CBCS SCHEME

USN | | | | | | | | | | | **15ME/MA34**

Third Semester B.E. Degree Examination, Jan./Feb. 2023
Mechanics of Materials

Time: 3 hrs. Max. Marks: 80

Note : 1. *Answer any FIVE full questions, choosing ONE full question from each module.*
2. *Missing data if any, may be suitably assumed.*

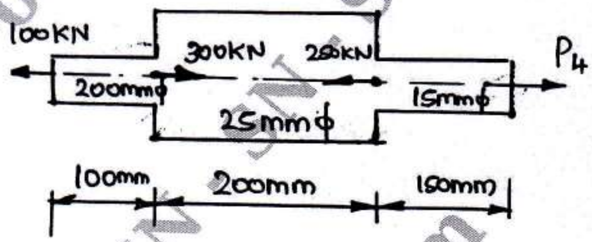
Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Derive an expression for extension due to a tensile load in an uniformly tapering rectangular bar. **(08 Marks)**

b. Determine the stresses in the various segment of circular bar shown in the Fig. Q1(b). Compute the total elongation. Take E = 195 GPa. **(08 Marks)**

Fig. Q1(b)



OR

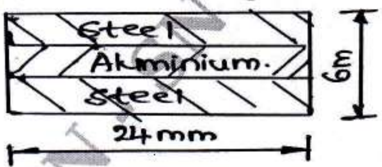
2 a. Derive an expression to show the relation between Modulus of Elasticity and Modulus of Rigidity. **(08 Marks)**

b. A compound bar is made up of Aluminium plate and steel plate as shown in Fig. Q2(b). The length of the compound bar at temperature 20°C is 100mm. If the temperature of the whole assembly is raised by 60°C, determine the stress in each of the material. Further if new compressive load of 20kN is applied to the composite bar. What are the final stresses in steel and aluminium?

Given : $E_S = 2 \times 10^5$ N/mm^2 ; $E_A = \frac{2}{3} \times 10^5$ N/mm^2 ;

$\alpha_S = 12 \times 10^{-6}$ per °C ; $\alpha_A = 23 \times 10^{-6}$ per °C. **(08 Marks)**

Fig. Q2(b)

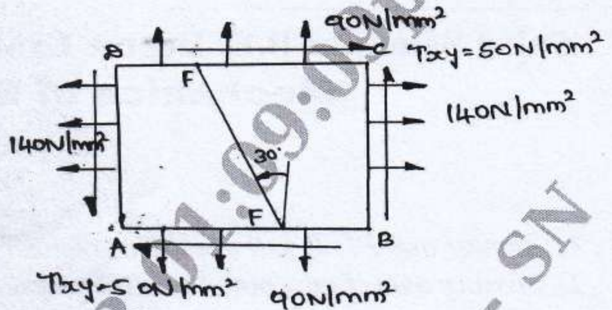


Module-2

3 A point in a strained material is subjected to a stresses as shown in the Fig. Q3. Find

i) Normal stress
ii) Tangential stress.
iii) Resultant stress across the plane EF.

Also determine the maximum , minimum principal stresses, its locations, maximum shear stress and its location. Check the answer analytically. **(16 Marks)**

Fig. Q3


OR

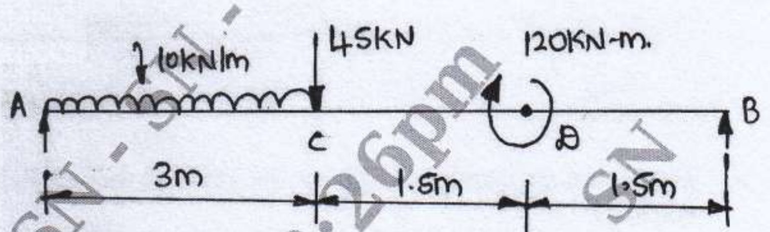
4 a. Derive Lame's equations for radial and hoop stress in case of thick cylinders. **(08 Marks)**

b. A thick spherical shell of 160mm internal diameter is subjected to an internal pressure of $40N/mm^2$. Find the thickness of the shell if the permissible tensile stress is $80N/mm^2$. **(08 Marks)**

Module-3

5 a. Explain the different types of Beams (with sketches). **(04 Marks)**

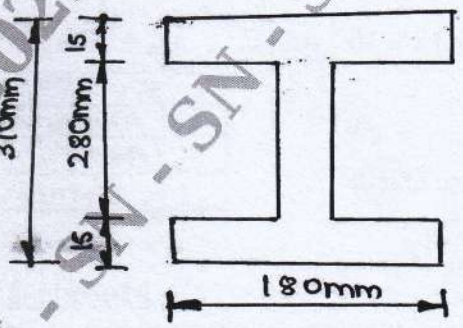
b. Draw SFD and BMD for the beam shown in Fig. Q5(b). Locate point of Contra flexure if any. **(12 Marks)**

Fig. Q5(b)


OR

6 a. With Assumptions, arrive at Euler's Bending equation. **(08 Marks)**

b. An I – section Beam shown in the Fig. Q6(b), is subjected to a Bending Moment of 120kNm and a shear force of 60kN. Sketch the Bending and shear stress distribution along the depth of the section. **(08 Marks)**

Fig. Q6(b)


Module-4

7 a. Arrive at Torsion equation. Also state the assumptions made in the theory of Pure torsion. **(08 Marks)**

b. Prove that hollow shaft is stronger and stiffer than the solid shaft for the same material, length and weight. **(08 Marks)**

OR

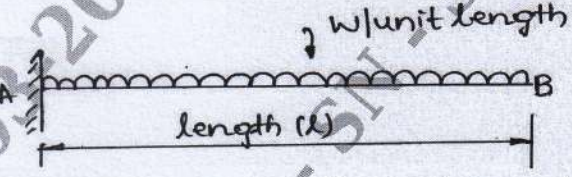
8 a. Derive an expression for Euler's crippling load for a column when both of its ends are fixed. **(08 Marks)**

b. A column of timber section is 200mm × 300mm and 5m long. One end of the column is fixed and the other end free. If the Young's Modulus is 17.5 kN/mm^2. Determine
   i) Euler's crippling load.
   ii) Safe load if the factor of safety is 2.5. **(08 Marks)**

Module-5

9 a. A Cantilever Beam AB supports a uniformly distributed load 'W' per unit length as shown in the Fig. Q9(a). Determine the deflection and slope by using Castigliano's theorem. **(08 Marks)**

Fig. Q9(a)



b. Define the terms : i) Modulus of resilience ii) Toughness iii) Strain Energy iv) Castigliano's theorem. **(08 Marks)**

OR

10 a. Explain briefly i) Maximum principal stress theory ii) Maximum shear stress theory. **(08 Marks)**

b. A plate of C – 45 steel (σ_{yt} = 353Mpa) is subjected to following stresses :
   $\sigma_x = 150 N/mm^2$; $\sigma_y = 100 N/mm^2$; $\tau_{xy} = 50 N/mm^2$. Find factor of safety by
   i) Maximum principal stress theory.
   ii) Maximum shear stress theory. **(08 Marks)**

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