ME 360: FUNDAMENTALS OF SIGNAL PROCESSING, INSTRUMENTATION, AND CONTROL

Experiment No. 4
Modeling and Identification of an Electric Motor using Step Response and Frequency Response Methods
Pre-lab Questions

These short answer questions must be completed and turned in at the beginning of the laboratory period.

1. a. Use the tf, step and bode functions in Matlab, to generate both a step response and bode plot of a DC motor system with these parameters. (3 pts)

   Steady state gain K 1.2
   Time constant τ ..... 50 ms
   Step input voltage V_{in} (∞) ..... 4 V

```
Motortf = tf([K],[tau 1]);
step(4*Motortf);
bode(Motortf);  % Note that this Bode plot, plots Decibels and Phase verses frequency in units of radians/sec.  The rest of the Bode plots we create in this lab will plot verses frequency in Hertz.
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   b. On the step response plot, determine the time at which the voltage response reaches 63.2% of its steady state value. Mark this point on the plot. Does that time equal the time constant τ? (3 pts)

   c. Explain mathematically why τ is found at this 63.2% point. (3 pts)

   d. In Matlab plot the same step response using the solution to this first order transfer function: (3 pts)

```
t = 0:0.001:3;
v = 4*K*(1-exp(-t/tau));
plot(t,v)
```

2. Variation in K as a function of input voltage demonstrates what about our real system's model? (2 pts)

3. Use the data below in a MATLAB script to create a Bode plot. This is the magnitude (in dB) and phase (in degrees) of a first order system driven at the given frequencies. (8 pts)

Frequency (Hz)	Magnitude (dB)	Phase (Degrees)
0.0100	21.5833	-0.5156
0.0400	21.5780	-2.0597
0.1000	21.5486	-5.1428
0.2324	21.3977	-11.8119
0.6179	20.4134	-29.0785
1.0000	19.0068	-41.9872
2.4297	13.9630	-65.4251
6.4609	6.1663	-80.2421
10.0000	2.4455	-83.6598
11.6182	1.1564	-84.5371
20.8922	-3.9132	-86.9557
37.5691	-9.0016	-88.3060
55.5556	-12.3975	-88.8542
100.0000	-17.5018	-89.3634

4. With the plot created in 3, find two approximations for tau from both these magnitude and phase plots. Make sure to draw on each plot how/where you found tau. (8 pts)