Indian Institute of Science

UE 204: Midsemester Test

Date: 24/2/15.
Duration: 10.00 a.m.–12.00 noon
Maximum Marks: 100

1. A bar fixed at one end is subjected to a point load $P\boldsymbol{e}_x$ at point B which is at a distance of 2 m from the fixed support as shown in Fig. 1. The free end is at a distance of 0.1 m from a rigid wall. Assuming the Young modulus to be $E = 1$ Pa, cross sectional area to be $A = 1$ m^2, and using a 1D approximation $\tau = E\epsilon$, find the stresses τ_{AB} and τ_{BC} in sections AB and BC for the following two cases: (i) $P = 0.01$ N, (ii) $P = 0.1$ N. (25)

2. A frame has pin joints at A, B and D, and is subjected to a vertical load of P as shown in Fig. 2. Assume the Young modulus and areas of both members to be E and A, respectively. Find the normal stress in the member BD and the average shear stress in the pin at A assuming the diameter of the pin to be d (note that the pin at A is in 'double' shear). (35)

3. A semicircular vessel of radius R and unit width (into the paper) is filled with water which exerts a pressure of $\rho g y$ (or $\rho g R \sin\theta$) on the vessel surface as shown in Fig. 3a. Determine the (internal) axial force N, shear force V and bending moment M shown in Fig. 3b as a function of θ for $\theta \in [0, \pi/2]$ (for $\theta \in [\pi/2, \pi]$, the relations can be found using symmetry). You may use the relations $\sin 2\theta = 2\sin\theta\cos\theta$, $2\sin^2\theta = 1 - \cos 2\theta$. While solving for N and V, it may simplify things if you write your equations in the form (40)

$$\boldsymbol{K}\begin{bmatrix} N \\ V \end{bmatrix} = \boldsymbol{f},$$

where $\boldsymbol{f}$ is a 2×1 vector, and $\boldsymbol{K}$ is a 2×2 matrix that can be inverted to find N and V.

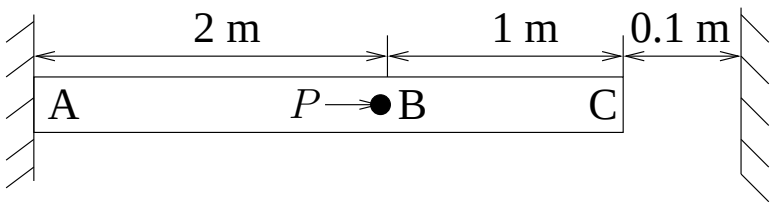


Figure 1:

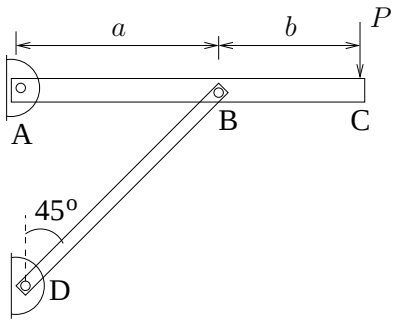
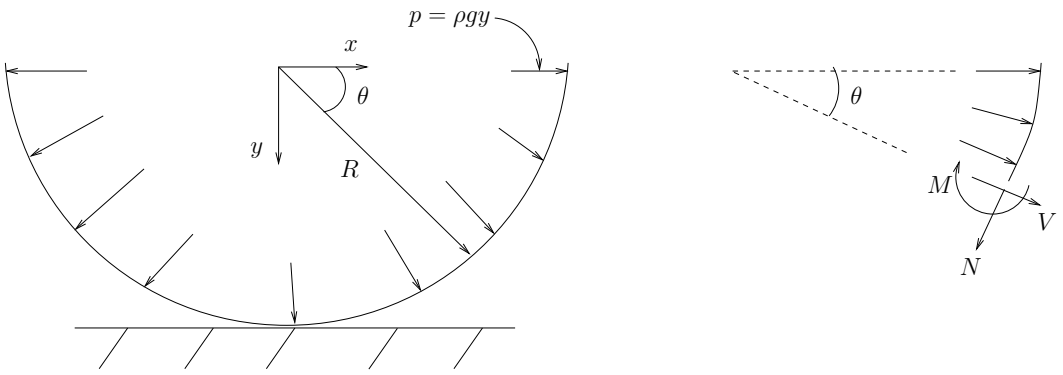


Figure 2:



(a) (b)

Figure 3: