Experiment No. 4

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Branch: Electronics and Communication **Section/Group: A**
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Subject Name: Industrial Automation & Robotics **Code: 20ECA-446**

1. **Aim of the practical:** To transform joint velocity into end effector velocity using Jacobian and Velocity Kinematics in MATLAB Simulink.
2. **Tool Used:** MATLAB Simulink.

3. **Theory:**

A trapezoidal velocity profile trajectory is a motion pattern commonly employed in robotics and motion control systems. It smoothly connects waypoints by gradually increasing velocity from zero to a peak, maintaining a constant speed, and then smoothly decelerating back to zero at the next waypoint. This trajectory is valued for its balance between speed and smoothness, making it popular in various applications.

The Jacobian of a trapezoidal velocity profile trajectory is a 2x1 matrix that encapsulates the first and second derivatives of the velocity profile concerning time. This mathematical tool proves useful in determining acceleration and deceleration rates along the trajectory, enabling the calculation of velocity at any given moment. This analytical approach aids in the effective control and implementation of trapezoidal velocity profiles in motion systems.

4. **Steps for experiment:**

- Create a MATLAB Simulink model.
- Add the Robotics System Toolbox block set to the model.
- Add a robot model to the model.
- Add a Jacobian block to the model.

- Connect the joint velocity signals to the Jacobian block.
- Connect the output of the Jacobian block to the end effector velocity signals.
- Add a trapezoidal velocity profile generator block to the model. This block generates a trapezoidal velocity profile, which is a smooth velocity profile that starts at zero, accelerates to a peak velocity, maintains that velocity for a period of time, decelerates back to zero, and then stops.
- Connect the output of the trapezoidal velocity profile generator block to the joint velocity signals.

