Indian Institute of Science

UE 204: Midsemester Test

Date: 17/2/16.
Duration: 2.30 p.m.–4.30 p.m.
Maximum Marks: 100

1. Two elastic bars AB and AC of lengths L and $\sqrt{3}L$ are connected by a spring of stiffness k as shown in Fig. 1. Assume the Young modulus and areas of both the elastic members to be E and A, respectively. The spring and the two elastic members are undeformed before the application of the load P. Assuming the joints to be frictionless pin-joints, find the vertical deflection under the load P, and the stress in the two elastic members in the equilibrium configuration. (30)

2. A *rigid* bar is supported by two vertical elastic bars of lengths L and $2L$ as shown in Fig. 2. Both the elastic members have Young modulus E and cross sectional area A. The rigid bar is horizontal before the application of the loading. A point moment M_0 is now applied to this rigid bar at a distance of λL from the left end as shown in the figure. Find the value of λ such that the point of application of the moment does not undergo any vertical displacement. Assume the joints to be frictionless pin-joints. Using a 1D approximation $\tau = E\epsilon$, find the stresses in the two vertical members for this value of λ. (35)

3. A semicircular bar of radius a and unit width (into the paper) clamped at both ends is subjected to a uniform pressure loading p as shown in Fig. 3. Determine the (internal) axial force F_θ, shear force F_r and bending moment M_b as a function of the shear and bending moment at the walls and as a function of the angle θ (You may directly use projected areas for finding some of these quantities). While solving for F_r and F_θ, it may simplify things if you write your equations in the form (35)

$$\boldsymbol{K} \begin{bmatrix} F_r \\ F_\theta \end{bmatrix} = \boldsymbol{f},$$

where $\boldsymbol{f}$ is a 2×1 vector, and $\boldsymbol{K}$ is a 2×2 matrix that can be inverted to find F_r and F_θ. *Do not* attempt to find the wall shear and bending moments. Evaluate F_r, F_θ and M_b at $\theta = \pi/2$. Do they meet symmetry requirements?

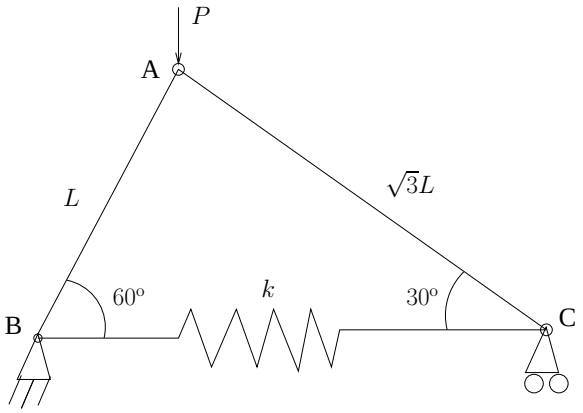

Figure 1: Problem 1

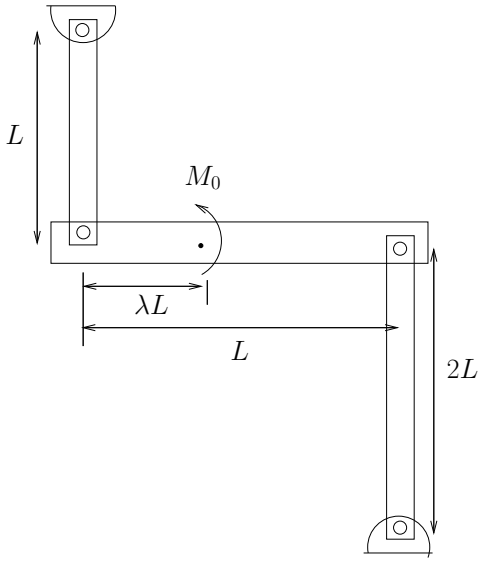

Figure 2: Problem 2

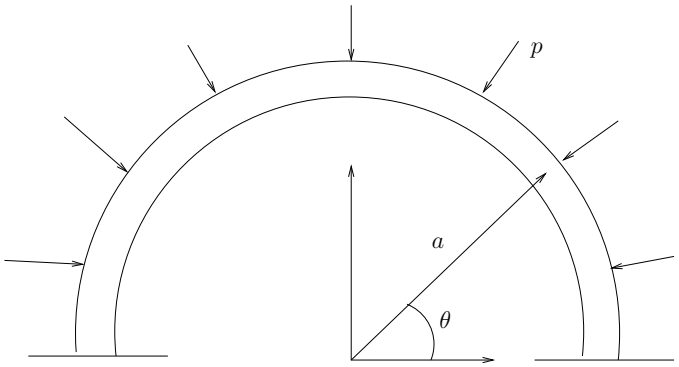

Figure 3: