UNIVERSITY OF VICTORIA

Department of Electrical and Computer Engineering
ECE 360 – Control Systems I

Laboratory

Experiment no.: 2
Speed Control using a DC Motor

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Introduction

The purpose of thus lab was to understand the Proportional and Integral control using a DC motor. In this lab we tested the qualitative properties and tested the response of the motor to load disturbances and in the end, we did some manual tuning of the motor.

Experimental Results

1. Calibration and setup

The first step in the experiment was to set up the software and the DC motor. For this lab, we used the speed control module of the QICii software. The speed control module runs the motor in a closed loop. In step 1, we set the initial conditions as stated in the lab manual bsp = 1 and the proportional gain to 0.04 V.s/rad and the results can be seen in Figure1.

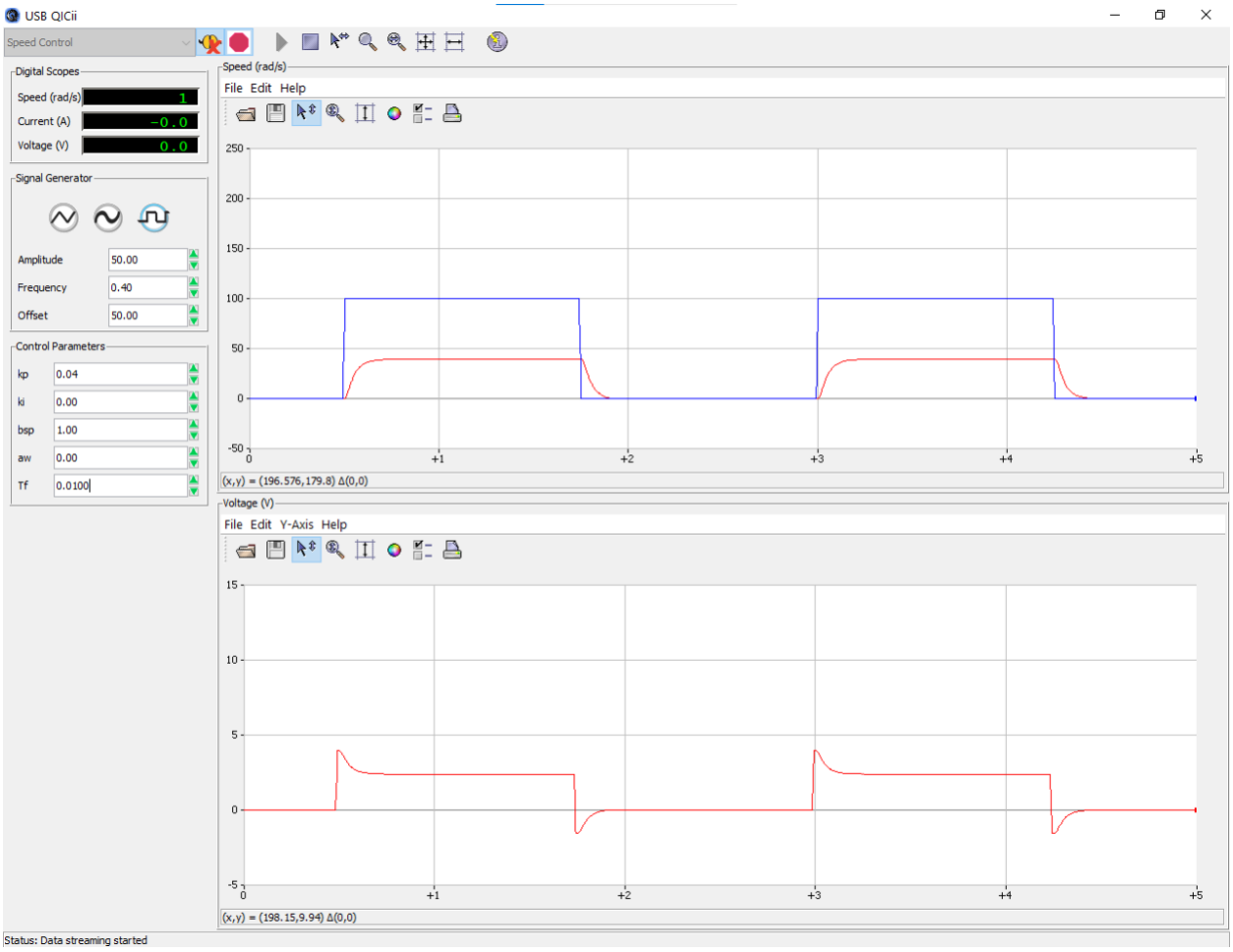

Figure 1: Initial conditions set

Then we Changed the Kp from 0.1 to 0.4 and observed the output. With each increment of 0.1, the output starts oscillating more. The effects can be seen in the following screenshots:

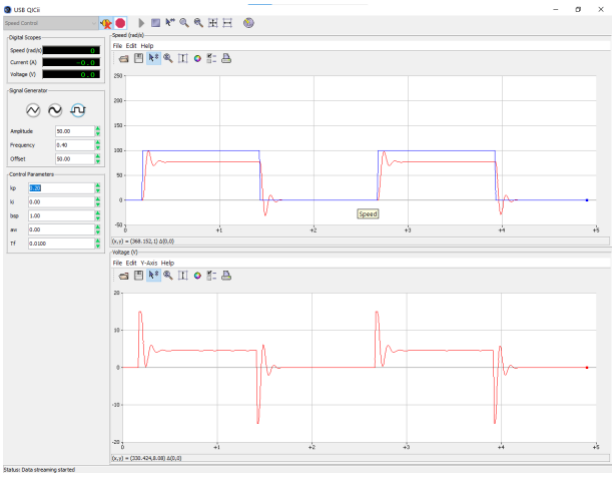

Figure 2: Kp = 0.2

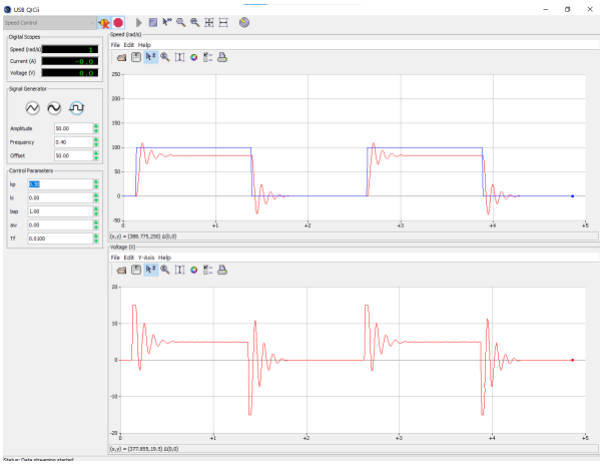

Figure 3: Kp = 0.3

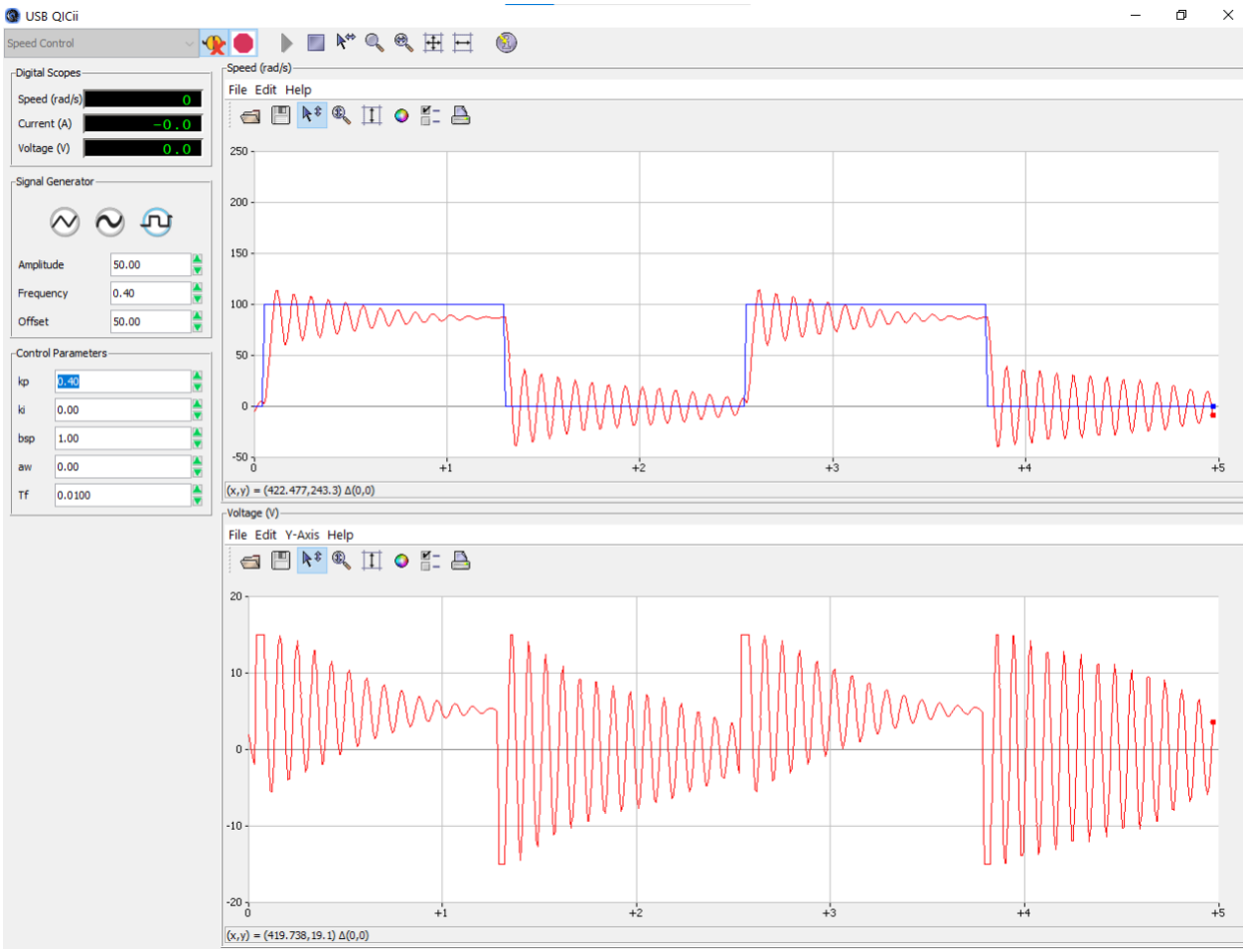

Figure 4: Kp = 0.4

2. Integral Control

For this part of the lab, we first set proportional gain to zero and integral gain to 0.4. The results of doing this are seen in the following:

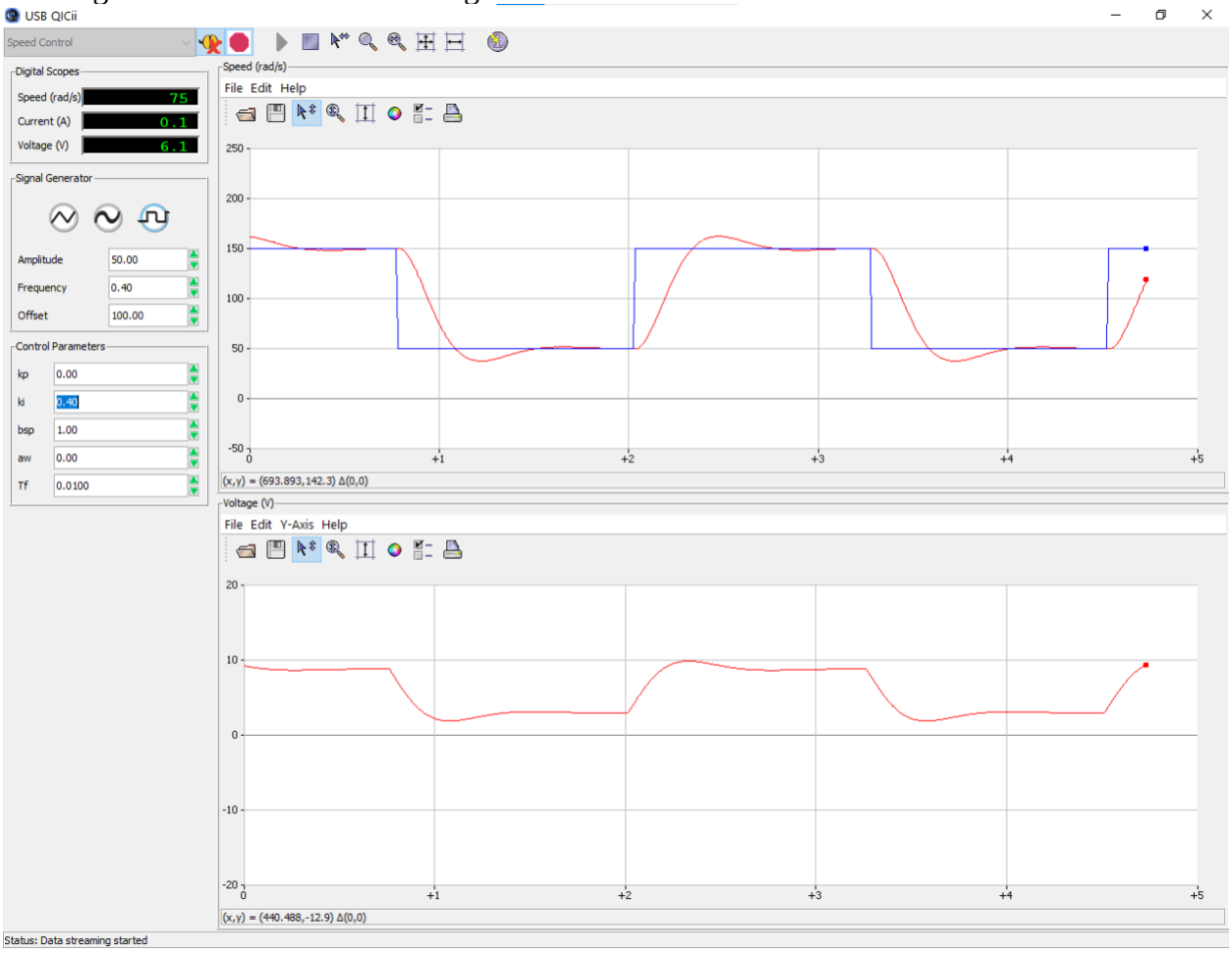

Figure 5: Ki = 0.4

Then we changed the integral gain in steps of o.5 increments or decrements with Kp = 0 to see what happens on the output. The results can be seen in the following screenshots:

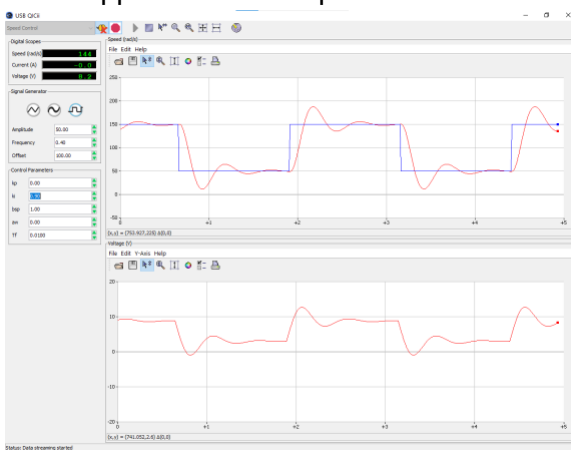

Figure 6 Ki = 0.9

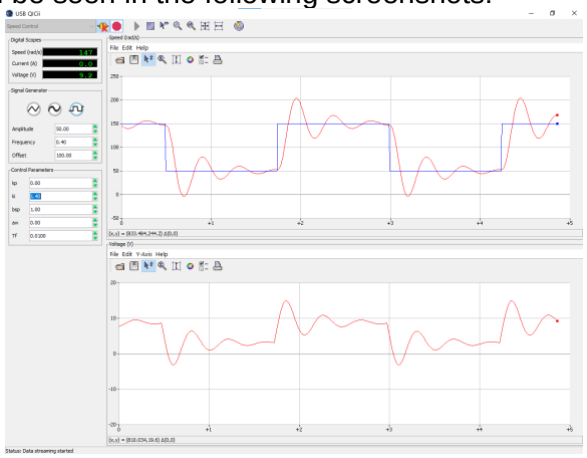

Figure 7: Ki = 1.4

In this final screenshot for this part of the lab, Ki = 1.9:

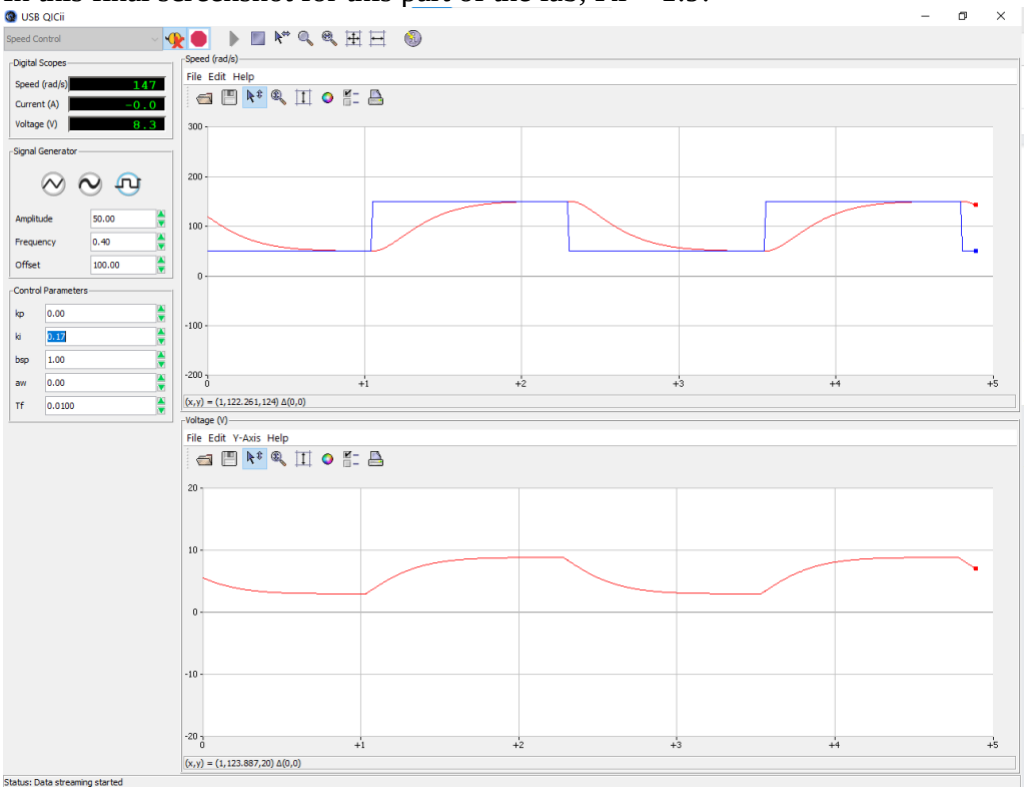

Figure 7: Ki = 1.9

Then, we determined the value of integral gain which gives the quickest response without overshooting, this was found to be Ki = 1.7 for our motor.

3. Proportional and Integral Control

Initial setup as per the manual:

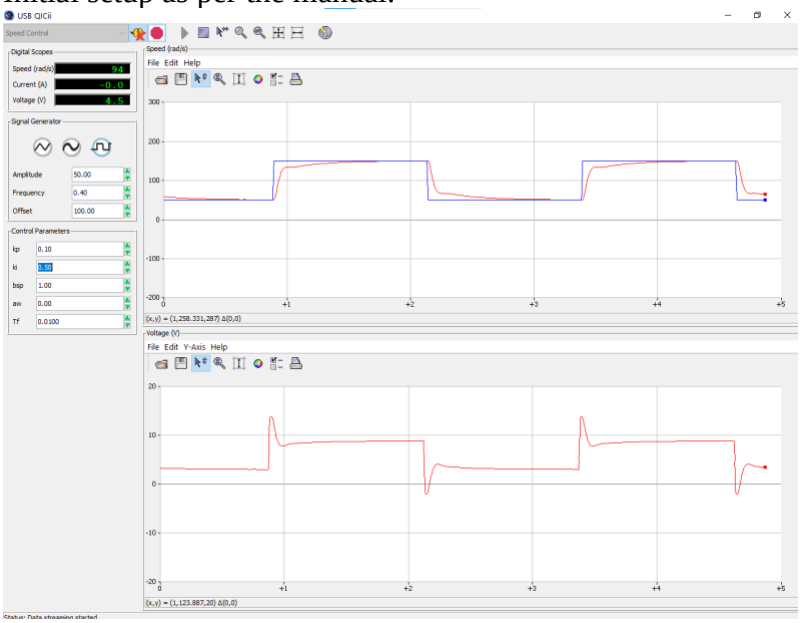

Figure 8: initial setup for P & I control.

Then we changed the proportional and Integral gain values to the ones we obtained in the prelab. Ki = 1.472 Kp = 0.13 and we observed that the step response was exponential. the results of doing this are below:

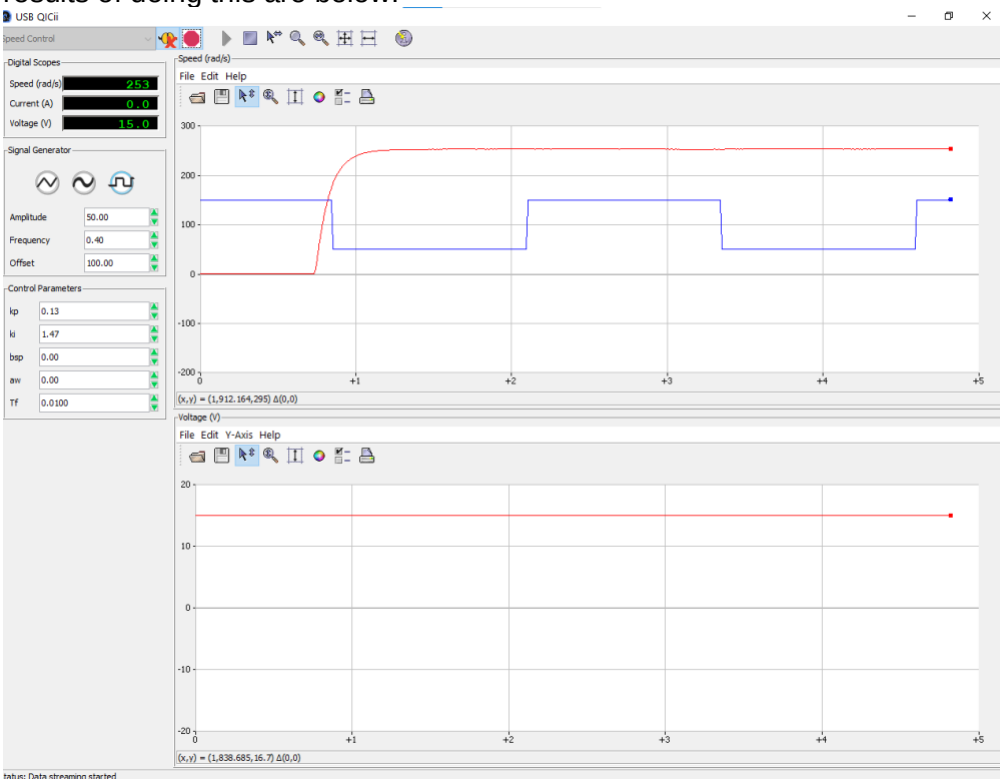

Figure 9: Prelab values set for PI control

Then we changed the Ki to maximum value of 5. The following was observed:

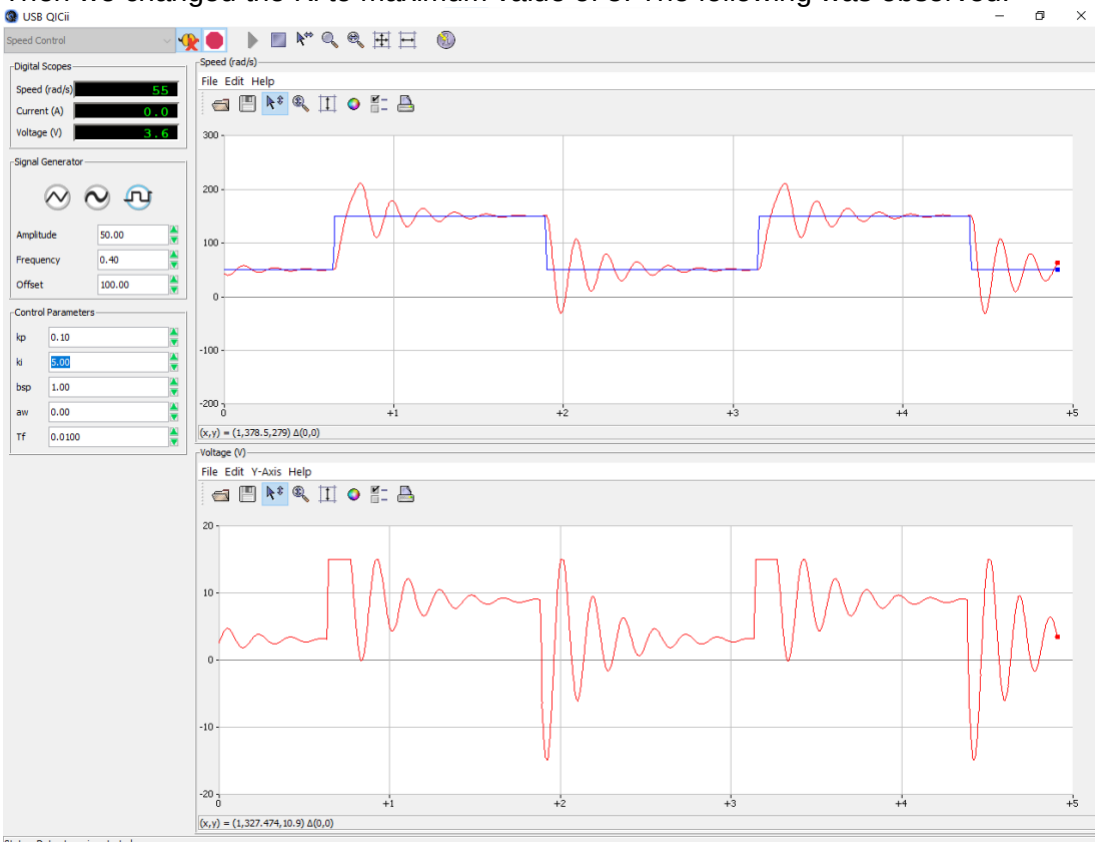

Figure 10: Ki = 5.

4. Close-loop System's Response to Disturbances

For this part of the lab we observed the response of the system when we disturb it.

