Ref. No.: Ex/ME(M2)/PC/B/T/123/2022

B.E. MECHANICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM – 2022

SUBJECT: STRENGTH OF MATERIALS

Time: 3 Hours **Full Marks: 100**

Any missing data may be assumed with suitable justification
Symbols/notations carry its usual meanings
For Question Q7, the figure should be drawn in graph paper
ANSWER ANY TEN QUESTIONS

Q1. The rod *ABC*, as shown in **Fig. Q1**, is made of an aluminum for which $E = 70$ GPa. Knowing that $P = 6$ kN and $Q = 42$ kN, determine **(*a*)** the maximum normal stress developed, **(*b*)** the deflection of point *A*, (*c*) the deflection of point *B*.

Q2. A rod (**Fig. Q2**) consisting of two cylindrical portions *AB* and *BC* is restrained at both ends. Portion *AB* is made of steel (E_s=200 GPa, $\alpha_s = 11.7\times10^{-6}/^{\circ}C$) and portion *BC* is made of brass (E_b=105 GPa, $\alpha_b = 20.9\times10^{-6}/^{\circ}C$). Knowing that the rod is initially unstressed, determine the compressive force induced in the rod *ABC* when there is a temperature rise of 50°C.

Q3. The aluminum rod *BC* (G=26 GPa) is bonded to the brass rod *AB* (G=39 GPa) (**Fig. Q3**). Knowing that each rod is solid and has a diameter of 12 mm, determine the angle of twist **(*a*)** at *B*, **(*b*)** at *C*.

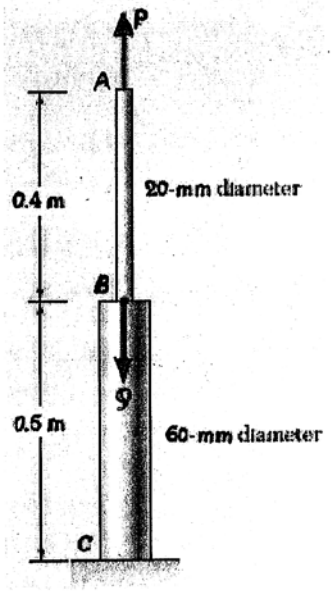

Fig. Q1

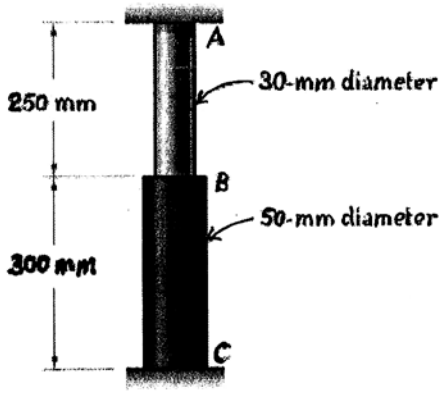

Fig. Q2

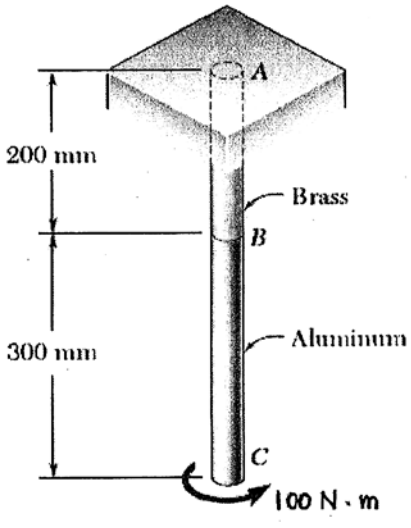

Fig. Q3

Q4. Draw the complete shear force and bending moment diagrams for the beam shown in **Fig. Q4**. Neglect the mass of the beam.

Q5. The beam shown (**Fig. Q5**) is made of a nylon for which the allowable stress is 24 MPa in tension and 30 MPa in compression. Determine the largest couple **M** that can be applied to the beam.

