Lab 2 DC Motor

Real System Step Response

The following Figure 1-1 shows the step repsonse of the DC Motor with position closed-loop feedback collected during lab.

Figure 1-1 Step Response of DC Motor with Position Closed-Loop Feedback

The gain is 19.22 Volts.

```
Tau_Location = 0.63*19.22
```

```
Tau_Location = 12.1086
```

The location of the time constant, Tau, sits at 63% of the gain. This is at 12.1086 Volts. By observation, the time response sits at about 0.5 seconds into the step response curve.

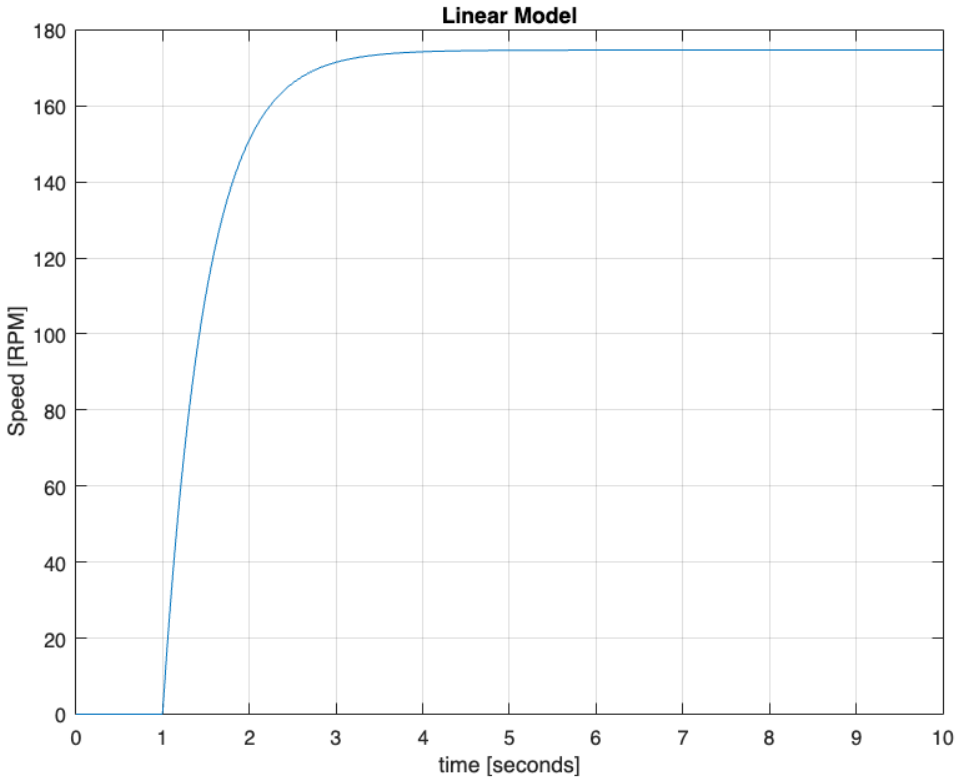
Simulink Models

Open Loop Step Responses

```
sim_OL = sim('Ex2Week1Simupdate.slx');
```

