1. Items done this session:

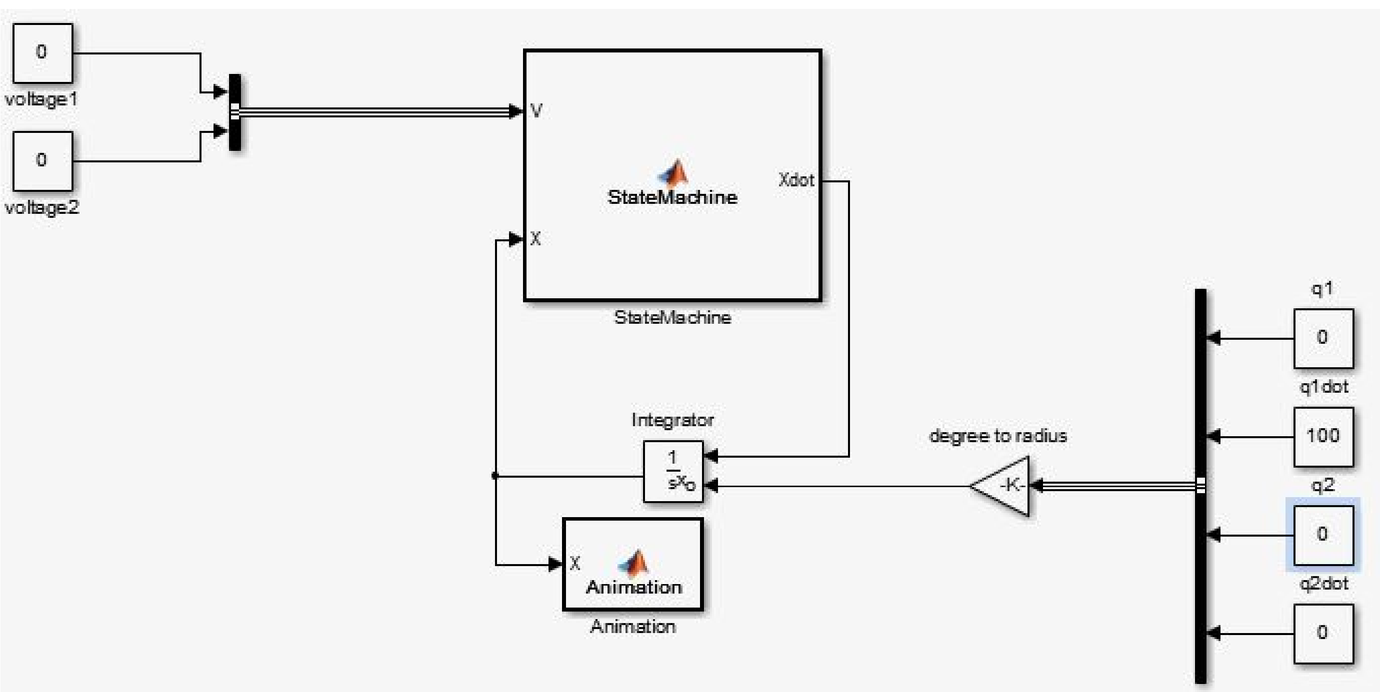
TASK-3: Using the following list of "Robot" characteristics, find values for the "Physical Parameters" of the system.

Given physical parameters: $J_1=0.0012$ $l_2=0.3$ $\beta_2=0.002$ $k_r=70$ $m_2=0.127$ $l_{c2}=0.15$ $R_a=2.6$ $(l_1+l_2')=0.2$ $\beta_1=0.015$ $k_t=k_v=0.00768$

$$\begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} m_{11}(q) & m_{12}(q) \\ m_{21}(q) & m_{22}(q) \end{bmatrix} * \begin{bmatrix} \ddot{q}_1 \\ \ddot{q}_2 \end{bmatrix} + \begin{bmatrix} c_{11}(q,\dot{q}) & c_{12}(q,\dot{q}) \\ c_{21}(q,\dot{q}) & c_{22}(q,\dot{q}) \end{bmatrix} * \begin{bmatrix} \dot{q}_1 \\ \dot{q}_2 \end{bmatrix} + \begin{bmatrix} f_1(\dot{q}_1) \\ f_2(\dot{q}_2) \end{bmatrix} + \begin{bmatrix} g_1(q_1) \\ g_2(q_2) \end{bmatrix}$$

In the first part of this session, we started with implement MATLAB function named "StateMachine" for the two equations we derived in last session. The function firstly calculates theta1, ..., theta6 with those physical parameters given above, so for the each iteration in simulation phase the function will not take too much time to unefficiently recalculate all the thetas again.

