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18ME32

Third Semester B.E. Degree Examination, Feb./Mar. 2022
Mechanics of Materials

Time: 3 hrs.

Max. Marks: 100

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

Module-1

1 a. Define i) Poisson's ratio   ii) Stress   iii) Percentage Reduction in area
iv) Toughness. **(04 Marks)**

b. Derive the relationship between Modulus of Rigidity and Modulus of elasticity. **(06 Marks)**

c. A stepped bar is subjected to an external loading as shown in Fig. Q1(c). Calculate the change in the length of bar. Take E = 200GPa for steel , E = 70 GPA for Aluminum and E = 100 GPa for copper. **(10 Marks)**
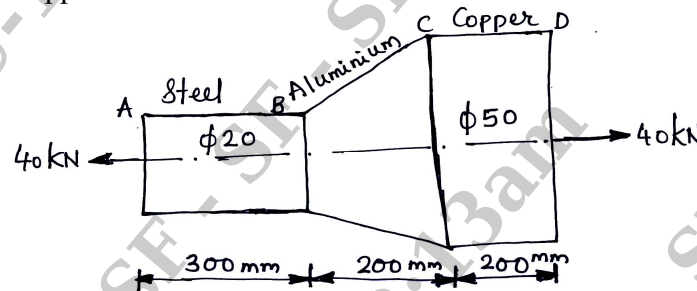

Fig. Q1(c)

OR

2 a. Draw Stress – Strain diagram for mild steel subjected to tension and indicate salient points on the diagram. **(06 Marks)**

b. A composite section comprises of a steel tube 10cm internal diameter and 12cm external diameter fitted inside a brass tube of 14cm internal diameter and 16cm external diameter. The assembly is subjected to a compressive load of 500kN. Find the load carried by each tube and change in the length of tubes. The length of tube is 150cm. Take E_S = 200 GPa and E_b = 100 GPa. **(08 Marks)**

c. The bronze bar 3m long with 320mm^2 cross sectional area is placed between two rigid walls. At -20°C there is a gap Δ = 2.5mm as shown in Fig. Q2(c). Find the magnitude and the type of stress induced in the bar when it is heated to a temperature 60°C. Take E = 80GPa and $\alpha_B = 18 \times 10^{-6}/°C$. **(06 Marks)**

Fig. Q2(c)

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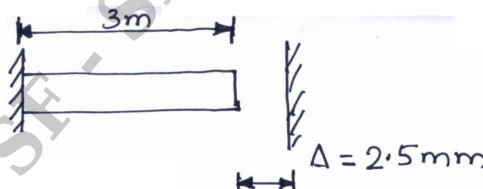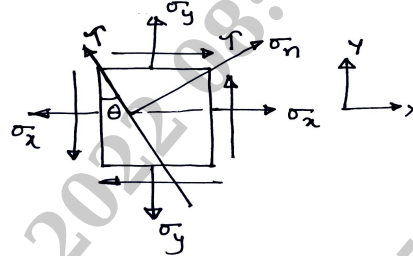## Module-2

**3** a. Derive the expression for normal stress and tangential stress on a plane inclined at θ° to the vertical axis in a biaxial stress system with shear stress as shown in Fig.Q3(a). Also find Resultant stress and Angle of Obliquity. **(10 Marks)**

Fig. Q3(a)

b. The state of stress at a point in a strained material as shown in Fig. Q3(b). Determine
   i)   The principal stresses and principal planes.
   ii) Maximum shear stress and plane on which it is acting. Also find the normal stress on the maximum shear plane.
   iii) Sketch the element aligned with planes of principal stresses and planes of maximum shear. **(10 Marks)**

Fig. Q3(b)
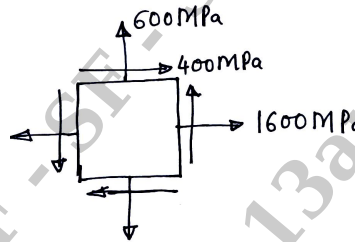
OR

4 a. A thin cylinder of 75mm internal diameter and 250mm long has 2.5mm thick walls. The cylinder is subjected to an internal pressure of $7MN/m^2$. Determine the change in internal diameter and change in length and change in volume of cylinder. Also compute the Hoop stress and Longitudinal stress and maximum shear stress. Take E = 200GPa and μ = 0.3. **(10 Marks)**

b. A thick cylinder with internal diameter 80mm and external diameter 120mm is subjected to an external pressure of $40kN/m^2$, when the internal pressure is $120kN/m^2$. Calculate the circumferential stress at external and internal surfaces of the cylinder. Plot the variation of circumferential stress and radial pressure on the thickness of the cylinder. **(10 Marks)**

