CBCS SCHEME

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15ME/MA34

Third Semester B.E. Degree Examination, June/July 2023
Mechanics of Materials

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Derive an expression for the extension of a uniformly tapering rectangular bar when it is subjected to an axial load P. **(08 Marks)**

b. Calculate the modulus of rigidity and bulk modulus of a cylindrical bar of diameter of 25mm and length 1.6m, if the longitudinal strain in a bar during a tension test is four times the lateral strain. Find the change in volume, when the bar is subjected to a hydrostatic pressure of 100N/mm^2. Take E = 1 × 10^{5}N/mm^2. **(08 Marks)**

OR

2 a. A mild steel rod of 20mm diameter and 300mm long is enclosed centrally inside a hollow copper tube of external diameter 30mm and internal diameter of 25mm. The ends of the tube and rods are brazed together, and the composite bar is subjected to an axial pull of 40kN. If E for steel and copper is 200GN/m^2 and 100 GN/m^2 respectively. Find the stresses developed in the rod and tube. Also find the extension of the rod. **(08 Marks)**

b. A steel bar is placed between two copper bars each having the same area and length as the steel bar at 15^{0}C. At this stage , they are rigidly connected together at both the ends. When the temperature is raised to 315^{0}C, the length of the bars increase by 1.5mm. Determine the original length and final stresses in the bars. Take $E_s = 2.1 \times 10^5$ N/mm^2 ; $E_c = 1 \times 10^5$ N/mm^2 ; $\alpha_s = 0.000012$ per ^{0}C ; $\alpha_c = 0.0000175$ per ^{0}C. **(08 Marks)**

Module-2

3 a Derive an expression for normal stress, shear stress and resultant stress on an oblique plane inclined at an angle θ with vertical axis (x-plane) in a biaxial stress system subjected to σ_x, σ_y and τ_{xy} also find angle of obliquity ϕ. **(10 Marks)**

b. Derive expressions for hoop stress and longitudinal stress for a thin cylinder subjected to internal fluid pressure. **(06 Marks)**

OR

4 a. A point in a strained material in subjected to a tensile stress of 500N/mm^2 and 300N/mm^2 in two mutually perpendicular planes and also these planes carries a shear stress of 100N/mm^2. Calculate the normal, tangential, resultant stresses (σ_θ, τ_θ, σ_r) on a plane making an angle of 30° with the vertical axis (x-plane). Also find principal stresses. **(10 Marks)**

b. A thin cylindrical shell 1.2m in diameter and 3m long has a metal wall thickness of 12mm. It is subjected to an internal pressure of 3.2MPa. Find the circumferential and longitudinal stress in the wall. Also determine change in volume of the cylinder. Assume E = 210 GPA and μ = 0.30. **(06 Marks)**

Module-3

5 For the beam shown in Fig. Q5. Draw shear force and bending moment diagram. Locate the point of contraflexure if any.

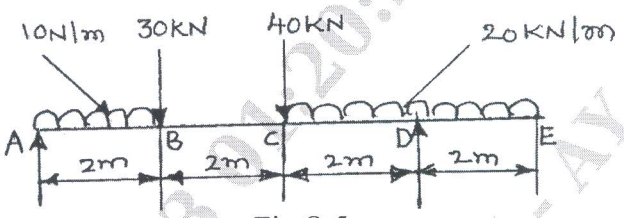


Fig.Q.5

(16 Marks)

OR

6 a. Derive a relationship between bending stress and radius of curvature. **(08 Marks)**

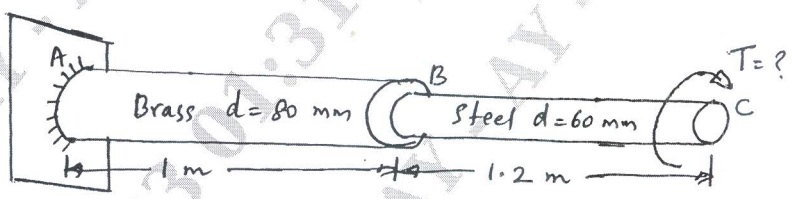
b. Derive the deflection equation, $EI\frac{d^2y}{dx^2} = M$. **(08 Marks)**

Module-4

7 a. Determine the diameter of a solid shaft which will transmit 300 KW at 250 rpm. The maximum shear stress should not exceed $30N/mm^2$ and twist should not be more than 1 in a shaft length of 2m. Take modulus of rigidity = $1 \times 10^5 N/mm^2$. **(08 Marks)**

b. The allowable shear stress in brass is $80N/mm^2$ and in steel $100N/mm^2$. Find the maximum torque that can be applied in the stepped shaft shown in fig. Q7(b). Find also the total rotation of free end with respect to the fixed end if G_{brass} = 40 kN/mm^2 and $G_{steel} = 80kN/mm^2$. **(08 Marks)**

Fig.Q7(b)

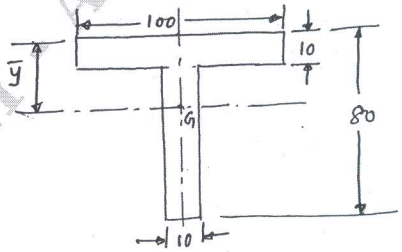


OR

8 a. Find an expression for crippling load for a column with one end fixed and other end free. **(08 Marks)**

b. Determine the buckling load for a strut of T – section , the flange width being 100mm, overall depth 80mm and both flange and stem 10mm thick as shown in fig. Q8(b). The strut is 3m long and is hinged at both ends. $E = 200GN/m^2$. **(08 Marks)**

Fig.Q8(b)



Module-5

9 a. Explain: i) Castigliano's first theorem ii) Castigliano's second theorem. **(08 Marks)**

b. Write a note on :

i) Maximum principal stress theory

ii) Maximum shear stress theory. **(08 Marks)**

OR

10 a. A hollow circular shaft of 2m length has an external diameter of 100mm and a thickness of 10mm. If it is subjected to a torque of 10kN-m, determine the strain energy stored in the shaft. Take G= 80Gpa. **(04 Marks)**

b. The plane state of stress at a point is given $\sigma_x = 70MPa$; $\sigma_y = 140MPa$; $\tau_{xy} = -35MPa$. If the yielding stress in tension in 175MPa, check whether there is failure according to

i) Maximum principal stress theory

ii) Maximum shear stress theory

If the material is safe then find the factor of safety. **(12 Marks)**

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