1. (30 Marks) Figure 1 shows two joint axes $z_0$ and $z_1$. Complete the Cartesian coordinate frame assignment for Frame 1 according to the Denavit-Hartenberg convention given in class. Identify the four Denavit-Hartenberg kinematic parameters that relate Frames 1 and 0.

![Figure 1](image1)

2. (30 Marks) A cuboid is initially at the configuration shown in Figure 2. It undergoes a rigid-body rotation about an axis directed from A to B by 30 degrees. Determine the new coordinates of the corner C of the cuboid in Frame 0. Express your answer in terms of matrix and/or vector products or known quantities. You do not need to provide the numeric answer.

![Figure 2](image2)
3. (40 marks) A 3-dof planar robot is shown in Figure 3. All joints are rotational and all the joint axes are parallel.

Assume that $L_1 > L_2 > L_3$.

(a) Derive an expression for the homogeneous transformation matrix $^0T_E$ as a function of $q_1$, $q_2$, and $q_3$. (Hint: You may be able to determine the orientation by inspection.)

(b) Identify the decoupled subsystem if any for this robot.

**END OF QUIZ**