University Institute of Engineering

Department of Electronics & Communication Engineering

Experiment No. :- 7

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Branch: Electronics and Communication **Section/Group:** A
Semester: 7th **Date of Performance:** 03/10/2023
Subject Name: Industrial Automation & Robotics **Subject Code:** 20ECA-446

1. **Aim of the practical:** To Implement and Design Walking Robot in Simulink

2. **Tool Used:** MATLAB and Simulink

3. **Theory:** The bipedal walking robot under consideration features a total of six degrees of freedom (DOF), covering the torso, legs, and feet. Each of these components is constructed with three revolute joints: the hip, knee, and ankle, as illustrated in the accompanying figure. To support real-time dynamic simulations, we've established essential parameters for each rigid part, including dimensions, mass density, and coordinate frames. These precise measurements are determined through MATLAB variables.
   In our initial approach to simulating the walking of a humanoid robot, we introduce some simplifications. We assume that the robot maintains a consistent height throughout its walk and minimizes angular momentum around its center of mass (COM). These simplifications are intended to model the robot's movement on a flat surface. We treat the entire system as if it were a single point representing the center of mass, allowing us to liken it to an inverted pendulum fixed at a certain height. By employing straightforward mathematical equations, we can determine the footstep locations of the robot. Motion Actuation, the necessary torque is calculated automatically. Our role is solely to define the motion profile and its derivatives, ensuring that we avoid infinite acceleration. Force Actuation, it's our responsibility to define the torque profile. Our primary task is to implement position controllers to track the walking trajectory.

4. Steps for experiment/practical:

Step 1:- Open the MATLAB software.

Step 2:- Create a new project under simulink. **Step 3:-** Name the project file and save it.

Step 4:- Create the robot arm using base, links, joints and end effectors. **Step 5:-** After that create the system kinematics.

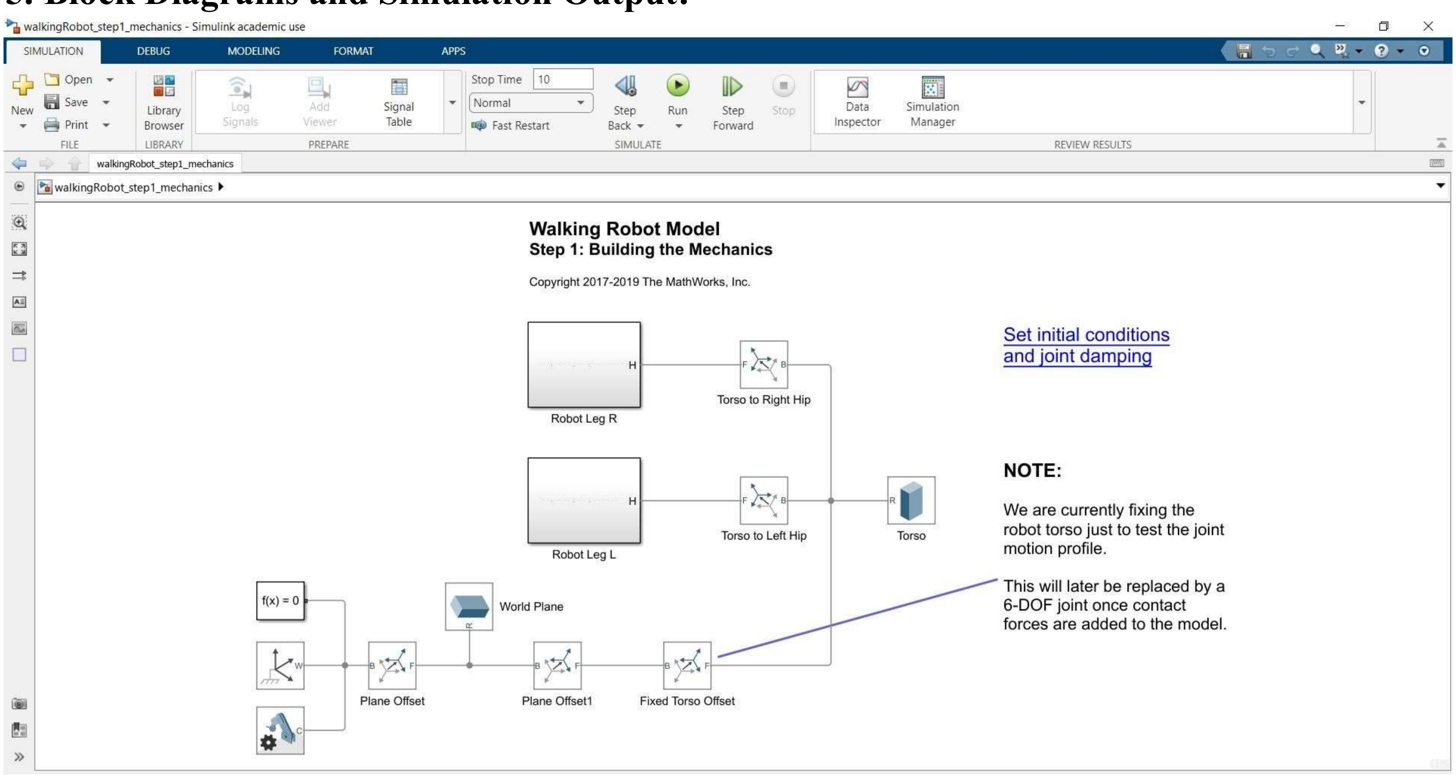
Step 6:- Connect both robot and kinematics block through a MUX.

