CBCS SCHEME

USN | | | | | | | | | | 17MT33

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. What is mechanics of materials? Explain :
   i) Resilience
   ii) Toughness
   iii) Elastic limit
   iv) Proof stress
   v) Possion ratio. **(06 Marks)**

b. Derive an expression for the extension of tapering bar whose diameter d_1 at one end tapers linearly to a diameter d_2 in a length "L" under axial pull "p" and young's modulus 'E' in N/mm^2. **(06 Marks)**

c. 25mm diameter and 200mm length mild steel specimen tested in laboratory. The following data obtained, load at yield point = 150kN, Maximum load = 225kN, Extension under a load of 20kN = 0.04mm, Neck diameter = 18.25 mm, Length of specimen after failure = 275 mm. Determine:
   i) Young's modulus
   ii) Yield stress
   iii) Ultimate stress
   iv) Percentage elongation
   v) Percentage reduction in area
   vi) Safe stress adopting a factor of safety 2.5. **(08 Marks)**

OR

2 a. Derive a Relationship between Young's modulus and modulus of rigidity. **(08 Marks)**

b. A solid steel bar 500mm long and 70mm diameter is placed inside on aluminum tube having 75mm inside diameter and 100mm outside diameter. The aluminium cylinder is 0.15mm longer than the steel bar. An axial load of 600kN is applied to the bar and cylinder through rigid cover plates as shown in Fig.Q.2(b). Find stress developed steel bar and aluminium tube. Assume E_s = 210 kN/mm^2 and $E_{A\ell}$ = 70kN/mm^2.

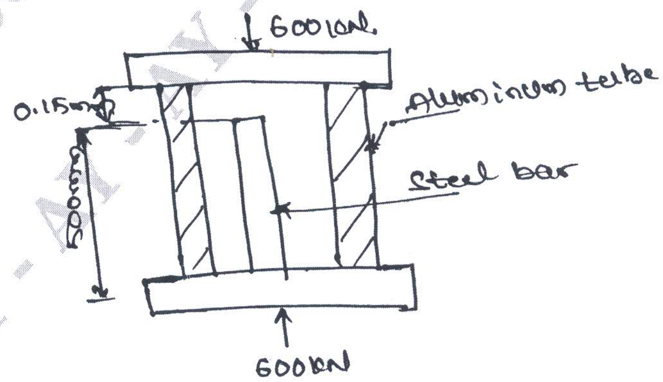

Fig Q2(b) **(12 Marks)**

Module-2

3 a. Derive the expression for a rectangular bar is subjected to two direct stresses σ_x and σ_y in two mutually perpendicular directions. Prove that the normal stress (σ_n) and shear stress (τ) on an oblique plane which is inclined at an θ with the axis of minor stress, are given by:

$$\sigma_n = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta \text{ and } \tau = \frac{\sigma_x - \sigma_y}{2}.\sin 2\theta .$$ **(08 Marks)**

b. A plane element is subjected to stresses as shown in Fig.Q.3(b). Determine principal stress, maximum shear stress, their planes and normal stress on maximum shear plane. Sketch the planes.

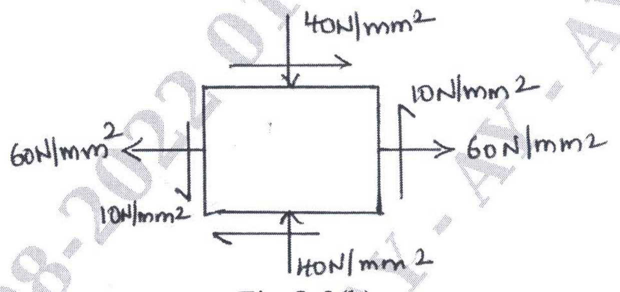

Fig.Q.3(b)

(12 Marks)

OR

4 a. Define the principal stresses and principal planes. **(04 Marks)**

b. The state of stress in two dimensionally stressed body is shown in Fig.Q.4(b). Determine the principal stresses, principal planes, maximum shear stress and their planes. Also draw the Mohr's cycle to verify the results obtained analytically. **(16 Marks)**

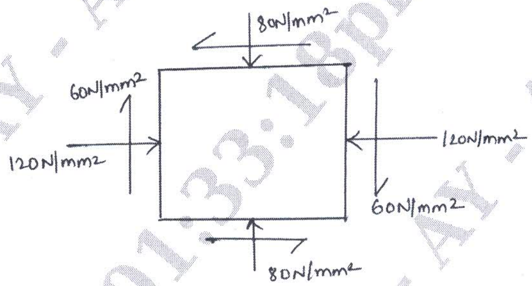

Fig.Q.4(b)

Module-3

5 a. Define the following :
i) Sagging Bending Moment
ii) Point of Contra-flexure
iii) Hogging Bending Moment **(06 Marks)**

b. A simply supported beam AB of 6m span is loaded as shown in Fig.Q.5(b). Draw shear force and bending moment diagram also indicate the point of contra-flexure if any.

