CBCS SCHEME

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18MT33

Third Semester B.E. Degree Examination, Dec.2024/Jan.2025
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 Hooke's law, and derive the expression for deformation of a longitudinal bar subjected to axial loading. **(05 Marks)**

b. With usual notations derive an expression for deformation of a tapered bar of rectangular cross-section. **(07 Marks)**

c. Determine the magnitude of load 'P' necessary to produce zero net change in the length of the straight bar shown in Fig.Q.1(c). Take, area A = 400mm^2. **(08 Marks)**

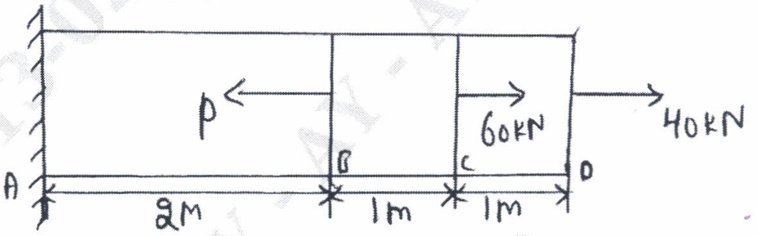

Fig.Q.1(c)

OR

2 a. Define Poisson's ratio. Derive the expression for volumetric strain for a body subjected to loading in three mutually perpendicular directions. **(07 Marks)**

b. A steel rod of 4 m long and 20 mm diameter is subjected to an axial tensile load of 40 kN. Determine the change in length, diameter and volume of the rod. Take, E = 200 GPa and Poisson's ratio $\upsilon = 0.25$. **(05 Marks)**

c. A reinforced concrete column 500 mm × 500 mm in section is reinforced with four steel bars of 25 mm diameter one in each corner. The column is carrying a load of 1000 kN. Find the stresses in the concrete and steel bars as shown in Fig.Q.2(c). Take, Young's modulus for E_{steel} = 210 GPa and $E_{concrete}$ = 14 GPa. **(08 Marks)**

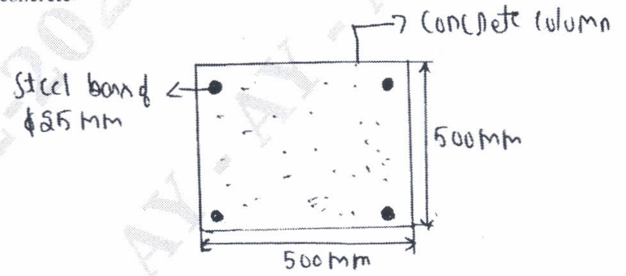

Fig.Q.2(c)

Module-2

3 a. Define principal stress and principal planes. **(02 Marks)**

b. Derive an expression for normal stress (σ_n) and tangential (σ_t) stress, for a body subjected to direct axial stresses in two mutually perpendicular directions. **(10 Marks)**

c. At a certain point in a strained material the following stress condition exists, as shown in Fig.Q.3(c). Determine the principal stresses and its planes, maximum shear stress and its planes, the normal stress acting on maximum shear stress planes, also sketch the planes. **(08 Marks)**

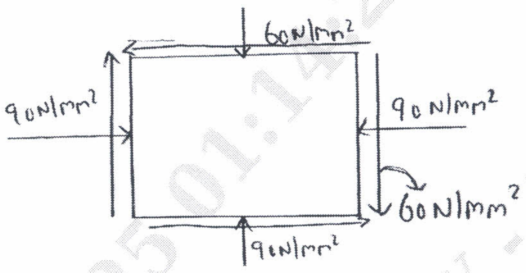

Fig.Q.3(c)

OR

4 a. Show that for a general 2-d state of plane stress condition, that on the planes of maximum normal stresses the shear stresses do not exists. **(05 Marks)**

b. At a certain point in a strained material the following stress condition prevails, as shown in Fig.Q.4(b). Find:
   i) Normal, shear and resultant stresses on the inclined plane AB.
   ii) Angle of obliquity.
   iii) Principal stress and principal planes.
   iv) Maximum and minimum shear stresses and their planes.
   v) Normal stresses on maximum shear stress plane.
   vi) Verify the answers by Mohr's circle method. **(15 Marks)**

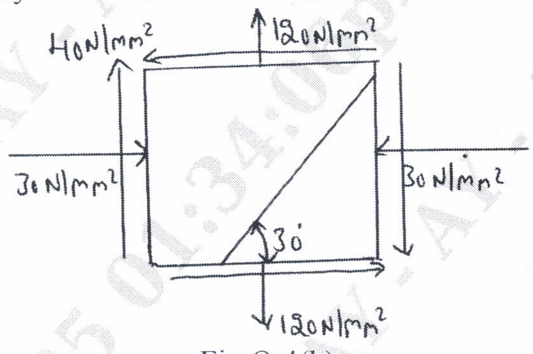

Fig.Q.4(b)

