Ref. No.: Ex/ME(M2)/PC/B/T/123/2023

B.E. MECHANICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM – 2023

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 Q10, the figure must be drawn in graph paper
All Questions Carry Equal Marks

ANSWER ANY TEN QUESTIONS

Q1. Two cylindrical rods (**Fig. Q1**), one of steel and the other of brass, are joined at *C* and restrained by rigid supports at *A* and *E*. For the loading shown and knowing that E_s=200 GPa and E_b=105 GPa, determine the reactions at *A* and *E*.

Q2. At room temperature (20^0 C), a 0.5-mm gap exists between the ends of the rods shown in **Fig Q2**. At a later time when the temperature has reached 140^0 C, determine **(i)** the normal stress in the aluminum rod, **(ii)** the change in length of the aluminum rod.

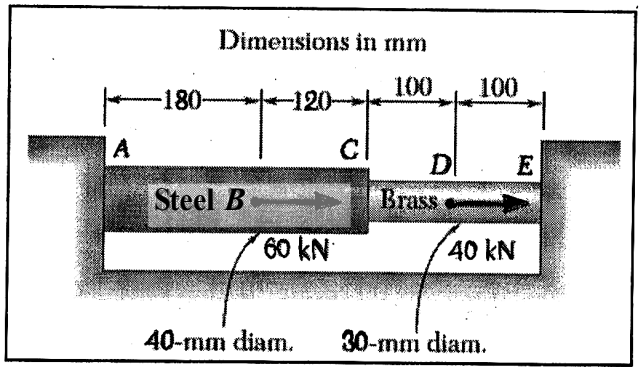

Fig. Q1

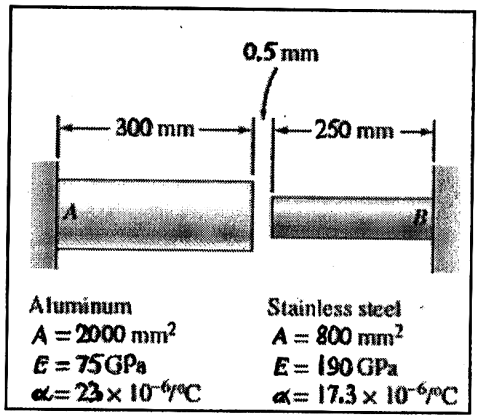

Fig. Q2

Q3. The torques shown in **Fig. Q3** are exerted on pulleys *A* and *B*. Knowing that both shafts are solid, determine the maximum shearing stress **(i)** in shaft *AB*, and **(ii)** in shaft *BC*.

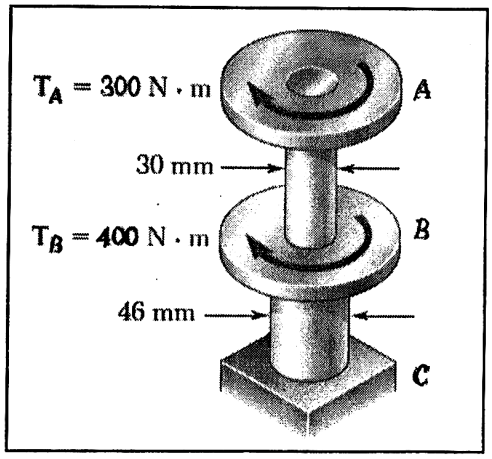

Fig. Q3

[Turn over

Q4. **[5+5]**

(a) Derive the expression for maximum shear stress in a close-coiled helical spring.

(b) Determine the maximum shear stress and elongation in a close-coiled helical steel spring composed of 20 turns of 20-mm-diameter wire on a mean radius of 90 mm when the spring is supporting a load of 1.5 kN. Use $G = 83$ GPa.

Q5. For the beam loading shown in **Fig. Q5**, **(i)** determine the equations of the shear force and the bending moment curves, and **(ii)** draw the shear force and the bending moment diagrams.

Q6. For the beam and loading shown in **Fig. Q6**, determine the minimum required width b, knowing that for the grade of timber used, $\sigma_{all} = 12$ MPa and $\tau_{all} = 825$ kPa.

