Indian Institute of Science

UE 204: Midsemester Test

Date: 22/2/19.
Duration: 2.00 p.m.–4.00 p.m.
Maximum Marks: 100

1. The structure shown in Fig. 1 is subjected to a uniform pressure p on the semicircular part. Find and then sketch the shear force, axial force and bending moment diagrams as a function of x in the straight beam, and as a function of θ in the semicircular part. Solve this problem using both approaches: (i) appropriate free-body diagrams and force and moment balances, i.e., 'first principles'; (ii) the differential equation approach with the equations in polar and Cartesian coordinates given by (40)

$$\begin{aligned}
\frac{1}{R}\frac{dM}{d\theta} &= V, \\
\frac{dN}{d\theta} + V &= 0, \\
\frac{dV}{d\theta} - N &= -qR, \\
\frac{dV}{dx} + q &= 0, \\
\frac{dM}{dx} + V &= 0, \\
\frac{dN}{dx} &= 0,
\end{aligned}$$

   where q denotes the distributed load.

2. Consider the setup shown in Fig. 2. Two bars of equal length L are initially separated by a given distance Δ, with the left end of the left bar fixed at $x = 0$, and the right end of the second bar connected to a wall via a spring of spring constant k which is initially undeformed. The entire left bar is heated by a given amount T_Δ which causes its right end to come into contact with the left end of the second bar and push it to the right. Assuming the Young modulus and cross sectional area to be E and A for both bars, find the stress in the two bars in the equilibrium position (Hint: After equilibrium is reached, the final position of the right and left ends of the left and right bars, respectively, is the same). (60)

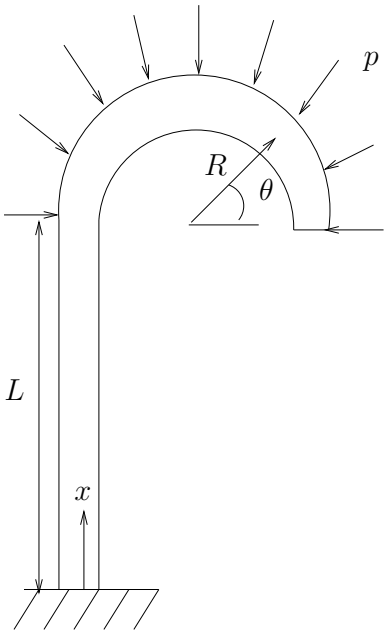

Figure 1: Problem 1

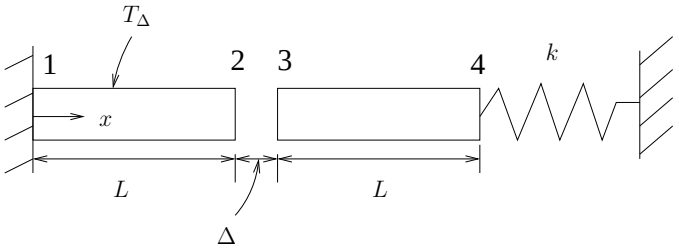

Figure 2: Problem 2: Initial setup.