Lab name
ECE 380
University of Alabama

Your Name

Date that you did the lab

Introduction

This laboratory experiment was to find more information about the transfer function of the dc motor which was used in lab 3. This will be done by drawing the root locus of the system, which includes the dc motor but additionally the unit step function, which was added using the computer in the lab station. We know that the transfer function has three poles. We know two of the poles, so we are searching for the third pole. The two poles that we know are $s = 0$ and $s = -12.36$.

Procedure

a) Prelaboratory

There was no prelab for this lab.

b) Setup and Data Collection

We followed the steps for setup and data collection that were in the lab manual. The data that we collected is in Table 1. The data that was collected was the gain of the computer simulated filter, the peaks of the step response, and the time between the two peaks of the step response.

Results

Several important values are given in Table 1. These values correspond to the attributes of the root locus plot of the transfer function. The angle values were calculated using the formulas which are attached to the report. The rest of the values were calculated using generally algebra of lines, and properties of the root locus.

Table 1. Measured Values for the different filter gain values and the root locus information

Gain of the computer filter	V1	V2	T	Theta 1	Theta 2	Theta 3	Beta	Dominant pole x Re(s)	Dominant pole Y Im(s) in J	Gain K of the system
0.6	0.66	0.58	0.152	90.0242	73.3752	16.6006	138.6735	-0.01880	44.48048	300668.9
0.5	0.64	0.5	0.168	90.0883	71.7919	18.1198	114.3488	-0.06203	40.24424	206583.8
0.4	0.62	0.44	0.188	90.1702	69.8542	19.9756	92.0450	-0.10682	35.96294	136001.1
0.3	0.58	0.28	0.212	90.7595	68.0121	21.2284	76.6912	-0.42277	31.89166	90682.94
0.2	0.62	0.18	0.264	92.1376	64.2658	23.5966	55.3730	-0.95591	25.60997	43819.1
0.1	0.64	0.14	0.388	93.1687	54.7055	32.1259	26.6857	-0.96467	17.42534	11575.68
0.05	0.46	0.08	0.528	94.1248	45.9747	39.9005	15.0901	-0.92343	12.80499	4365.974
						Geometric avg	59.02477	-0.23923	27.4462	55857.01

Figure 1 is an Excel Graphical representation of the calculated dominant poles, which makes up part of the root locus.

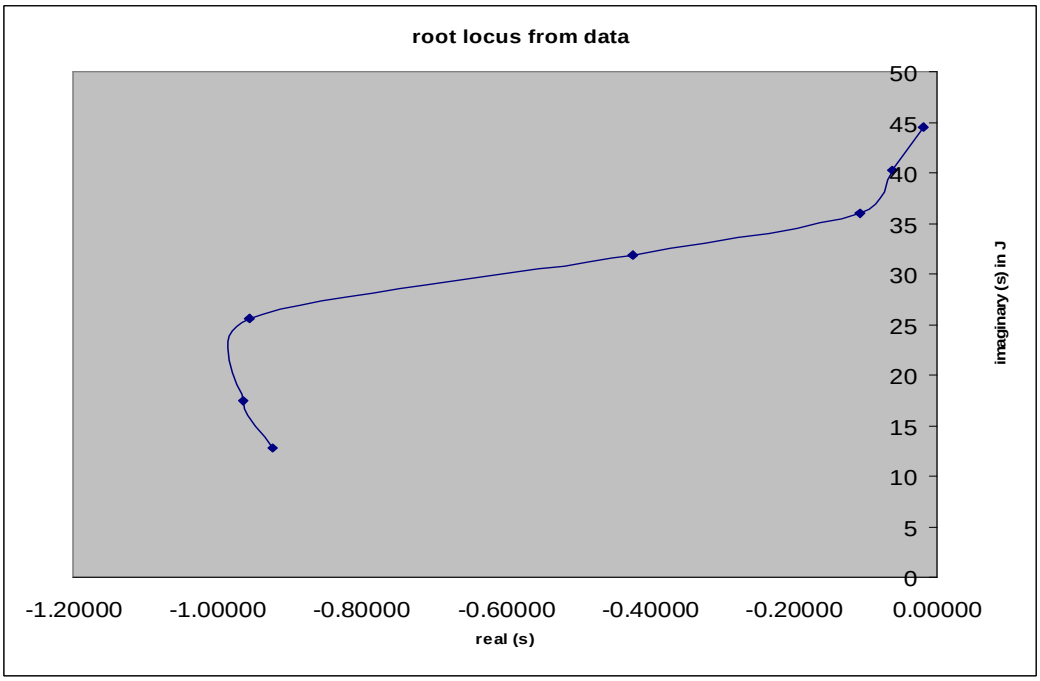

Figure 1. Excel Graph of Calculated Root Locus From Data in Table 1.

From the values of beta for each gain, we could estimate the third pole of the transfer function. We did this by calculating the geometric mean of each of the calculated beta values. We used the geometric mean instead of the arithmetic mean because the gain of the system fit the MATLAB Root Locus plot much better and it was more realistic. So we then estimated the third pole to be -59.02. We can now estimate the transfer function and it is below in equation 1.

$$G(s) = \frac{55857}{s\,(s + 12.36)(s+59.02)} \qquad \textbf{(Eq. 1)}$$

Figure 2 shows a MATLAB Root Locus plot for the transfer function that we came up with. Figure 3 is a close-up of the area in which our dominant poles occur of Figure 2. It also has the different dominant pole positions that we calculated from the data that we collected.

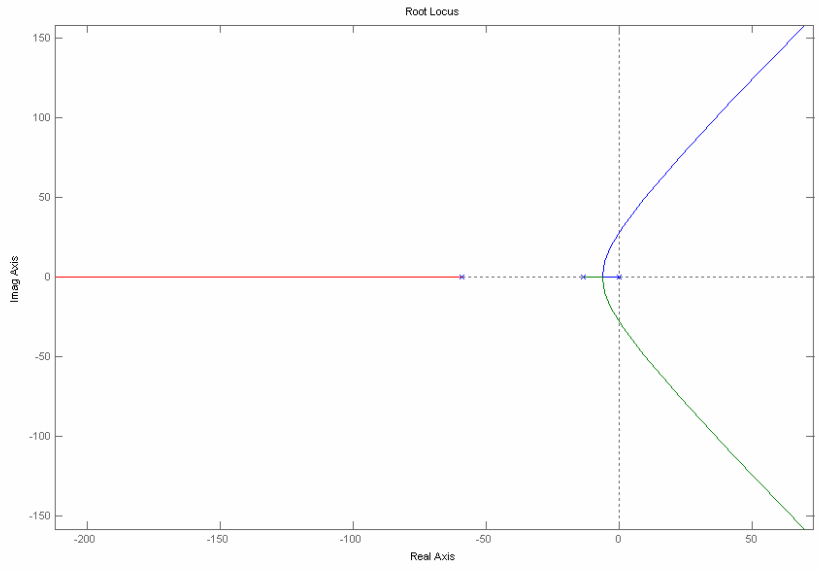

Figure 2. MATLAB Root Locus Plot for Specified Transfer Function, Equation 1.

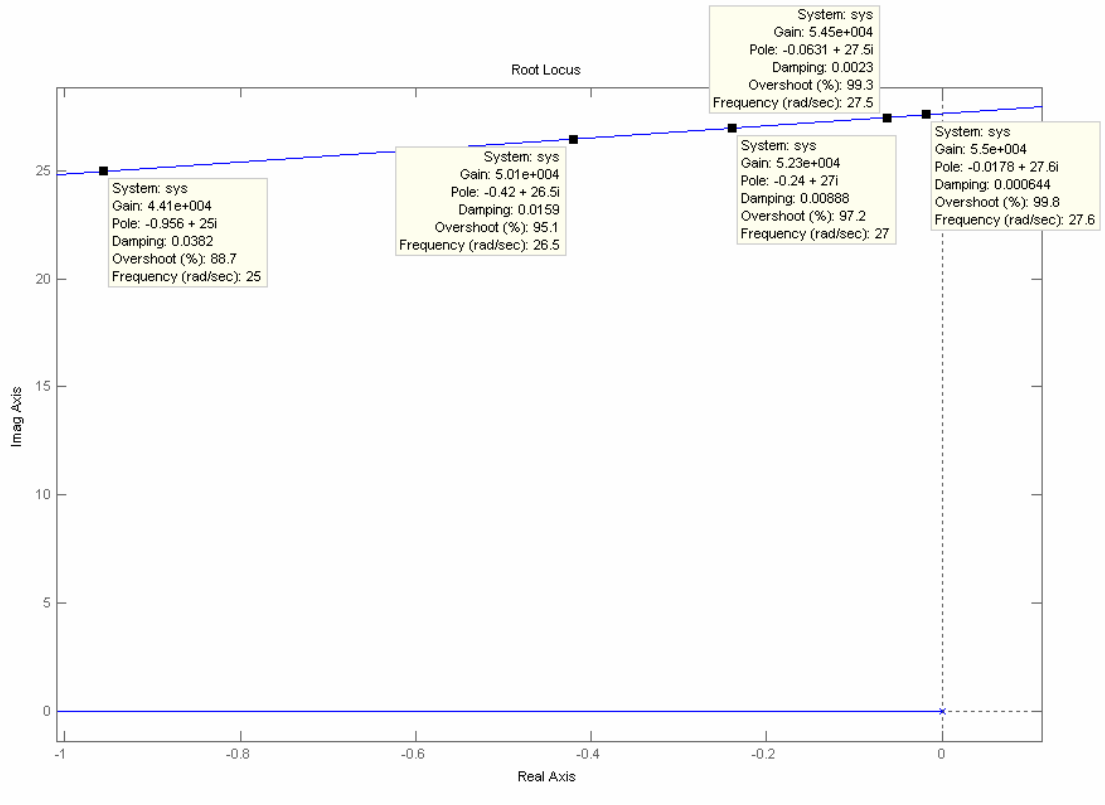

Figure 3. Close-up From Figure 2 Of Where the Estimated Dominant Poles Are.

Conclusion

The Results shown in Figure 3 are off from the calculated dominant pole values in table 1. However, the estimated function is right on with the average dominant pole value that we calculated. So the estimated transfer function is a very good estimate of the real systems transfer function. It is unlikely that all of the dominant poles would be on the root locus because for each of the estimated dominant poles there was a different value for the third pole. The estimated transfer function is the best fit of the systems transfer function of all the values of the third poles that we tested. The exercise successfully demonstrated how to observe the transient input response of a system.

Afterwards

Attached is a copy of the data sheet used to collect information during lab, which has the verification signature on it. Also attached is the work to determine the angle between the poles and the dominant pole.