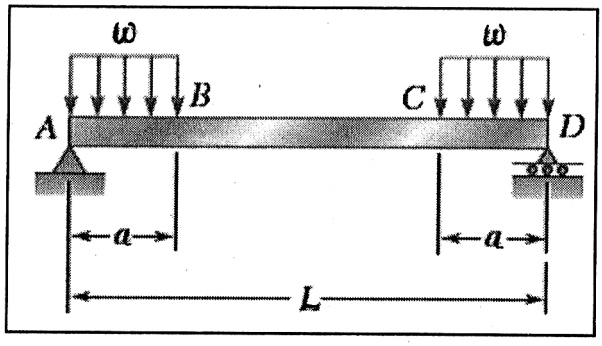

Fig. Q5

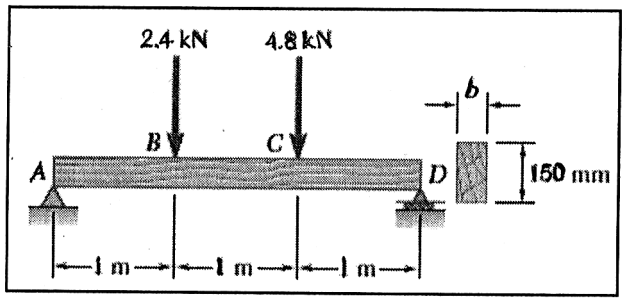

Fig. Q6

Q7. The simply-supported (**Fig. Q7**) prismatic beam AB carries a uniformly distributed load 'ω' per unit length. Determine the equation of the elastic curve and the maximum deflection of the beam.

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.

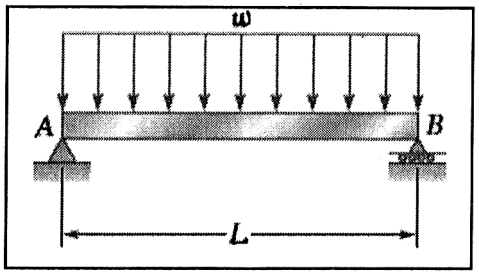

Fig. Q7

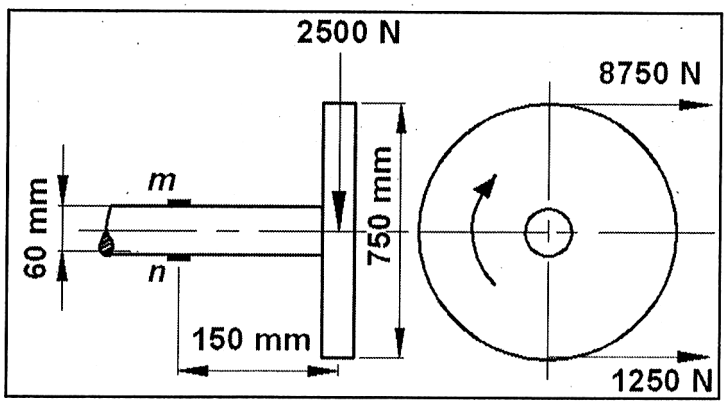

Fig. Q8

Q9. Derive the relationship between the circumferential and meridional stresses for a thin-walled pressure vessel subjected to an internal pressure with usual notations.

Q10. Referring to **Fig. Q10, (i)** draw the Mohr's circle, **(ii)** find the principal stresses and principal planes using Mohr's circle.

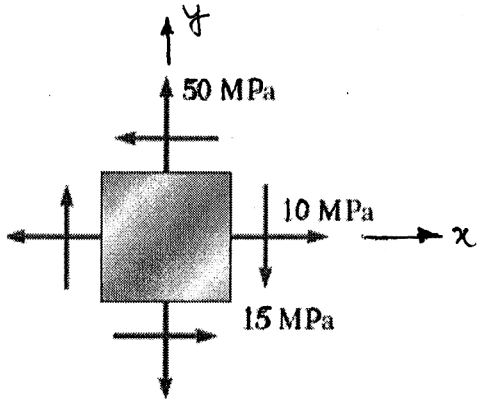

Fig. Q10

Q11. Derive an expression for the Euler's critical load for a fixed-free column with usual notations along with neat sketches. State the assumptions made.

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

(a) What do you mean by statically indeterminate problems? Explain with an example.

(b) Explain torsional rigidity and flexural rigidity.

(c) Explain critical compressive stress.

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