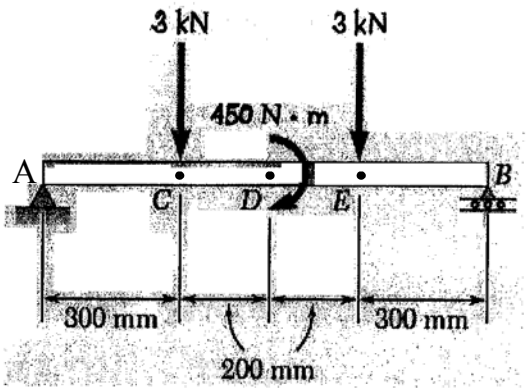

Fig. Q4

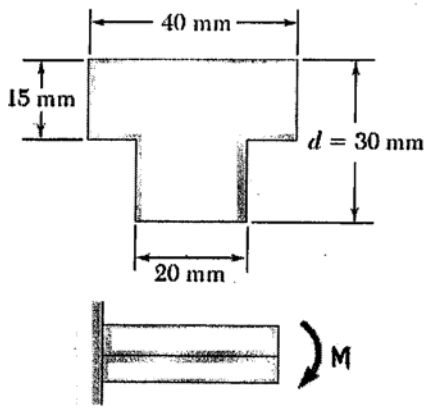

Fig. Q5

Q6. A simply supported prismatic beam of length L carries a uniformly distributed load of intensity ω for its entire span. Determine (***a***) the equation of the elastic curve, (***b***) the maximum deflection, (***c***) the slope at the right support. Take EI=constant.

Q7. Draw Mohr's circle for the given state of stress (**Fig. Q7**), and determine, from the Mohr's circle, (***a***) the principal planes, (***b***) the principal stresses.

Q8. A 60 mm diameter shaft supported in bearings carries a 750 mm diameter pulley weighing 2500 N at an overhanging end of the shaft as shown in **Fig. Q8**. Calculate the principal tensile stress at the section ***mn*** if the horizontal belt tensions are as shown in the figure.

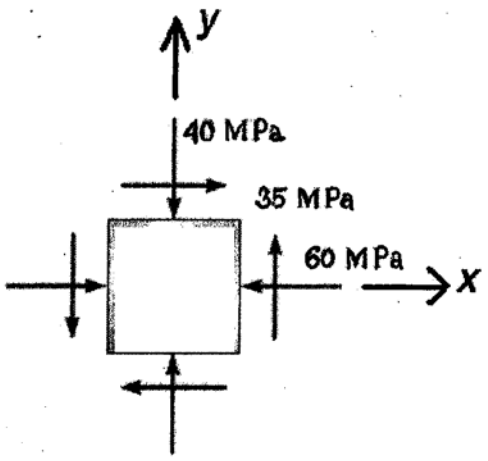

Fig. Q7

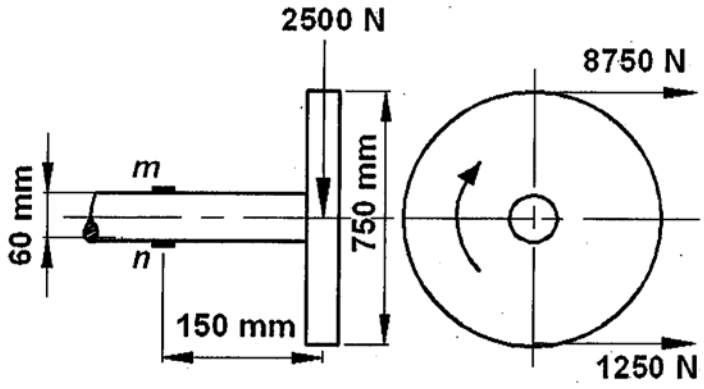

Fig. Q8

Q9. Derive Euler's critical load for a fixed-pinned column of length L. Take EI=constant.

Q10. Drawing suitable neat figures, derive membrane stress equation for an axi-symmetric thin-walled pressure vessel subjected to internal pressure.

Q11. Derive expressions for axial deflection and stiffness of a closely coiled helical spring with usual notations.

Q12. Answer any two: **[5+5]**

(a) Explain pure bending of beams.

(b) Explain slenderness ratio of a column.

(c) Derive the following: $\frac{dM}{dx} = V$.

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