CBCS SCHEME

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

18AU34

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

Time: 3 hrs. Max. Marks: 100

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

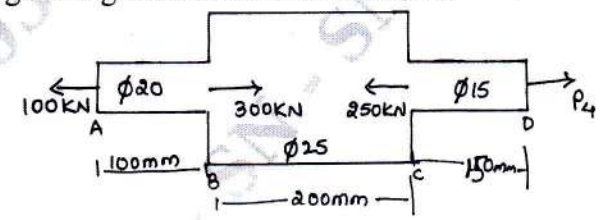
Module-1

1 a. Derive an expression for analysis of uniformly tapering circular bar. **(06 Marks)**

b. With neat sketch, explain stress – strain relation for mild steel. **(06 Marks)**

c. Determine the stresses in various segments of the circular bar shown in Fig. Q1(c). Compute the total elongation taking Young's modulus to be 195 GPa. **(08 Marks)**

Fig. Q1(c)

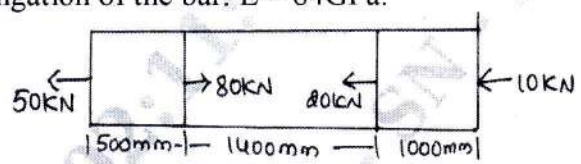


OR

2 a. Define i) Poisson's ratio ii) Bulk modulus iii) Stress iv) Hooke's law v) Elastic limit vi) Malleability. **(06 Marks)**

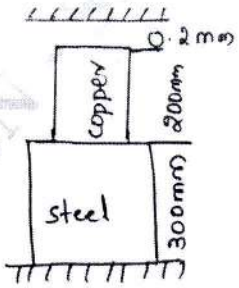
b. A brass bar having cross – sectional area 300mm^2 is subjected to axial forces as shown in Fig. Q2(b). Find the total elongation of the bar. E = 84GPa. **(06 Marks)**

Fig. Q2(b)



c. The composite bar shown in Fig. Q2(c) is 0.2mm short of distance between the rigid supports at room temperature. What is the maximum temperature rise which will not produce stresses in the bar? Find stresses induced when temperature rise is 40°C. Given $\alpha_s = 12 \times 10^{-6}$ per °C , $\alpha_c = 17.5 \times 10^{-6}$ per °C , $E_s = 2 \times 10^5$N/mm^2 , $E_c = 1.2 \times 10^5$ N/mm^2 , $A_s : A_c = 4 : 3$. **(08 Marks)**

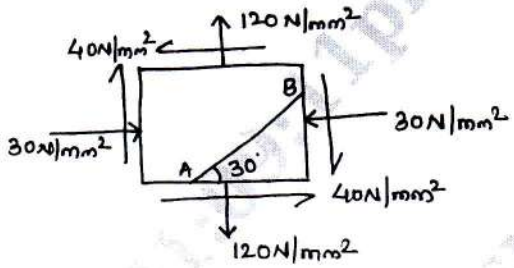
Fig. Q2(c)



Module-2

3 a. At a certain point in a strained material the stress condition shown in Fig. Q3(a) exists. Find
i) Normal and shear stresses on the inclined plane AB.
ii) Principal stresses and principle planes.
iii) Maximum shear stresses and their planes. **(12 Marks)**

Fig. Q3(a)



b. Derive an expression for circumferential and longitudinal stress for thin cylinder. **(08 Marks)**

OR

4 a. Derive Lame's equations for radial and hoop stress in case of thick cylinders. **(10 Marks)**

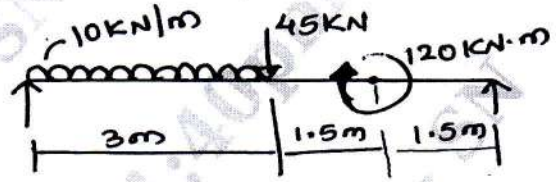
b. A thick cylinder with internal diameter 80mm and external diameter 120mm is subjected to an external pressure of $40N/mm^2$, when the internal pressure is $120N/mm^2$. Calculate circumferential stress at external and internal surfaces of the cylinder. Plot the variation of circumferential stress and radial pressure on the thickness of the cylinder. **(10 Marks)**

Module-3

5 a. Derive an expression to establish a relationship between the intensity of load, shear force and bending moment in the beam. **(06 Marks)**

b. A simply supported beam AB of 6m span is loaded as shown in Fig. 5(b). Draw SFD and BMD. Also indicate the point of contra flexure if any. **(14 Marks)**

Fig. Q5(b)

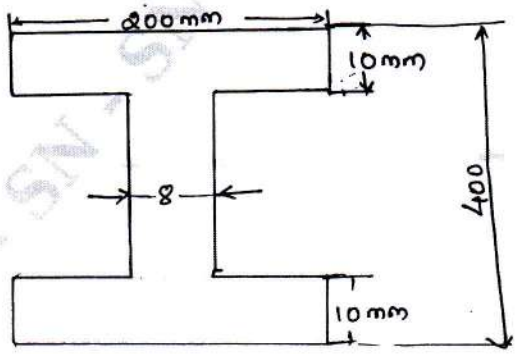


OR

6 a. Derive an expression for the bending stress and radius of curvature for a straight beam subjected to pure bending. Also state the assumptions made in the theory of simple bending. **(12 Marks)**

b. The cross section of a beam is shown in Fig. Q6(b). If permissible stress is $150N/mm^2$, find its moment of resistance. Compare it with equivalent section of the same area for a square section. **(08 Marks)**

Fig. Q6(b)



Module-4

7 a. State the assumptions made in pure torsion theory and drive torsional equation

$$\frac{\tau}{R} = \frac{G\theta}{\ell} = \frac{T}{J_p}.$$

(14 Marks)

b. A solid shaft rotating at 1000 rpm transmits 50kW. Maximum torque is 20% more than the mean torque. Material of the shaft has the allowable shear stress of 50MPa and modulus of rigidity 80GPa. Angle of twist in the shaft should not exceed 1° in one meter length. Determine the diameter of the shaft **(06 Marks)**

OR

8 a. State the assumptions made in the derivation of Euler's expression. Derive the Euler's expression for a column subjected to an axial compressive load. Consider both ends of the column as hinged. **(12 Marks)**

b. Derive an expression for Euler's crippling load for a column when one end of the column is fixed and other end free. **(08 Marks)**

Module-5

9 a. Explain Maximum Principal Stress theory and Maximum Shear Stress theory. **(10 Marks)**

b. A rod of circular section is to sustain a torsion moment of 300kN-m and bending moment 200k N – m selecting 45C8 steel (σ_{yt} = 353MPa) and assuming factor of safety = 3. Determine the diameter of rod as per following theories of failure :
i) Maximum principal stress theory ii) Maximum shear stress theory. **(10 Marks)**

OR

10 a. Derive an expression for strain energy stored in a body due to shear stress. **(07 Marks)**

b. State and derive Castigliano's theory. **(07 Marks)**

c. A simply supported beam of span 'ℓ' carries a point load F at mid – span. Determine the strain energy stored by the beam. Also find the deflection at mid – span. **(06 Marks)**

* * * * *