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M E M O R A N D U M

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From: Nash Elder, Parker Johnson

Course: ME 422 – 07

Team: Group 10

Subject: Root Locus Lab

Objective / Procedure

The objective of the Root Locus Lab is to utilize the RL Tool function in Matlab. This function takes the input of an open loop transfer function and allows the user to interact with values of poles and zeros to see how it affects the Root Locus. This allows the user to set design requirements, then move elements to design a suitable controller for a system.

For this lab, we are tasked with using RL Tool to design a PI controller suitable for the system of the Two Tanks Lab such that it meets the requirements in Table 1. First, we find the Root Locus graph, and then plot the step responses of the two tanks with and without the water leak disturbance.

Results and Discussion

Table 1: Controller design requirements.

Parameter	Value	Requirement
Steady State Error	0	Equal To
Settling Time	600 s	Maximum

Damping Ratio	0.5	Minimum
Natural Frequency	0.013 rad/s	Minimum

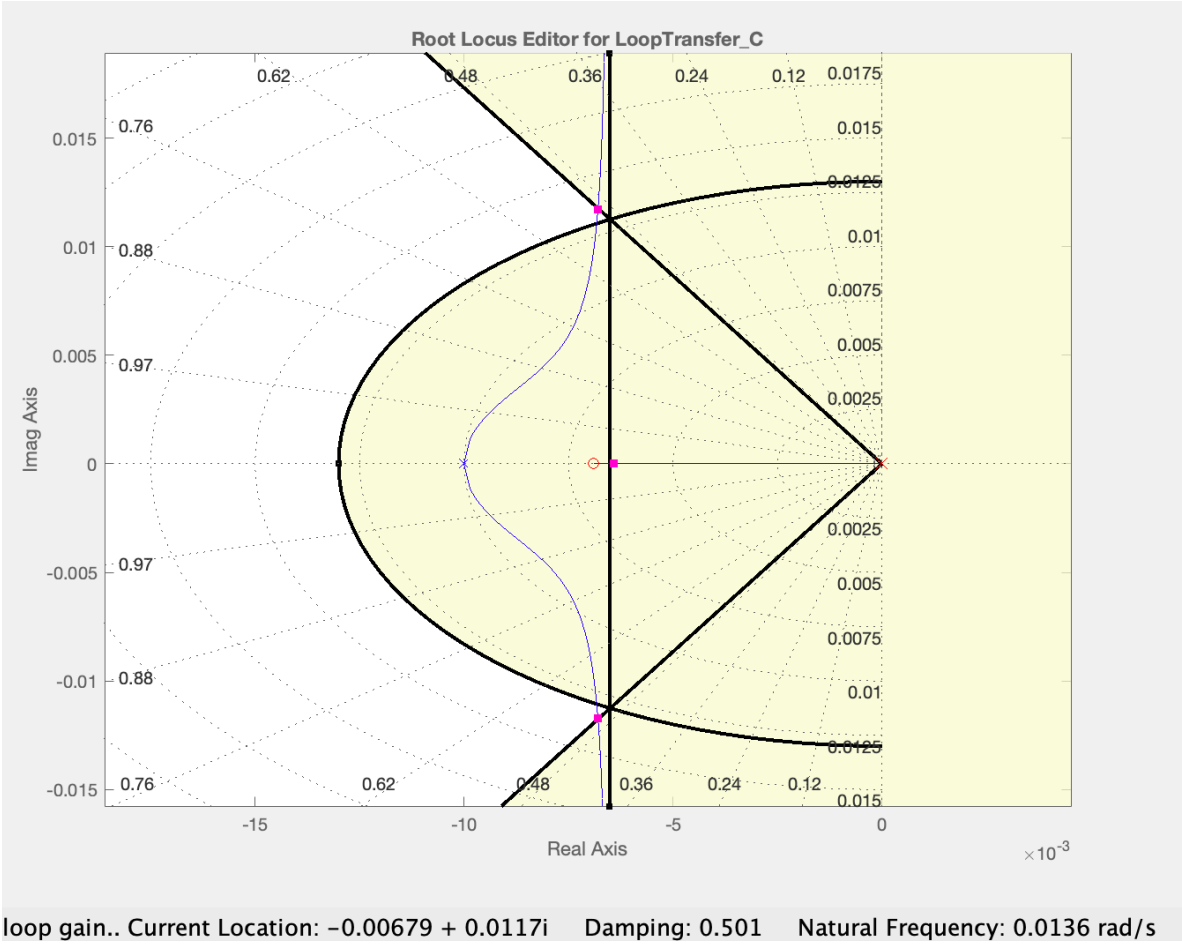

Figure 1: Root Locus graph of the PI controller that meets the given criteria.

