Lab 2

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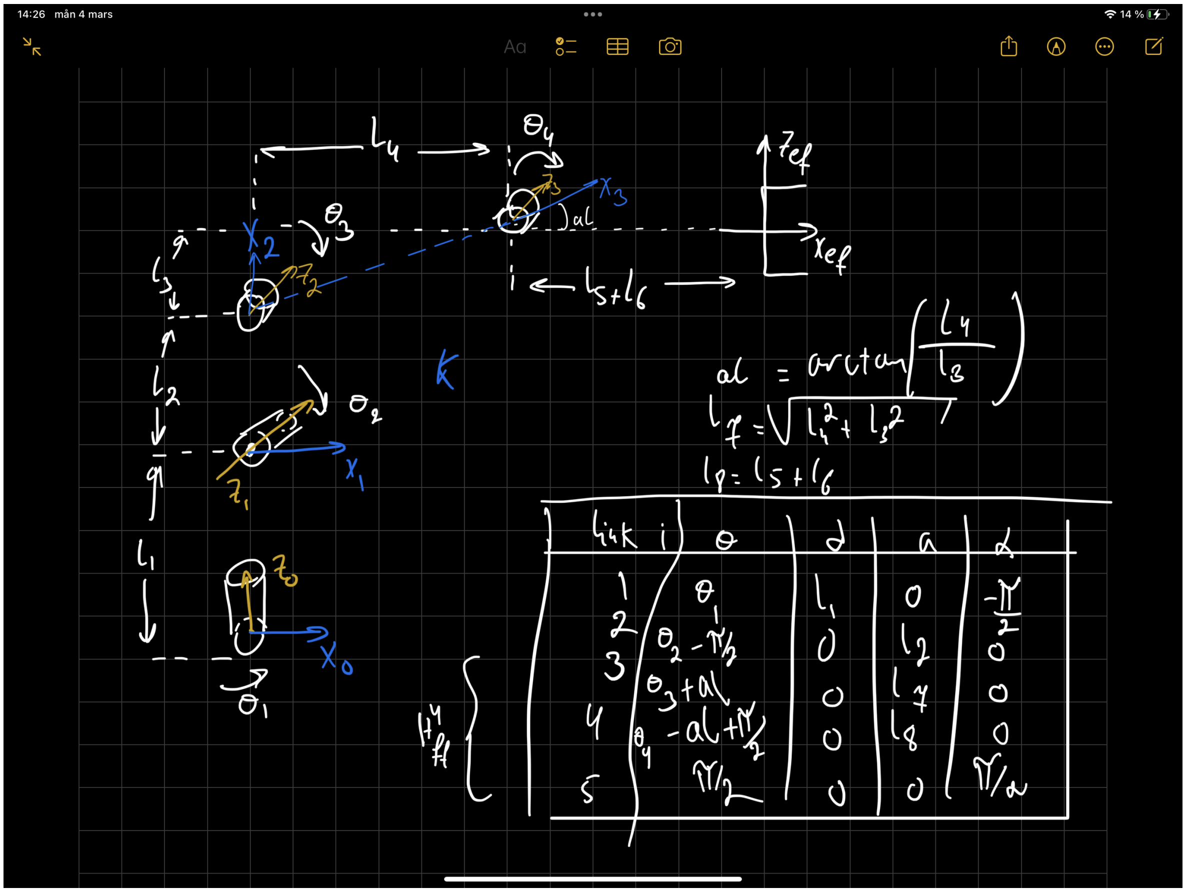

