CBCS SCHEME

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18ME32

Third Semester B.E. Degree Examination, June/July 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. Define :
(i) Normal stress
(ii) Shear stress
(iii) Normal strain
(iv) Shear strain
(v) Poisson's ratio **(05 Marks)**

b. A Prismatic bar of circular cross section A, length l, Young's modulus E, is suspended from a support. If γ is the specific weight of the material, find the elongation of bar due to its own weight. **(10 Marks)**

c. A steel rod [E = 200 GPa] with circular cross section is 7.5 m long. Determine the minimum diameter required if the rod must transfer a tensile load of 50 kN without exceeding allowable stress of 180 MPa and stretching not more than 5 mm. **(05 Marks)**

OR

2 a. Explain : (i) Young's modulus (ii) Shear modulus (iii) Bulk modulus (iv) Hooke's law (v) Volumetric strain **(05 Marks)**

b. A circular rod of 25 mm diameter and 500 mm long is subjected to a tensile force of 60 kN. Determine the shear modulus, bulk modulus and change in volume, if Poisson's ratio is 0.3 and Young's modulus is 2×10^5 N/mm^2. **(10 Marks)**

c. Derive the relation between modulus of elasticity and bulk modulus. **(05 Marks)**

Module-2

3 a. Derive an expression for normal stress and shear stress on an inclined plane making an angle θ with the vertical axis in a bi-axial stress system subjected to σ_x, σ_y and τ_{xy}. **(10 Marks)**

b. A point in a strained material is subjected to a tensile stress of 120 MPa and a compressive stress of 80 MPa acting at right angles to each other. Find the normal stress, shear stress and resultant stress on an inclined plane making an angle of 30° with the compressive stress. Also find the angle of obliquity. **(10 Marks)**

OR

4 a. Starting from the stress-transformation equations, derive the equation for Mohr's circle and show it on the coordinate axes. **(10 Marks)**

b. Derive an expression for the circumferential and longitudinal stress for a thin cylinder. Also find the maximum shear stress at the outer surfaces. **(10 Marks)**

Module-3

5 a. Obtain the equations for shear force and bending moment for any point on the beam. Also draw the shear force and bending moment diagram. Refer Fig. Q5 (a) **(15 Marks)**

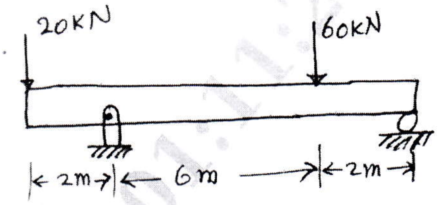

Fig. Q5 (a)

b. Explain with a neat sketch, different types of loads on beam. **(05 Marks)**

OR

6 a. Derive the bending equation for a beam using sample theory of bending. **(10 Marks)**

b. Obtain the expressions for section modulus from the expression of moment of inertia for,

(i) Rectangular section
(ii) Hollow rectangular section
(iii) Circular cross section
(iv) Hollow circular section
(v) Triangular section **(10 Marks)**

Module-4

7 a. Find the diameter of a rod subjected to bending moment of 3 kNm and a twisting moment of 1.8 kNm according to maximum normal stress theory. Take the normal stress yield point as 420 MPa and factor of safety as 3. **(10 Marks)**

b. A hollow steel shaft with an outside diameter of 100 mm and a wall thickness of 10 mm is subjected to pure torque of T = 5500 Nm. (i) Determine the maximum shear stress in the shaft. (ii) Determine the minimum diameter of the solid shaft for which the maximum shear stress is same as in part (i), for the same torque T. **(05 Marks)**

c. What are the assumptions made in the theory of pure torsion? **(05 Marks)**

OR

8 a. A compound shaft consists of two pipe segments. Segment (i) has an outer diameter of 200 mm and a wall thickness of 10 mm. Segment (2) has an outside diameter of 150 mm and a wall thickness of 10 mm. The shaft is subjected to torques $T_B = 42$ kNm and $T_C = 18$ kNm which act in the direction as shown in Fig. Q8 (a). Determine the maximum shear stresss magnitude in each shaft segment. **(10 Marks)**

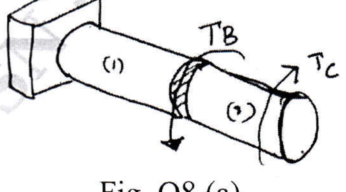

Fig. Q8 (a)

b. A solid circular shaft is subjected to a bending moment of 40 kNm and a torque of 10 kNm. Design the diameter of the shaft according to,

(i) Maximum principal stress theory.
(ii) Maximum shear stress theory. **(10 Marks)**

Module-5

9 a. Determine the slenderness ratio and Euler buckling load for a round wooden dowels (cylindrical rod) that are 1 m long and have a diameter of, (i) 16 mm and (ii) 25 mm. Assume E = 10 GPa. **(10 Marks)**

b. A compound solid aluminium rod is subjected to a tensile force P, Make the assumption that $E = 69$ GPa, $d_1 = 16$ mm, $L_1 = 600\,\text{mm}$, $d_2 = 25$ mm, $L_2 = 900$ mm, $\sigma_{uP} = 276\,\text{MPa}$. Calculate the largest amount of strain energy that can be stored in the rod without causing any yielding. Refer Fig. Q9 (b).

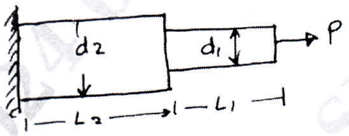

Fig. Q9 (b) **(10 Marks)**

OR

10 a. A solid 2.5 m long stainless steel rod has a yield strength of 276 MPa and an elastic modulus of 193 GPa. A strain energy of W = 13 Nm must be stored in the rod when a tensile load P is applied to rod. What is

(i) the maximum strain energy density that can be stored in the solid rod if a factor of safety of 4.0 with respect to yielding is specified?

(ii) the minimum diameter d required for the solid rod? **(10 Marks)**

b. Explain : (i) Buckling (ii) Stable equilibrium (iii) Unstable equilibrium (iv) Neutral equilibrium (v) Slenderness ratio **(10 Marks)**

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