Ref. No.: Ex/Che/ES/B/Mech/T/215/2024(S)

B.E. CHEMICAL ENGINEERING 2nd YEAR 1st SEMESTER SUPPLEMENTARY EXAMINATION - 2024
SUBJECT: STRENGTH OF MATERIALS

Time: 3 Hours **Full Marks: 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. Two solid cylindrical rods are joined at B, and it is loaded by an axial force P= 30 kN at A and Q=40 kN at B as shown in **Fig. Q1**. Rod AB is made of steel (E=200 GPa) and rod BC of brass (E=105 GPa). Determine *(a)* the total deformation of the composite rod ABC, *(b)* the deflection of point B.

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 (*a*) the normal stress in the aluminum rod, (*b*) the change in length of the aluminum rod.

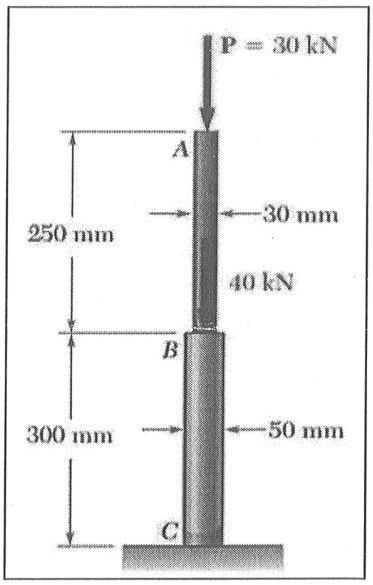

Fig. Q1

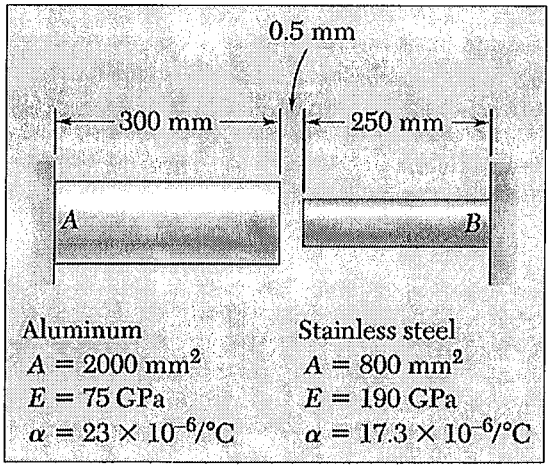

Fig. Q2

Q3. The 12 kN-m torque is applied to the free end of the 6-m steel shaft. The maximum angle of rotation of the shaft is to be limited to 3°. *(a)* Find the diameter d of the smallest shaft that can be used. *(b)* What will be the maximum shear stress in the shaft? Use G=83 GPa for steel.

Q4. A composite spring consists of two close-coiled helical springs connected in series. Each spring has 14 coils at a mean diameter of 20 mm. The stiffness of the composite spring is 800 N/m. If the wire diameter of one spring is 2.5 mm, find the wire diameter of the other. Use G=78 GPa.

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Q5. For the beam loaded as shown in **Fig. Q5**, draw the complete shear force and bending moment diagrams.

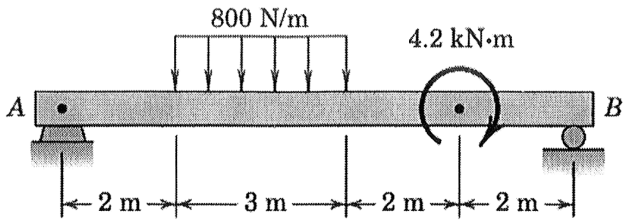

Fig. Q5

Q6. Stating the assumptions, derive the following relation for pure bending of beams: $\frac{M}{I} = \frac{\sigma_x}{y} = \frac{E}{\rho}$.

Q7. A simply supported prismatic beam of span 5 m, carries a uniformly distributed load of intensity 10 kN/m. The beam is of rectangular cross section having width 120 mm. Determine the minimum required depth h of the cross section, knowing that for the beam material, σ_{all}=12 MPa and τ_{all}=0.9 MPa.

Q8. A cantilever beam of 4 m length carries a uniformly distributed load over the entire length. The deflection at the free end is 30 mm. Deducing the necessary relations, determine the slope of the deflection curve at the free end.

Q9. Draw Mohr's circle for the given state of stress (**Fig. Q9**), and determine, from the Mohr's circle, (***a***) the principal planes, (***b***) the principal stresses.

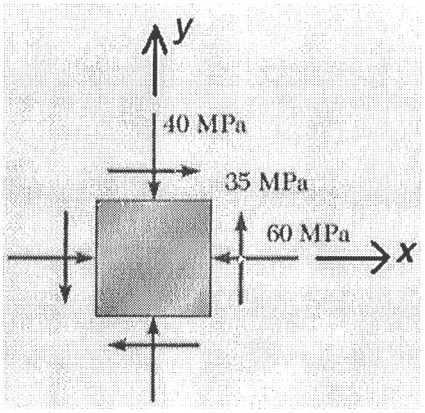

Fig. Q9

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 a pinned-pinned column of length L. Take EI=constant.

Q12. Answer any two: **[5 × 2 = 10]**

(i) Establish the relation between shear force and bending moment in beam.

(ii) Write a short note on 'Bearing stress'.

(iii) Deduce the expression of deformation of a taper cylindrical bar under uniaxial loading.