CBCS SCHEME

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18AU34

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Derive the equation for analysis of uniformly tapering rectangular bar. **(10 Marks)**

b. A brass bar having cross-sectional area 300 mm^2 is subjected to axial focus as shown in Fig.Q1(b) below. Find the total elongation of the bar. E = 84 GPa.

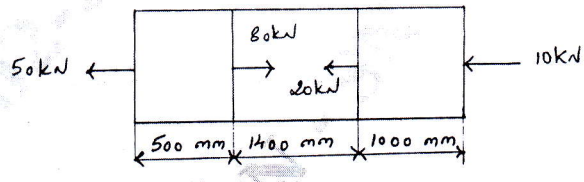

Fig.Q1(b) **(10 Marks)**

OR

2 a. List the elastic constants. Derive the relation between modulus of elasticity and modulus of rigidity. **(10 Marks)**

b. Define the following :
i) Poisson's ratio ii) Bulk modulus iii) Rigidity modulus
iv) Hooke's law v) Young's modulus. **(10 Marks)**

Module-2

3 A point in a strained material is subjected to stress as shown in Fig.Q3 below. Find graphically the normal, tangential and resultant stress across the plane EF. Also determine the maximum, minimum principal stresses, its locations, maximum shear stress and its locations. Check the answers analytically.

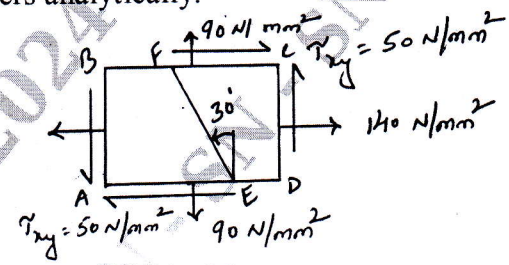

Fig.Q3 **(20 Marks)**

OR

4 a. Derive the equation for hoop stress and longitudinal stress. **(10 Marks)**

b. A boiler shell is to be made of 20mm thick plates having a limiting tensile stress of 125 N/mm^2. If the efficiencies of the longitudinal and circumferential joints are 80% and 30% respectively, determine
i) Maximum permissible diameter of the shell for an internal pressure of 2.5 N/mm^2.
ii) Permissible intensity of internal pressure when the shell diameter is 1.6. **(10 Marks)**

Module-3

5 a. Derive the relationship between load, shear force and bending moment. **(08 Marks)**

b. Draw the shear force and bending moment diagram for the cantilever beam shown in Fig.Q5(b) below.

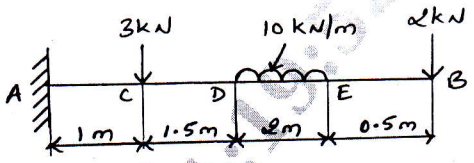

Fig.Q5(b) **(12 Marks)**

OR

6 a. Derive the bending equation $\frac{M}{I}=\frac{\sigma}{y}=\frac{E}{R}$ with assumptions. **(12 Marks)**

b. The cross-section of a beam is shown in Fig.Q6(b). If permissible stress is 150 N/mm^2 find its moment of resistance.

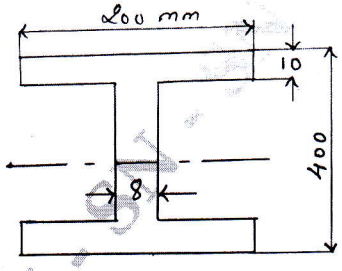

Fig.Q6(b) **(08 Marks)**

Module-4

7 a. Derive the torsion equation $\frac{T}{J_p}=\frac{\tau}{R}=\frac{G\theta}{\ell}$ with assumptions. **(12 Marks)**

b. A solid circular shaft has to transmit a power of 1000 kW at 120 rpm. Find the diameter of the shaft, if the shear stress of the material must not exceed 80 N/mm^2. The maximum torque 1.25 times of its mean. Find the diameter of the shaft if the shaft is replaced by a hallow one whose internal diameter is 0.6 times its external diameter, the length, material and maximum shear stress being same. **(08 Marks)**

OR

8 a. Derive the equations for Euler's crippling load for a column when both of its ends are hinged with assumptions. **(12 Marks)**

b. Find the Euler's crippling load for a hollow cylindrical steel column of 40mm external diameter and 4mm thick. The length of the column is 2.5m and is hinged at both ends. Also compute the Rankine's crippling load using constants 335 MPa and 1/7500. Take E = 205 GPa. **(08 Marks)**

Module-5

9 a. Derive the equation for strain energy due to normal stress and bending. **(12 Marks)**

b. Explain Castigliano's theorem I and II. **(08 Marks)**

OR

10 a. Explain the maximum principal stress theory and maximum shear stress theory. **(10 Marks)**

b. In a plate of C45 steel (σ_y = 353 MPa) subjected to a system of loads, following stresses are induced at critical point. σ_x = 150 N/mm^2 , σ_y = 100 N/mm^2 and τ_{xy} = 50 N/mm^2. Find the factor of safety according to (i) Maximum normal stress theory (ii) Maximum shear stress theory. **(10 Marks)**

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