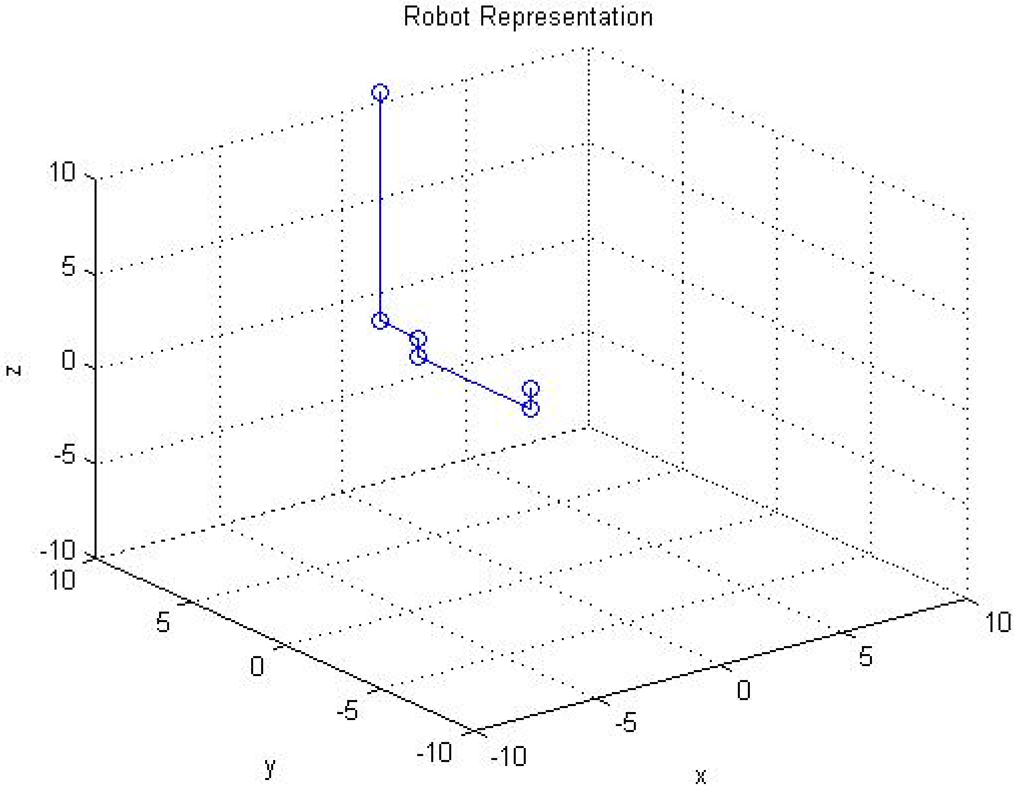
For the simulink design, we put the voltage 1 and voltage 2 as constant input value which can be change before or during simulation. The "State Machine" finished above takes voltages and X as input and output Xdot, where X=[q1;q1dot;q2;q2dot] and Xdot=[q1dot;q1dotdot;q2dot;q2dotdot]. From two matrix form equations, we can obtain q1dotdot and q2dotdot, then combine then with q1dot and q2dot from input X into Xdot as output. Next state X can be get from integrating Xdot, and it can be plot by Animation function we implemented in the last assignment.

