CBCS SCHEME

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Third Semester B.E. Degree Examination, July/August 2022
Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

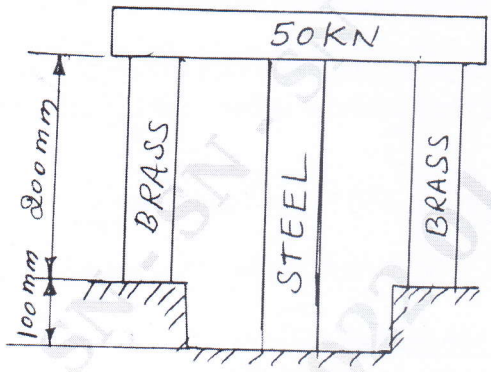
1 a. State the Hooke's law. Explain with neat sketch stress-strain diagram for mild steel indicating its salient points. **(10 Marks)**

b. The following data refers to a mild steel specimen tested in a laboratory.
Diameter of specimen = 25 mm Gauge length of specimen = 200 mm
Extension under a load of 20 kN = 0.04 mm Load at yield point = 150 kN
Maximum load = 225 kN Length of specimen after failure = 275 mm
Neck diameter = 18.25 mm
Determine: (i) Young's modulus (ii) Yield stress (iii) Ultimate stress
(iv) Percentage of elongation (v) Percentage reduction in area **(10 Marks)**

OR

2 a. Obtain the relation between modulus of elasticity and modulus of rigidity. **(10 Marks)**

b. A steel rod of cross sectional area 1600 mm^2 and two brass rods each of cross sectional area of 1000 mm^2 together support a load of 50 kN as shown in Fig.Q2(b). Find stresses in the rods.



$E_{steel} = 2 \times 10^5$ N/mm^2
$E_{brass} = 1 \times 10^5$ N/mm^2

Fig.Q2(b) **(10 Marks)**

Module-2

3 a. Describe the construction of Mohr's circle for plane stress condition. **(10 Marks)**

b. The principal stresses at a point in a bar are 200 N/mm^2 (Tensile) and 100 N/mm^2 (compressive). 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. **(10 Marks)**

OR

4 a. Derive an expression for circumferential and longitudinal stress of thin cylinder. **(10 Marks)**

b. A pipe of 500 mm internal diameter and 75 mm thick is filled with a fluid at a pressure of 6 N/mm^2. Find the maximum and minimum hoop stress across the cross-section of the cylinder. Also sketch the radial pressure and hoop stress distribution across the section. **(10 Marks)**

Module-3

5 a. Define a beam. Explain the different types of beams and types of loads with neat sketches. **(08 Marks)**

b. A simply supported beam of span 6 m is subjected to a concentrated load of 25 kN acting at a distance of 2 m from the left end. Also subjected to an uniformly distributed load of 10 kN/m over the entire span. Draw the SFD and BMD. **(12 Marks)**

OR

6 a. With assumptions in simple bending, derive an expression $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$ with usual notations. **(10 Marks)**

b. Derive an expression for $M = EI\frac{d^2y}{dx^2}$. **(10 Marks)**

Module-4

7 a. Derive an expression $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{\ell}$ with usual notations. **(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

8 a. Derive an expression for Euler's crippling load for a column when both ends are hinged. **(10 Marks)**

b. A 1.5 m long column has a circular cross section of 50 mm diameter. One end of the column is fixed in direction and position and the other end is free. Taking the FoS = 3, calculate the safe load using:

(i) Rankine's formula taking yield stress 560 N/mm^2 and $\alpha = \frac{1}{1600}$.

(ii) Euler's formula, taking $E = 1.2 \times 10^5$ N/mm^2. **(10 Marks)**

Module-5

9 a. Derive an expression for strain energy due to normal stress. **(10 Marks)**

b. A tensile load of 50 kN is applied to a circular cross-section bar of diameter 50 mm and 4 m long, if $E = 2 \times 10^5$ N/mm^2, determine:

(i) Stretch in the rod

(ii) Stress in the rod

(iii) Strain energy absorbed by the rod in

- load is applied gradually
- load is applied suddenly. **(10 Marks)**

OR

10 a. Write notes on : (i) Maximum shear stress theory (ii) Maximum principal stress theory. **(10 Marks)**

b. A plate of C45 steel (σ_{yt} = 353 MPa) is subjected to the following stresses: σ_x = 150 N/mm^2, σ_y = 100 N/mm^2 and τ_{xy} = 50 N/mm^2. Find the factor of safety by:
(i) maximum principal stress theory (ii) maximum shear stress theory **(10 Marks)**

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