CBCS SCHEME

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21ME44

Fourth Semester B.E./B.Tech. Degree Examination, June/July 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. Draw stress strain diagram for mild-steel and explain all the silent points. **(10 Marks)**

b. A member ABCD is subjected to point loads P_1, P_2, P_3 and P_4 as shown in Fig.Q1(b). Calculate the force P_3 necessary for equilibrium if P_1 = 120 KN, P_2 = 220 KN, and P_4 = 160 KN. Determine also the net change in the length of the member.
Take E = 200 GPa.

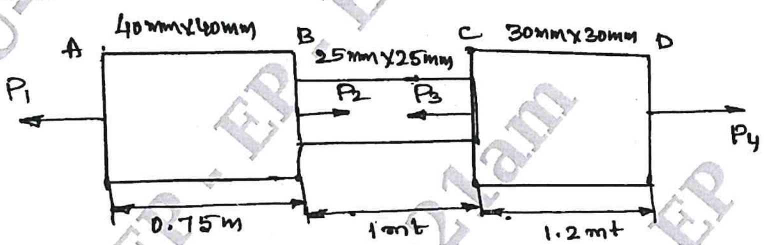

Fig.Q1(b) **(10 Marks)**

OR

2 a. Derive the expression for the extension of uniformly tapering circular rod subjected to axial load. **(10 Marks)**

b. A bar of 20 mm diameter is subjected to a pull of 50 KN. The measured extension on gauge length of 250 mm is 0.12 mm and change in diameter is 0.00375 mm. Determine
(i) Young's modulus (ii) Poisson's ratio (iii) Bulk modulus (iv) Modulus of rigidity. **(10 Marks)**

Module-2

3 a. What are principal stresses and principal planes. **(04 Marks)**

b. Derive an equation for normal and shear stress for a member subjected to direct stresses on two mutually perpendicular directions [Bi-axial stress]. **(08 Marks)**

c. The principal stresses at a point in a bar are 200 N/mm^2 (Tensile) and 100 N/mm^2 (Compression). Determine the resultant stress in magnitude and direction on a plane inclined at 60° to the axis of major principal stress. Also determine the maximum intensity of shear stress in the material at the point. **(08 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

4 The state of stress in a two dimensionally stressed body is as shown in Fig.Q4(a). Determine
(i) Normal and tangential stresses on plane AC.
(ii) Principal stresses, principal planes and maximum shear stress and its location.
(iii) Normal stress on maximum shear stress plane
(iv) Verify answers by Mohr's circle method.

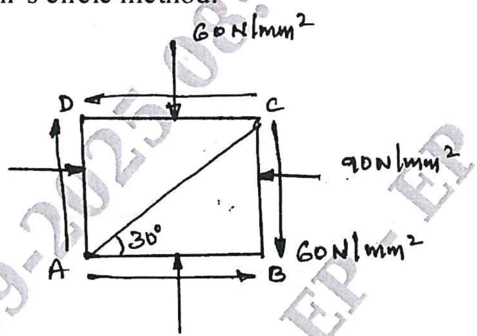

Fig.Q4(a) **(20 Marks)**

Module-3

5 a. Explain the term :
(i) Sagging bending moment (ii) Hogging bending moment (iii) Point of contraflexture **(06 Marks)**

b. For the beam shown in Fig.Q5(b). Draw shear force diagram (SFD) and bending moment diagram (BMD). Locate the point of contraflexture if any.

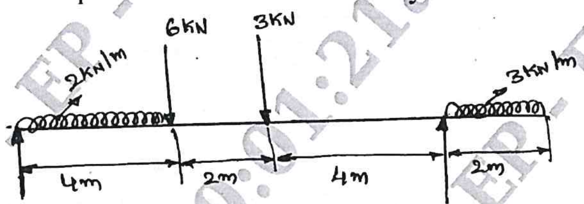

Fig.Q5(b) **(14 Marks)**

OR

6 a. Derive an expression for relationship between bending stress and radius of curvature with suitable assumptions. **(10 Marks)**

b. A simply supported beam 15 mm × 20 mm is 1.5 m long and it fails if a concentrated load of 425 N is applied at its centre. Determine what udl can break a cantilever beam of same material 50 mm × 110 mm in section and 2 m long. **(10 Marks)**

Module-4

7 a. Derive an expression $EI\frac{d^2y}{dx^2} = M$ with usual notations. **(10 Marks)**

b. Find the slope and deflection at the free end of the cantilever shown in Fig.Q7(b). $E = 200\ KN/mm^2$, $I = 40\times10^6\ mm^4$.

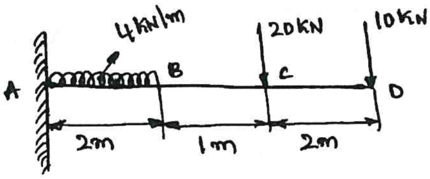

Fig.Q7(b) **(10 Marks)**

OR

8 a. Derive the relation for a circular shaft when subjected to torsion as given below:

$$\frac{T}{J_p} = \frac{\tau}{R} = \frac{G\theta}{\ell}$$ **(10 Marks)**

b. A solid shaft rotating at 1000 rpm transmits 50 KW. Maximum torque is 20% more than the mean torque. Material of the shaft has the allowable shear stress of 50 MPa and modulus of rigidity 80 GPa. Angle of twist in the shaft should not exceed 1° in one metre length. Determine the diameter of the shaft. **(10 Marks)**

Module-5

9 a. What are the difference between thin cylinder and thick cylinder? **(04 Marks)**

b. Explain the stresses induced in a thin cylindrical shell subjected to internal pressure. **(06 Marks)**

c. A thick cylinder of radii 200 mm and 300 mm is subjected to internal fluid pressure 50 N/mm^2 and external pressure of 20 N/mm^2. Determine Hoop stress developed a internal and external radii. Sketch the variation of stress. **(10 Marks)**

OR

10 a. Define : (i) Slenderness ratio (ii) Radius of gyration **(04 Marks)**

b. Derive Euler's critical load for a column when both ends are fixed. **(10 Marks)**

c. Calculate the instantaneous stress produced in a bar 1000 mm^2 in area and 4 m long by the sudden application of a tensile load of unknown magnitude, if the extension of the bar due to suddenly applied load is 1.35 mm. Also determine the magnitude of the suddenly applied load. $E = 2 \times 10^5$ N/mm^2. **(06 Marks)**

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