The root locus in figure 1 exhibits a response time of 599 seconds, a damping ratio of 0.501, and a natural frequency of 0.0136 rad/s. The values of proportional gain and integral gain are: Kp = 0.18164 and Ki = 0.001253.

The following step response graphs in figures 2 through 5 were accomplished through a Simulink block diagram and Matlab script. The variables determined using the RL Tool were used. The initial unit input step is a desired change in height of 1 inch.

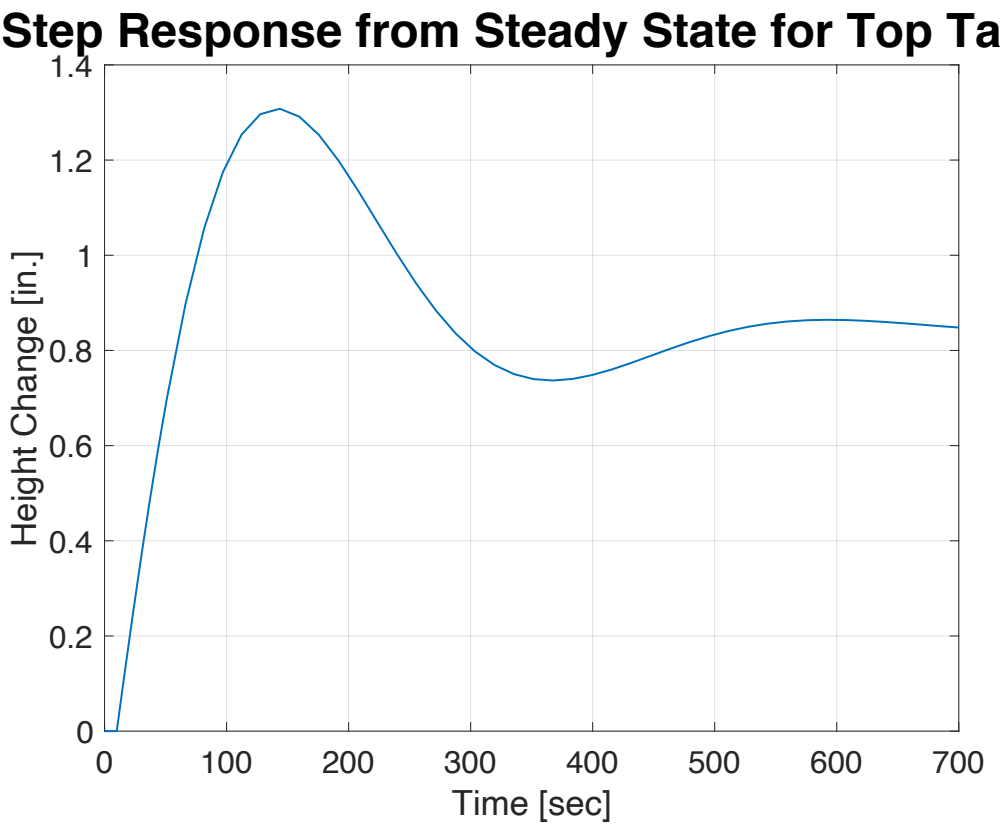

Figure 2: Step response of the top tank with no disturbance input.

