CBCS SCHEME

USN | | | | | | | | | | |

18ME32

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: (i) Stress (ii) Elasticity (iii) Hooke's law (iv) Principle of superposition. **(04 Marks)**

b. Explain stress-strain diagram of mild steel indicating its salient points. **(06 Marks)**

c. A brass bar having cross-sectional area 1100 mm^2 subjected to axial force as shown in Fig.Q1(c). Determine the total elongation of the bar by assuming the modulus of elasticity as 106 GN/m^2.

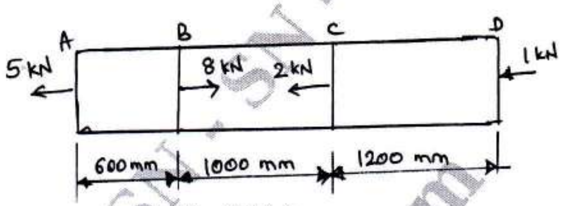

Fig.Q1(c) **(10 Marks)**

OR

2 a. From first principles establish the relationship between Young's modulus and bulk modulus. **(06 Marks)**

b. Derive an expression for the extension of uniformly tapering circular bar subjected to axial load. **(06 Marks)**

c. A bar of brass 25mm diameter is enclosed in a steel tube of 50mm external diameter and 25mm internal diameter. The bar and tube fastened at the ends and are 1.5m long. Find the stresses in the two materials when the temperature raises from 30°C to 80°C.
Take E_{steel} = 200 GPa , E_{brass} = 100 GPa , $\alpha_{steel} = 11.6\times10^{-6}$/°C, $\alpha_{brass} = 18.7\times10^{-6}$/°C. **(08 Marks)**

Module-2

3 a. Show that sum of the normal stresses on any two planes at right angles in a general 2-D stress system is constant. **(05 Marks)**

b. An element is subjected to stress system as shown in Fig.Q3(b). Determine (i) Normal and tangential stress on the oblique plane. (ii) Resultant stress (iii) Angle of obliquity (iv) Principal stresses and their planes (v) Maximum shear stress and its planes.

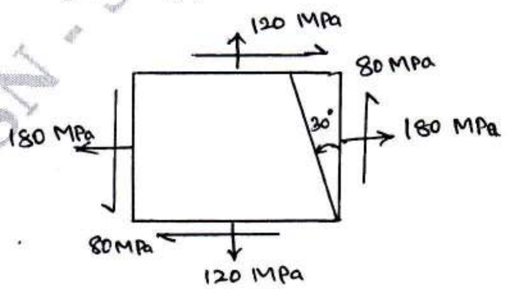

Fig.Q3(b) **(15 Marks)**

OR

4 a. State the assumptions made in the cylinders. Derive an expression for circumferential stress and longitudinal stress for thin cylinders. **(10 Marks)**

b. A thick cylinder of 500mm inner diameter is subjected to an internal pressure of 9 MPa. Taking the allowable stress for the material of the cylinder as 40 MPa, determine the wall thickness of the cylinder. **(10 Marks)**

Module-3

5 a. Define (i) Shear force (ii) Bending Moment (iii) Point of contraflexure. **(03 Marks)**

b. Derive an expression to establish the relationship between the intensity of load, shear force and bending moment. **(05 Marks)**

c. Draw shear force and bending moment diagram for the beam shown in Fig.Q5(c). Mark the position of maximum bending moment and determine its value. Also find the point of contraflexure.

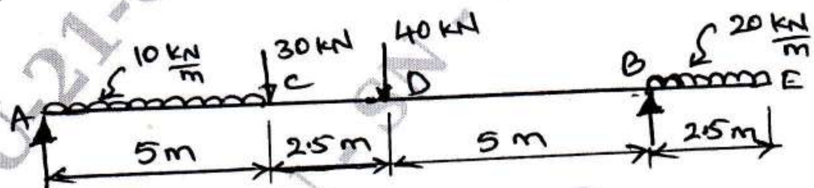

Fig.Q5(c) **(12 Marks)**

OR

6 a. List the assumptions made in theory of pure bending. **(04 Marks)**

b. Prove that the maximum shear stress is 1.5 times the average shear stress in a beam of rectangular cross-section. **(06 Marks)**

c. A cast iron beam of T-section with flange dimensions 100mm×20mm and web 80mm×20mm. The beam is simple supported over a span of 8m. The beam is uniformly distributed load of 1.5 kN/m length over the entire span. Determine the maximum tensile and maximum compressive stresses. Plot the stress distribution. **(10 Marks)**

Module-4

7 a. State the assumptions in the theory of pure torsion. Derive torsion equation with usual notations. **(10 Marks)**

b. Determine the diameter of a solid steel shaft which will transmit 90 kW at 160 rpm. Also determine the length of the shaft if the twist must not exceed 1° over the entire length. The maximum shear stress is limited to 60 N/mm^2. Take the value of modulus of rigidity as 8×10^4 MPa. **(10 Marks)**

OR

8 a. Prove that a hollow shaft is stronger than solid shaft of the same material, length and weight. **(06 Marks)**

b. Explain maximum principal stress theory and maximum shear stress theory. **(06 Marks)**

c. The stresses induced at a critical point in a machine component made of steel are as $\sigma_x = 100$ MPa , $\sigma_y = 40$ MPa , $\tau_{xy} = 80$ MPa. Calculate the factor of safety by
i) Maximum normal stress theory ii) Maximum shear stress theory. Take $\sigma_{yield} = 380$ MPa. **(08 Marks)**

Module-5

9 a. Derive an expression for Euler's buckling load of a column for one end fixed and other end free. **(10 Marks)**

b. Find the Euler's crippling load for a hollow cylindrical steel column 40mm external diameter and 4mm thickness. The length of the column is 2.5m and it is hinged at both ends. Also compute the Rankine's crippling load using constant σ_c = 335 MPa and $\alpha = \frac{1}{7500}$. Take E = 205 GPa. **(10 Marks)**

OR

10 a. State Castigliano's theorem I and II. **(04 Marks)**

b. Derive an expression for strain energy due to shear stress. **(08 Marks)**

c. Determine the strain energy of the simply supported prismatic beam, subjected to uniformly distributed load 25 kN/m over total span of 10m. Assume $I = 195.3 \times 10^3\ mm^4$, $E = 2\times10^5 MPa$ **(08 Marks)**

* * * * *