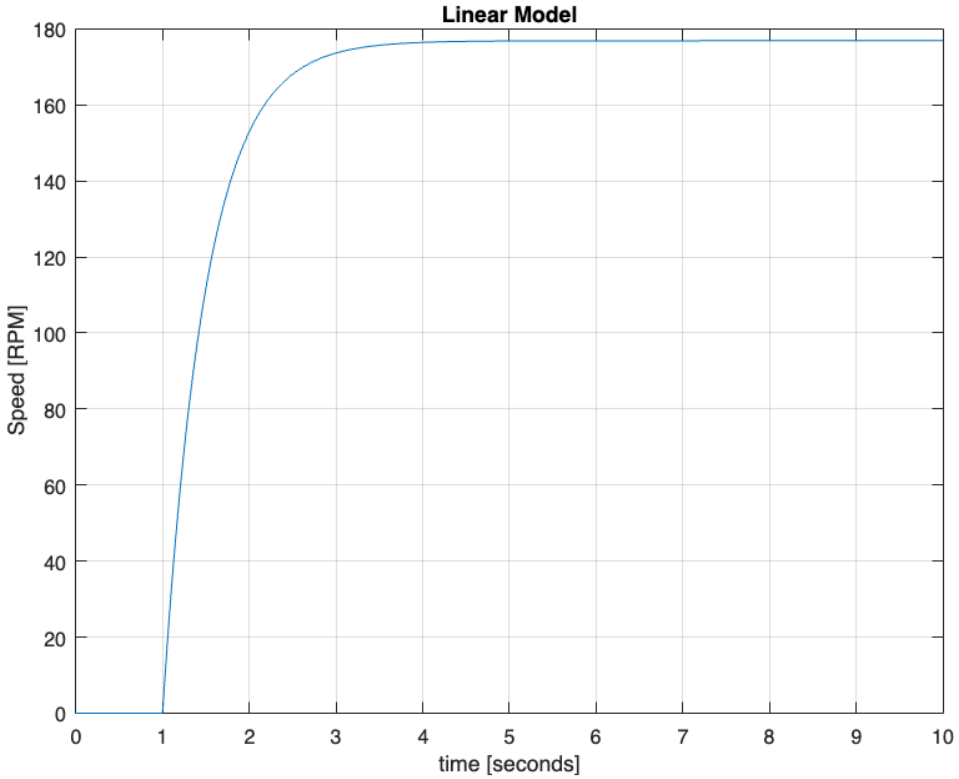
The constant, Km,lin, was determined for the linear model by making an estimate of the "average" slope of the wm vs VA data collected during lab. The linear model uses Km,lin as the motor constant.

```
plot(sim_OL.tout,sim_OL.Linear)
title("Linear Model")
ylabel("Speed [RPM]")
xlabel("time [seconds]")
grid on
```



The constant Km for the nonlinear model was determined by finding the slope of the wm vs VA data outside of the deadband area.

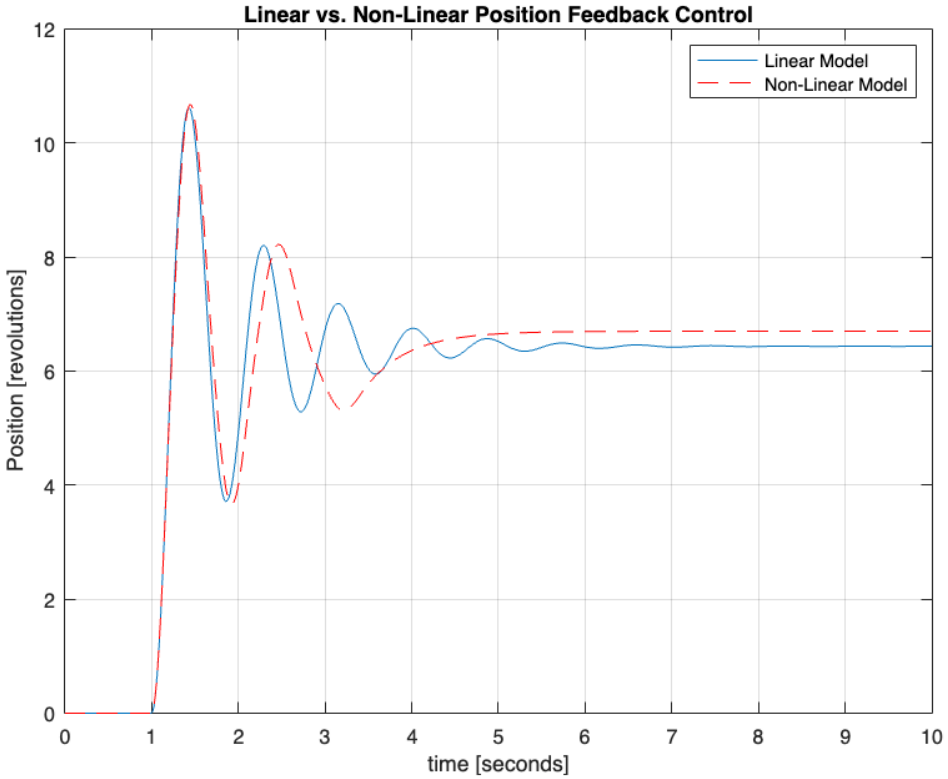
```
% Km=0.194
plot(sim_OL.tout,sim_OL.nonlinear)
title("Non-Linear Model")
ylabel("Speed [RPM]")
xlabel("time [seconds]")
grid on
```