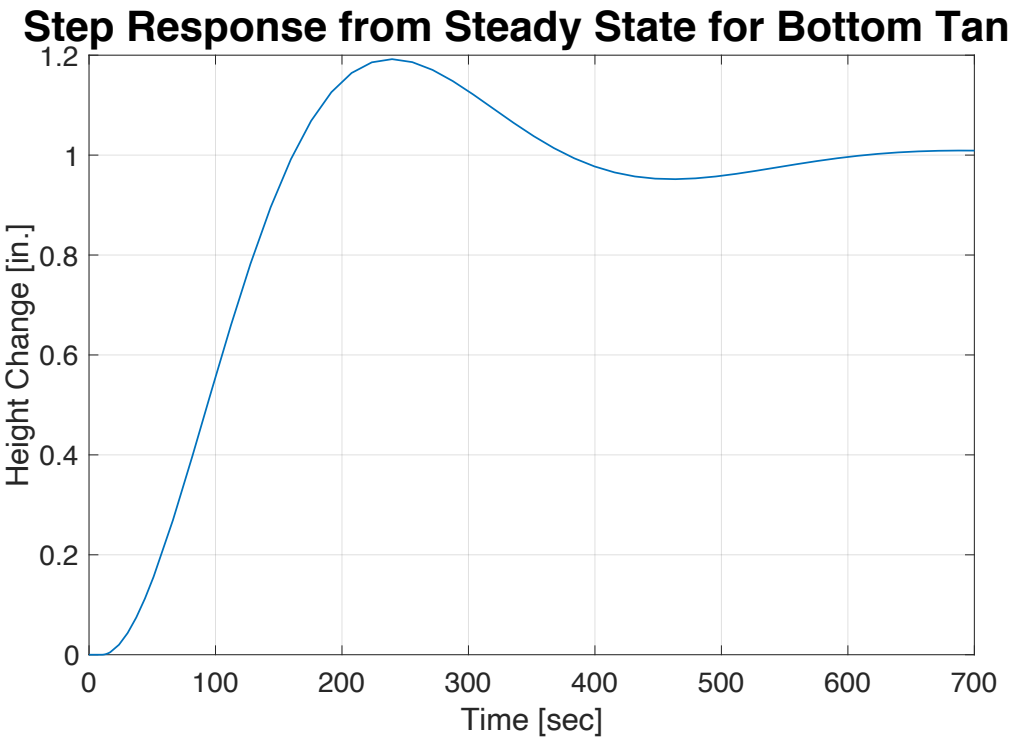

Figure 3: Step response of the bottom tank with no disturbance input.

