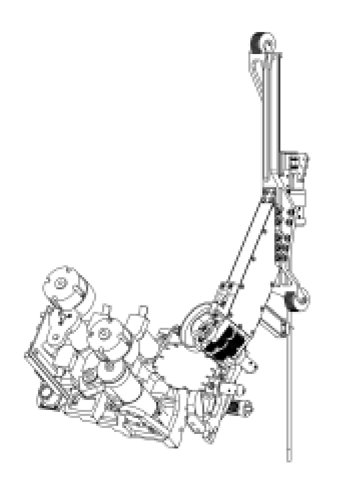
EE 449 Project Presentation III



Group 5 – Imam Tjung and Kiran Thomas

Automatic Cable Winding For Surgical Robot Arms

Milestone III

- Project Description
- Project Update
- State Machine Diagram
- Simple System Schematic
- Controller Design
- Simulation
- Implementation
- Performance, Stability and Robustness
- Updated Project Plan
- Updated Bibliography

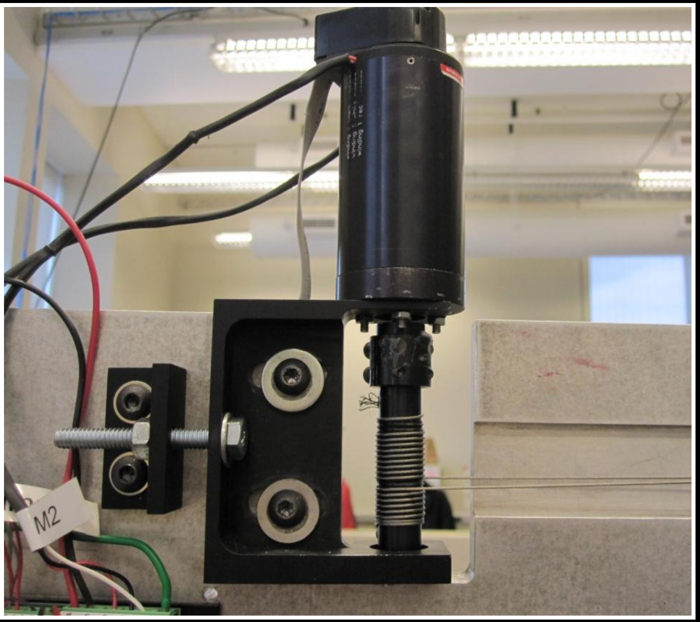
Project Description

The controller we create will wind the cable onto the capstan automatically.

One end of the cable is attached to the capstan while the other end will be attached to a unwinding bobbin which will provide constant torque.

The system should be able to wind the cable in two different directions.

The user can specify the velocity and number of turns. (Ranges from ~10-20 rotation per minute).



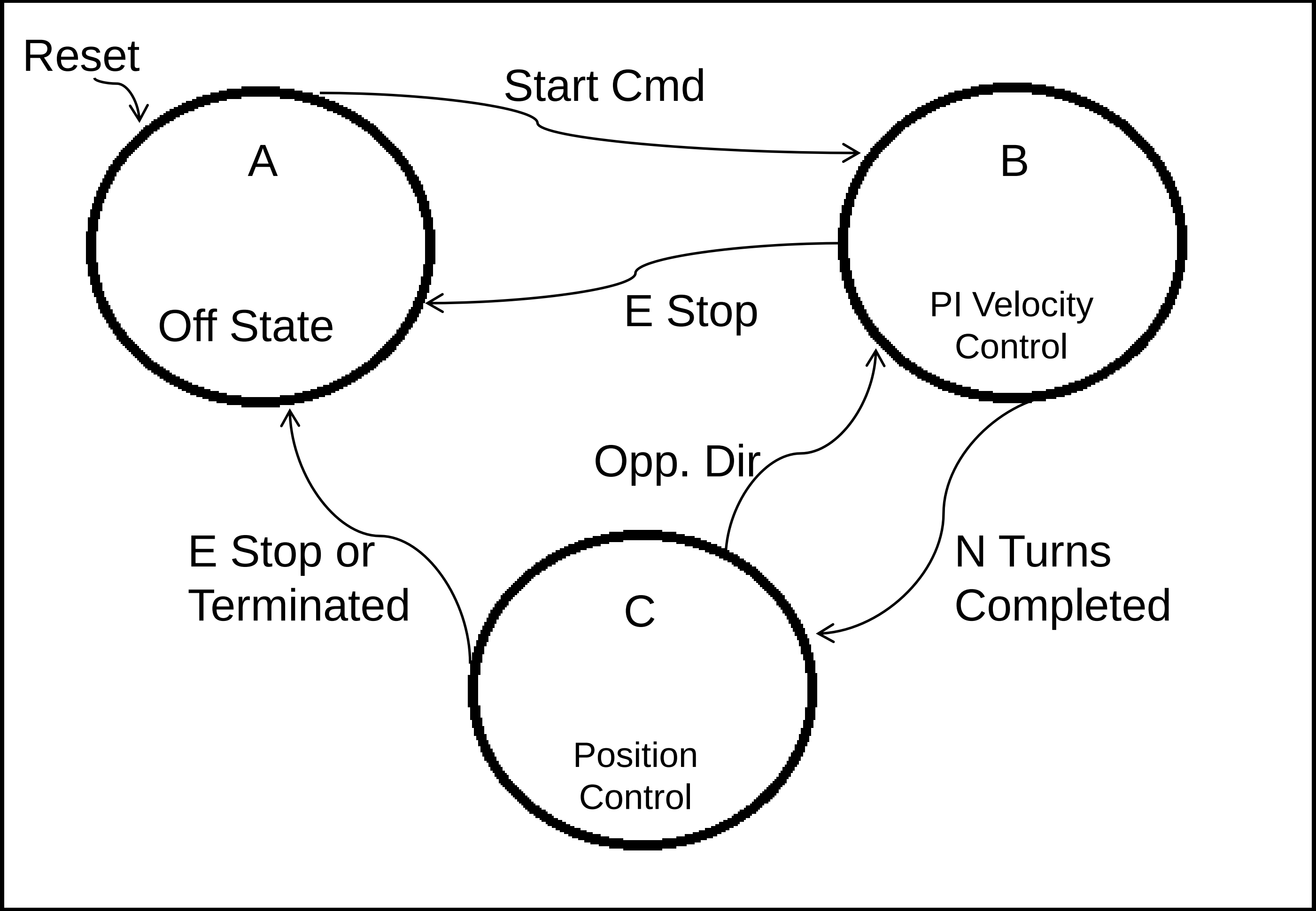
Project Update

- We switched the C program implementation into week 7 and controller design into week 5 and 6 to match the MS3.