5. Program Screenshots:

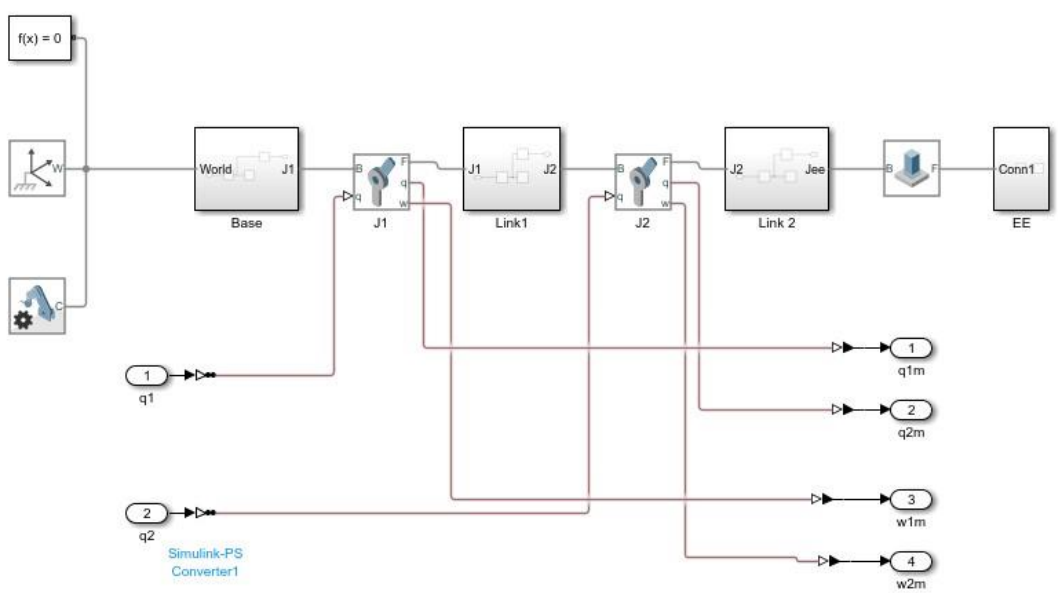

Figure: -4.1 Sub-Systems of Robo

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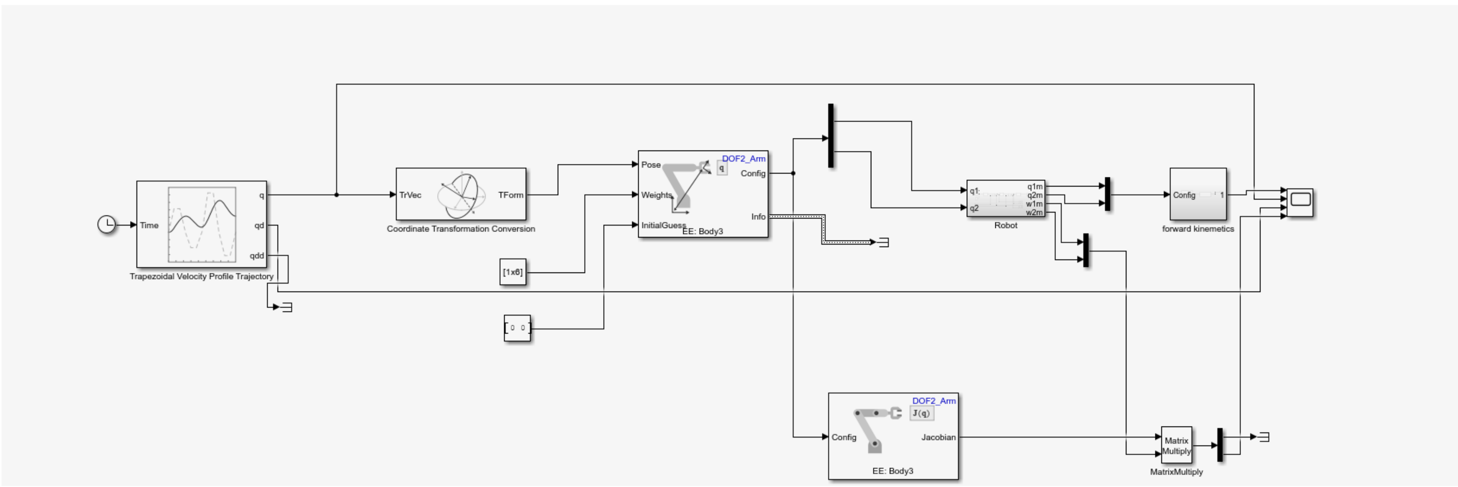
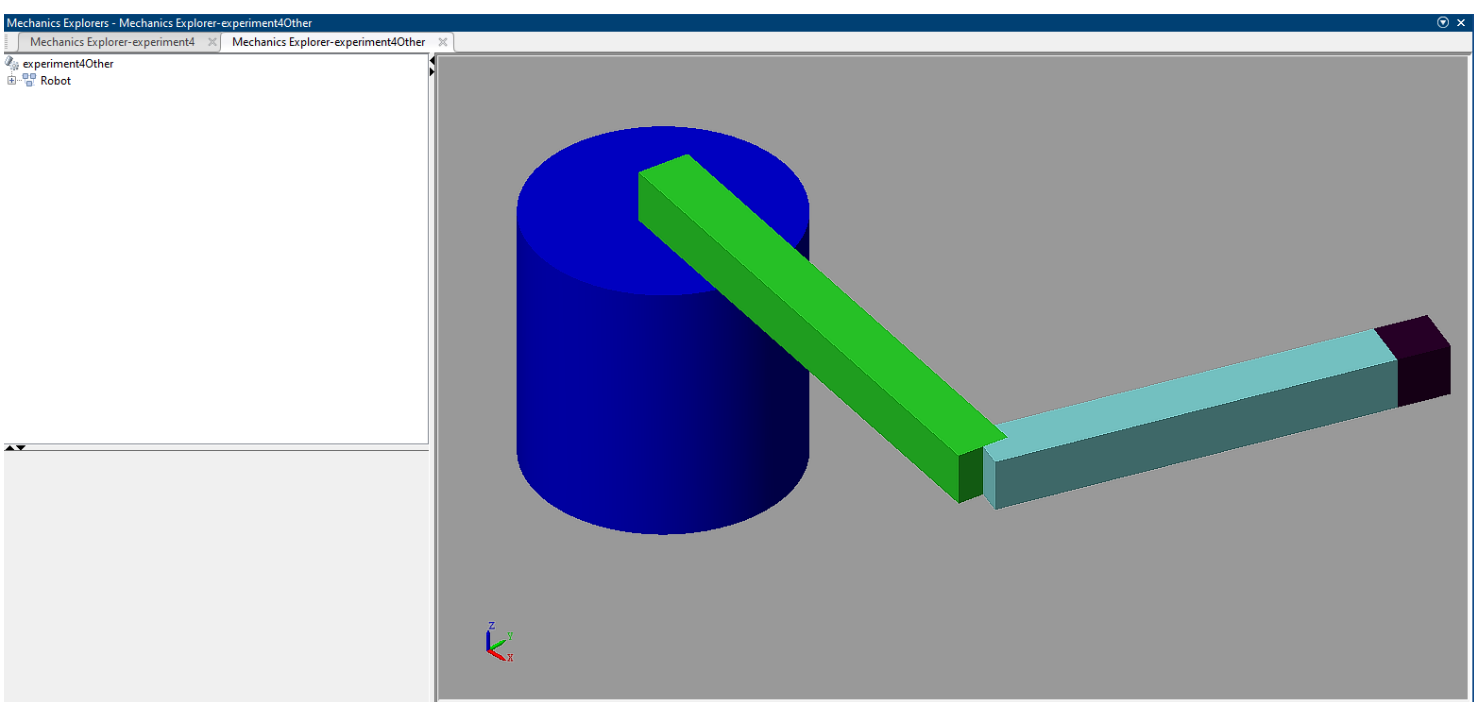