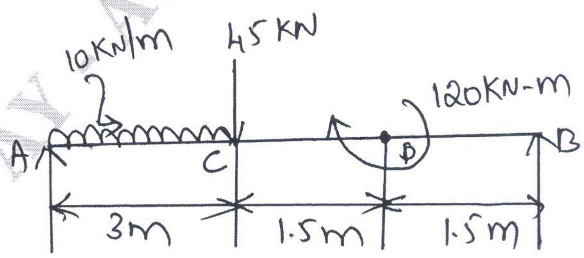

Fig.Q.5(b) **(14 Marks)**

OR

6 a. Derive the relationship between load, shear force and Bending moment. **(06 Marks)**

b. For the beam shown in Fig.Q.6(b) draw the SFD and BMD. Locate the point of contra-flexure if any.

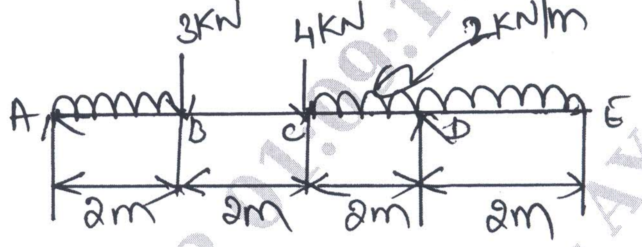

Fig.Q.6(b) **(14 Marks)**

Module-4

7 a. A 2m long cantilever with an unsymmetric "I" section is subjected to UDL of 20kN/m. The I – Section has (180mm × 10mm) Upper flange, (100mm × 10mm) bottom flange and (220mm × 10mm) web. Draw the bending stress of shear stress distribution diagram. **(12 Marks)**

b. With proper assumption derive relationship between Bending moment and Radius of curvature. **(08 Marks)**

OR

8 a. Derive deflection equation for a simply supported beam of length "L" subjected to couples at the ends. **(08 Marks)**

b. A cantilever is subjected to forces as shown in Fig.Q.8(b). Determine: i) Deflection and slope at point 'B' ii) Deflection and slope at a point which is at a distance of 3m from the free end.

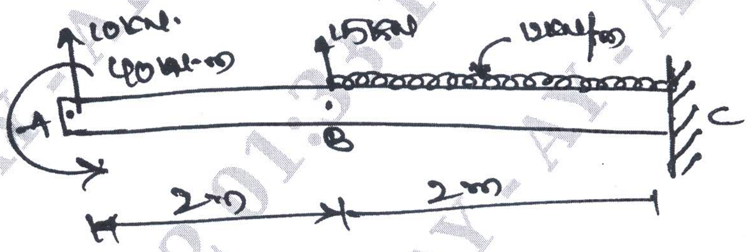

Fig.Q.8(b)

(12 Marks)

Module-5

9 a. State the assumptions in the theory of pure torsion and derive the torsional equation of shear stress produced in a circular shaft subjected to torsion. **(08 Marks)**

b. Compare the weight, strength of hollow shaft of same external diameter as that of solid shaft. The inner diameter of hollow shaft is half the external diameter. Both the shafts have the same material, length. **(06 Marks)**

c. A hollow shaft having internal diameter 40% of its external diameter, transmits 562.5kW power at 100 rpm. Determine the internal and external diameter of shaft if the shear stress is not to exceed $60 N/mm^2$ and the twist in a length of 2.5m should not exceed 1.3 degrees. The maximum torque being 25% greater than mean modulus of rigidity $= 9 \times 10^4 N/mm^2$. **(06 Marks)**

OR

10 a. Define slenderness ratio and derive Euler's expression for buckling load for column with both ends hinged. **(12 Marks)**

b. A hollow CI column whose outside diameter is 200mm has a thickness of 20mm. It is 4.5m long and is fixed at both ends. Calculate the safe load by Rankine's formula using a factor of safety of 4. Calculate slenderness ratio and the ratio of Euler's and Rankine's critical loads.

Take $f_C = 550 N/mm^2$, $\alpha = \frac{1}{1600}$ in Rankine's formula and $E = 9.4 \times 10^4 N/mm^2$. **(08 Marks)**

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