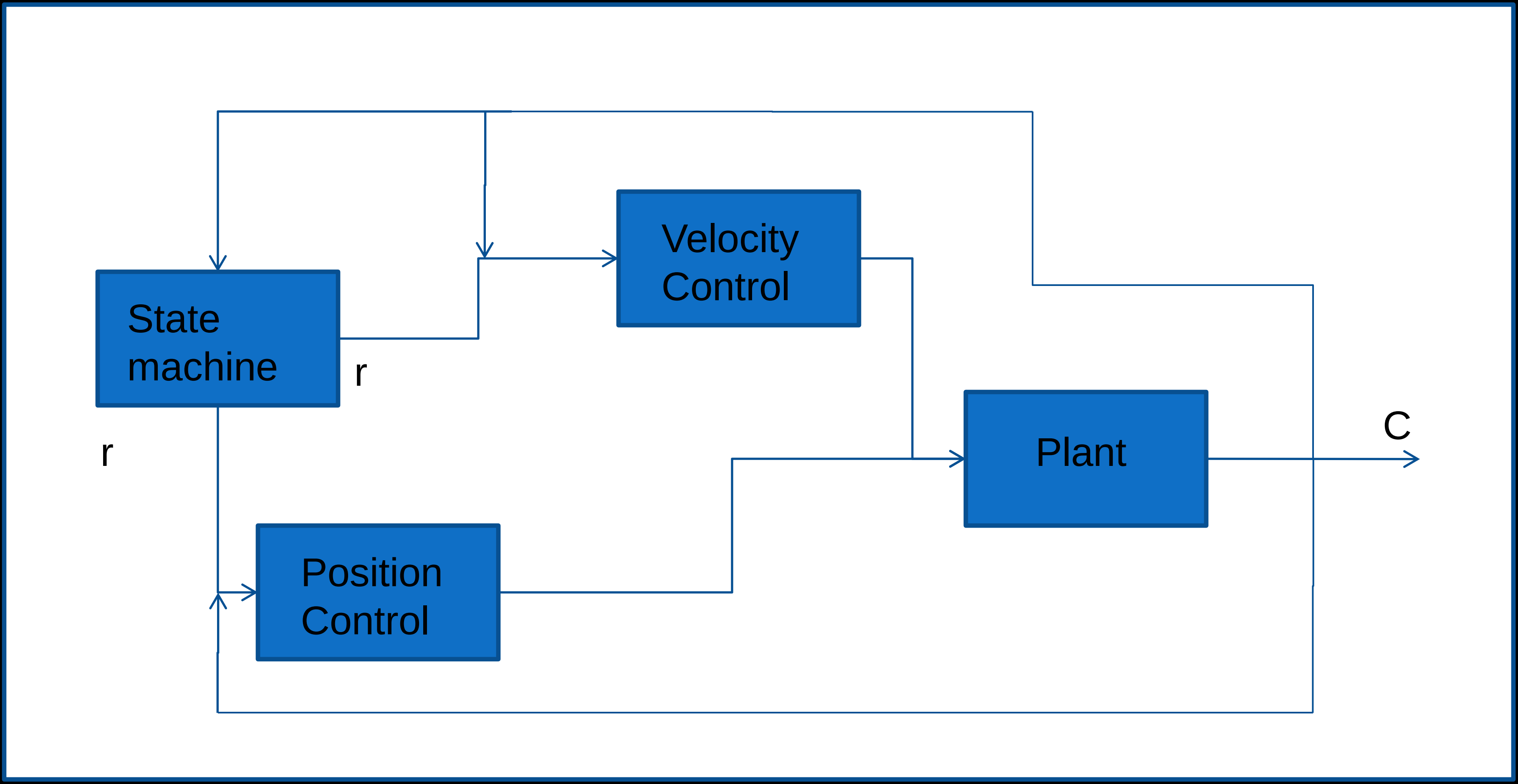
- Started testing position control on the pulley board