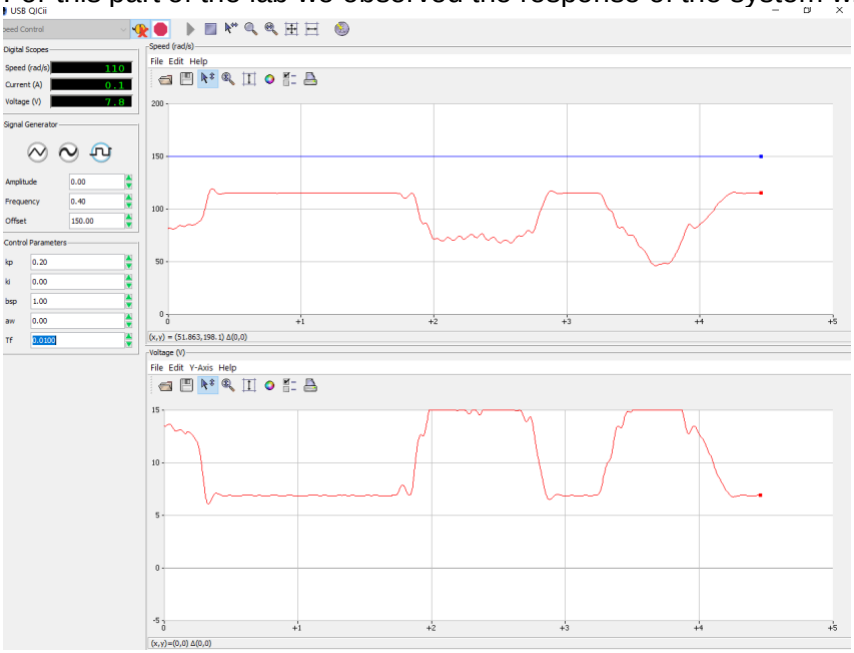

Figure 11. Proportional Controller response with Disturbance

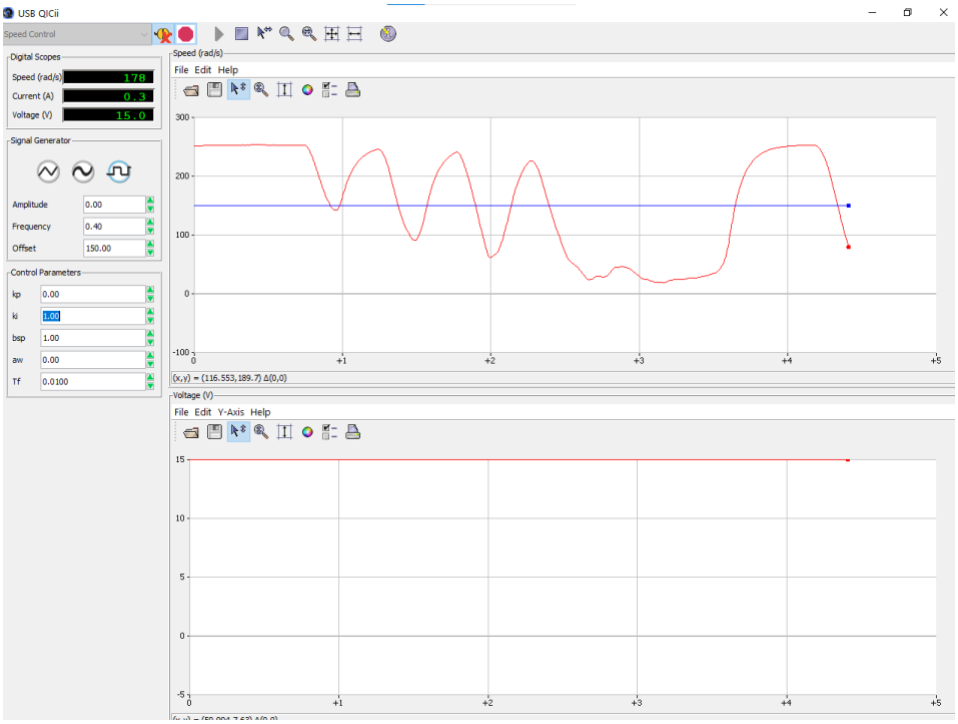

Figure 12. Integral Controller response with Disturbance

5. Manual Tuning of PI Controller: Ziegler-Nichols

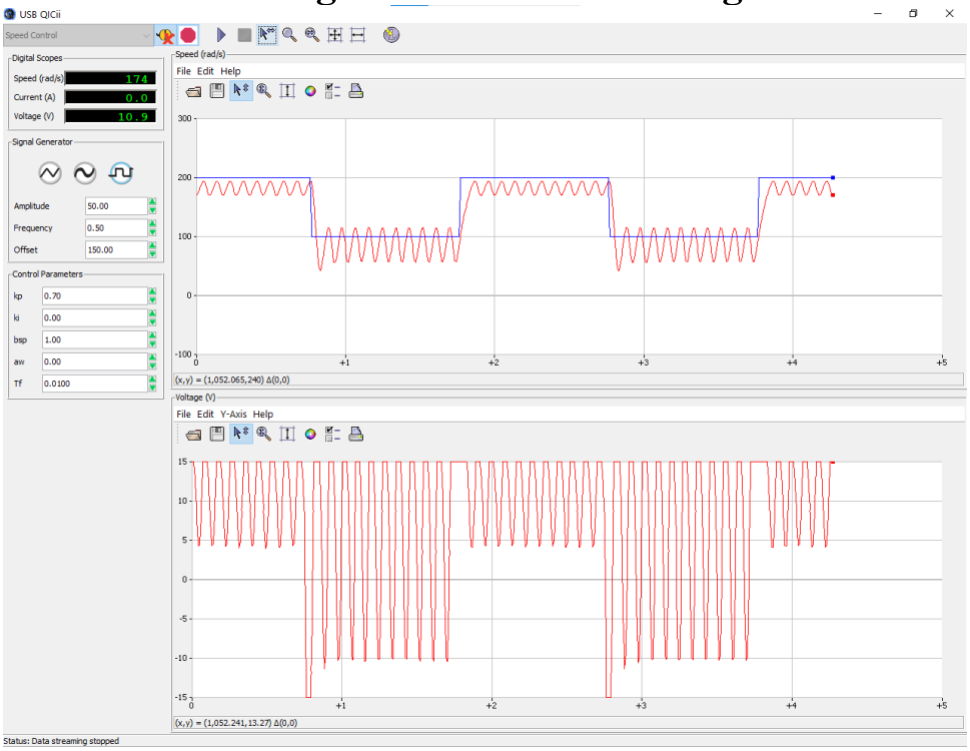

Figure 13. Initial conditions of Manual tuning as per the lab manual

In the last part of the lab, we tried to achieve a state of the system where it becomes critically stable and has stable oscillations. We also determined the critical period of the oscillations.

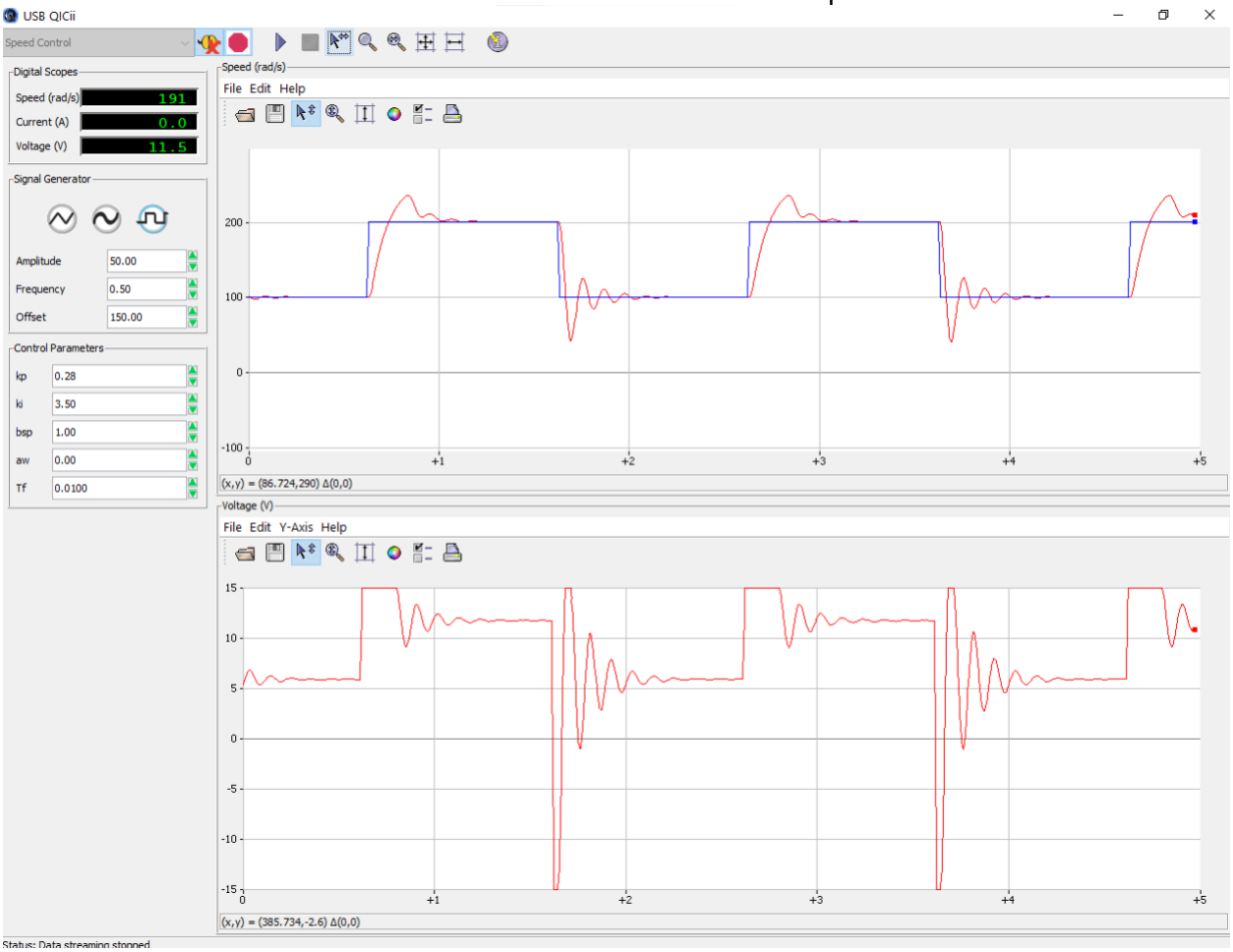

Figure 14. Manual tuning last step

Table of findings for the manual tuning:

Kpc	0.7
Tpc	0.1
kp	0.4*0.7
ki	0.5 * 0.7 / 0.1

Conclusion and Discussion

Throughout the lab, we developed a clear understanding of how proportional and Integral controller works and it was fun to see the theory in action through this lab. Since we have learned about these processes in class. Overall, this experiment provided a good approximation of the DC motor model and PI control introduction.