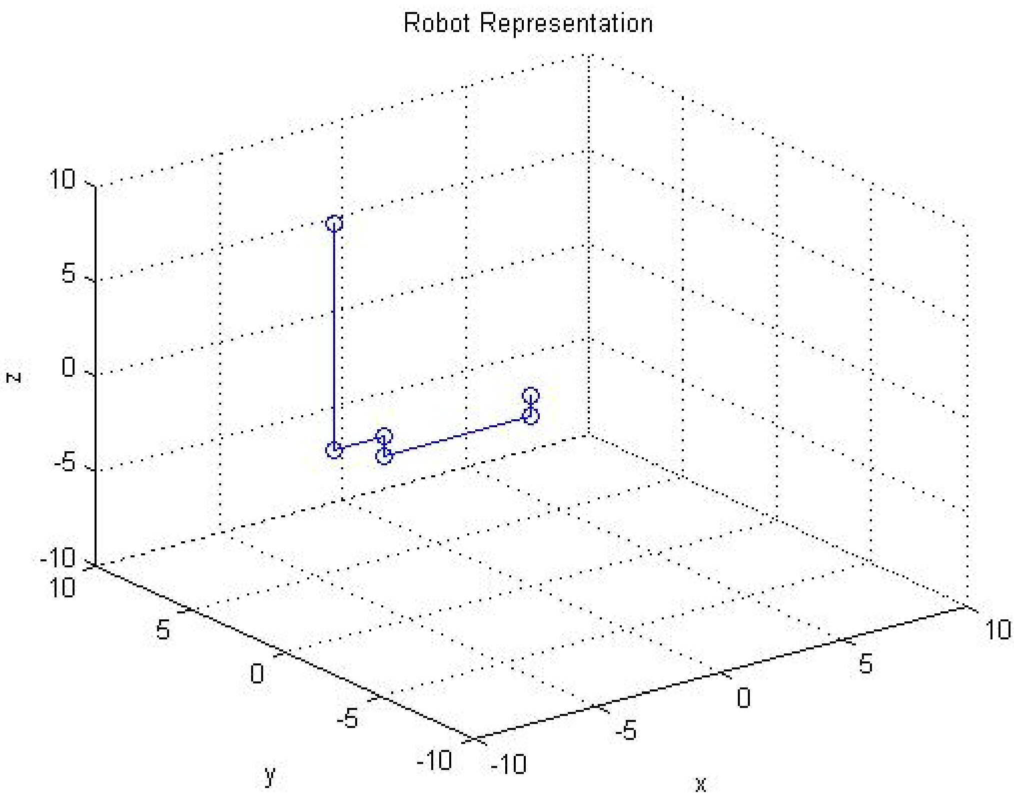


TASK-4: In order to show simulated motion for the robot, it is necessary to solve the above matrix equation (Task-2) for the acceleration in each joint. We can then implement this in Simulink to bring the "Robot" to life with its own "physics engine"(class discussion). Demonstrate your virtual robot behaves as physics would dictate. Compare this to the actual motion of the real system.