Module-3

5 a. Define Beam. Explain the significance of shear force and bending moment diagram. **(05 Marks)**

b. Derive the relationship between load, shear force and bending moment. **(05 Marks)**

c. Find the reactions at the fixed end and draw the shear force diagram and bending moment diagram for the cantilever beam as shown in Fig.Q.5(c). **(10 Marks)**

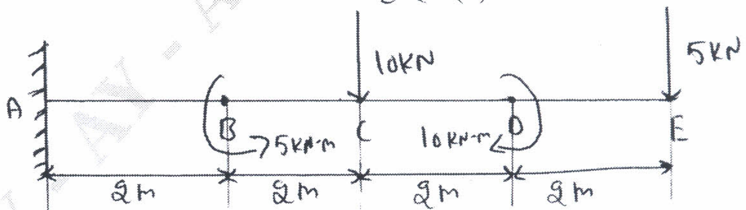

Fig.Q.5(c)

OR

6 a. Illustrate the different types of support conditions for beams subjected to transverse loading. **(05 Marks)**

b. Draw the shear force diagram and bending moment diagram for a overchanging beam as shown in Fig.Q.6(b), and locate the point of contraflexure. **(15 Marks)**

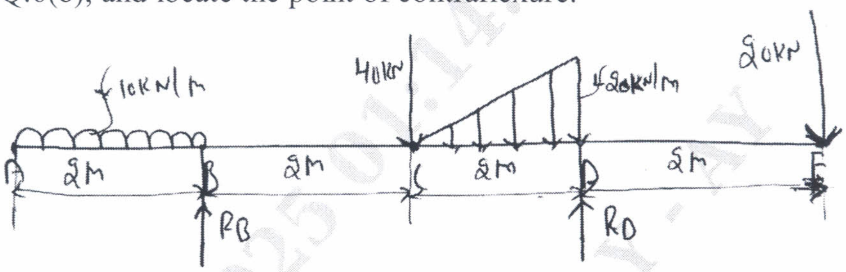

Fig.Q.6(b)

Module-4

7 a. State the assumptions made and derive the bending equation, $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$. **(10 Marks)**

b. A cantilever has a length of 3 m, its cross-section is T-section as shown in Fig.Q.7(b) and flange is in tension. What is the intensity of Uniformly Distributed Load (UDL) that can be applied if the maximum tensile stress is limited to 30 N/mm^2. Also compute the maximum compressive stress. **(10 Marks)**

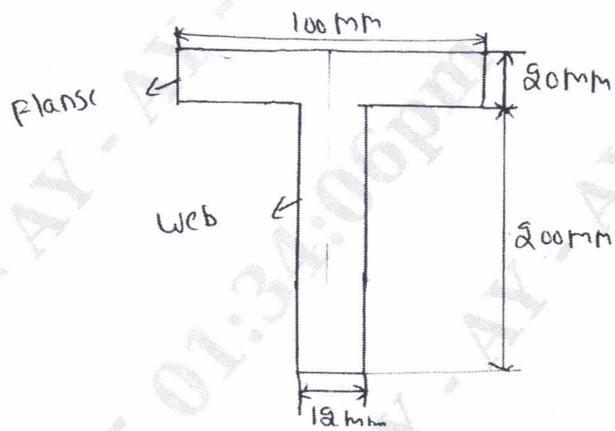

Fig.Q.7(b)

OR

8 a. Derive the Euler Bernoulli equation for deflection. **(10 Marks)**

b. A cantilever is loaded as shown in Fig.Q.8(b). Determine the slope and deflection at the free end. Take, E = 200 GPa and I = 10^{-4} m^4. **(10 Marks)**

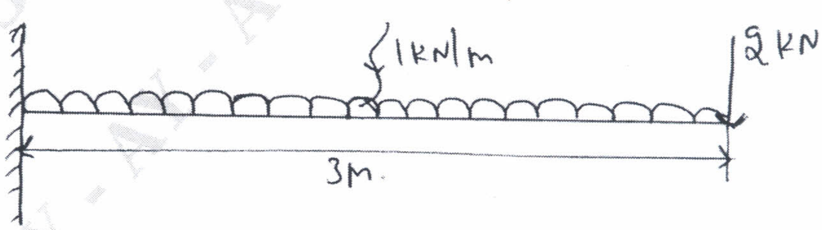

Fig.Q.8(b)

Module-5

9 a. Compare the weight of solid and hollow shaft of the same material, length and torsional strength. **(10 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. 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 the external diameter, the length, material and maximum shear stress being the same? **(10 Marks)**

OR

10 a. Define:

i) Buckling load
ii) Slenderness ratio
iii) Effective length **(06 Marks)**

b. Explain the limitations of Euler's buckling theory. **(04 Marks)**

c. 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:

i) Rankine's formula taking yield stress as 560 N/mm^2 and Rankines constant, $\alpha = \frac{1}{1600}$.

ii) Euler's formula, taking $E = 1.2 \times 10^5$ N/mm^2. **(10 Marks)**

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