Lab Section: Tues 3-5

Your Name: Elissa Ito

**Lab 4 – Closed-Loop Position Control, and the Effect of Derivative Control Action**

**Prelab:**

Graphical user interface, application

Description automatically generated

Graphical user interface, application, Word

Description automatically generated

**Experiment #1. Simulink model**Diagram

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**Experiment #2. Proportional control of position**

1. *The effect of proportional gains. Make a single plot of all the responses when Kp = 75, 100, 150.*

Chart, line chart

Description automatically generated

1. *Would you classify the response as “satisfactory” based on the settling of the response? Explain any discrepancies between the observed responses and the closed loop transfer function.*

*No, the response takes about a second to settle.*

![Text, letter

Description automatically generated]()

**Experiment #3. PD control of position**

1. *Generate a step response plot and overlay your experimental data and simulation data on one plot for each of the following three cases.*
2. *Determine if the controller is saturated or not for each case.*
3. *Compare the transient performance of simulation and experiment in each case. Comment on any discrepancies between simulation and actual experiment.*
4. *Kp = 100, Kd = 2*

Chart, line chart

Description automatically generated

Saturated, actual response slower and with higher overshoot than simulation.

1. *Kp = 100, Kd = 10*

Chart, line chart

Description automatically generated

Saturated, actual response very similar to simulated response.

1. *Kp = 100, Kd = 20*

Line chart

Description automatically generated with medium confidence

Saturated, actual response reached smaller settling point than simulated response.

1. *Are the PD responses more satisfactory than responses with only proportional control?*

*Yes, the there was a smaller overshoot.*

1. *Compare your three plots. Briefly describe how the value of Kd has affected a) any “over-shoot" in the step response, b) the time to the peak response, and c) the time to reach the steady-state response.*

*A greater Kd yielded a smaller overshoot, a greater time to the peak response, and a smaller settling time.*

*tau\*s^2 + (1+KKp)s + Kd = 0*

*1+KKp = 2\*zeta\*wn; Kd = wn2*

**Experiment #4. PD controller design**

*1. Design a PD controller such that the closed-loop step response has and .*

196.221

20.349

*2. Use as the desired position and command the wheel to follow a square wave.*



**★Extra Credit Task ★**

*Program a setpoint profile that mimics the “second” hand on a clock. Specifically, command the wheel to increment 36 degrees every second. The wheel has to rotate in the same direction forever.*

*set\_point = (millis()/1000)\*(PI/5);*