Ref. No.: Ex/Che/ES/B/Mech/T/215/2025

B.E. CHEMICAL ENGINEERING SECOND YEAR FIRST SEMESTER EXAMINATION - 2025

SUBJECT: STRENGTH OF MATERIALS

Time: 3 Hours **Full Marks: 100 (10 × 10)**

Any missing data may be assumed with suitable justification

The symbols/notations carry its usual meanings

For question Q9, the figure should be drawn in GRAPH PAPER

ANSWER ANY TEN QUESTIONS
(All Questions Carry Equal marks)

Q1. The timber member (**Fig Q1**) has a cross-sectional area of 1750 mm^2 and its modulus of elasticity is 12 GPa. Compute the change in the total length of the member after the loads shown are applied.

Q2. As shown in the **Fig. Q2**, there is a gap between the aluminum bar and the rigid slab that is supported by two copper bars. At 10°C, $\Delta = 0.18$ mm. Neglecting the mass of the slab, calculate the stress in each rod when the temperature in the assembly is increased to 95°C. For each copper bar, $A = 500$ mm^2, $E = 120$ GPa, and $\alpha = 16.8$ μm/(m·°C). For the aluminum bar, $A = 400$ mm^2, $E = 70$ GPa, and $\alpha = 23.1$ μm/(m·°C).

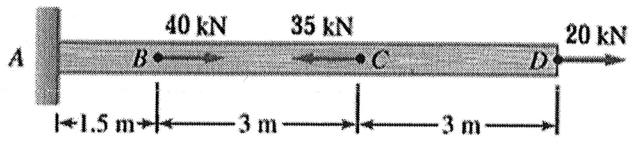

Fig Q1

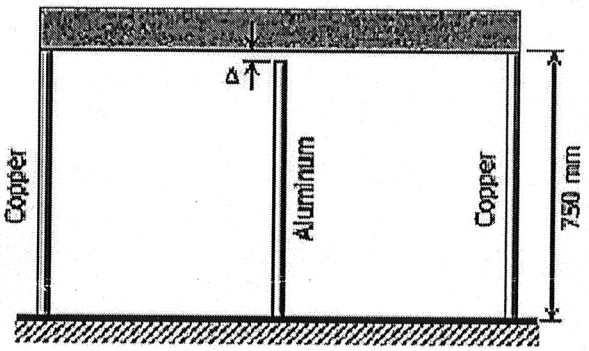

Fig Q2

Q3. A composite spring consists of two close-coiled helical spring in series and the stiffness of the composite spring is 1.3 N/mm. The mean diameter of each spring is eight times its wire diameter. One spring is of 2.5 mm wire diameter and has 20 coils. Determine the wire diameter of other spring if it has 15 coils. For both the spring consider $G = 83$ GPa.

[Turn over

Q4. A solid steel shaft 5 m long is stressed at 80 MPa when twisted through 4°. Using G = 80 GPa, compute the shaft diameter. What power can be transmitted by the shaft at 20 Hz?

Q5. The simply supported beam shown in **Fig Q5** supports a 30 kN concentrated force at B and a 40 kN-m couple at D. Sketch the complete shear force and bending moment diagrams.

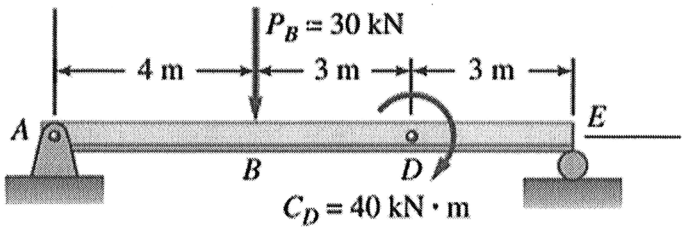

Fig Q5

Q6. A simply supported cast iron beam is to have the inverted T-section shown in the **Fig Q6**. If the allowable stresses for cast iron in tension and compression are 28 MPa and 56 MPa, calculate the proper stem thickness t of the section. The dimensions given in the figure are in cm.

Q7. For the simply supported beam (flexural rigidity = EI) loaded as shown in **Fig Q7**, find the equation of the elastic curve. Also find the maximum deflection and maximum slope.

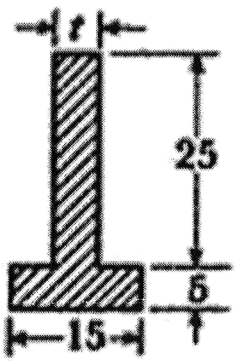

Fig Q6

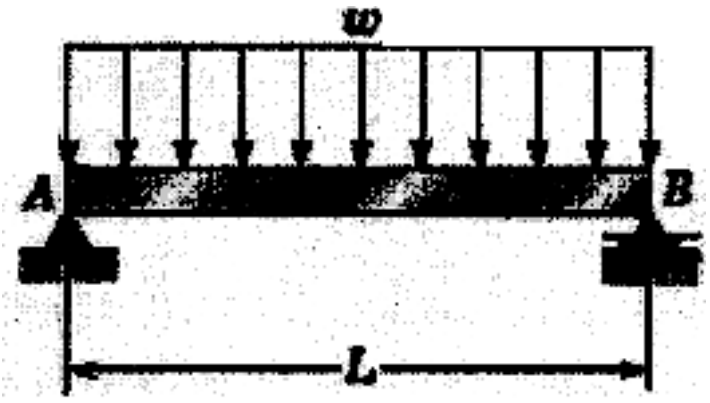

Fig Q7

Q8. Derive Euler's critical load for the fundamental mode of a fixed-hinged column of length L. Take EI = constant.

Q9. Draw the Mohr's circle on a graph paper for a state of plane stress defined by the following: σ_x = 40 MPa, σ_y = - 100 MPa and τ_{xy} = 50 MPa. Find the principal stresses and principal planes using Mohr's circle.

Q10. Draw suitable neat sketches and derive the membrane stress equation for an axisymmetric thin-walled pressure vessel subjected to internal pressure.

Q11. Stating the assumptions, derive the following relation for torsion of a uniform cylindrical shaft:

$$\frac{\tau}{\rho} = \frac{T}{J} = \frac{G\phi}{L}.$$

Q12. Answer any two: **[5 × 2 = 10]**

(i) Write short note on Bearing Stress.

(ii) Explain statically indeterminate problems in brief with example.

(iii) Prove that the maximum shear stress in a rectangular section beam is 1.5 times the average shear stress.

---------- X ----------