Exam.Code:0939
Sub. Code: 6702

2123
B.E. (Mechanical Engineering)
Third Semester
MEC-302: Mechanics of Materials

Time allowed: 3 Hours

Max. Marks: 50

NOTE: *Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Part. Assume suitably the missing data, if any. Use usual notations and symbols for derivations. All questions carry equal marks.*

x-x-x

Q.1 Provide *brief* and *clear* answers to the following:

a. Give one difference between normal stress and shear stress.
b. Give one difference between a determinate and indeterminate problem.
c. Give the expression for the impact factor.
d. Write the expression for the distributed load w given by the concentrated moment M_0 acting on a beam using discontinuity functions?
e. What is the expression for shear flow q in a thin walled tube?
f. Write the expression for the critical load P_{cr} of a column with fixed-fixed end supports.
g. Axial torque is applied to a piece of chalk. At what angle relative to the longitudanal axis will it fail?
h. Write the expression for strain energy stored due to bending.
i. What is a dummy load?
j. What is margin of safety.

Part A

Q.2 The infinitesimal rectangle at a point in the reference state of a material becomes a parallelogram in the deformed state (see Figure 1). Determine (a) the normal strain in the dL_1 direction, (b) the normal strain in the dL_2 direction, (c) the shear strain corresponding to the dL_1 and dL_2 directions, and (d) the normal strain in the direction of the diagonal dL.

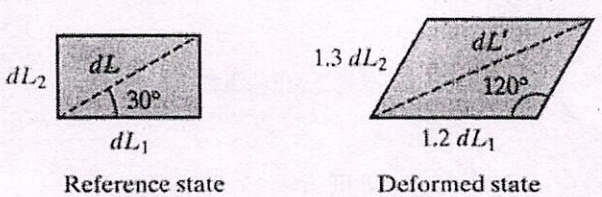

Figure 1

Q.3 Two aluminum bars with modulus of elasticity $E_{Al} = 10 \times 10^6$ psi are attached to a rigid support at the left and a rigid cross-bar at the right (see Figure 2). An iron bar with $E_{Fe} = 28.5 \times 10^6$ psi is attached to the rigid support at the left, and there is a gap $b = 0.02$ in between the right end of the iron bar and the cross-bar. The cross-sectional area of each bar is $A = 0.5\,\text{in}^2$ and $L = 10$ in. If the iron bar is stretched until it contacts the cross-bar and is welded to it, what are the normal stresses in the bars afterward?

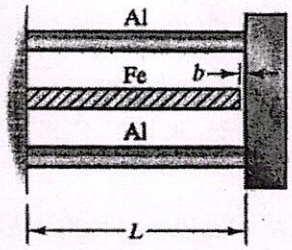

Figure 2

Q.4 A bar has a circular cross section with polar moment of inertia J and shear modulus G (see Figure 3). The distributed torque is $c = c_0(x/L)^2$, where c_0 is a constant. Show that the magnitudes of the torques exerted on the bar by the left and right walls are $c_0L/12$ and $c_0L/4$, respectively.

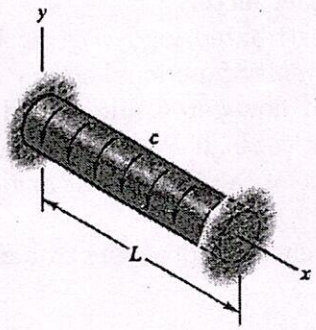

Figure 3

Part B

Q.5 Determine (see Figure 4) the beam's deflection at B . Use Castigliano's second theorem.

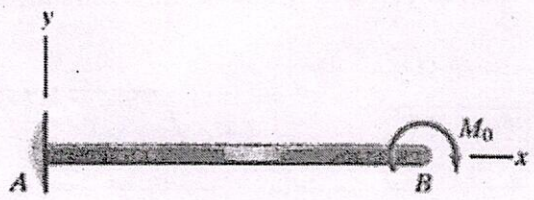

Figure 4

Q.6 Bars AB and CD (see Figure 5) have a solid circular cross section with 20 mm radius. They consist of material with modulus of elasticity $E = 14$ GPa. If the force F is gradually increased, at what value does the structure fail due to buckling?

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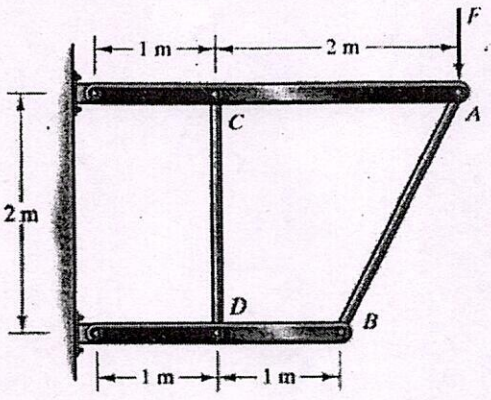

Figure 5

Q.7 A cylindrical pressure vessel with hemispherical ends has radius $R = 2\,\text{m}$ and wall thickness $t = 10\,\text{mm}$ and is made of steel with yield strength $S_Y = 1800\,\text{MPa}$. It is internally pressurized at $p = 2\,\text{MPa}$. Compare the Tresca and von Mises safety factors.