University of Utah
Electrical & Computer Engineering Department
ECE 3510 Lab 4
DC Motor Characteristics

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rev,

Note : Bring the dSpace Tutorial you used in lab 1.

Objectives
- Perform a number of tests to determine the individual parameters which determine the DC motor's characteristics.
- Create a full model of the motor and compare the theoretical results from this full model to a measured angular velocity step response.
- Explore the sensitivity of the model to the individual motor parameters.
- Tweak one of the parameters to improve the model.
- Learn how the position encoder works.

Equipment and materials from stockroom:
- Wire kit
- DC Brush Motor (The motor you will characterize)
- Small DC motor (Only used to drive the other one as a generator)
- Motor rack & BOB (Bucket of Bolts)
- Dual Power Amp
- DSpace kit

Experiment
As you may have noticed, this lab assignment looks quite different from what you're used to, it's much less wordy. At each step along the way, you will get only a short description of what to do. That's followed by the results that I got when I did that part of the lab and the calculations that I made with that data to get the parameters that I am interested in. Your job will be to roughly reproduce what I have done and to get similar (but not exactly the same) results.

Hook up the computer, dSpace box, power amp, but not the motor as you did in the first lab. Refer to "Hardware Setup" in the dSpace Tutorial. Leave the power amp off for now. For the software, look in the MyDocuments\ECE3510_Lab_Files\ECE 351 Lab1 folder on the computer. You've used these files before. You can continue through the dSpace Tutorial to setup the software and data saving, but you won't need that for a while yet. Do not try to save data in MyDocuments\ECE3510_Lab_Files\ or its sub-folders. They are write-protected and the dSpace program will not warn you when it is not actually saving data.

Sensitivities
Next you'll artificially change each of the parameters in turn and see how much they affect the theoretical plot. You may want to add a third curve to your plot that will be the one that you change. That way the original can be a reference. Otherwise your measured data can be your reference.

Change each parameter by a factor of 2 (either bigger or smaller), see how the curve is affected, and note the type and relative magnitude of the affect in your notebook. Then change it back to what it was and try a different parameter. In the end I want you to rank the parameters from those that have the most affect on the curve to those that have the least. You are finding out how sensitive the output is to each parameter.

A few interesting things to try:
You probably found that L_a has very little effect on the curve. Try setting R_a to 20% of what it was and then messing with L_a. It has a bit more effect now, doesn't it?

Set R_a back to normal and change L_a to 1% of what it was. Note that the first curve goes away, as expected, but also note where the old and new curves cross, almost right at the 63% line, makes me wonder about eliminating the first curve from the time constant measurement.

Set L_a back to normal, C_m to 0 and B_m to B_{m2}. This eliminates the nonlinear friction and replaces it with viscous damping only. Curve still looks pretty good, doesn't it? However, there are cases where the C_m makes a big difference, like the steady-state error in the last lab. Set all the parameters back to normal.

Tweak one or two of your parameters (probably just J) to make your theoretical to measured match better. Consider the "tweaked" parameters as the true values for future use.

Encoder
One last thing that really doesn't have much to do with the rest of this lab. The little black plastic box on the back of your motor is called an encoder. It contains a little disk with slots in it and two light sensors. Your TA has a broken one that you can look at and a little circuit board which can plug into a good one to illustrate how it works. It is probably set up somewhere in the lab, ask to see it. Look at the disk with a magnifying glass and play with the working one to see if you can figure out the pattern. Record that pattern in your notebook either as waveforms or as 1' s and 0' s. How can a digital circuit work out direction, speed, and location from these two signals? These discs have 500 slots. How many transitions is that per revolution? What is the smallest angular change that can be measured? If the rotational velocity is calculated every 2ms, what is the smallest increment of speed that can be measured (1 transitions in 2ms). This is why our speed display is so bouncy (unless it's been fixed to average many readings).

There is actually a third light sensor in the encoder that picks up only one slot in the whole revolution. It is connected to the extra wire that is not used on our encoder and it can give a "zero" or start location.

Conclusion Check - off and conclude as always.