Module-3

5 Draw Shear force and Bending moment diagrams for the beam shown in Fig. Q5. Locate the point of contra flexure if any. **(20 Marks)**

Fig. Q5
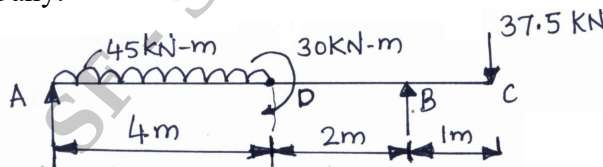
OR

6 a. A simply supported of beam span 5m has a cross section of 150mm × 250mm. If the permissible stress is $20N/mm^2$. Find
   i) Maximum intensity of uniformly distributed load it can carry.
   ii) Maximum concentrated load P applied at 2m from one end it can carry. **(10 Marks)**

b. The cross section of a beam is a T section (Fig. Q6(b)) 150mm × 100mm × 15mm with 150mm horizontal. Find the maximum intensity of shear stress and sketch the shear stress distribution across the section if it has to resist a shear force of 90kN. **(10 Marks)**
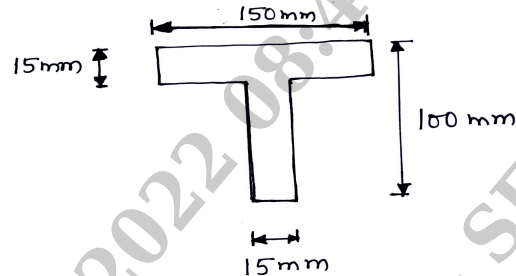
Fig. Q6(b)

Module-4

7 a. Derive the torsional equation for a circular shaft with usual notations. State the assumptions made. **(10 Marks)**

b. A solid circular shaft is subjected to a bending moment of 10kN-m and a torque of 15kN-m. The yield stress of the material in simple tension is 250MPa and E = 200GPa. If factor of safety is 3. Determine the maximum diameter of the shaft using Maximum Principal Stress theory and Maximum Shear Stress theory. **(10 Marks)**

OR

8 a. Write a note on :
   i) Maximum Principal Stress theory   ii) Maximum Shear Stress theory. **(08 Marks)**

b. A solid circular shaft is required to transmit 300kW at 120 rpm. The shear stress in the material is not to exceed $80N/mm^2$. Find the diameter required. If the shaft is replaced by a hollow one whose internal diameter is 0.6 times its external diameter. The length material and maximum shear stress being same. Calculate the percentage saving in weight, that could be obtained. **(12 Marks)**

Module-5

9 a. Explain Castigliano's theorem I with its applications and Castigliano's theorem II. **(10 Marks)**

b. A hallow cast iron column whose outside diameter is 200mm and thickness of 20mm is 4.5m long and is fixed at both ends. Calculate the safe load by Rankine formula using factor of safety 2.5. Find the ratio of Euler's to Rankine's loads. Take E = $1 \times 10^5 N/mm^2$ and Rankine constant = $\dfrac{1}{1600}$ for both ends fixed and $\sigma_c = 550N/mm^2$. **(10 Marks)**

OR

10 a. Derive an expression for a critical load in a column subjected to compressive load. When one end is fixed and other end is free. **(10 Marks)**

b. Calculate the strain energy stored in a bar shown in Fig. Q10(b), subjected to a gradually applied axial load of 80kN. Compare this value with what obtained in uniform bar of same length and having the same volume, when subjected to the same load. E = $2 \times 10^5 N/mm^2$. **(10 Marks)**
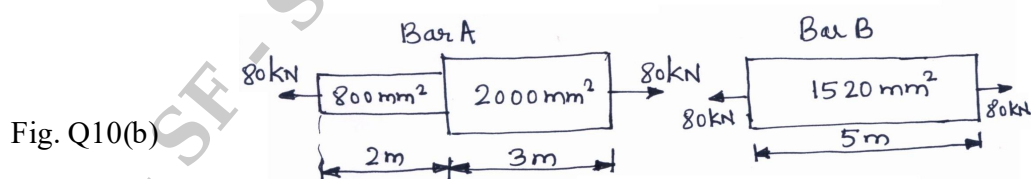
Fig. Q10(b)

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