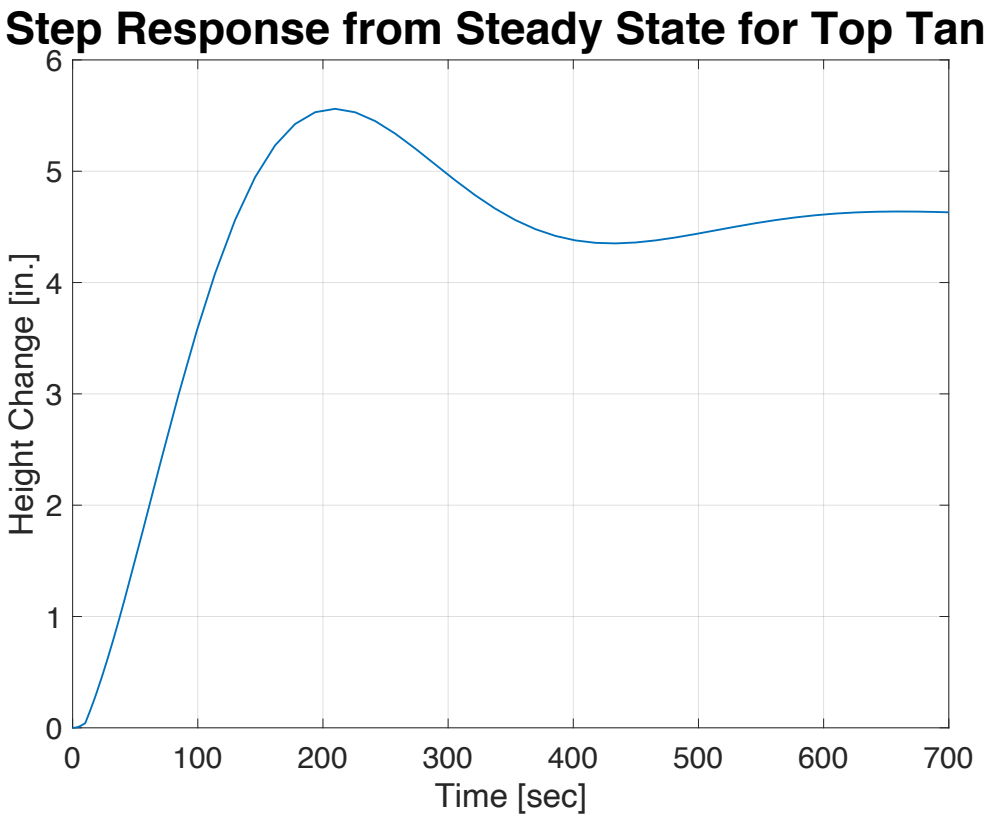

Figure 4: Step response of the top tank with a 0.3 gpm disturbance input.

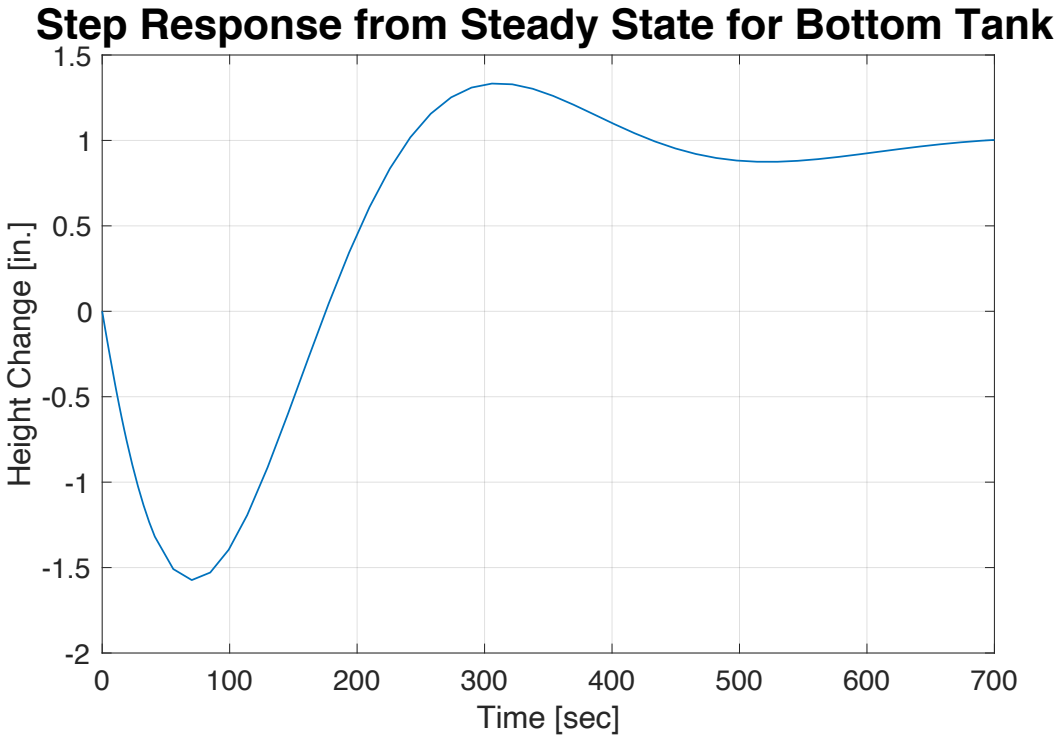

Figure 5: Step response of the bottom tank with a 0.3 gpm disturbance input.

Conclusion

In the RL Tool Lab, the RL Tool function was utilized to move the locations of poles and zeros to find the Root Locus of a proper PI controller given certain design requirements. This tool was implemented for the two-tank system, and step responses were determined by using the RL Tool values of proportional and integral gain in a Simulink block diagram and a Matlab script similar to those used in the second week activity of the Two Tank Lab. Overall, RL Tool provides a simpler, more interactive way of finding controller gains, rather than the trial and error method used in previous labs.