Step 7:- Go to Matlab screen. Write the code for the initialization of the rigid body.

Step 8:- Run that program and wait till conformation of the formation of rigid body in the workspace.

Step 9:- After that run the program on the Simulink page and observe the outputs on scope as well as on mechanics explorer.

5. Block Diagrams and Simulation Output:



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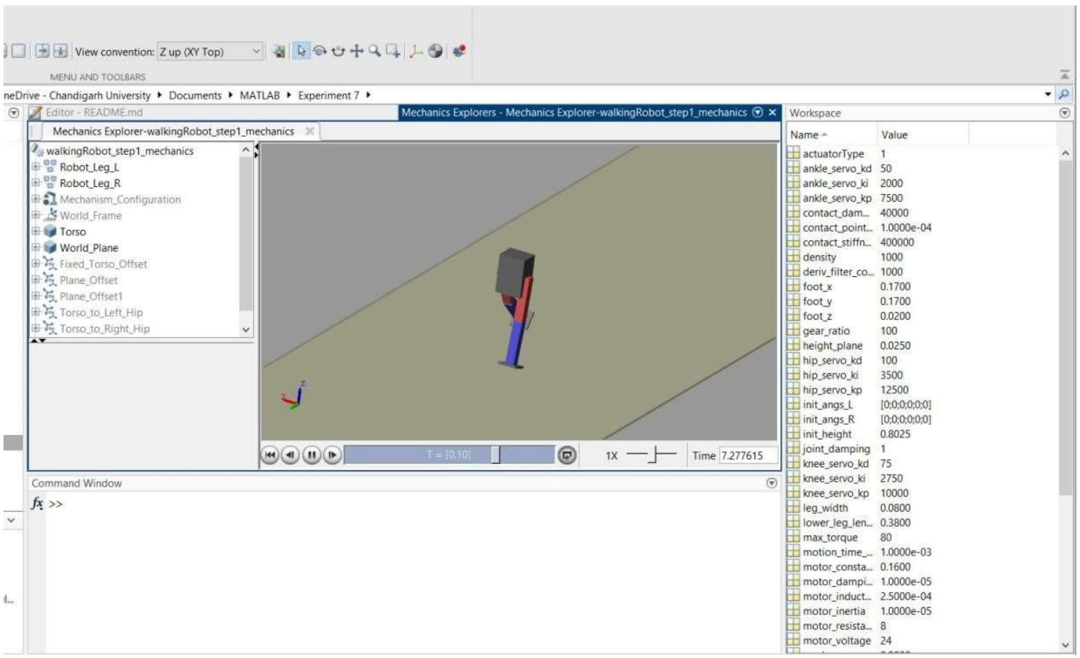

