Ref. No.: Ex/Met/ES/B/ME/T/213/2023

B.E. METALLURGICAL AND MATERIAL ENGINEERING SECOND YEAR FIRST SEMESTER EXAM 2023

SUBJECT: STRENGTH OF MATERIALS

Time: 3 Hours **Full Marks: 10 X 10 = 100**

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 4 mm-diameter cable *BC* is made of a steel with $E = 200$ GPa. Knowing that the maximum stress in the cable must not exceed 190 MPa and that the elongation of the cable must not exceed 6 mm, find the maximum load **P** that can be applied as shown in **Fig. Q1**.

Q2. A copper bar *AB* of length 635 mm is placed in position at room temperature with a gap of 0.25 mm between end *A* and a rigid restraint (see **Fig. Q2**). Calculate the axial compressive stress developed in the bar if the temperature rises 50° F. For copper, use $\alpha = 9.6 \times 10^{6}$/° F and $E = 210$ GPa.

Q3. (a) For the aluminium pipe shown in **Fig. Q3** (G=27 GPa), determine the torque T_0 causing an angle of twist of 2^0. (b) Determine the angle of twist is the same torque is applied to a solid cylindrical shaft of the length and cross-sectional area.

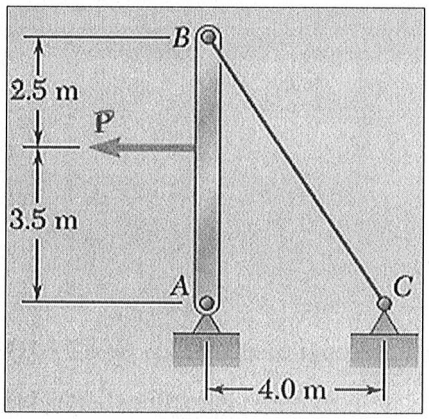

Fig. Q1

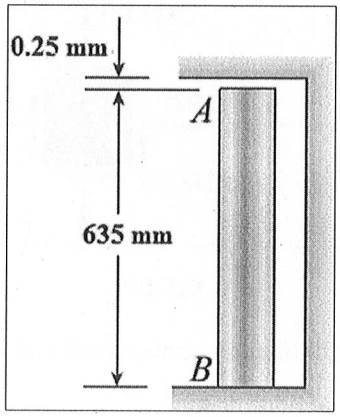

Fig. Q2

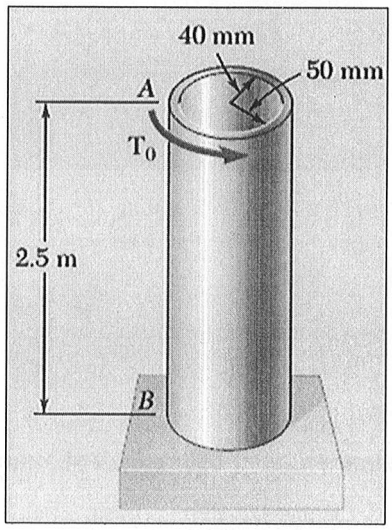

Fig. Q3

Q4.

(i) Deduce the expression of developed stress for a close-coiled helical spring under the action of an axial load.

(ii) A close-coiled helical spring carries a load of 400 N. its mean coil diameter is 10 times the wire diameter. Determine these diameters if the maximum value of shear stress in the spring is not to exceed 75 MPa.

[Turn over

Q5. A simply supported beam *ABC* is loaded by a vertical load *P* acting at the end of a bracket *BDE* (see **Fig. Q5**). Draw the shear-force and bending-moment diagrams for beam *ABC*.

Q6. Determine the maximum tensile stress and maximum compressive stress due to the load *P* acting on the simple beam *AB* (see **Fig. Q6**). Data are as follows: P =5.4 kN, L = 3.0 m, d =1.2 m, b =75 mm, t =25 mm, h =100 mm, and h_1 =75 mm.

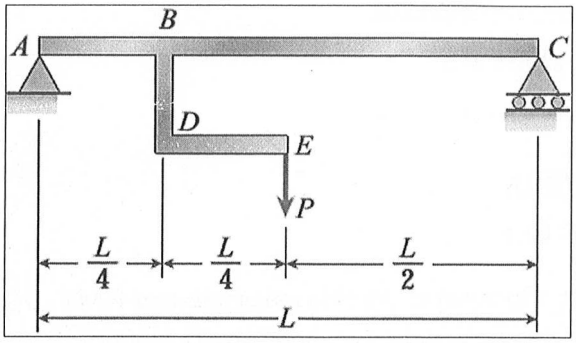

Fig. Q5

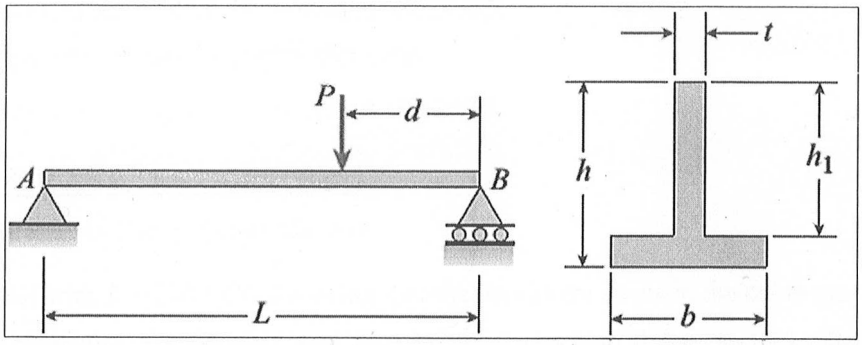

Fig. Q6

Q7. Prove that the maximum shear stress developed at the neutral axis of a beam with circular cross section is (4/3) times the average shear stress.

Q8. Derive the equation of the deflection curve for a cantilever beam of length *L* supporting a load *P* at the free end. Also, determine the deflection and slope at the free end. Take *EI*=constant.

Q9. For the state of plane stress shown in **Fig. Q9**, (a) construct Mohr's circle, determine (b) the principal planes, (c) the principal stresses, (d) the maximum shearing stress and the corresponding normal stress.

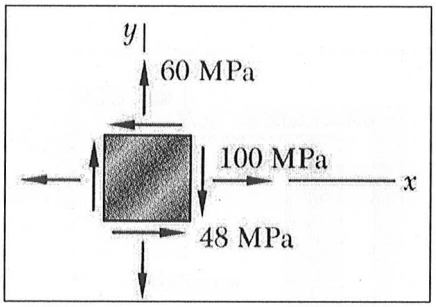

Fig. Q9

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

Q11. Derive Euler's critical load for the fundamental mode of a fixed-free column of length *L*. Take *EI*=constant.

Q12. Answer any two from the followings: **[5 × 2 = 10]**

(i) Draw the stress-strain diagram for mild steel under uniaxial loading.

(ii) Write a short note on 'Buckling Stress'.

(iii) Prove that under uniaxial loading maximum shear stress is 0.5 times the uniaxial stress.