# Indian Institute of Science

# UE 204: Midsemester Test

**Date:** 26/2/14.
**Duration:** 10.00 a.m.–12.00 noon
**Maximum Marks:** 100

1. A bar fixed at both the ends is subjected to loads $2P\boldsymbol{e}_x$ and $-P\boldsymbol{e}_x$ at points B and C at distances $L/3$ and $2L/3$, respectively, as shown in Fig. 1. Assuming the Young modulus to be $E$, cross sectional area to be $A$, and using a 1D approximation $\tau = E\epsilon$, find the stresses $\tau_{AB}$, $\tau_{BC}$ and $\tau_{CD}$ in the sections AB, BC and CD, and the displacements $\Delta_B$ and $\Delta_C$ of the points B and C. (20)

2. A two-bar truss has pin joints at A, B and C, and is subjected to a vertical load of $P$ as shown in Fig. 2. Given that $E_{AB} = E_{BC}$, $A_{AB} = A_{BC}\cos^3\theta$, determine the angle $\theta$ such that the *magnitudes* of the horizontal and vertical deflections under the load $P$ are the same. (40)

3. A cantilever beam of length $L$ and unit width (into the paper) makes an angle $\theta$ with the vertical ($z$-axis), and has water on one side as shown in Fig. 3. The pressure $p$ in the water is governed by the differential equation $dp/dz = \rho g$, where $\rho$ is the density, and $g$ is the gravitational acceleration (both are constant). Assuming that $p = 0$ at $z = 0$, find the pressure field as a function of $z$. Using the sign convention introduced in the class, determine the (internal) shear force $V$ and bending moment $M$ for the beam as a function of the local coordinate $\bar{x}$ shown in the figure ($\bar{x} = 0$ at the fixed end and $\bar{x} = L$ at the free end.). Assume the pressure on the lower side of the beam to be zero as shown in the figure. (40)

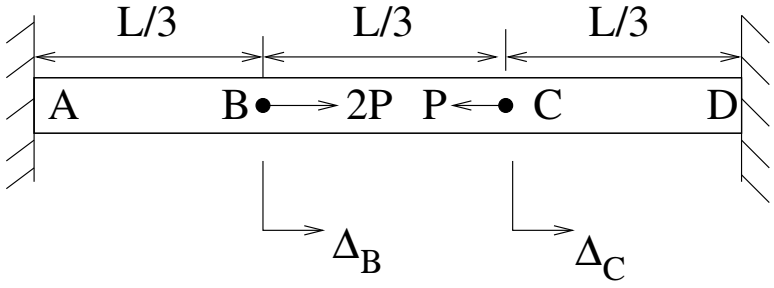


Figure 1:

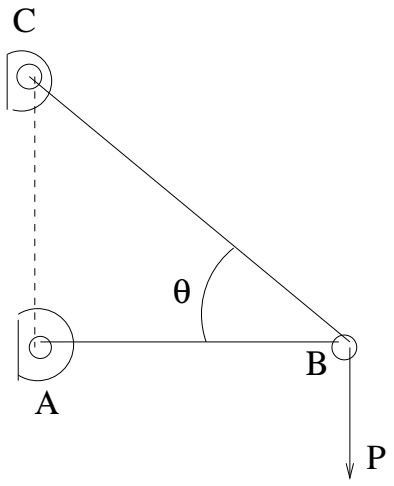


Figure 2:

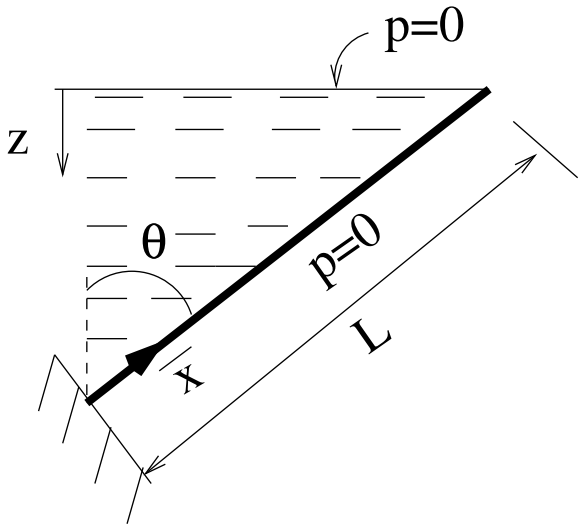


Figure 3: