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By filling out the names above, the group members acknowledge that a) they have jointly authored this submission, b) this work represents their original work, c) that they have not been provided with nor examined another person's assignment, either electronically or in hard copy, and d) that this work has not been previously submitted for academic credit.			

LAB 3. DIRECT CURRENT MOTOR SPEED AND POSITION CONTROL

On your pre-lab and post-lab submissions, always include this page at the beginning of the document.

Select your lab session:	☐ morning lab; ☒ afternoon lab; ☒ Tue; ☐ Wed; ☐ Thu
Bench number:	15

5.1.1

	Angle (deg)	V	V_M	V_M/V	V_T
Dead-Zone	227	1.6	4.77	2.98	0.9
Saturation	3.16	3.95	11.75	2.97	10.44

Table 1: Dead zone and saturation measurements

Saturation Explanation At some point the force that we apply is equally matched by the friction that the system pushes back with. This results in acceleration dropping to 0 and the velocity plateauing.

5.1.2

$$\begin{aligned} V_M &= V K_a \\ 10 &= 3.36 \times K_a \\ K_a &= 2.98 \end{aligned}$$

Since we took our measurements at steady state we can assume that they are the values at $t = \infty$ and use the final value theorem.

$$\begin{aligned} V_T &= \lim_{t \to \infty} V_T \\ &= \lim_{s \to 0} V_M \times \frac{K}{\tau_m s + 1} \\ &= V_M \times K \\ K &= \frac{V_T}{V_M} \\ &= \frac{8.2}{10} \\ &= 0.82 \end{aligned}$$

Number of Rotations	**Duration**	$V_{SmallDisk}$	w(rot/s)	w(rot/min)
10	26	0.38	-	-
10	26.07	0.38	-	-
10	26.18	0.38	-	-
-	-	0.38	24.32	1459.2

Table 2: Experimental data for angular speed

$$\begin{aligned} \omega \times K_{tach} &= V_T \\ K_{tach} &= \frac{V_T}{\omega} \\ &= \frac{8.2}{1.4592} \\ &= 5.62 \end{aligned}$$

Our calculated is within 15% of 6V so we meet tolerance amounts.

$$\omega = V_M \times K_m$$
$$K_M = \frac{\omega}{V_M} = \frac{1.4592}{10} = 0.14592$$

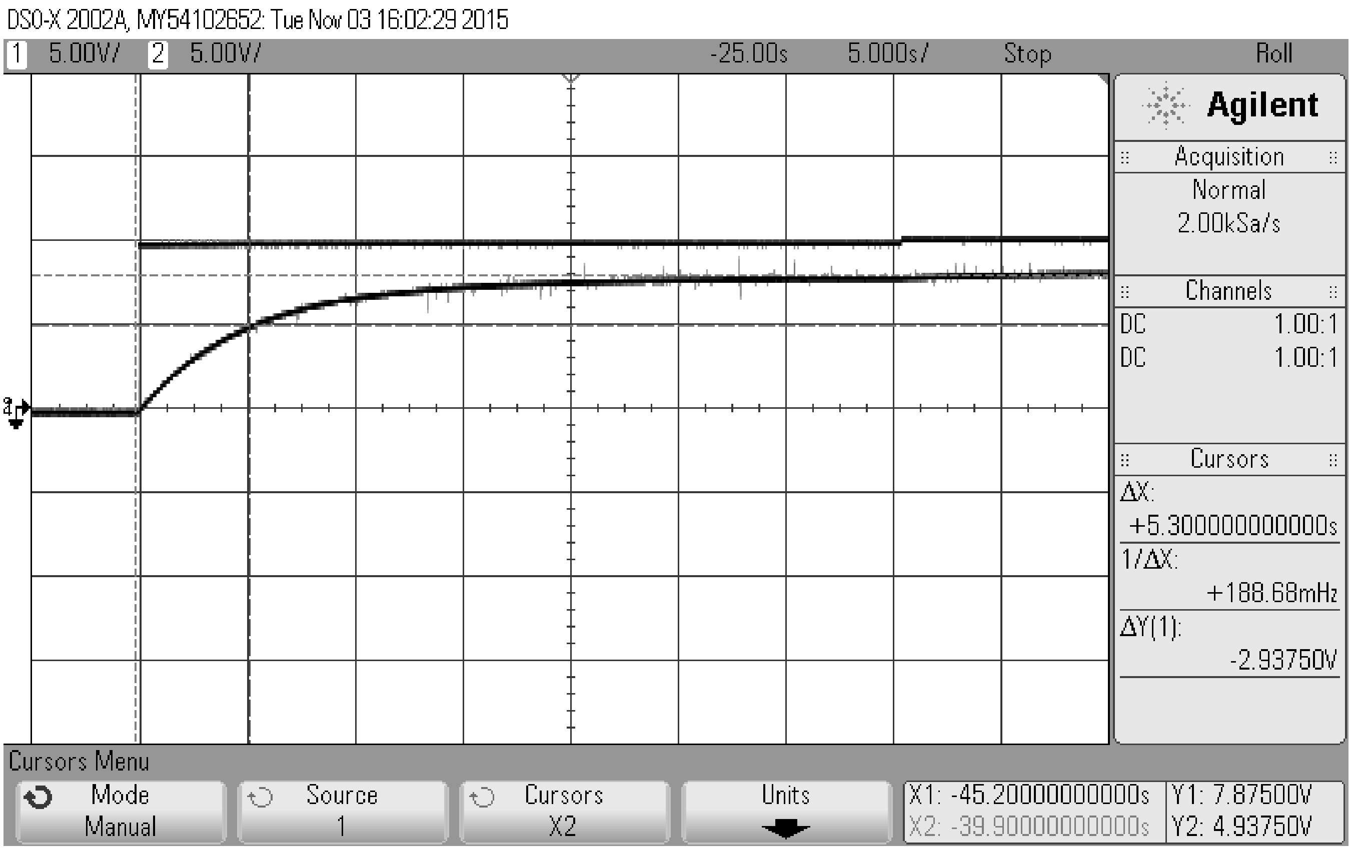

Figure 1: Step response of step input 1-10

V_M	V_{TSS}	τ_m
10	7.88	5.3

Table 3: Motor time-constant measurement

Experimental method for finding poles We know that for a standard first order system as τ tends to 0 the pole will tend to $-\infty$. Using this we can muck with settings on the system an watch how τ moves. From this we can attempt to calculate the location of the pole.

K_p	V	V_{TSS}	τ_{cl}	e_{ss}
1	1	0.7	1.2	30
2	1	0.81	0.7	19
4	1	0.96	0.4	4

Table 4: Motor speed control data for Kp=variable

As the gain increased proportionally it decreased the steady state error making the performance of our system closer match the input. This fits with control theory by looking at the final value theorem. We can see from our prelab that the steady state error signal is inversely related to K so as K tends to infinity the error signal will tend to 0.

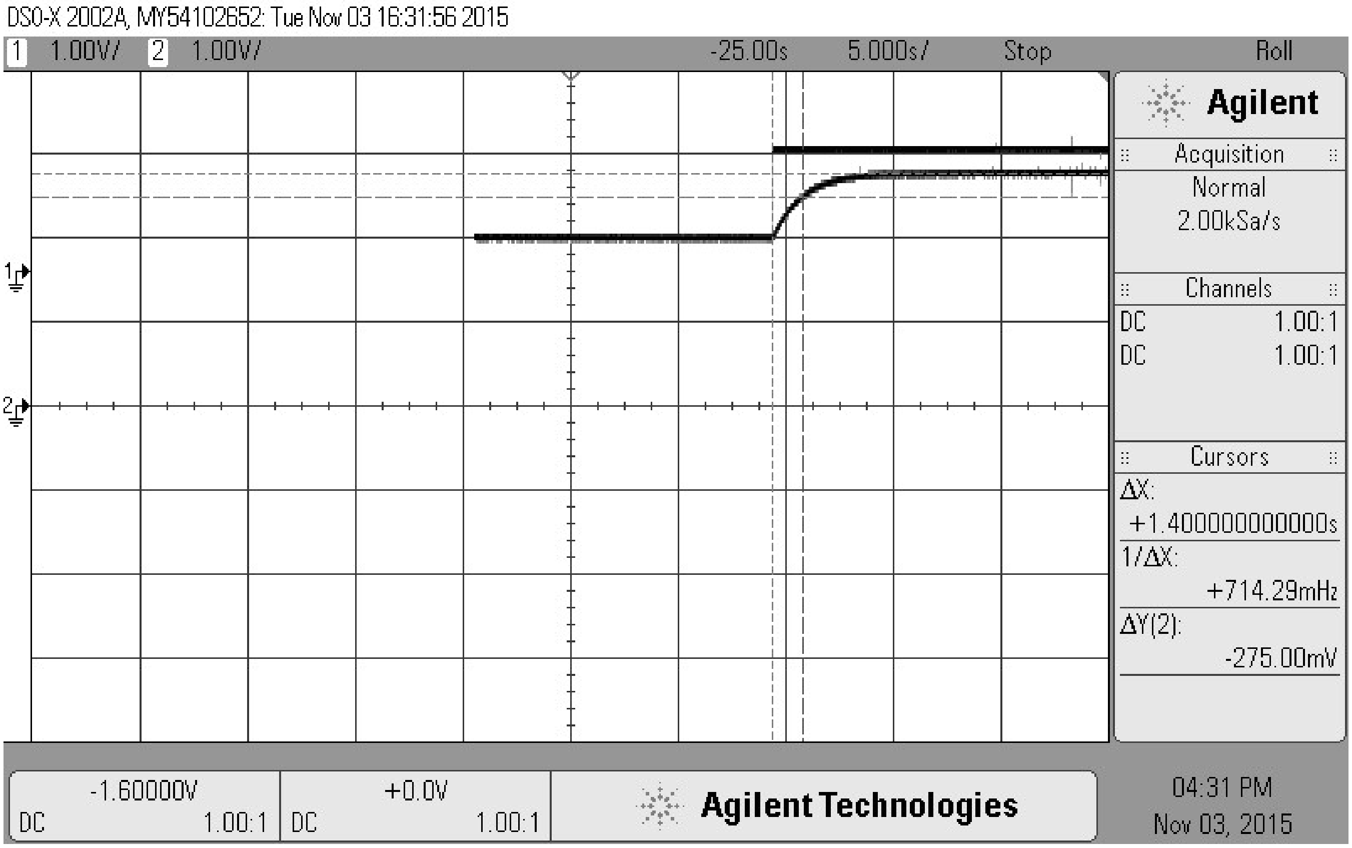

Figure 2: Step response of step input 2-3

K_p	V	V_{Omax}	C_{OSS}	OS	T_p	e_{ss}
3	3	4.15	3.1	38	4.12	3
4	3	3.8	2.8	27	3.92	7
5	3	3.65	2.58	27	3.73	14

Table 5: Motor position control data for Kp=variable

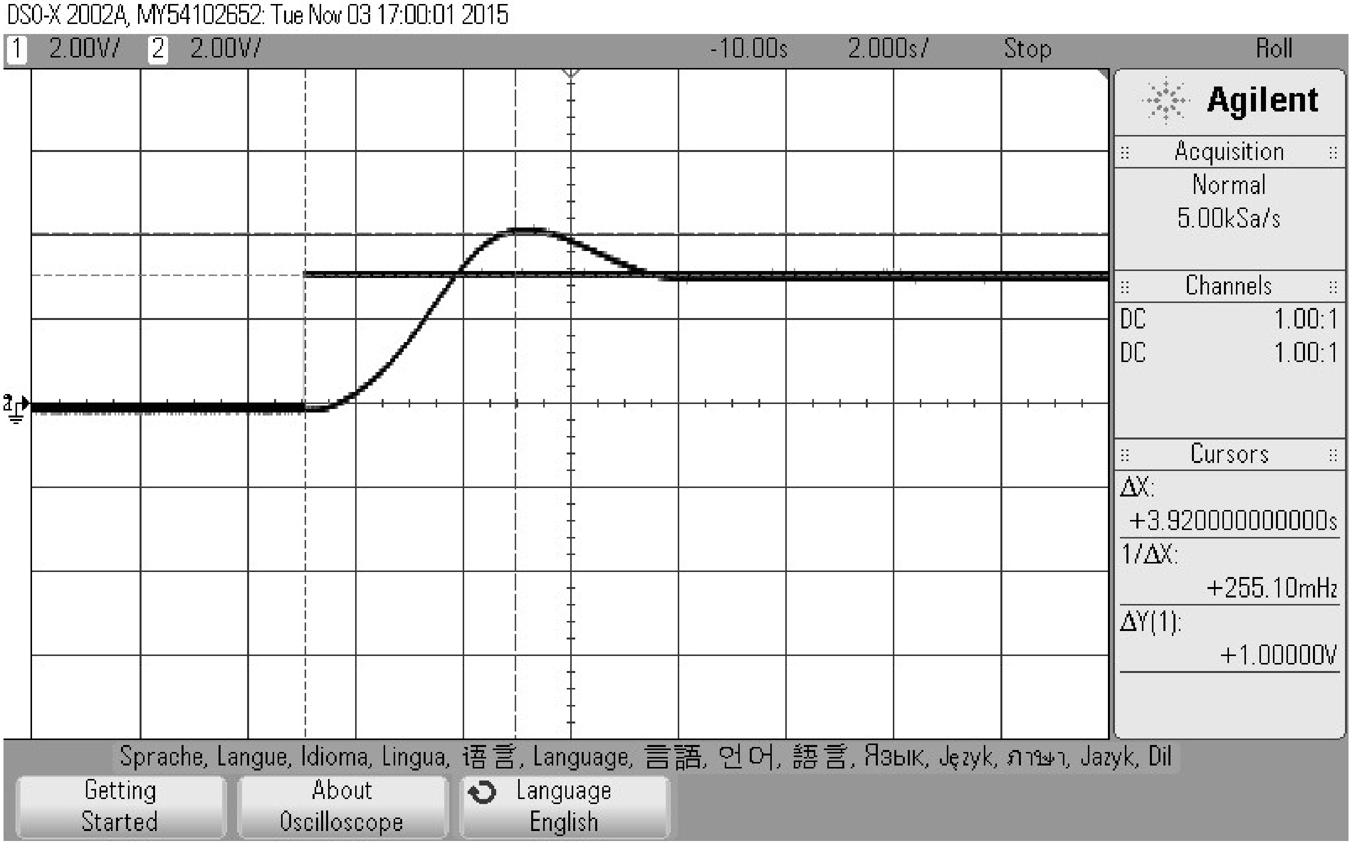

Figure 3: Step response of step input 0-3

As gain increases the overshoot decreases we fits with control theory as in our prelab we found that ζ is inversly proportional to K and that overshoot is proportional to ζ. This means that as K tends to infinity the overshoot tends to zero. As gain increased we found that the steady state error increased as well. This does not fit with control theory as we saw in our prelab that the steady state error should not at all be related to K as it is equal to zero. This could be due to error in reading measurements or inaccuracies in setting values. It is also likely due to the fact that we are dealing with a non-ideal system where friction and other forces may effect results.