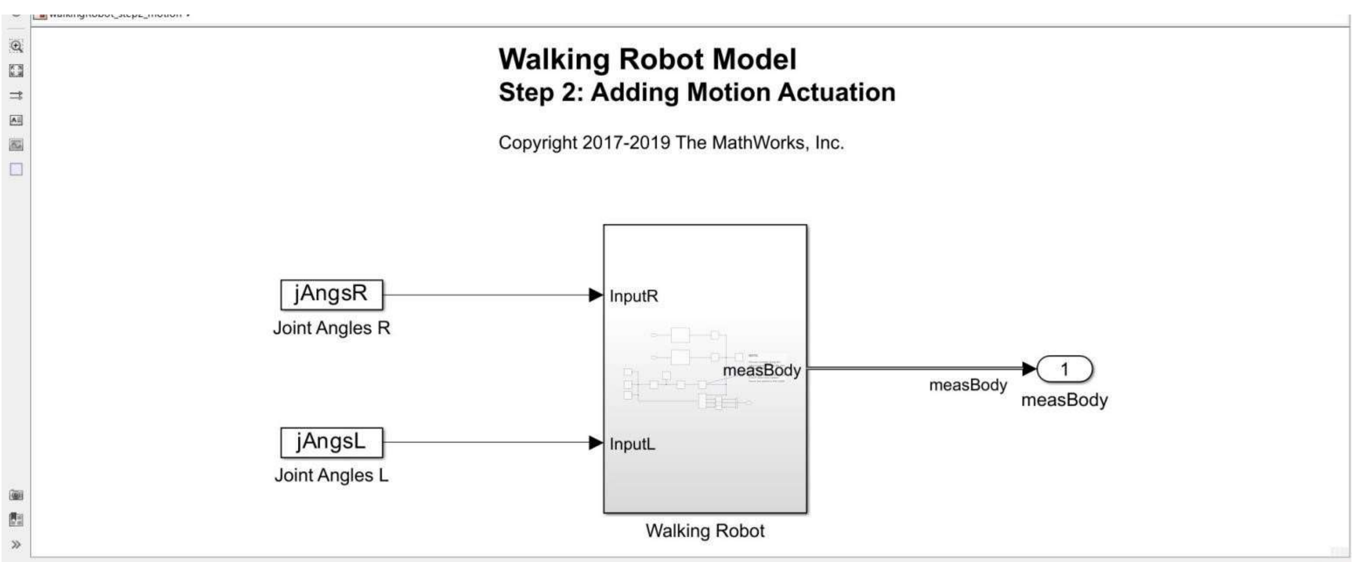

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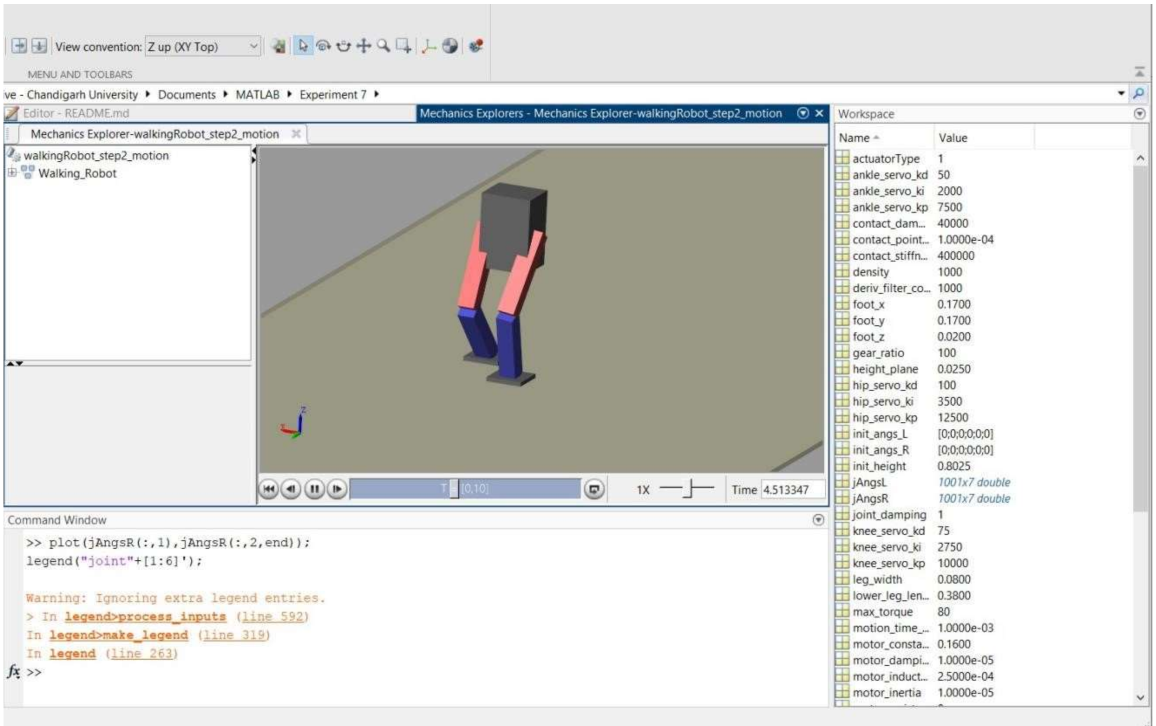