- Continue with the project plans

State Machine Diagram

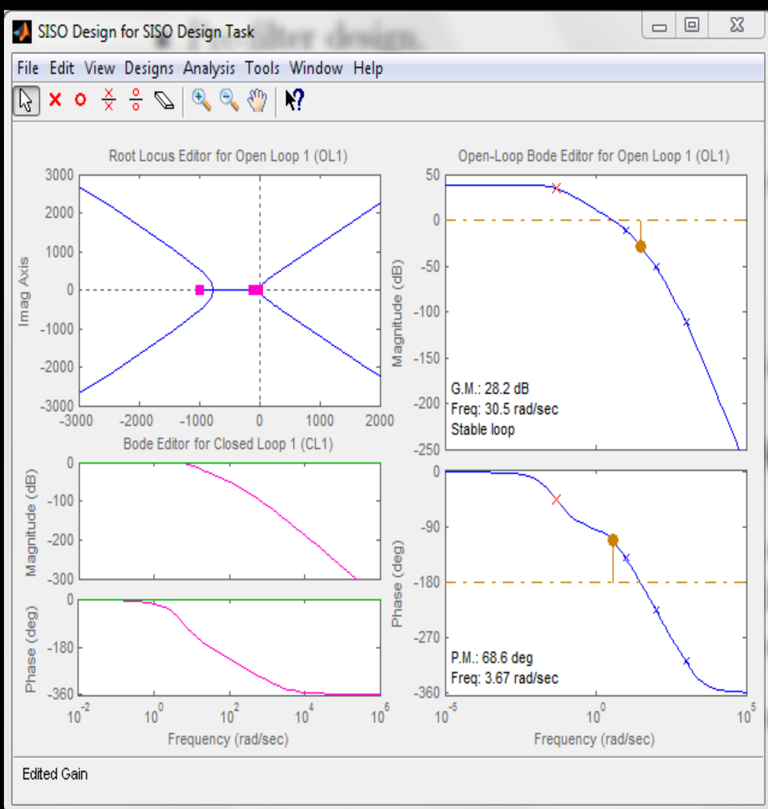


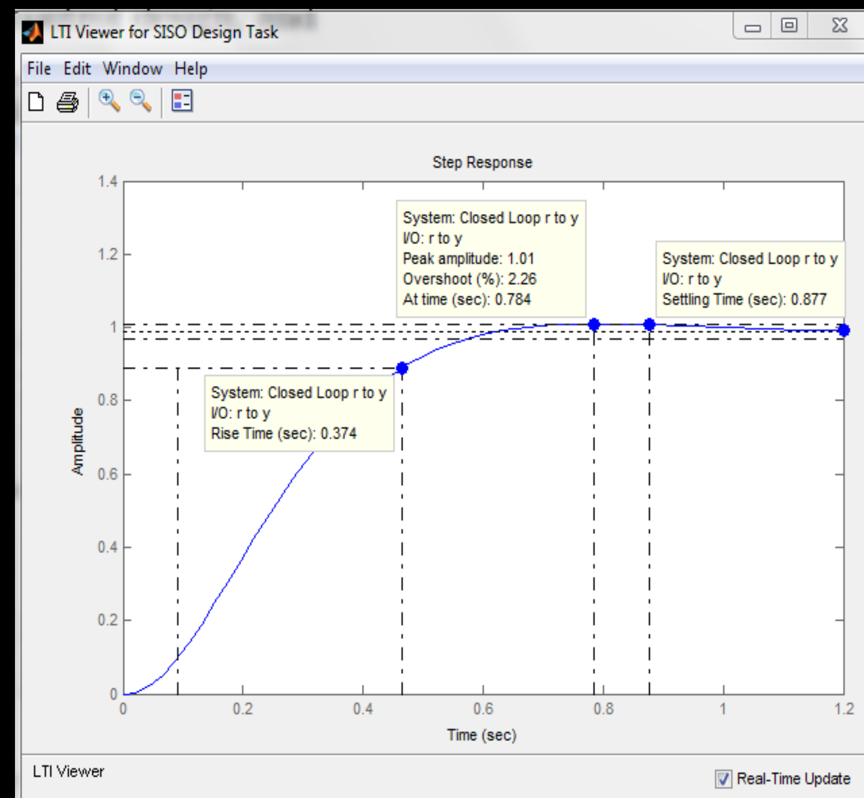
Simple System Schematic



Controller Design

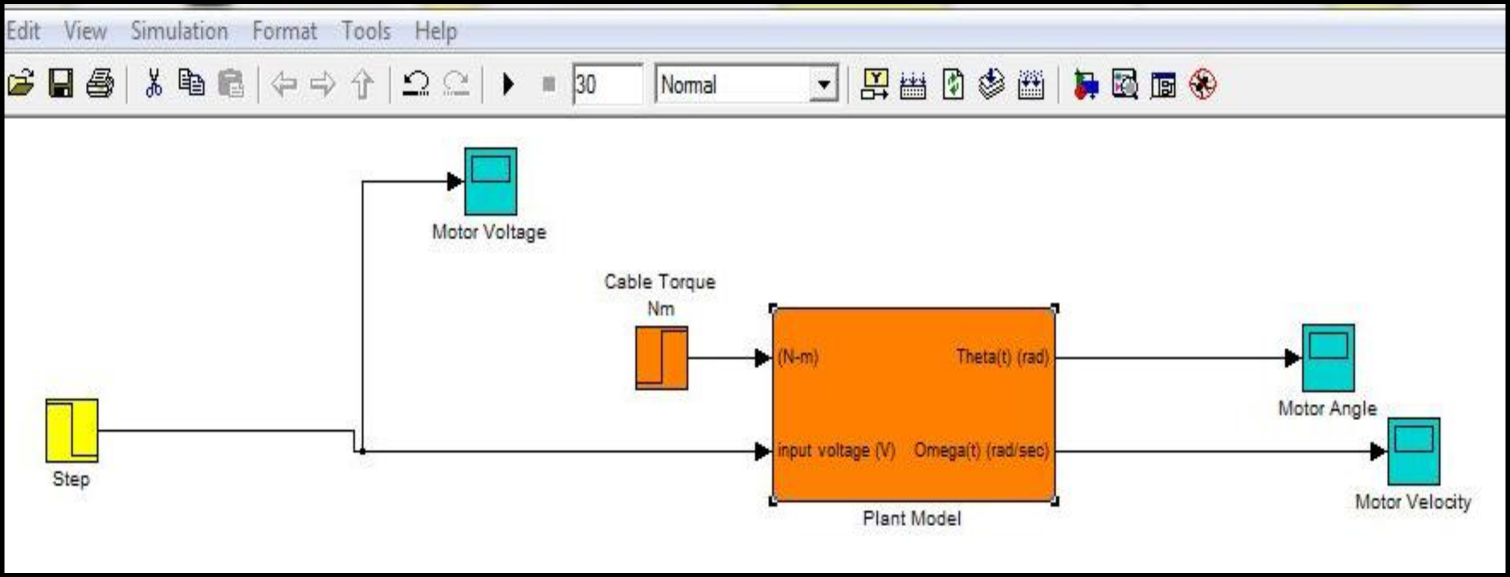
- Example screen shots of initial gain design method



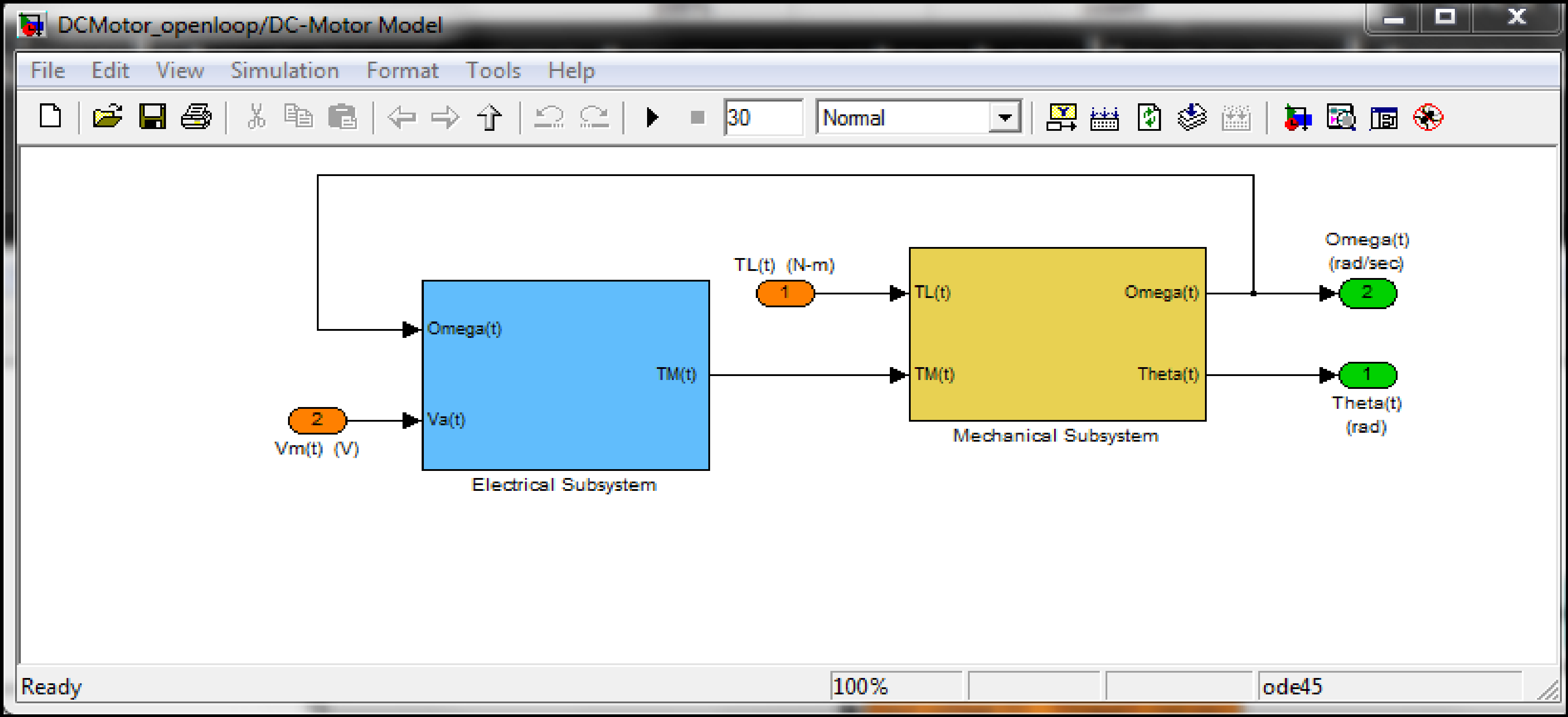


Open Loop Simulation (MS2)