Figure 1: Coordinate frames for links

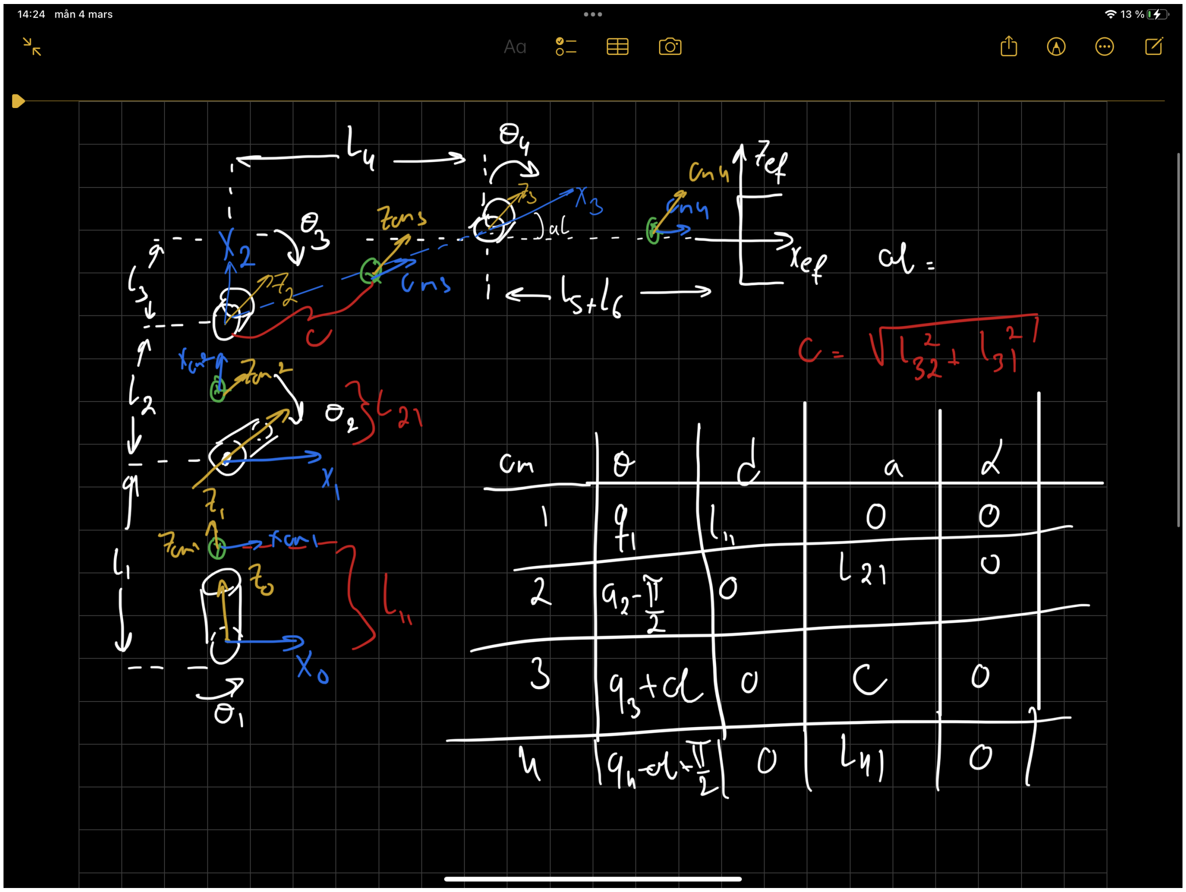

Figure 2: Coordinate frames CM

The variables for robot is: $L_1 = 0.29$
$L_2 = 0.27$
$L_3 = 0.07$
$L_4 = 0.302$
$L_5 = 0.072$
$L_6 = 0.1$
$L_7 = \sqrt{L_3^2 + L_4^2}$
$L_8 = L_5 + L_6$
$al = arctan(\frac{L_4}{L_3})$
$L_{11} = \frac{L_1}{2}$
$L_{21} = \frac{L_2}{2}$
$L_{31} = \frac{L_3}{2}$
$L_{32} = \frac{L_4}{2}$
$L_{41} = \frac{L_8}{2}$
$L_{51} = \sqrt{L_{32}^2 + L_{31}^2}$
and qi corresponds to the rotation (θ_i) of the revolute joints. Following the computation of absolute and relative homogeneous transformation matrices for each link and center of mass, the Jacobian was derived for each center of mass, as stipulated in Exercise 1 and Exercise 2. Utilizing this data, the M, C, and G vectors were determined for the dynamic model of the robot. Subsequently, simulations were

conducted with varying viscous parameters (e.g., $B = [0.1, 0.1, 0.1, 0.1]$, $B = [0.2, 0.31, 0.51, 0.71]$) and diverse initial conditions (e.g., $q_{\text{initial}} = [0, 0, 0, 0]$, $q_{\text{initial}} = [\frac{\pi}{4}, -\frac{\pi}{2}, \pi, -\pi]$). The resulting plots are as follows:

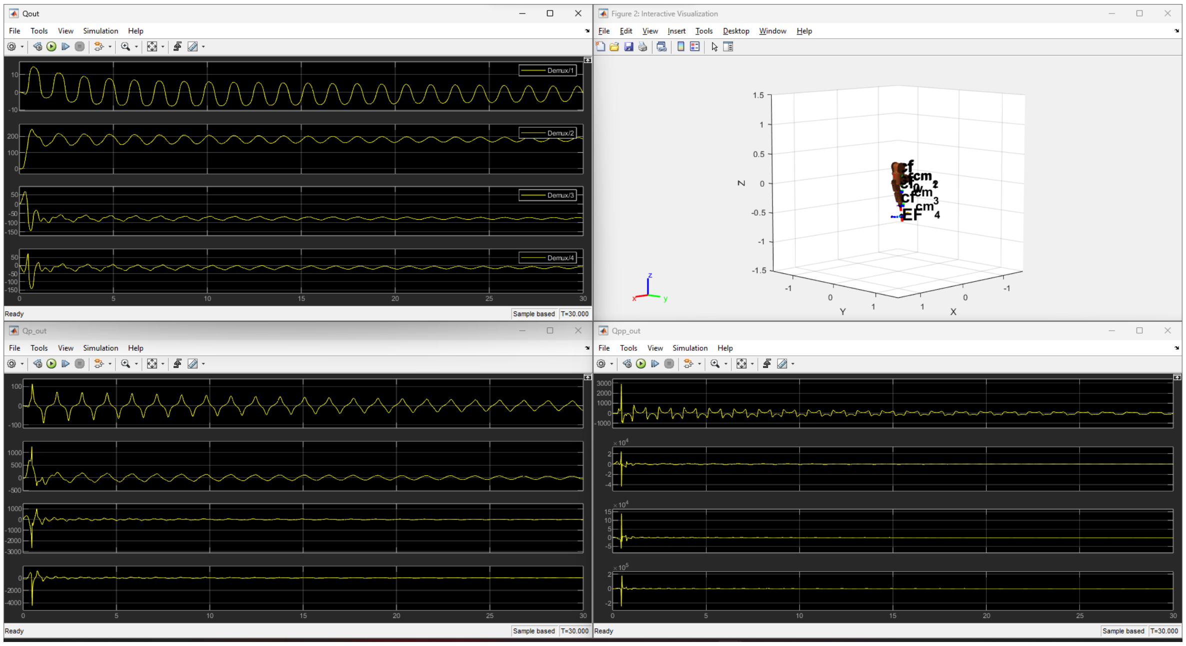

Figure 3: B = [0.1, 0.1, 0.1, 0.1] and qinitial = [0, 0, 0, 0]