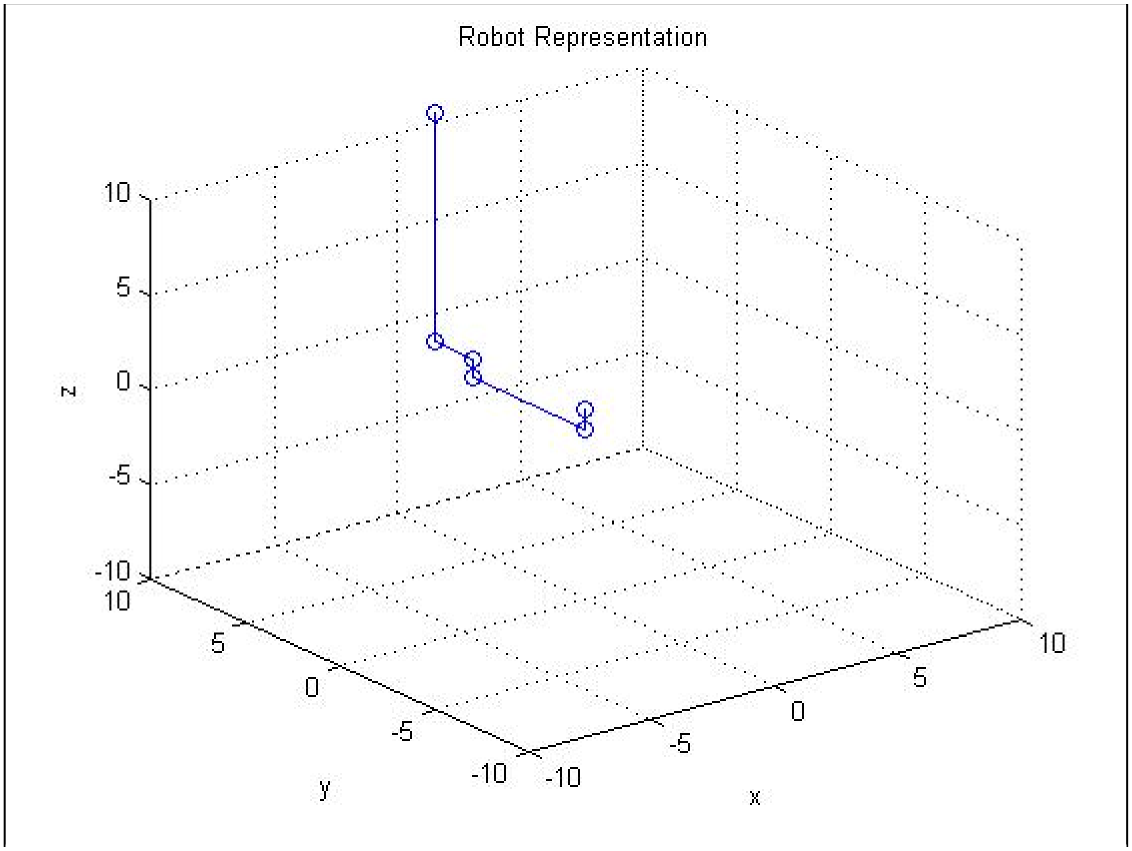
After building the simulation block diagram, we firstly output some static output graph with different q1, q2 input to confirm the direction is consistent with the last assignment.

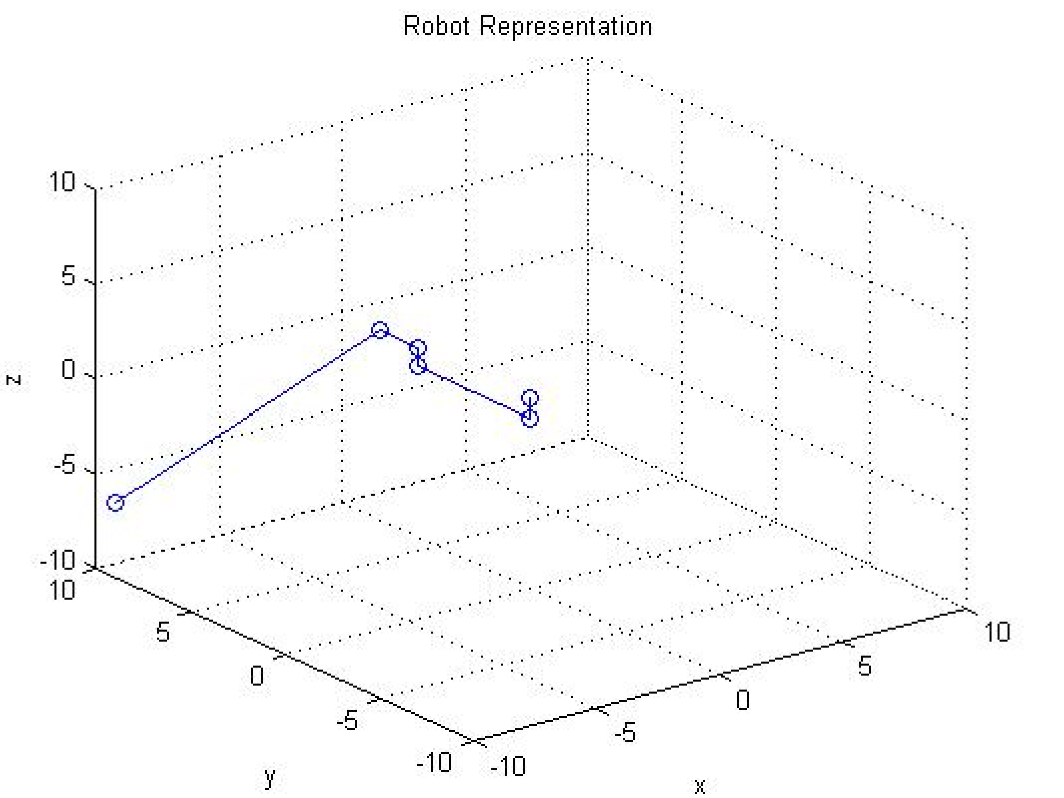
The left graph below is static plot of X_initial=[0;0;0;0] while the right graph is with X_initial=[90;0;0;0]. The two graphs show the positive direction of q1 in Z1 axis is consistent with the last assignment.





