Linear Systems Analysis Project 1a (Before Project Day 1)

Guidelines:

1. Complete the pre-project task 1 before Project Day 1.
2. Work in assigned teams to complete tasks 2 through 4 on Project Day 1
3. Complete the post-project task 5 on your own (with appropriate help from your teammates) before the due date
4. Each student will turn in their own work
5. The objective is to determine the physical parameters of the provided DC motor

Project Description:

In lab, you will see two DC motors with a belt attached from one shaft to the other. One motor will be driven by a voltage source to vary the speed. The other motor will be driven by the belt, and will generate a voltage proportional to its speed. Each motor has an attached encoder that outputs a square wave which cycles 48 times for every full revolution of the shaft. The motor's encoder will be output to the oscilloscope through the Encoder ports. You will use a selection of DC motor tests during class time, then use the results of these tests to calculate physical constants for the motor.

Tasks:

1. Find the transfer function for the system
    a. We derived the equations of motion in class for an unloaded DC motor. Here is what we got, expressed in Laplace form.
    - $\left(J s^2+bs\right)\Theta_m(s)=K I_a(s)$
    - $\left(L_a s+R_a\right) I_a(s)=E_{¿}(s)-K_b s\Theta_m(s)$
    a. Find the transfer function from input voltage $\left(E_{¿}(s)\right)$ to output shaft speed $\left(\Omega(s)=s\Theta_m(s)\right)$. In other words, algebraically solve the two equations to find: $T(s)=\frac{s\Theta_m(s)}{E_{¿}(s)}=\frac{\Omega(s)}{E_{¿}(s)}$

b. In task 1a, you should have gotten something algebraically equivalent to the equation below. If you did not, see if you can find your mistake, then get help if you cannot.

$$T(s)=\frac{\Omega(s)}{E_i(s)}=\frac{K}{(Js+b)(L_a s+R_a)+K\,K_b}$$

c. List the physical constants we will need before we can use this transfer function.

d. Do some online searching to find an experiment that might work to find J or b(your choice) for a DC motor. Describe the gist of the experiment you found, and list your source.