CBCS SCHEME

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15MN34

# Third Semester B.E. Degree Examination, Jan./Feb. 2023
## 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) Hook's law (ii) Factor of safety (iii) Principle of superposition (iv) Malleability. **(04 Marks)**

b. Neatly draw the stress-strain diagram for mild steel indicating all salient points and zones on it. **(04 Marks)**

c. The following data refers to a mild steel specimen tested in a laboratory :
(i) Diameter of specimen = 25 mm (ii) Gauge length = 200 mm
(iii) Extension under a load of 20 kN = 0.04 mm (iv) Load at yield point = 150 kN
(v) Maximum load = 225 kN
(vi) Length of specimen after failure = 275 mm
(vii) Neck diameter = 18.25 mm **(08 Marks)**

**OR**

2 a. Derive an expression for the extension of uniformly tapering rectangular bar subjected to axial load P. **(08 Marks)**

b. Determine the stresses in various segments of the circular bar shown in Fig. Q2 (b) and also find out its total elongation assuming Young's modulus of steel to be 200 GPa.

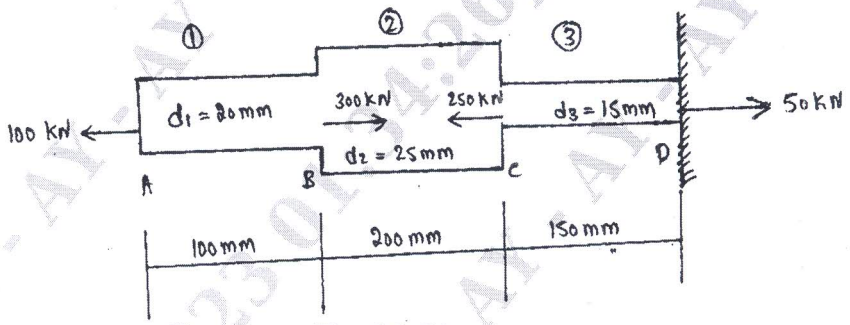


Fig. Q2 (b) **(08 Marks)**

### Module-2

3 a. Derive the relationship between modulus of elasticity and modulus of rigidity. **(08 Marks)**

b. The state of stress in two dimensionally stressed body is shown in Fig Q3 (b). Determine the principle stresses. Principal planes, maximum shear stress and their planes.

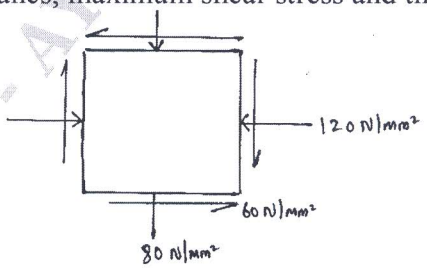


Fig.Q3 (b) **(08 Marks)**

**OR**

4 a. Define thin cylinder. Also derive an expression for longitudinal stress of a thin cylinder. **(04 Marks)**

b. A thin cylinder of internal diameter 2000 mm contains a fluid at an internal pressure of 3 $N/mm^2$. Determine the maximum thickness of the cylinder, if (i) longitudinal stress is not to exceed 30 $N/mm^2$ and (ii) Circumferential stress is not exceed 40 $N/mm^2$. **(04 Marks)**

c. A thin cylindrical shell 1 m in diameter and 3000 mm long has a metal thickness of 10 mm. It is subjected to an internal fluid pressure of 3 MPa. Determine (i) Circumferential and longitudinal stress (ii) Circumferential, longitudinal & volumetric strain (iii) Change in length, diameter and volume. Also find maximum shearing stress in the shell. Assume Poisson's ratio = 0.3 and E = 210 GPa. **(08 Marks)**

## Module-3

5 a. Derive the relationship between relating load (w), shear force (F) and Bending moment (M). **(06 Marks)**

b. Draw the SFD and BMD for the cantilever beam loaded as shown in Fig. Q5(b).

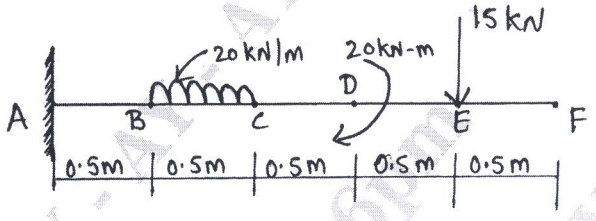


Fig Q5(b) **(10 Marks)**

**OR**

6 a. Define:
i) Shear Force ii) Bending moment iii) Point of contra flexure. **(06 Marks)**

b. Draw SFD and BMD for the beam shown in Fig. Q6(b).

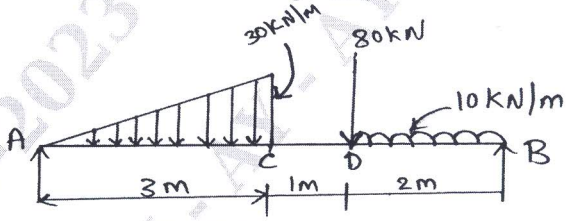


Fig Q6 (b) **(10 Marks)**

## Module-4

7 a. State the assumptions made in theory of simply bending and derive the relation between bending stress and radius of curvature. **(08 Marks)**

b. A beam having T section with its flanges (180mm×10mm) and web of (220mm×10mm) is subjected to sagging bending moment 15 KN-m. Determine maximum Tensile stress and Maximum compressive stress and their location in the section. Draw a sketch showing bending stress distribution.

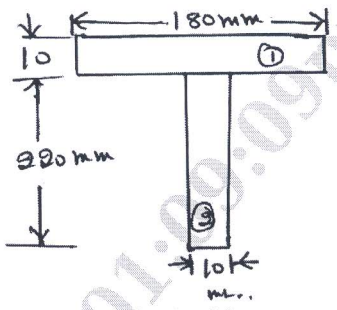


Fig Q7(b) **(08 Marks)**

**OR**

8 a. Show that shear stress distribution along neutral axis is $\tau_{NA}$ is 1.5 times the average shear stress $\tau_{avg}$ for rectangular section. **(08 Marks)**

b. Find the expression for the slope and deflection of a cantilever of length L subjected to point load at its free end. **(08 Marks)**

## Module-5

9 a. Derive an expression for torsional equation with usual notations. **(08 Marks)**

b. Determine the diameter of solid shaft which will transmit 440 KW at 280 rpm. The angle of twist should not exceed 1 degree per meter length and maximum torsional shear stress is to be limited to 40 N/mm$^2$. Assume G = 84 KN/mm$^2$. **(08 Marks)**

**OR**

10 a. Derive an expression for the critical load in a column subjected to compressive load, when one end is fixed and other end is free. **(08 Marks)**

b. A 2 meters long column has square cross section of side 40 mm. Taking the factor of safety as 4. Determine the safe load for end conditions if

i) Both ends are hinged
ii) One end is fixed and other end is free
iii) Both ends are fixed
iv) One end is fixed and other end is hinged

Take E = 210 GPa. **(08 Marks)**

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