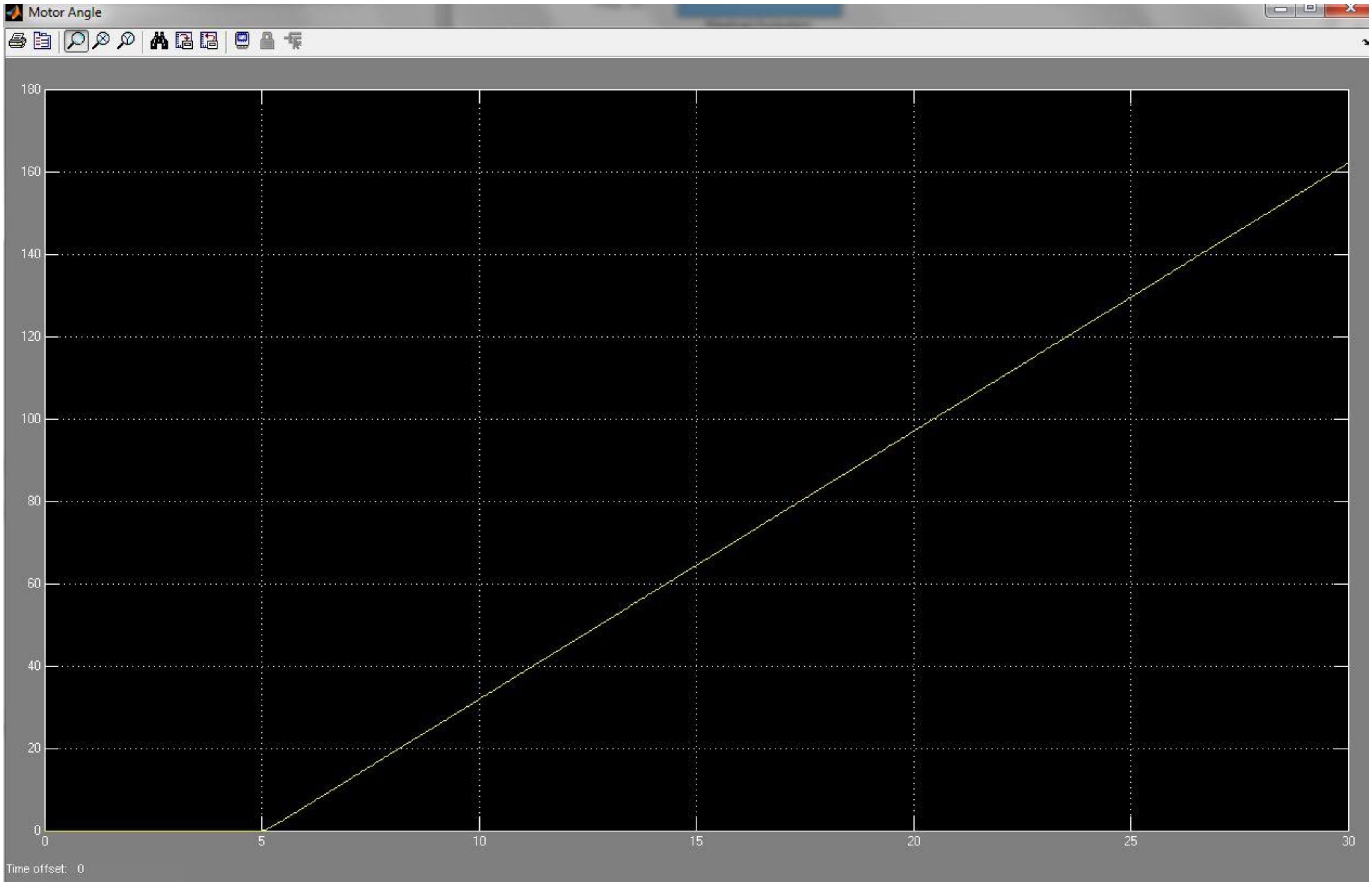
- A Simulink block was created with the plant model to simulate a response to a constant voltage and torque.



