2124
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. In simple bending, what is the neutral axis. Is it the same as the centroidal axis? Explain.
b. What failure theory would you use for a brittle material? For plane stress show failure envelope on a σ_1 vs. σ_2 plot.
c. In a pressurized cylindrical pipeline what are the values of σ_r, σ_θ, and σ_z. Explain.
d. Draw a Mohr circle for a solid circular shaft in pure shear. Does an element on the surface at the horizontal diameter experience any normal stress? If so at what angle?
e. Discuss and give the mathematical expressions for the *four* boundary conditions for a fixed-free column under compressive load P.

Part-A

Q.2 A solid circular steel cylinder (cross-sectional area A_S, modulus of elasticity E_S, and length L) is placed inside a copper tube (cross-sectional area A_C, modulus of elasticity E_C, and length L), see Figure 1. The assembly is compressed between a rigid plate and the rigid floor by a force F. Determine the normal stresses in the cylinder and the tube. Calculate the shortening of the assembly.
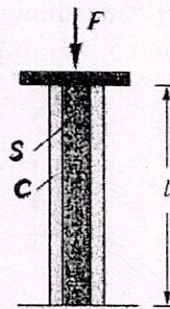

Figure 1

Q.3 The solid shaft in Figure 2 is made from two segments with circular cross sections. It is fixed at its ends A and B and subjected to a torque M_0 .Calculate the support reactions M_A and M_B due to the applied torque and the angle of twist ϕ_C at point C.
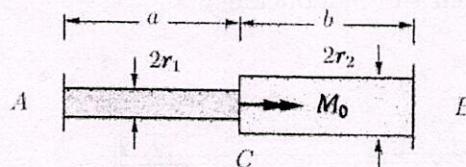

Figure 2

Q.4 By using a strain gage rosette, the strains $\epsilon_a = 1200\mu$, $\epsilon_b = 200\mu$, and $\epsilon_c = -200\mu$ have been measured in a steel sheet in the directions a, b, and c, as shown in Figure 3. Calculate the principal strains, principal stresses, and principal directions. Use $E = 210$ GPa and $\nu = 0.3$.
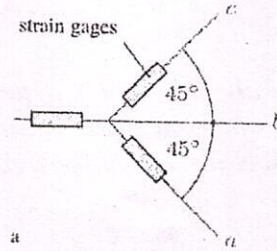
strain gages

Figure 3

Part-B

Q.5 A simply supported beam is subjected to a concentrated force F at $x = a$, see Figure 4. Determine the deflection w at the location $x = a$. Find your results by integrating separately over the two regions using boundary and continuity conditions.
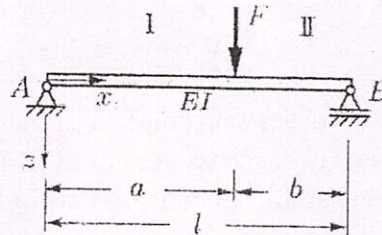

Figure 4

Q.6 A circular arch is subjected to a force F as shown Figure 5. Determine the displacement of the point of application of the force due to bending.
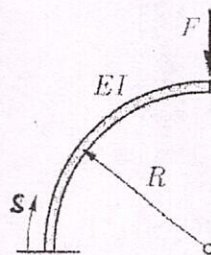

Figure 5

Q.7 A stress free bar, supported as shown Figure 6 is uniformly heated. Determine the increase ΔT in temperature at which the bar buckles.
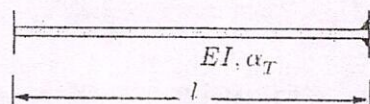

Figure 6

x-x-x