Figure 4.2 Adding coordinates to the system as signals

6. Observations, Simulation/Output Screen Shots and Discussions:

Figure 4.3: - Mechanics Explorer Window result



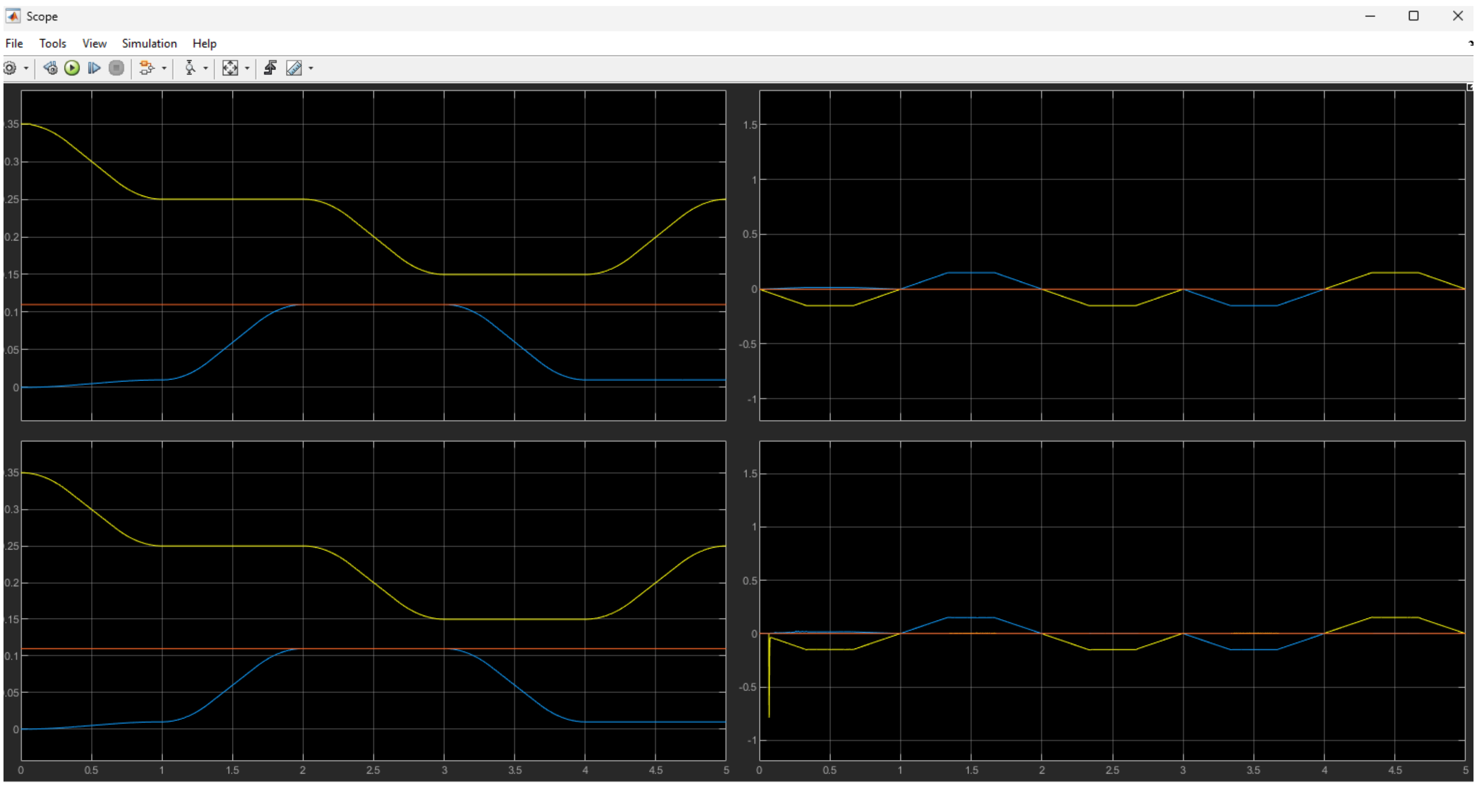


Figure 4.4: - Scope Graph of movement

7. Additional Creative Inputs (If Any):

Learning outcomes (What I have learnt):

1. Learn to simulate on Simulink.
2. Learnt to use Browser Library of Simulink.
3. Learnt about Jacobian.
4. Learnt to trapezoidal Velocity Profile Trajectory.

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Evaluation Grid (To be filled by Faculty):

Sr. No.	**Parameters**	**Marks Obtained**	**Maximum Marks**
1.	Worksheet completion including writing learning objectives/Outcomes. (To be submitted at the end of the day)		10
2.	Viva Result		8
3.	Student Engagement in Simulation/Demonstration/Performance and Controls		12
	Signature of Faculty (with Date):	**Total Marks Obtained:**	