CBCS SCHEME

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18MT33

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. Define the following :
  (i) Hook's law.
  (ii) Poisson's ratio.
  (iii) Young's modulus.
  (iv) Principle of Super position **(04 Marks)**

b. Derive an expression for deformation of uniformly Tapering Rectangular bar. **(08 Marks)**

c. A member ABCD is subjected to point leads as shown in Fig. Q1 (c). Calculate
  (i) Force P necessary for equilibrium
  (ii) Total elongation of the bar. Take E = 210 GN/m^2.

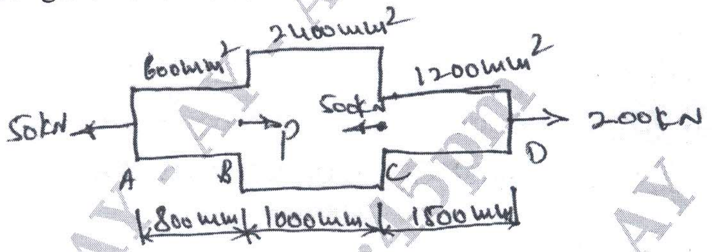

Fig. Q1 (c) **(08 Marks)**

OR

2 a. Derive an expression for relation between E, G and μ as $E = 2G(1+\mu)$. **(08 Marks)**

b. Define Elastic constants. **(04 Marks)**

c. A bar shown in Fig.Q2 (c) is subjected to a tensile load of 150 KN. If the stress in the middle portion is limited to 160 N/mm^2, determine the diameter of the middle portion. Also find the length of the middle portion. If the total elongation of the bar is to be 0.25 mm, young's modulus is equal to 2×10^5 N/mm^2 **(08 Marks)**

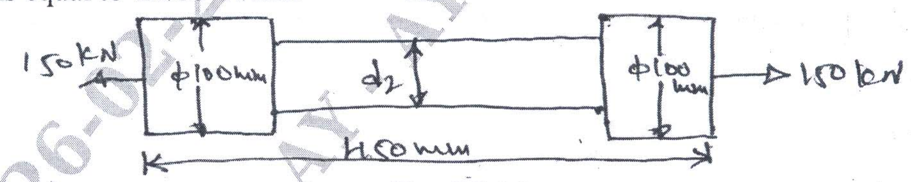

Fig. Q2 (c)

Module-2

3 a. Define principle stress and principle planes. **(04 Marks)**

b. Derive the expression for a rectangular bar is subjected to two direct stresses σ_x and σ_y two mutually perpendicular directions. Prove that the normal stress (σ_n) and shear stress (τ) on an oblique plane which is inclined at an θ with the axis of minor stress, are given by $\sigma_n = \frac{\sigma_x+\sigma_y}{2}+\frac{\sigma_x-\sigma_y}{2}\cos 2\theta$ and $\tau = \frac{-\sigma_x+\sigma_y}{2}.\sin 2\theta$ **(08 Marks)**

c. The state of stress in a two dimensionally stressed body is as shown in Fig. Q3 (c). Determine
   (i) Normal and Tangential stresses on plane AC.
   (ii) Principle stresses, principle planes and maximum shear stress and its location.
   (iii) Normal stress on maximum shear stress plane. **(08 Marks)**

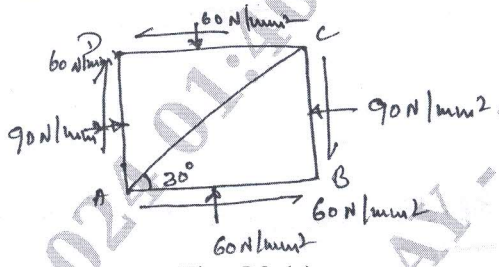

Fig. Q3 (c)

OR

4 a. Explain sign conventions for Mohr's circle. **(04 Marks)**

b. A point is subjected to a tensile stress of 60 N/mm^2 and a compressive stress of 40 N/mm^2, acting on two mutually perpendicular planes and a shear stress of 10 N/mm^2 as shown in Fig. Q4 (b). Determine the principal as well as maximum shear stress by Mohr's circle method. **(16 Marks)**

