CBCS SCHEME

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15ME/MA34

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Define: i) Hooke's law ii) Poison's ratio iii) Factor of safety iv) Bulk modulus v) Modulus of elasticity. **(05 Marks)**

b. Draw and explain stress-strain diagram of a mild steel specimen subjected to tension test. **(05 Marks)**

c. A circular rod of 100mm diameter and 500mm length is subjected to a tensile load of 1000kN. Determine the i) Modulus of rigidity ii) Bulk modulus iii) Change in volume. Take Poisson's ratio = 0.30 and E = 200GPa. **(06 Marks)**

OR

2 a. Define: i) Elasticity ii) Plasticity iii) Resilience iv) Toughness v) Stiffness **(05 Marks)**

b. Derive a relation between modulus of elasticity and bulk modulus. **(05 Marks)**

c. A bar of brass 25mm diameter is enclosed in a steel tube of 50mm external diameter and 25mm internal diameter. The bar and the tube fastened at the ends and are 1.5m long. Find the stresses in the two materials when the temperature raises from 30°C to 80°C.
Take : $E_{steel} = 200GPa$; $E_{brass} = 100GPa$
$\alpha_{steel} = 11.6 \times 10^{-6}/°C$; $\alpha_{brass} = 18.7 \times 10^{-6}/°C$. **(06 Marks)**

Module-2

3 a. A point in a strained material is subjected to a tensile stress of 500 N/mm^2 and 300 N/mm^2 in two mutual perpendicular planes. Calculate the normal, tangential, resultant stresses and its obliguity on a plane making an angle of 30° with the axis of second stress. Also find the maximum shear stress. **(10 Marks)**

b. A thick cylindrical shell of 160 mm internal diameter is subjected to an internal pressure of 8 N/mm^2. Find the thickness of shell if the permissible or hoop stress in the section is not to exceed 35 N/mm^2. **(06 Marks)**

OR

4 a. An elemental cube is subjected to tensile stresses of 30 N/mm^2 and 10 N/mm^2 acting on two mutually perpendicular planes and a shear stress of 10 N/mm^2 on these planes. Draw the Mohr's circle of stresses and hence determine the magnitudes and directions of principal stresses and also the greatest shear stress. **(08 Marks)**

b. A thin cylindrical shell with following dimensions is filled with a liquid at atmospheric pressure : Length = 1.2 m, External diameter = 200 mm, Thickness of metal = 8 mm. Find the value of the pressure exerted by the liquid on the walls of the cylinder and the hoop stress induced if an additional volume of 25000 mm^3 of liquid is pumped into the cylinder. Take $E = 2.1 \times 10^5$ N/mm^2 and $\mu = 0.33$. **(08 Marks)**

Module-3

5 a. Classify beams and loads with sketch. **(04 Marks)**

b. Draw the shear force and bending moment diagrams for the beam shown in Fig.Q.5(b). Locate the salient point. **(12 Marks)**

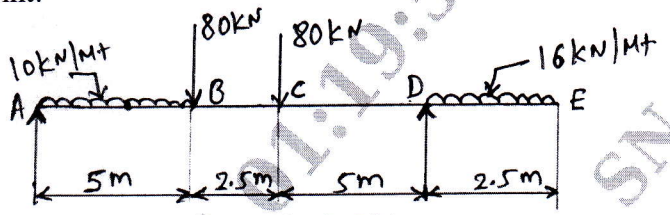

Fig.Q.5(b)

OR

6 a. A cast iron beam has an 'I' section with top flange 80mm × 40mm, web 120mm × 20mm and bottom flange 160mm × 40mm. If the tensile stress is not to exceed 30N/mm^2 and compressive stress 90N/mm^2, what is the maximum uniformly distributed load the beam carry over a simply supported span of 6m, if the large flange is in tension. **(10 Marks)**

b. Derive an expression for the maximum deflection of a cantilever beam carrying a point load at its free end. **(06 Marks)**

Module-4

7 a. State the assumptions made in pure torsion theory. **(04 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 time of its mean. What percentage of saving in material would be obtained 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? **(12 Marks)**

OR

8 a. Derive a Euler's crippling load for a column when both of its ends are hinged. **(08 Marks)**

b. A 1.5 m long column has a circular cross section of 50 mm diameter. One end of the column is fixed in direction and position and the other end is free. Taking the factor of safety as 3, calculate the safe load using Euler's formula. Taking E = 1.2 × 10^5 N/mm^2. **(08 Marks)**

Module-5

9 a. Define: i) Strain energy ii) Castigliano's theorem iii) Modulus of resilience iv) Toughness. **(08 Marks)**

b. A cantilever beam of uniform cross section carries a point load at the free end. Determine strain energy and deflection at the free end. If F = 200kN, E = 200GPa, L = 3mt and I = 10^{-4}m^4. **(08 Marks)**

OR

10 a. Explain maximum normal stress theory and maximum shear stress theory. **(08 Marks)**

b. A plate of 45C8 steel (σ_{yt} = 353MPa) is subjected to the following stresses. σ_x = 150 N/mm^2, σ_y = 100N/mm^2 and τ_{xy} = 50N/mm^2. Find the factor of safety by i) Rankine's theory ii) Guest's theory. **(08 Marks)**

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