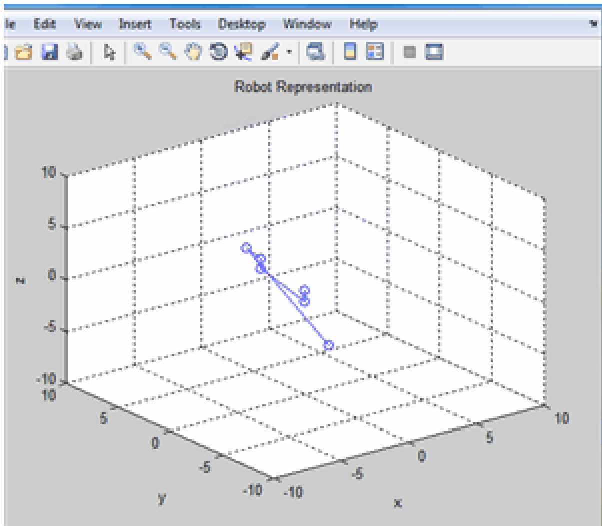
The left graph below is static plot of X_initial=[0;0;0;0] and the right graph is with X_initial=[0;0;90;0]. The two graphs show the positive direction of q2 in Z2 axis is consistent with the last assignment.

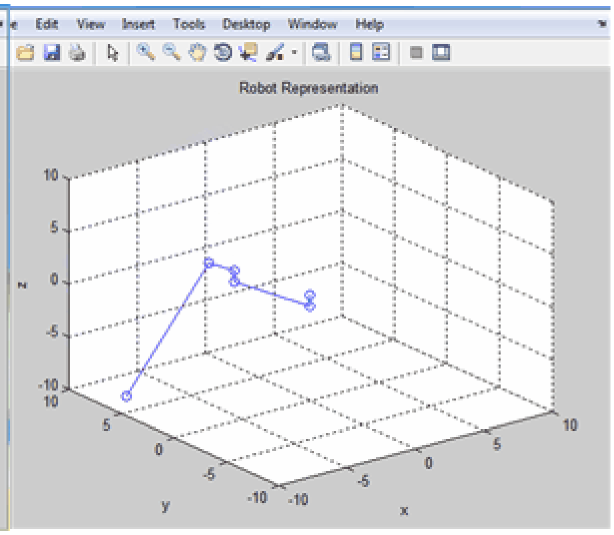




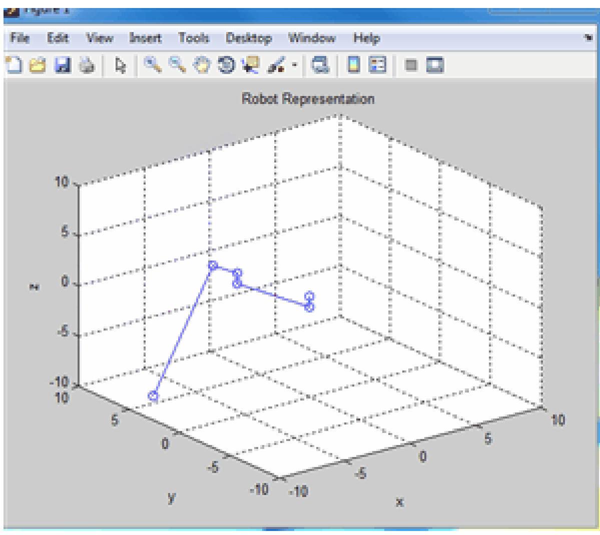
Then we try some different dynamic plot for different parameters of initial X and Voltages to confirm the simulation make sense in physical world.