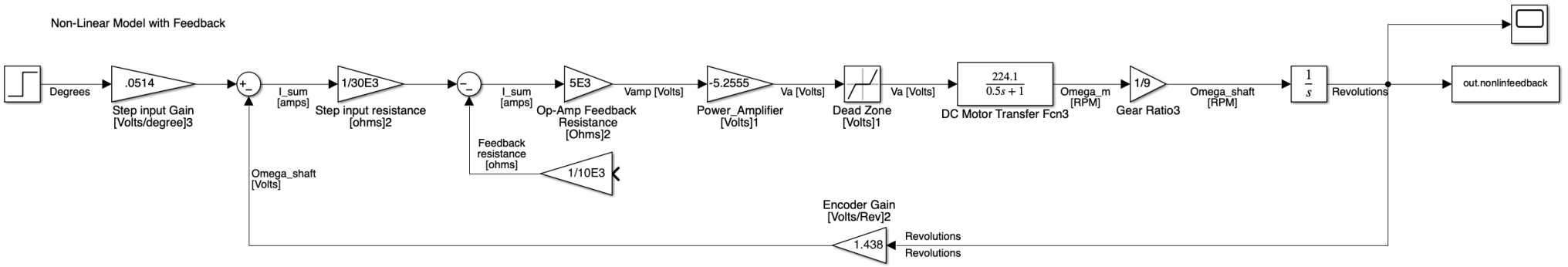


Closed Loop Step Responses

The previous open loop simulink model was modified to represent a closed loop model. This was done by adding an output potentiometer in a feedback path that connected the output position theta to the correct input of the op-amp summing amplifier.

```
figure()
plot(sim_OL.tout,sim_OL.linfeedback)
hold on
plot(sim_OL.tout,sim_OL.nonlinfeedback,"r--")
title("Linear vs. Non-Linear Position Feedback Control")
ylabel("Position [revolutions]")
xlabel("time [seconds]")
legend("Linear Model", "Non-Linear Model")
grid on
hold off
```


Linear vs. Non-Linear Position Feedback Control
Linear Model
Non-Linear Model
Position [revolutions]
time [seconds]
0
2
4
6
8
10
12
0
1
2
3
4
5
6
7
8
9
10


Non-Linear Model with Feedback
Degrees
.0514
Step input Gain
[Volts/degree]3
+
–
I_sum
[amps]
1/30E3
Step input resistance
[ohms]2
–
–
I_sum
[amps]
5E3
Op-Amp Feedback
Resistance
[Ohms]2
Vamp [Volts]
-5.2555
Power_Amplifier
[Volts]1
Va [Volts]
Dead Zone
[Volts]1
Va [Volts]
224.1
0.5s + 1
DC Motor Transfer Fcn3
Omega_m
[RPM]
1/9
Gear Ratio3
Omega_shaft
[RPM]
1
s
Revolutions
out.nonlinfeedback
Feedback
resistance
[ohms]
1/10E3
Omega_shaft
[Volts]
Encoder Gain
[Volts/Rev]2
1.438
Revolutions
Revolutions

Parameter		Value	Units	Parameter		Value	Units
Knob gain	K_{knob}	0.0514	$\frac{Volt}{deg}$	linear motor gain	$K_{m,lin}$	194	$\frac{RPM}{Volt}$
step input res	R_S	$\frac{1}{30E3}$	Ohms	non linear motor gain	K_m	224.1	$\frac{RPM}{Volt}$
Feedback res	R_B	5E3	Ohms	Deadban volt	V_{DB}	± 1.8	Volt
OP-Amp res	R_F	$\frac{1}{10E3}$	Ohms	Time const.	T_m	0.5	seconds
Power amp gain	K_a	-5.2555	Volts	Pulley gear ratio	K_{pulley}	9	no units
				Position sensor gain	K_{pot}	1.438	$\frac{Volt}{rev}$