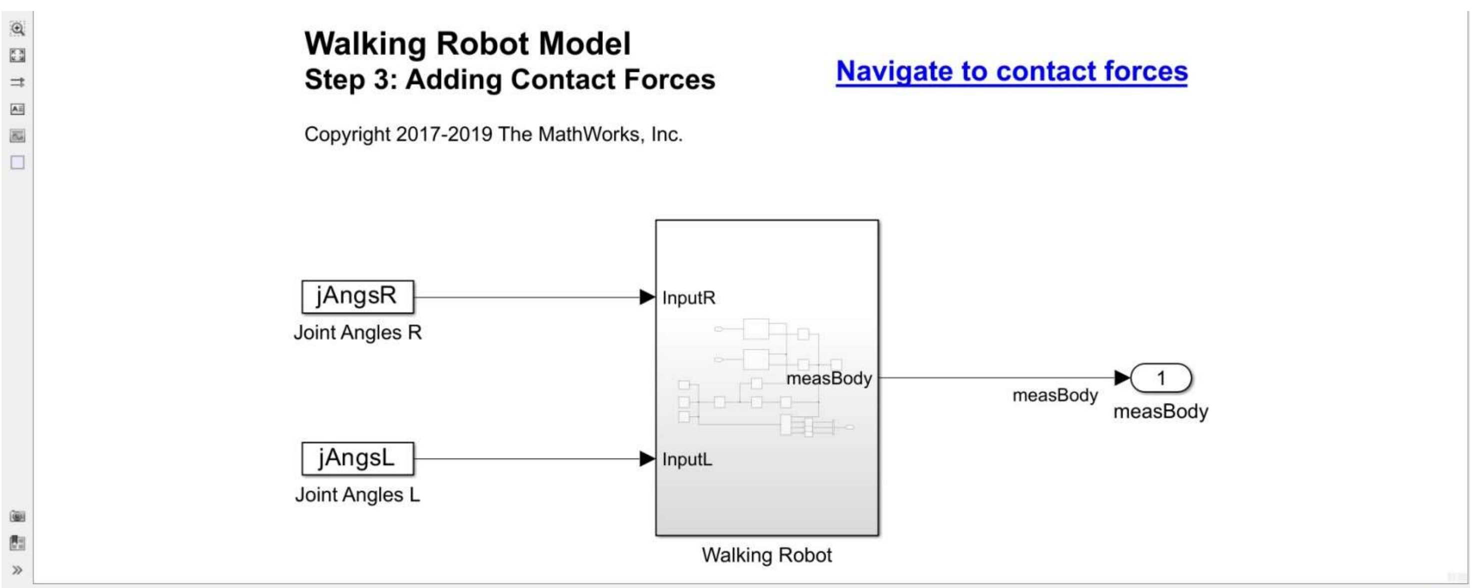

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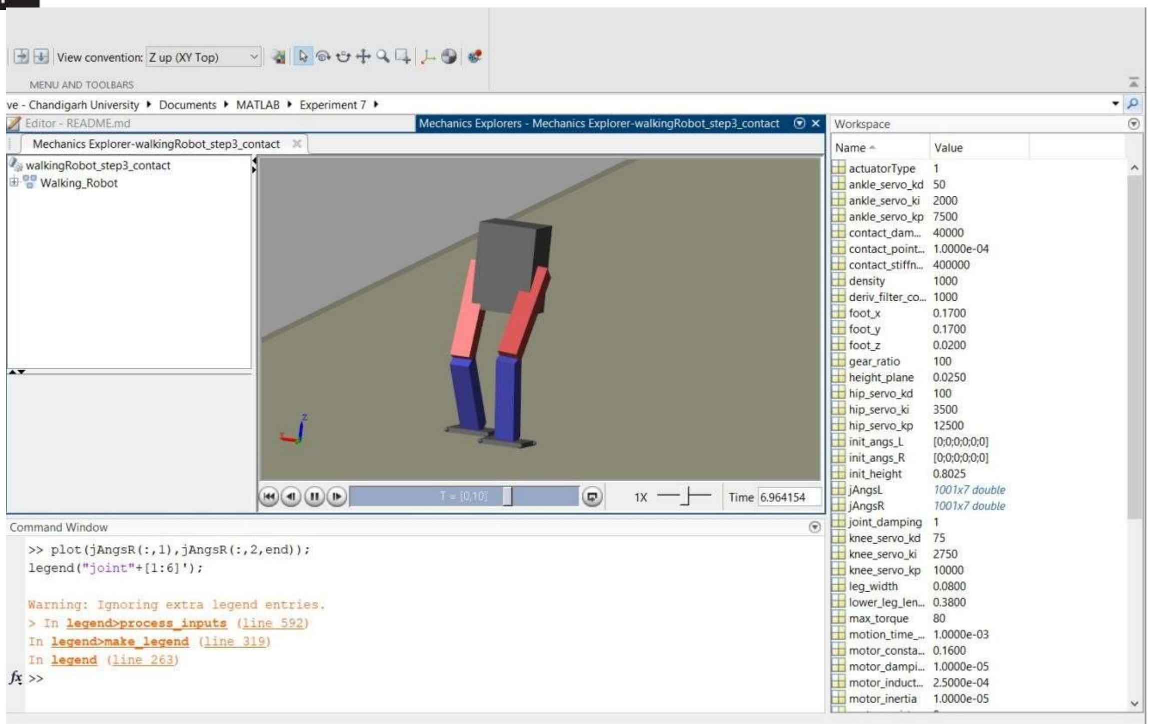