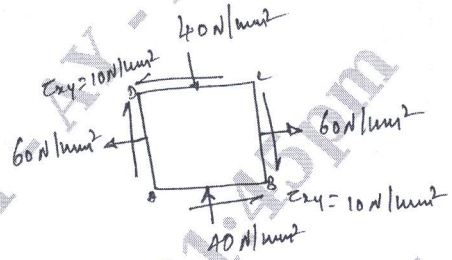

Fig. Q4 (b)

Module-3

5 a. Define beam. Explain with simple sketches, different types of beams. **(06 Marks)**

b. Draw the shear force and bending moment diagrams for the Cantilever beam shown in Fig. Q5 (b). **(14 Marks)**

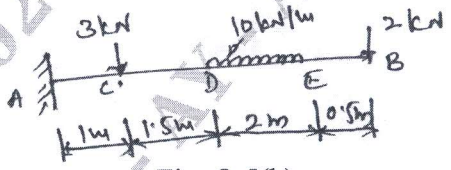

Fig. Q 5(b)

OR

6 a. Explain the following :
   (i) Shear force
   (ii) Bending moment
   (iii) Sagging Bending moment
   (iv) Hogging bending moment
   (v) Point of contraflexture. **(05 Marks)**

b. A simply supported beam AB of 6 m span is loaded as shown in Fig. Q6 (b). Draw the shear force and bending moment diagrams.

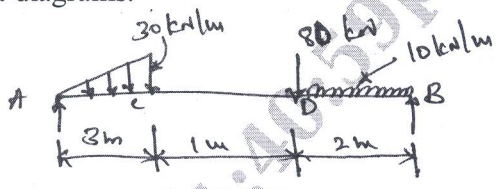

Fig. Q6 (b) **(15 Marks)**

Module-4

7 a. With assumptions derive bending moment equation, $\frac{\mu}{I} = \frac{\sigma}{y} = \frac{E}{R}$ **(10 Marks)**

b. The cross section of a beam is as shown in Fig. Q7 (b). If permissible stress is 150 N/mm^2. Find its moment of resistance. Compare it with equivalent section of the same area for a square section.

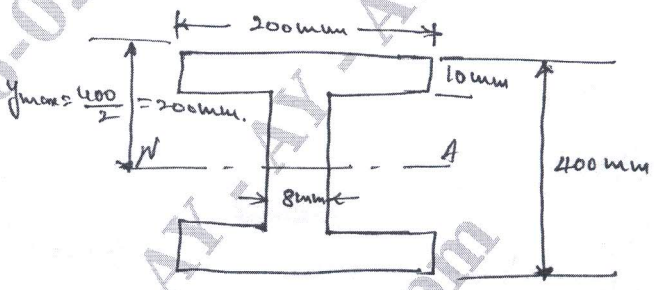

Fig. Q7 (b) **(10 Marks)**

OR

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

b. Derive an expression for maximum deflection in a Cantilever beam subjected to a point load at free end. **(10 Marks)**

Module-5

9 a. With assumptions, derive Torsion equation for circular shaft. **(10 Marks)**

b. A hollow circular steel shaft has to transmit 60 kW at 210 rpm such that the maximum shear stress does not exceed 60 MN/m^2. If the ratio of Internal to External diameter is equal to $\frac{3}{4}$ and the value of rigidity modulus is 84 GPa. Find the dimensions of the shaft and angle of twist in a length of 3 m. **(10 Marks)**

OR

10 a. Define slenderness ratio and derive Euler's expression for bucking load for column with both ends hinged. **(10 Marks)**

b. A hollow circular section 2.8 m long column is fixed at one end and hinged at the other end. External diameter is 150 mm and thickness of wall is 15 mm. Rankine constant = $\frac{1}{1600}$ and $\sigma_c = 550$ MPa. Compare the buckling loads obtained by using Euler's formula and Rankine formula. Also find the length of column for which both formulae gives the same load. Take E = 80 GPa. **(10 Marks)**

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