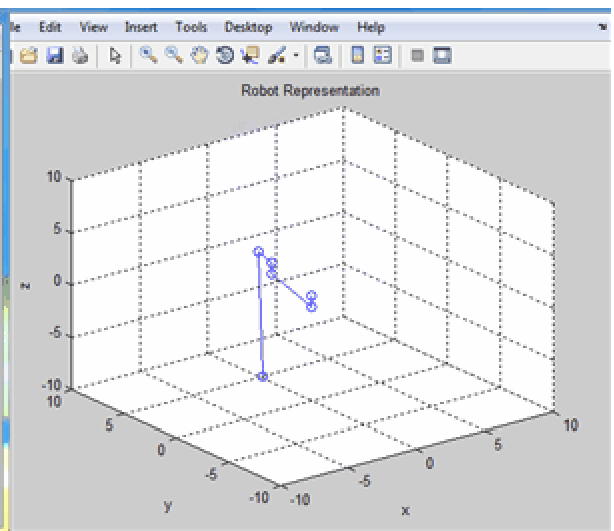
The left graph below is static plot of X_initial=[0;100;0;0], and voltages=[0;0]. The right graph is with X_initial=[0;-100;0;0], and voltages=[0;0].



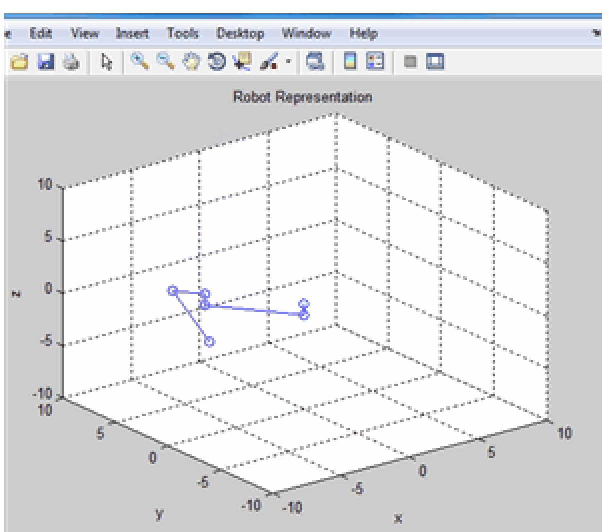


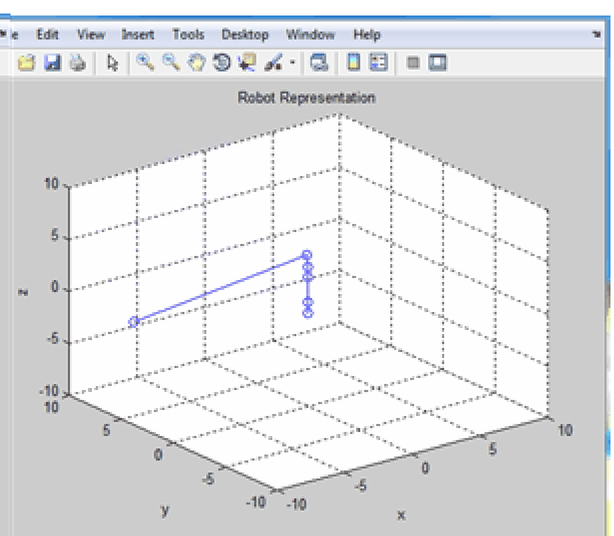
The left graph below is static plot of X_initial=[0;0;0;100], and voltages=[0;0]. The right graph is with X_initial=[0;0;0;-100], and voltages=[0;0].





The left graph below is static plot of X_initial=[0;0;0;0], and voltages=[1;0]. The right graph is with X_initial=[0;0;0;0], and voltages=[-1;0].





2. Items for next session:

Continue on the next Lab assignment.