

2023
B.E. (Mechanical Engineering)
Fourth Semester
MEC-402: Mechanics of Solids

Time allowed: 3 Hours

Max. Marks: 50

NOTE: Attempt five questions in all, including Question No. 1 which is compulsory and selecting two questions from each Part. Use usual notations and symbols for derivations. Assume suitably missing data if any. All questions carry equal marks.

x-x-x

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

- What alloy is commonly used in making resistance strain gages? Give some of its properties.
- What is the Rayleigh-Ritz method?
- A circular shaft made of cast iron. What angle does the fracture surface make with respect to the axis of the shaft at the time of failure? Explain briefly.
- What is a Wheatstone bridge? How is it used with strain gages?
- What is the virtual force method? Explain briefly.

Part A

Q.2 Determine the stress fields that arise from the following stress functions:

$$\Phi = Cy^2,$$

$$\Phi = Ax^2 + Bxy + Cy^2,$$

$$\Phi = Ax^2 + Bx^2y + Cxy^2 + Dy^2,$$

where A , B , C , and D are constants. Also suggest what states of stress the functions are suitable for.

Q.3 Determine the location of the neutral axis and the eccentricity e for the curved bar of rectangular cross section shown in the Figure 1. With $M = 250\text{N}\cdot\text{m}$ determine the tangential stress at the inner and outer radius.

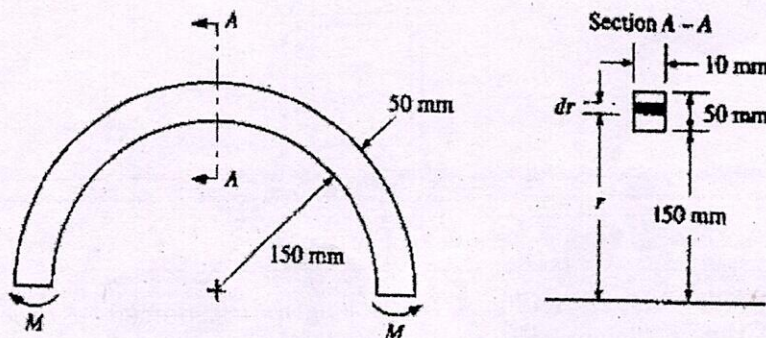


Figure 1

(2)

Q.4 Using Castigliano's theorem, determine the reactions at A and B of the beam shown in Figure 2.

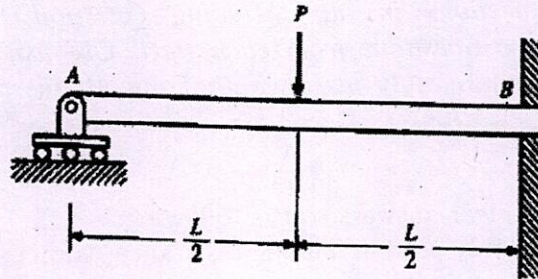


Figure 2

Part B

Q.5 Figure 3 shows a round shaft of diameter 1.5 in loaded by a bending moment $M_z = 5000 \text{ lbf} \cdot \text{in}$, a torque $T = 8000 \text{ lbf} \cdot \text{in}$, and an axial tensile force $N = 6000 \text{ lbf}$. If the material is ductile with a yield strength $S_Y = 40,000 \text{ lbf/in}^2$, determine the factor of safety corresponding to failure by yielding using the Tresca theory and the von Mises theory.

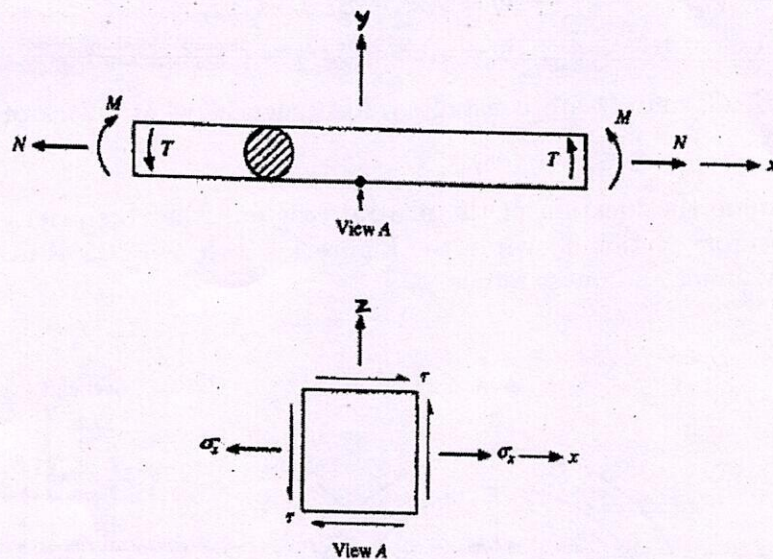


Figure 3

Q.6 A long slender bar of rigidity EI and length L is pinned at each end to a very rigid foundation. If the coefficient of thermal expansion of the bar is α , determine the increase in temperature ΔT which will cause the bar to buckle.

(3)

Q.7 A three element rectangular rosette strain gage is mounted on a steel specimen. For a particular state of loading of the structure the strain gage readings are $\epsilon_A = 200\mu$, $\epsilon_B = 900\mu$, and $\epsilon_C = 1000\mu$. Determine the values and orientations of the principal stresses and the value of the maximum shear stress at the point. Let $E = 200\text{GPa}$ and $\nu = 0.285$.

x-x-x