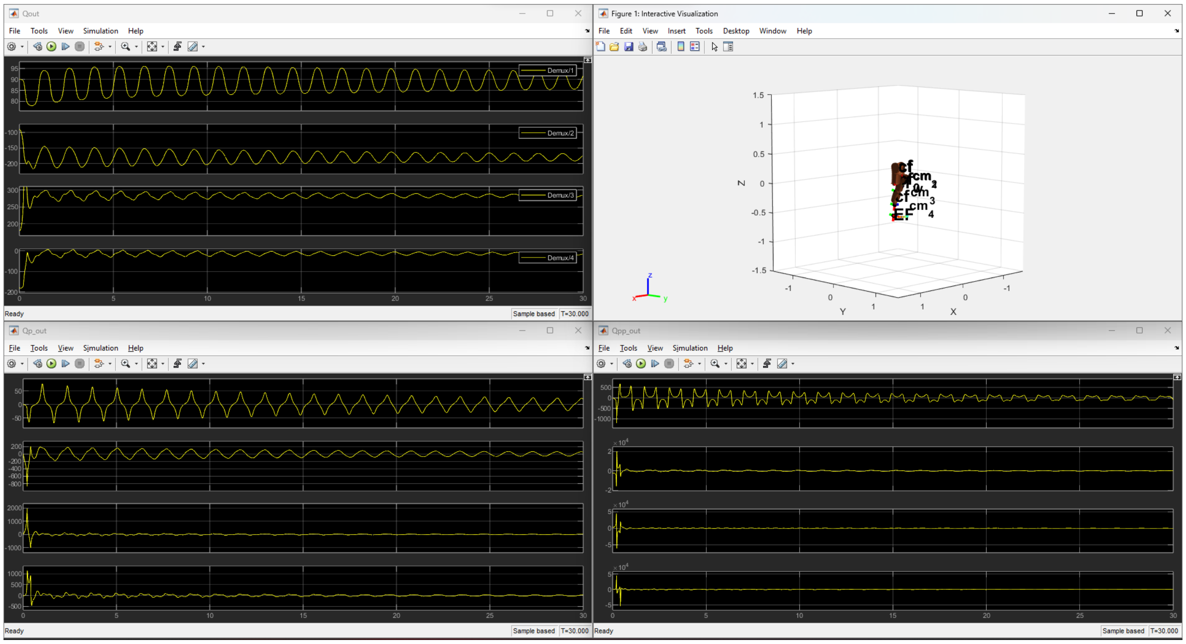

Figure 4: [0.1, 0.1, 0.1, 0.1] and $q_{\text{initial}} = [\frac{\pi}{4}, -\frac{\pi}{2}, \pi, -\pi]$

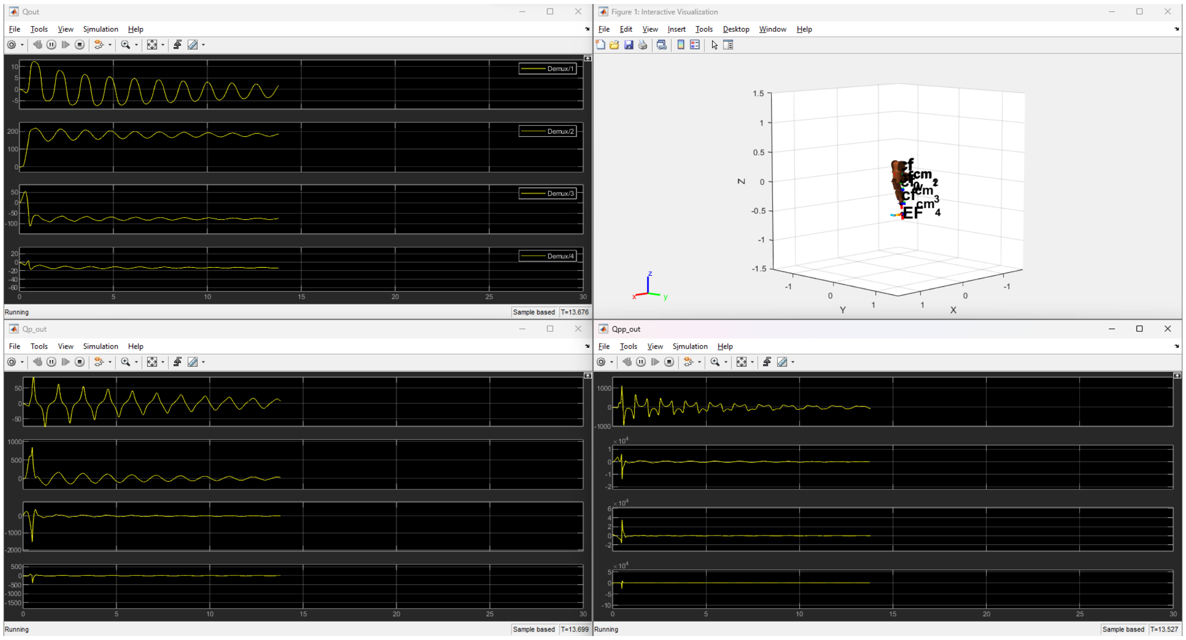

Figure 5: B = [0.2, 0.31, 0.51, 0.71] and qinitial = [0, 0, 0, 0]

