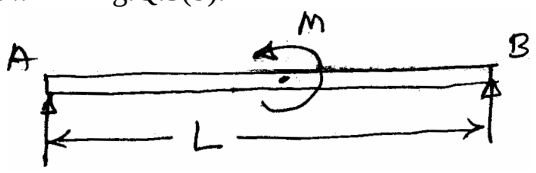


Fig.Q.5(b)

c. A cantilever beam is loaded as shown in Fig.Q.5(c). Draw the shear force and bending moment diagrams, for the beam. **(12 Marks)**

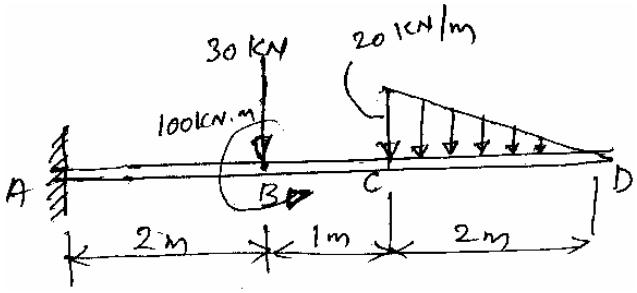


Fig.Q.5(c)

**6** a. A simply supported beam of span 5m has a cross section 150mm × 250mm. If the permissible stress is 10 N/mm$^2$, find:
   i) Maximum intensity of uniformly distributed load it can carry.
   ii) The maximum concentrated load P applied at 2m from one end it can carry. **(10 Marks)**

b. Prove that the maximum shear stress in a circular section of a beam is 4/3 times the average shear stress. **(10 Marks)**

**7** a. Find the expressions for the slope and deflection of a cantilever of length L carrying uniformly distributed load over the whole length. **(08 Marks)**

b. A horizontal girder of steel having uniform section is 14m long and is simply supported at its ends. It carries concentrated loads of 120kN and 80kN at two points 3m and 4.5m from the two ends respectively. 'I' for the section of the girder is 16 × $10^8$ mm$^4$ and $E_s$ = 210 kN/mm$^2$. Calculate the deflections of the girder at points under the two loads. Also find the maximum deflection. **(12 Marks)**

**8** a. Derive the torsion equation with usual notations. State the assumptions made in the derivation. **(10 Marks)**

b. Derive an expression for Euler's buckling load for a long column having one end fixed and other end hinged. State the assumption made in the derivation. **(10 Marks)**

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