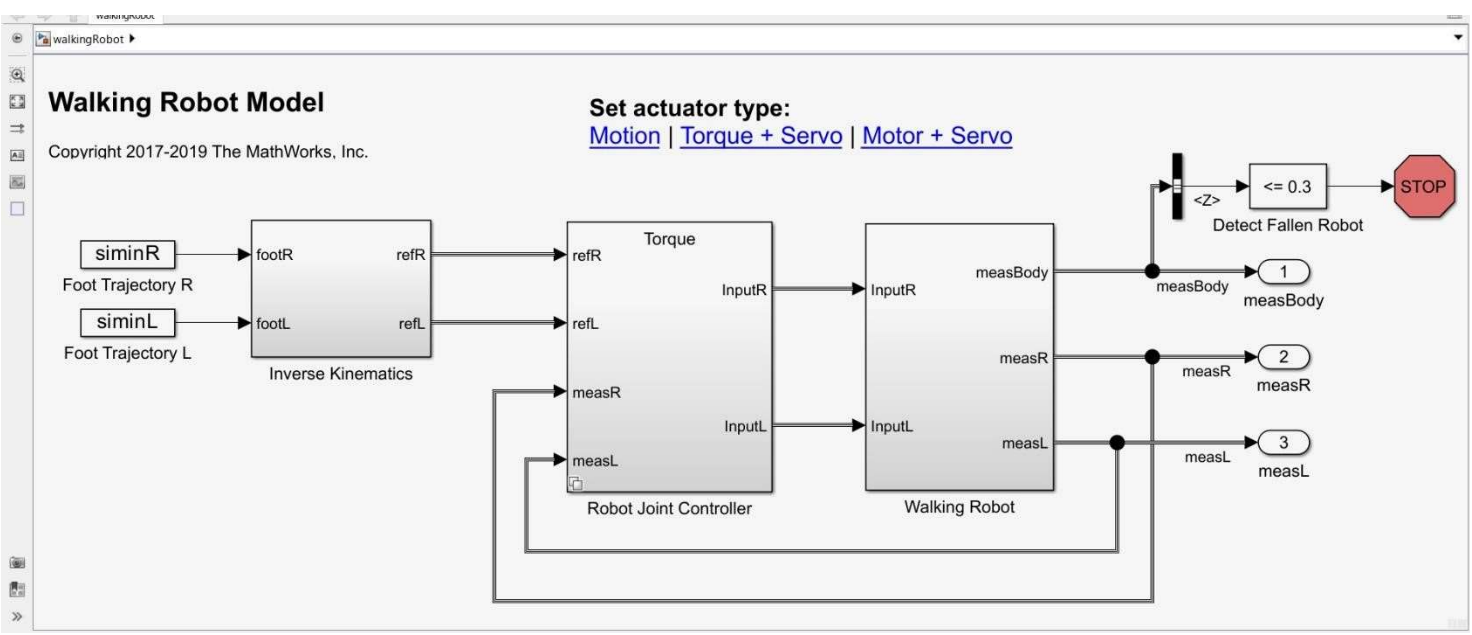

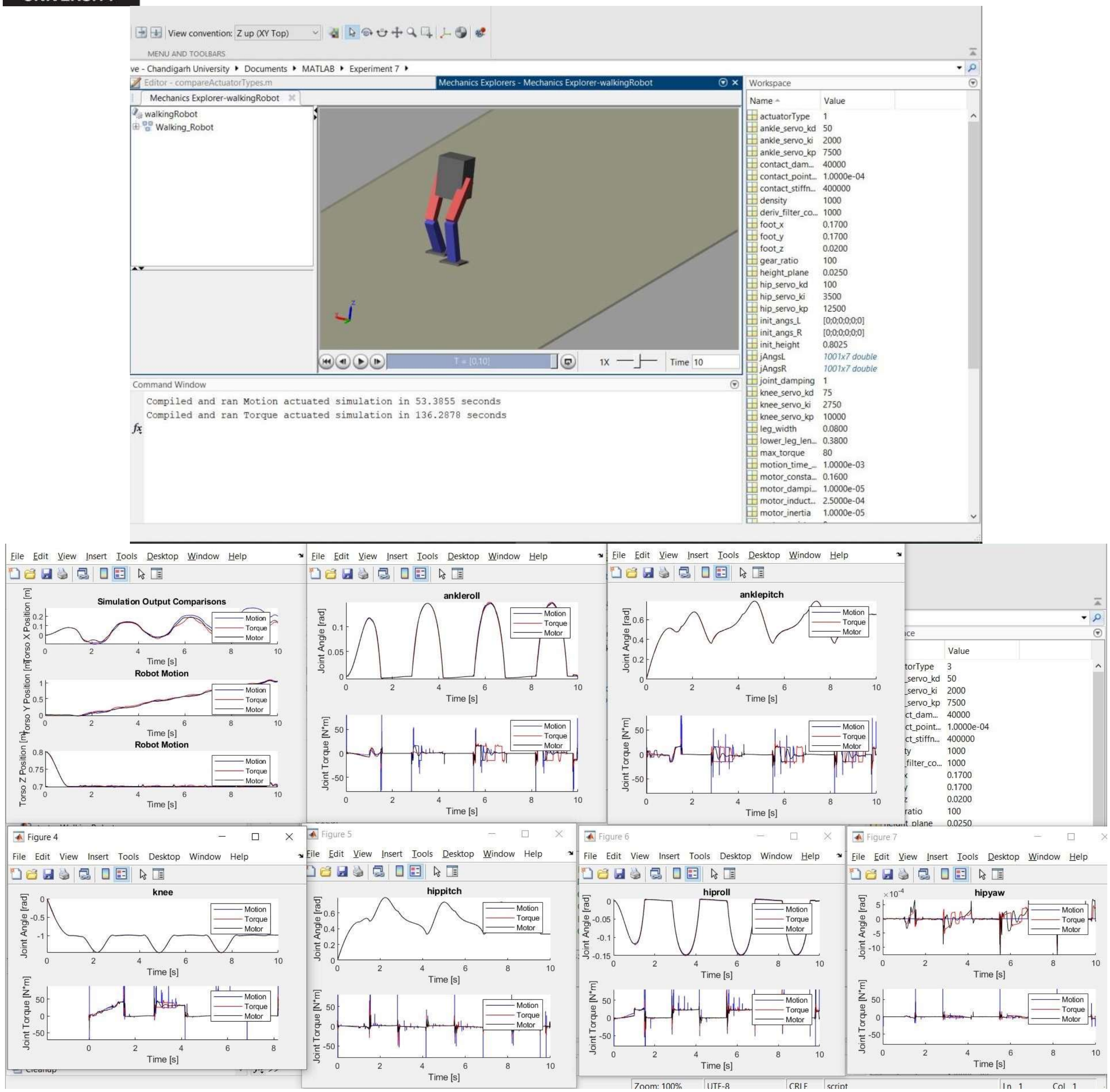

Results and Discussion:-

In this experiment, we created a simulation of a bipedal humanoid robot model, with a walking path derived from the linear inverted pendulum model. To facilitate the process of obtaining the inverse kinematics solution, we employed the principles of analytical geometry, which served as the mathematical foundation for our simulation.

Learning outcomes (What I have learnt):

- Learnt about the linear inverted pendulum model (LIPM).
- Learnt how to build the simulation of the walking robot, including contact forces, various actuator models.
- Learnt about analytical geometry.

Evaluation Grid:

Performance (12 Marks)	Worksheet (10 Marks)	Viva (8 Marks)	Total
		Teacher Sign	