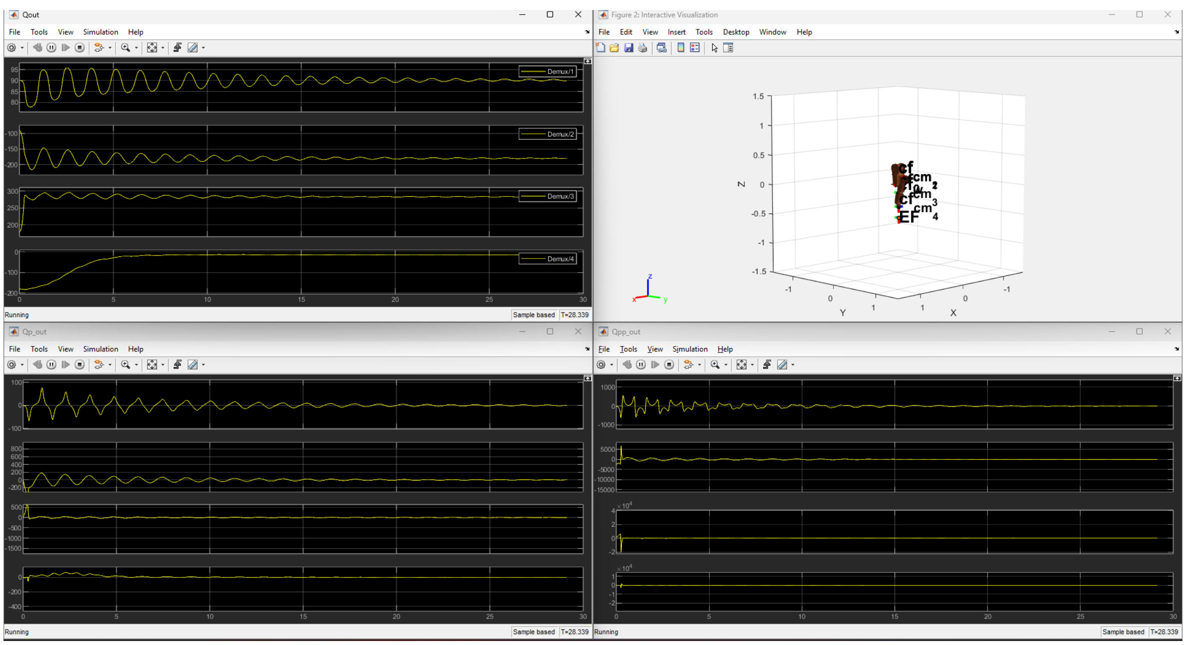

Figure 6: B = [0.2, 0.31, 0.51, 0.71] and $q_{\text{initial}} = [\frac{\pi}{4}, -\frac{\pi}{2}, \pi, -\pi]$

When we increase the viscous parameters while keeping the initial position the same, the robot moves with fewer swings, and the joints reach their normal positions faster. Also, the robot moves slower and smoother, and its speed and acceleration decrease. This happens because increasing the viscous parameters means there's more resistance in the joints, which makes the robot's motion slower and more stable, but it's not as good at doing dynamic movements.

When we keep the viscous parameters the same but change the initial joint positions, the robot moves differently because it starts from a different point. If we start with initial joint positions of $[\frac{\pi}{4}, -\frac{\pi}{2}, \pi, -\pi]$, the robot swings more. But if we start with initial joint positions of $[0, 0, 0, 0]$, the changes in speed and acceleration are bigger. This happens because starting from different positions makes the robot move in different ways, compared to starting from a stable position.