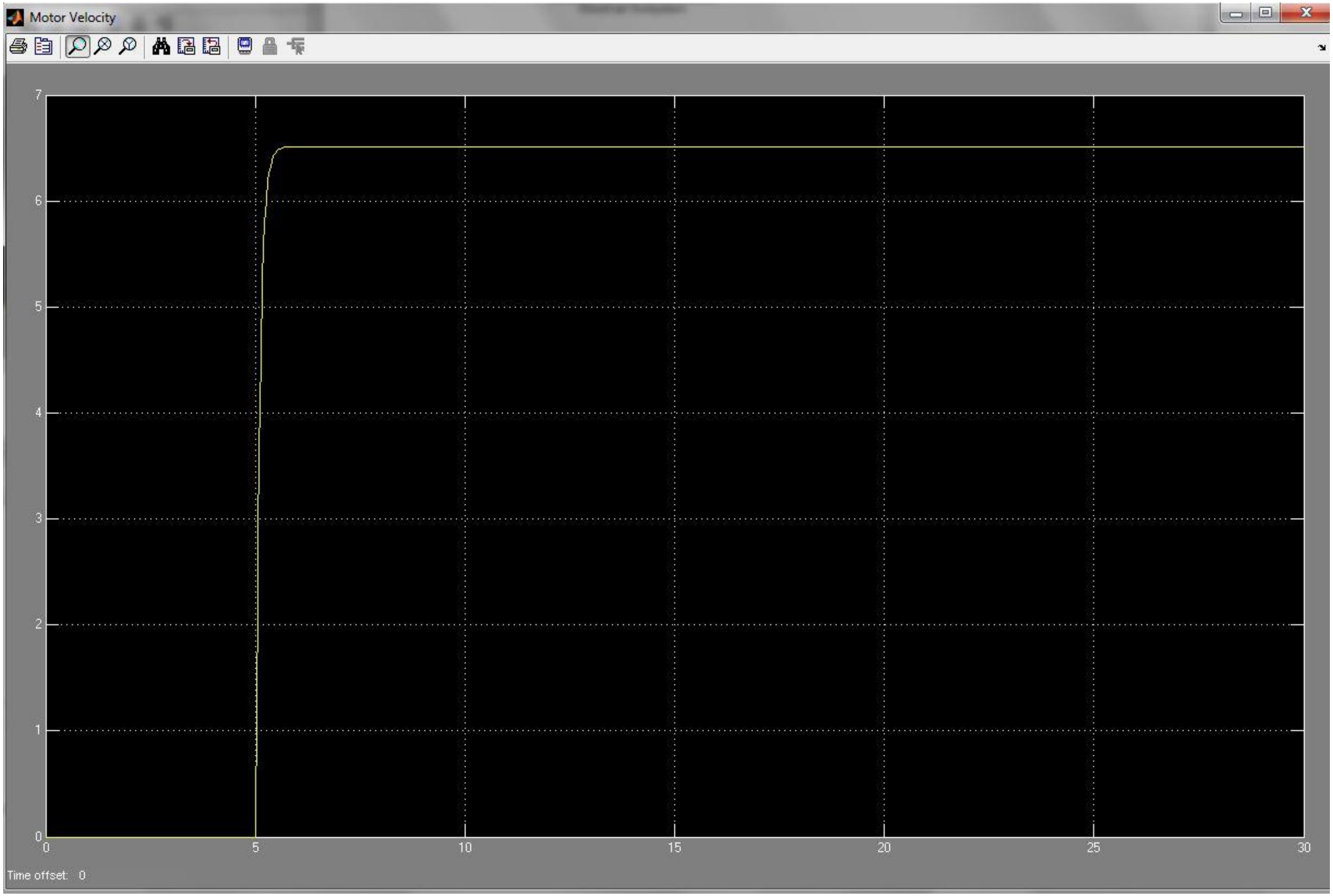
Inside Plant Model



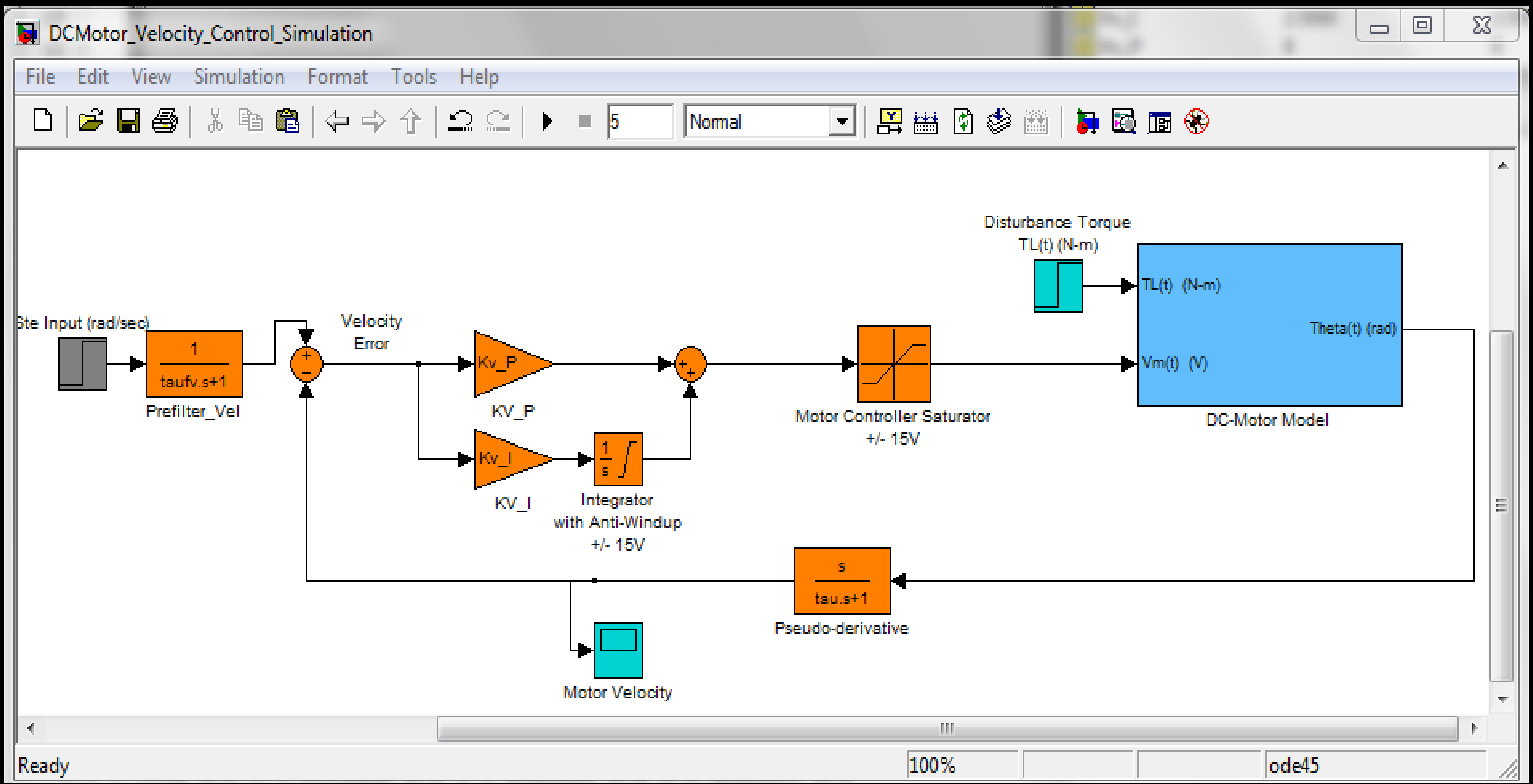
Simulation Results – Motor Angle



Simulation Results- Motor Velocity

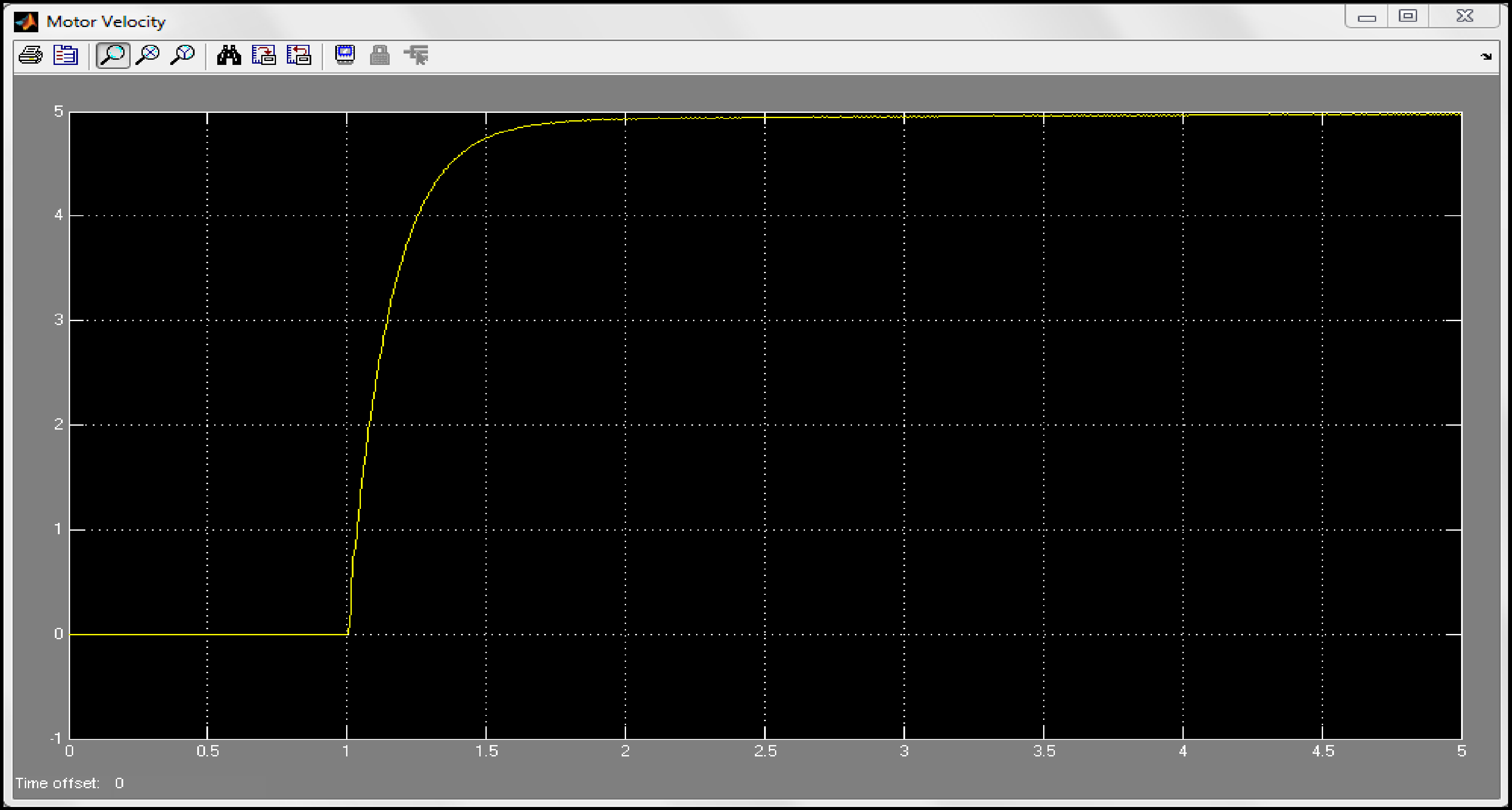


Velocity Control

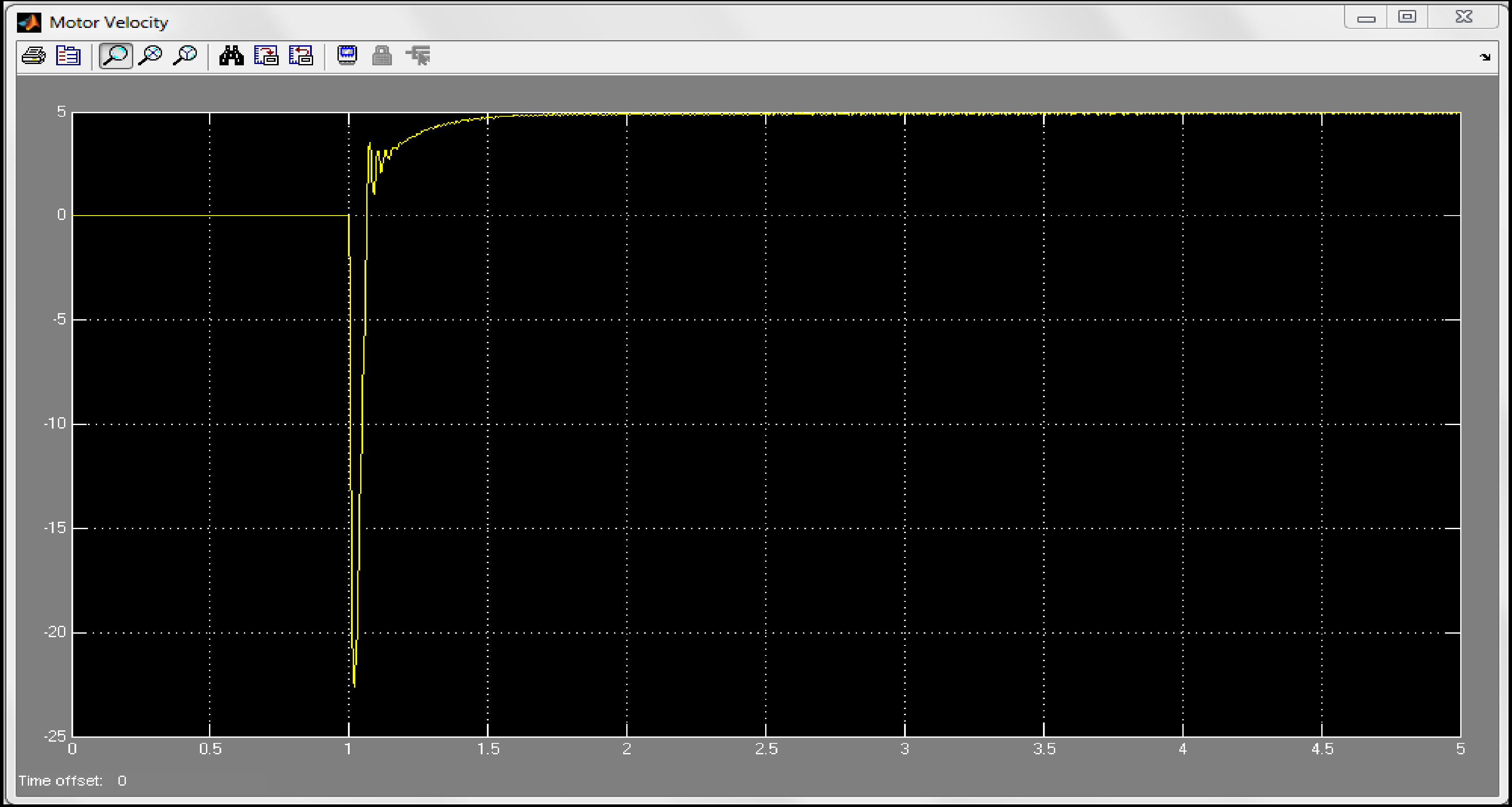


Kv_P = 8 Kv_I = 2.5

Velocity Control – Motor Velocity

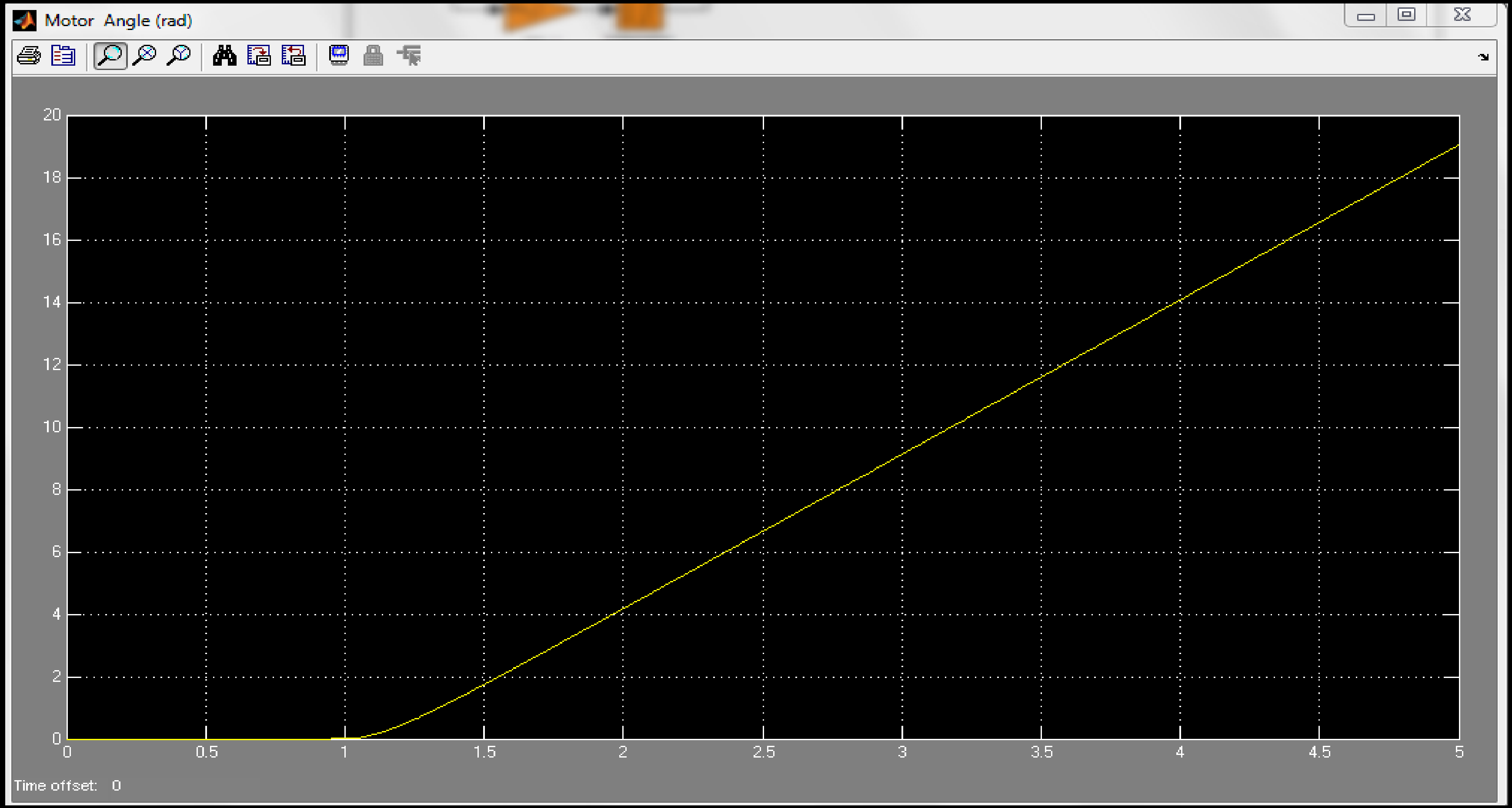


Simulation Result – Motor Velocity with Load

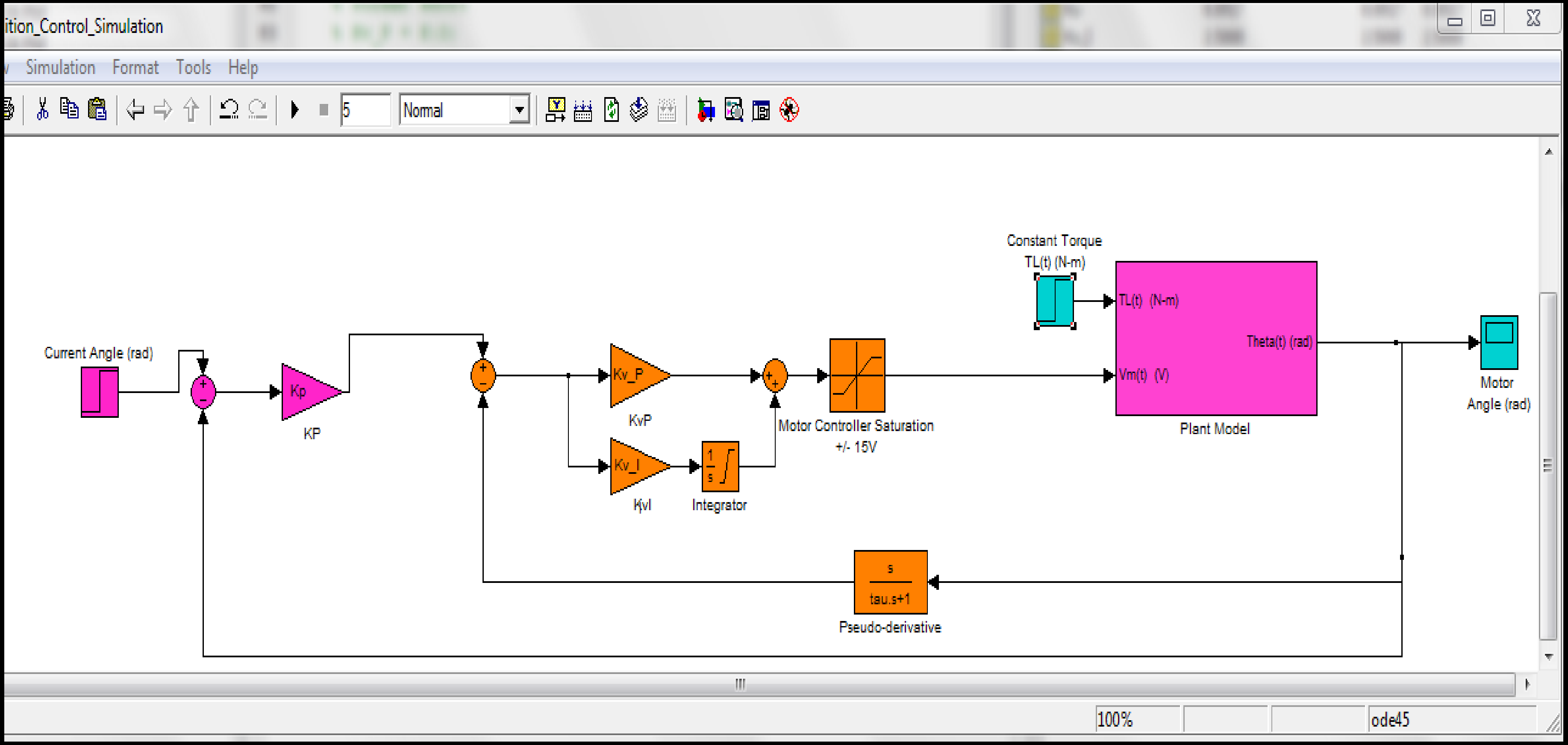


Simulation Result-Motor Position

Graph showing motor angle changing for velocity control

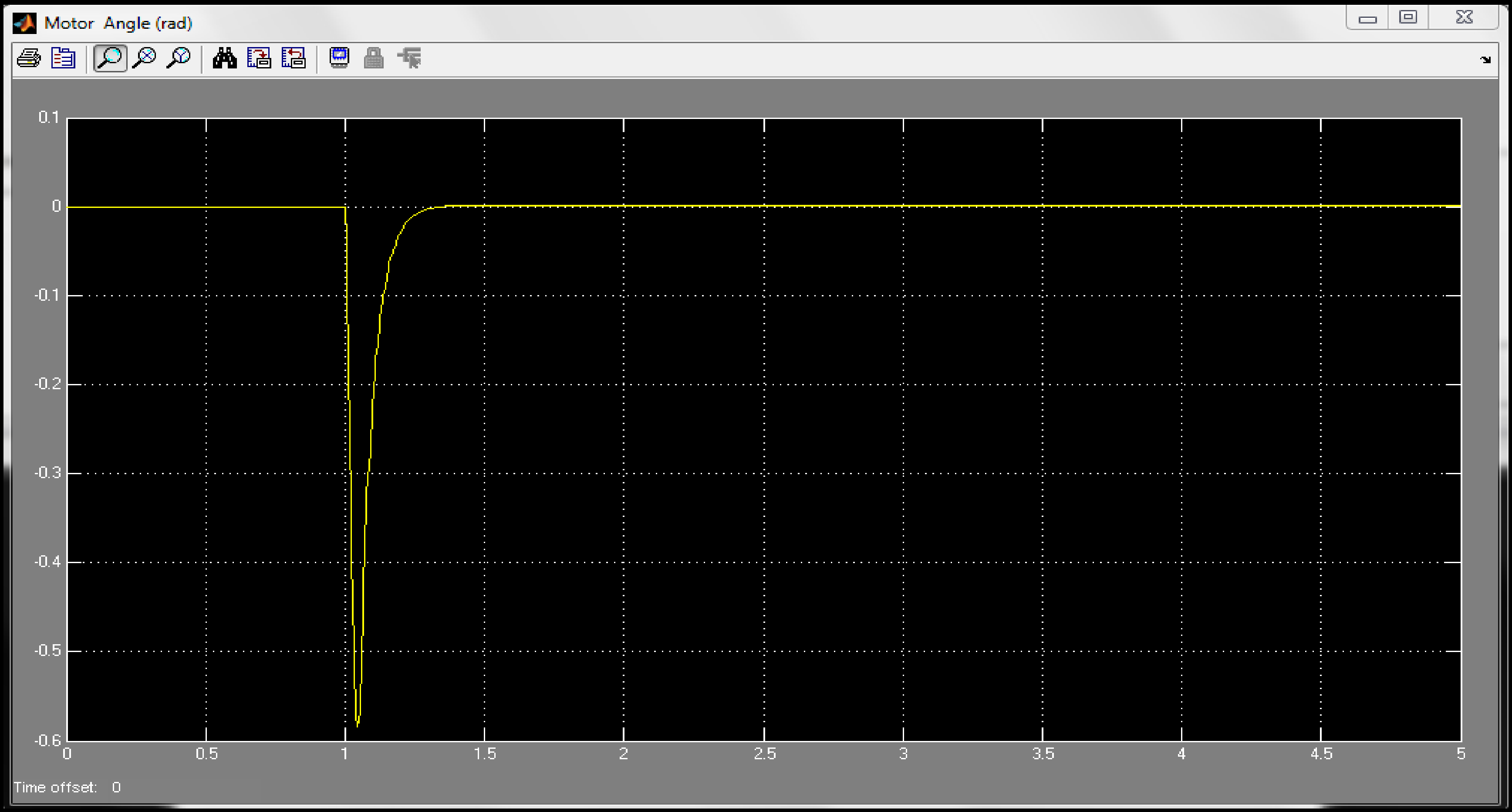


Position Control



KP = 20

