CBCS SCHEME

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21ME44

Fourth 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 the following terms:
(i) Stress (ii) Strain (iii) Young's modulus
(iv) Poisson's ratio (v) Hooke's law **(05 Marks)**

b. Derive an expression for the total elongation of a tapered circular bar cross section of diameter 'D' and 'd' subjected to an axial load 'p'. **(05 Marks)**

c. A bar of 800 mm length is attached rigidly at A and B as shown in Fig.Q1(c). Determine reaction at both ends and stress in each portion. Bar diameter is 25 mm and Young's modulus E = 200 MPa.

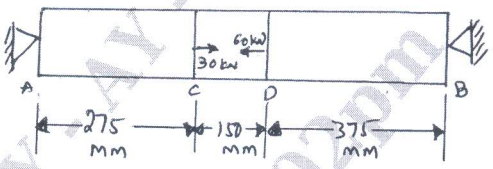

Fig.Q1(c) **(10 Marks)**

OR

2 a. A steel rail is 12.6 m long and is laid at a temperature of 24°C. The maximum temperature is expected to raise to 44°C.
(i) Estimate the minimum gap between the rails to be left so that temperature stress do not develop.
(ii) If the stress developed is 20 N/mm^2, what is the gap left between the rails?
Take E = 2×10^5 N/mm^2 and $\alpha = 12 \times 10^{-6}$/°C **(10 Marks)**

b. Derive a relation between modulus of elasticity and modulus of rigidity. **(10 Marks)**

Module-2

3 a. Derive the expression for normal stress and tangential stress or a plane inclined at θ to the vertical axis in a biaxial stress system with shear stress. **(08 Marks)**

b. State of stress at a point in a strained material is as shown in Fig.Q3(b). Determine:
(i) Direction of principal plane and magnitude of principal stresses
(ii) Maximum shear stress and its directions
(iii) Sketch and indicate above planes.

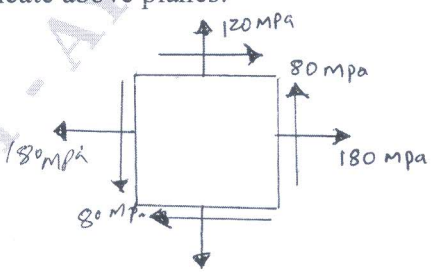

Fig.Q3(b) **(12 Marks)**

OR

4 The state of stress at a point in a strained material is shown in Fig.Q4. Determine:
(i) Direction of principal plane and magnitude of principal stress.
(ii) Direction of maximum shear stress and its magnitude
(iii) Draw Mohr's circle to verify the results obtained analytically

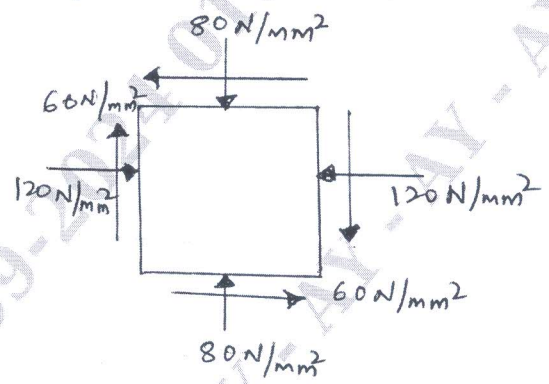

Fig.Q4 **(20 Marks)**

Module-3

5 a. A cantilever of length 2m carries an uniform distributed load of 1 kN/m run over a length of 1.5 m from the free end. Draw the shear force and bending moment diagram for the cantilever beam. **(06 Marks)**

b. Draw the BMD and SFD for the overhanging beam shown in Fig.Q5(b). Find also point of contraflexure with corresponding value of bending moment.

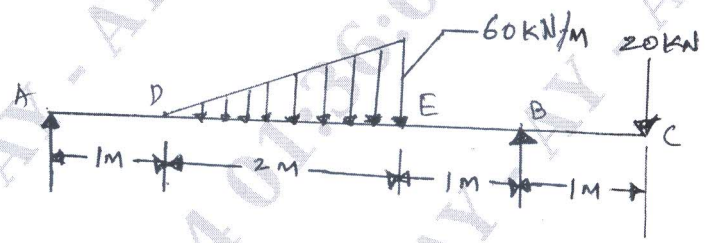

Fig.Q5(b) **(14 Marks)**

OR

6 a. Prove the relation $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$ with usual notations. **(10 Marks)**

b. Fig.Q6(b) shows the cross-section of a beam which is subjected to a shear force of 20 kN. Draw shear stress distribution across depth marking values at salient points.

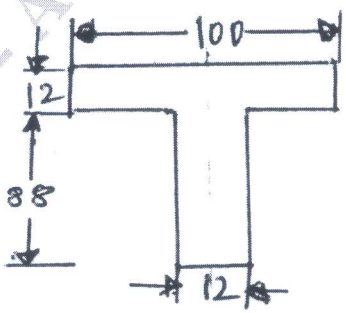

Fig.Q6(b) All dimension are in mm **(10 Marks)**

Module-4

7 a. Derive an expression for deflection, slope and maximum deflection of simply supported beam of span 'L' subjected to a concentrated load W at its mid span using differential equation for deflection. **(10 Marks)**

b. A simply supported beam of 6m span is subjected to a point load of 18 kN at 4 m from left support. Calculate:

(i) The position and the value of maximum deflection

(ii) Slope at mid-span

Assume E = 200 GPa and I = 15×10^6 mm^4. **(10 Marks)**

OR

8 a. Derive the torsional equation for a circular shaft with usual notations. State the assumptions made. **(10 Marks)**

b. A shaft is required to transmit 245 KW power at 240 rpm. The maximum torque may be 1.5 times the mean torque. The shear stress in the shaft should not exceed 40 N/mm^2 and the twist 1° per metre length. Determine the diameter required if shaft is hollow with external diameter twice the internal diameter. Take modulus of rigidity, G = 80 kN/mm^2. **(10 Marks)**

Module-5

9 a. A thick cylinder of outside diameter 300 mm and internal diameter 200 mm is subjected to an internal fluid pressure of 14 N/mm^2. Determine the maximum hoop stress developed in the cross section. Sketch the variation of hoop stress across the thickness of the cylinder. **(10 Marks)**

b. What is strain energy? Explain in brief. **(05 Marks)**

c. Obtain an expression for strain energy due to shear stress. **(05 Marks)**

OR

10 a. State the assumptions made while deriving Euler's column formula. Also derive Euler's expression of buckling for column with both ends hinged. **(10 Marks)**

b. A hollow cast from iron whose outside diameter is 200 mm and has a thickness of 20 mm is 4.5 m long and is fixed at both ends. Calculate the safe load by Rankine's formulae with factor of safety 2.5. Find the ratio of Euler's to Rankine's loads. Assume E = 1×10^5 N/mm^2, Rankine's constant = 1/1600 for both ends pinned and f_c = 550 N/mm^2. **(10 Marks)**

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