Ex/EE/AM/ME/T/3/2019 (Old)

B.E. ELECTRICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM 2019 (Old)

STRENGTH OF MATERIALS

Time: Three Hours **Full Marks: 100**

Any missing data may be assumed with suitable justification
For question Q3(a), the figure should be drawn in graph paper
PARTS OF THE SAME QUESTION MUST BE ANSWERED TOGETHER

ANSWER ANY FIVE QUESTIONS

Q1. **[12+8]**

(a) Fig. Q1a shows a composite bar in which a 0.50 mm gap exists between the bronze part and the left wall when the temperature is 75^0 C. The cross-sectional areas and the material properties for bronze and aluminum are given in the figure. Determine (i) the temperature at which the normal stress in the aluminum bar will be equal to 75 MPa, (ii) the corresponding exact length of the aluminum bar.

(b) A solid cone of base diameter d and vertex angle 90^0 is hanging freely with its base being fixed to a rigid ceiling. Calculate its elongation due to own weight. Assume the material density of the cone to be ρ.

Q2. **[10+10]**

(a) A drop-weight of 240 N is allowed to fall on a closed-coiled helical spring made of 18 mm diameter steel wire. The spring consists of 22 nos. of active turns and wound to a diameter of 180 mm. If the instantaneous compression of the spring be 120 mm, find the height of the drop-weight from which it has fallen and the maximum stress developed in the spring. Assume G=90 GPa.

(b) 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?

Q3. **[10+10]**

(a) Fig. Q3a shows a differential bi-axial stress element. Draw Mohr's circle for stresses of the element and then find the principal stresses and the orientations in body plane of the principal planes.

(b) Using appropriate sign conventions, prove that $dM/dx=V$ and $dV/dx = w$

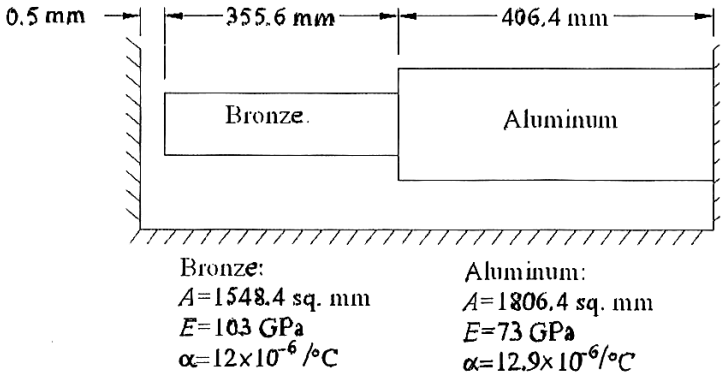

Fig. Q1a

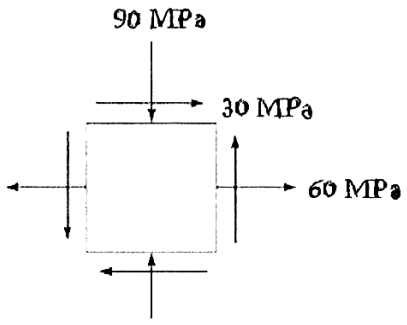

Fig. Q3a

[Turn over

Q4. **[12+8]**

For the rectangular cross section beam loaded as shown in **Fig. Q4**, draw the shear force and bending moment diagrams, neatly marking all the important points and the corresponding values.

Also determine the height h of the beam cross section, knowing that σ_{all} =20 MPa and τ_{all} =8 MPa.

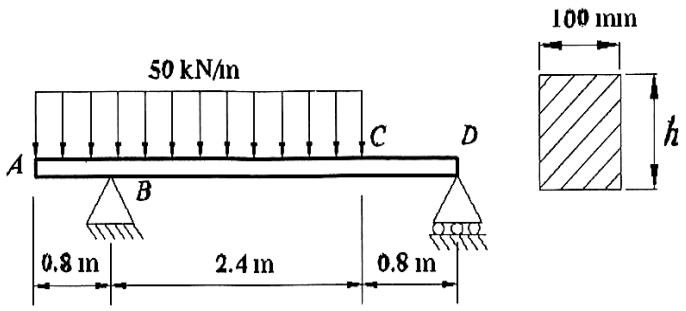

Fig. Q4

Q5. **[10+10]**

(a) For a simply supported beam of length L and flexural rigidity EI, subjected to uniformly distributed load of intensity w_0, find the deflection and slope of the elastic line at the free end of the beam.

(b) Deduce the governing equation of stresses developed in a thin-walled axi-symmetric pressure vessel subjected to internal pressure.

Q6. **[12+8]**

(a) Deduce the expression of Euler's critical load for the fundamental mode of a pin-ended column of length L. Take EI=constant for the column.

(b) Prove the theorem:- "In order to produce a uniform stress distribution due to an axial force P in a prismatic member, the line of action of the force must pass through the centroid of the member".

Q7. Answer any four from the following: **[5×4=20]**

(a) What do you mean by pure bending of beam?

(b) Draw and explain the stress-strain diagram of mild steel.

(c) "A long column under centric compressive load becomes unstable even though the stress remains within the proportional limit" – justify the statement.

(d) What do you mean by "point of contra-flexure"? Explain with neatly drawn sketch.

(e) What do you mean by statically indeterminate system? Explain with examples.