Simulation Result-Motor Position with Load



Implementation

- Next challenge – implementing state machine and controller, ensure smooth transitions between states
- Simulation does not cover all disturbances and noise.
- Assess accuracy of model parameters by comparing simulation to actual data.

Performance, Stability and Robustness

After initial implementation:

- Simulation of maximum continuous torque in velocity control and maximum stall torque in position control
- Evaluate actual gain margin and phase margin.
- Compare actual performance to target goals

Updated Project Plan

Task	Week
Get familiar with the interfaces.	2
System modeling and model simulation	3-4
Create a closed loop controller (pulley-board)	5-6
Finish the N-turns at specified velocity and specified acceleration (pulley-board)	7
Start collecting data parameters from the actual surgical robot.	8
Implementing the controller on the surgical robot.	9-10

Updated Bibliography

E Naerum, H. Hawkeye King, B. Hannaford**, 'Robustness of the Unscented Kalman Filter for State and Parameter Estimation in an Elastic Transmission**,' Proceedings Robotics Science and Systems 2009 (http://www.roboticsproceedings.org), Seattle, July 2009.

Atef Saleh Othman Al Mashakbeh**, "Proportional Integral and Derivative Control of Brushless DC Motor"** European Journal of Scientific Research
ISSN 1450-216X Vol.35 No.2 (2009), pp.198-203
-Used the author's method to model the BLDC motor.

Norman S. Nise, "Control Systems Engineering", Wiley 2008
-The techniques for assessing controlability and observability were obtained from this book

Uy-Loi Ly, "DC Motor Control", 2010, https://courses.washington.edu
/aa448/DCMotorControl_LabDescription.pdf
-Used to determine the simulink simulation.

"Maxon EC Motor Data Sheet", 2010. http://shop.maxonmotor.com/ishop
/article/article/118898.xml
- Used to get the model parameters